APPENDIX IAAC-10A: PLATES

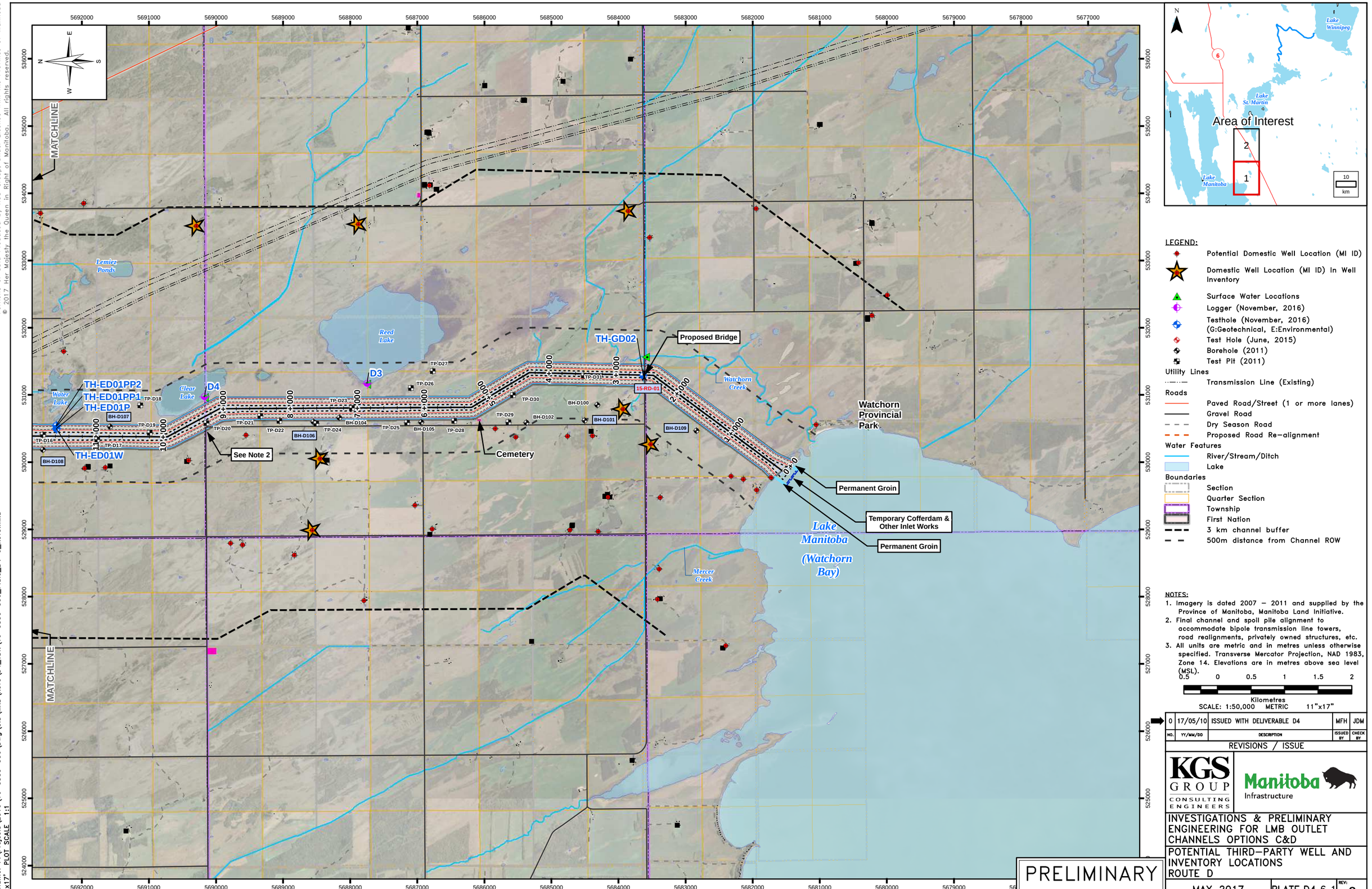
LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-10A: Plates
May 31. 2022

Manitoba Infrastructure

Stantec

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LEGEND:

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- Transmission Line (Existing)

Roads
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- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

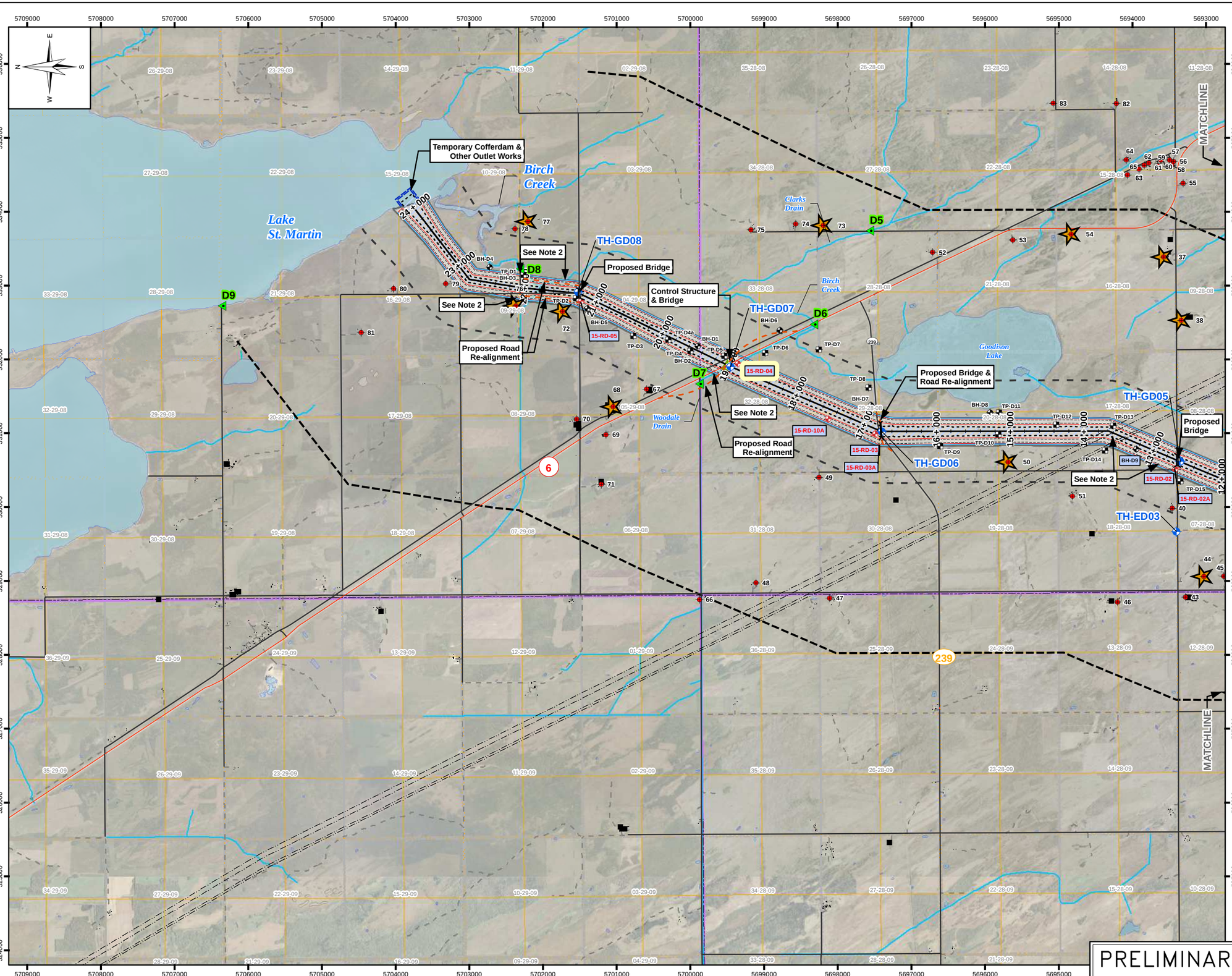
POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

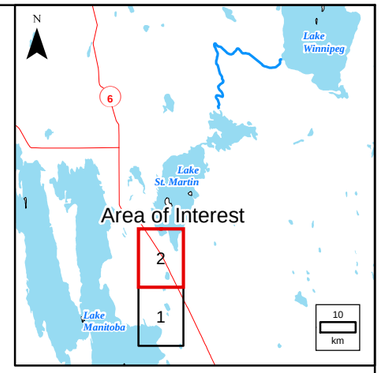
MAY 2017 | PLATE D4-6.1 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

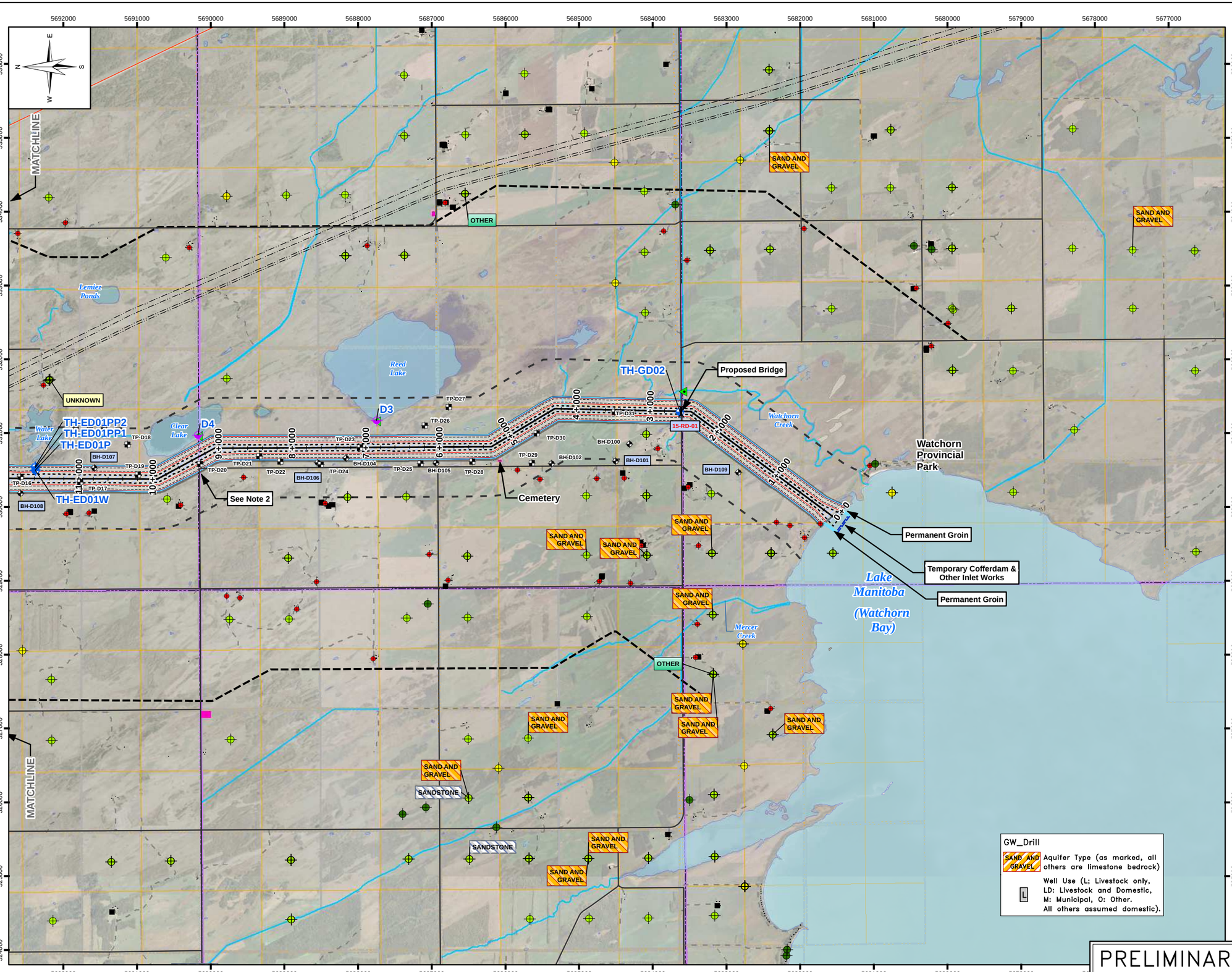
POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

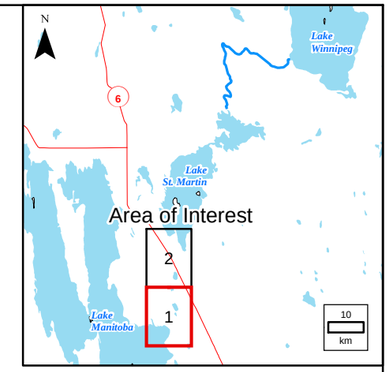
MAY 2017 | PLATE D4-6.2 | REV: 0

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11"x17" PLOT SCALE 1:1

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- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
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0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

GW_Drill

SAND AND GRAVEL — Aquifer Type (as marked, all others are limestone bedrock)

L — Well Use (L: Livestock only, LD: Livestock and Domestic, M: Municipal, O: Other. All others assumed domestic).

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS LOCATION, AQUIFER AND USE ROUTE D

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-7.1 | REV: 0

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11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
SAND AND GRAVEL
TH-GD08
Proposed Bridge
See Note 2
Control Structure & Bridge
TH-GD07
TH-GD05
TH-GD06
TH-ED03
Proposed Road Re-alignment
Proposed Bridge & Road Re-alignment
Proposed Bridge
Clarks Drain
Goodison Lake
Woodale Drain
MATCHLINE
SHALE
SANDSTONE
D5
D6
D7
D8
D9
15-RD-05
15-RD-04
15-RD-10A
15-RD-03
15-RD-03A
15-RD-02
15-RD-02A
239
6

Area of Interest
Lake Winnipeg
Lake St. Martin
Lake Manitoba
10 km

LEGEND:
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145385 GW_Drill – PID

GW_Drill Accuracy
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- Within Section

Utility Lines
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GW_Drill
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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

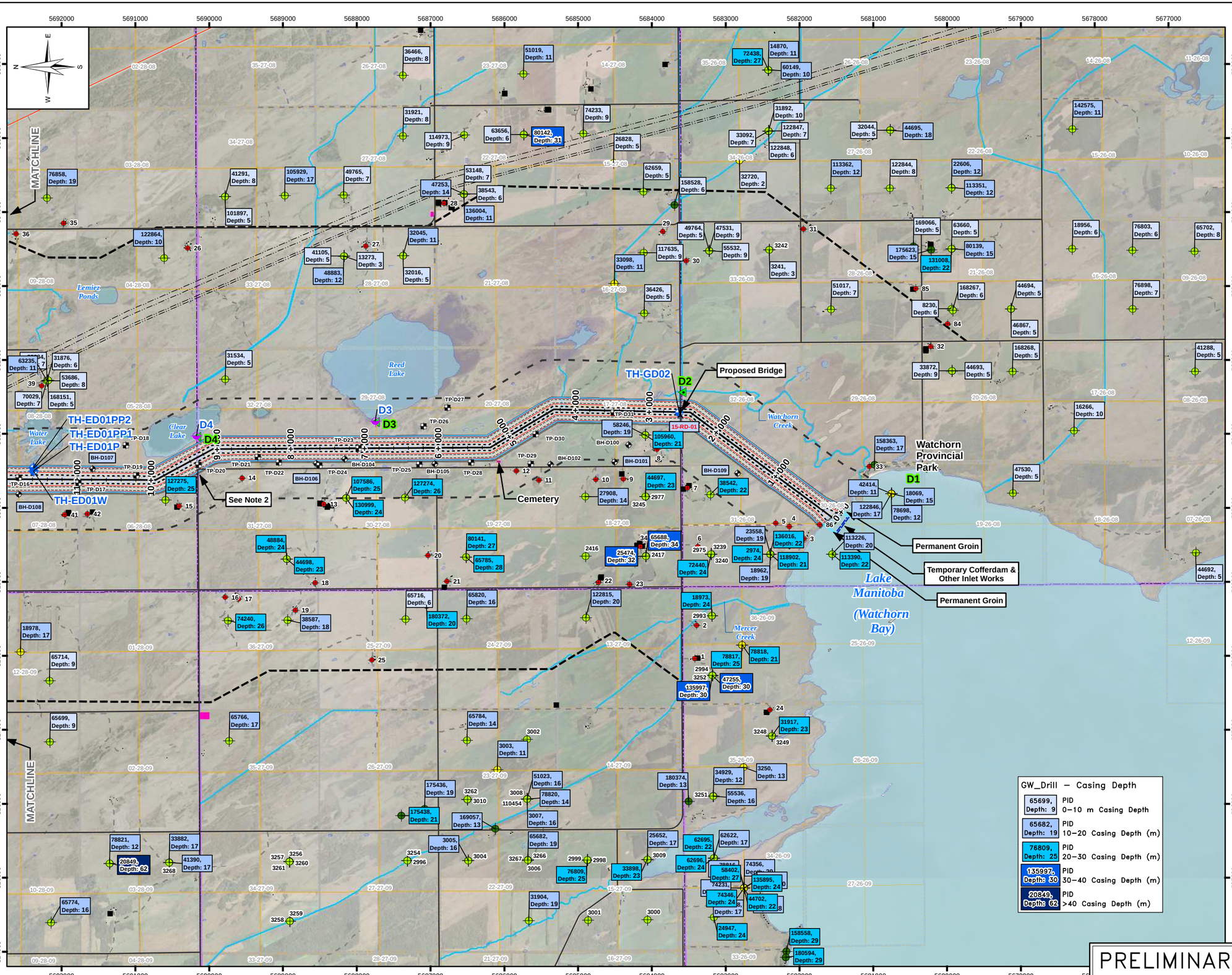
GW DRILL LOGS
LOCATION, AQUIFER AND USE
ROUTE D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-7.2 | REV: 0

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11"x17" PLOT SCALE 1:1

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

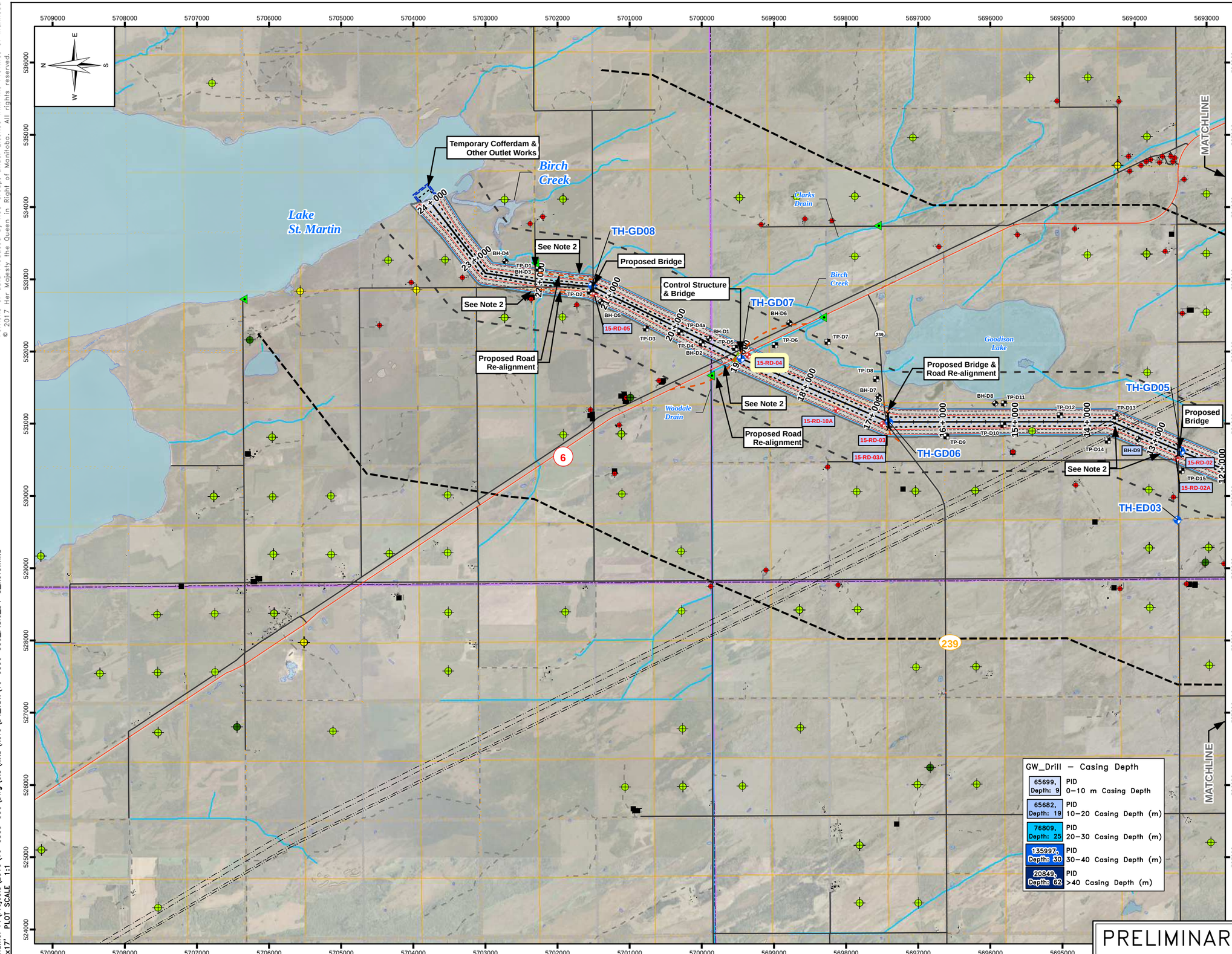
GW DRILL LOGS
CASING DEPTH
ROUTE D

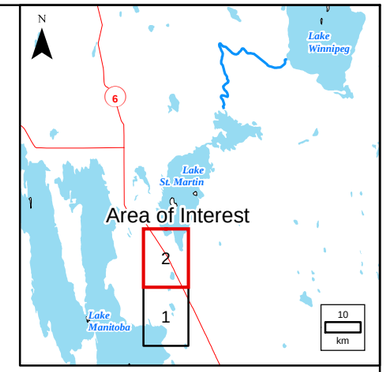
MAY 2017 | PLATE D4-8.1 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

GW_Drill – Casing Depth

65699, Depth: 9	PID 0–10 m Casing Depth
65682, Depth: 19	PID 10–20 Casing Depth (m)
76809, Depth: 25	PID 20–30 Casing Depth (m)
135997, Depth: 30	PID 30–40 Casing Depth (m)
20849, Depth: 62	PID >40 Casing Depth (m)

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS
CASING DEPTH
ROUTE D

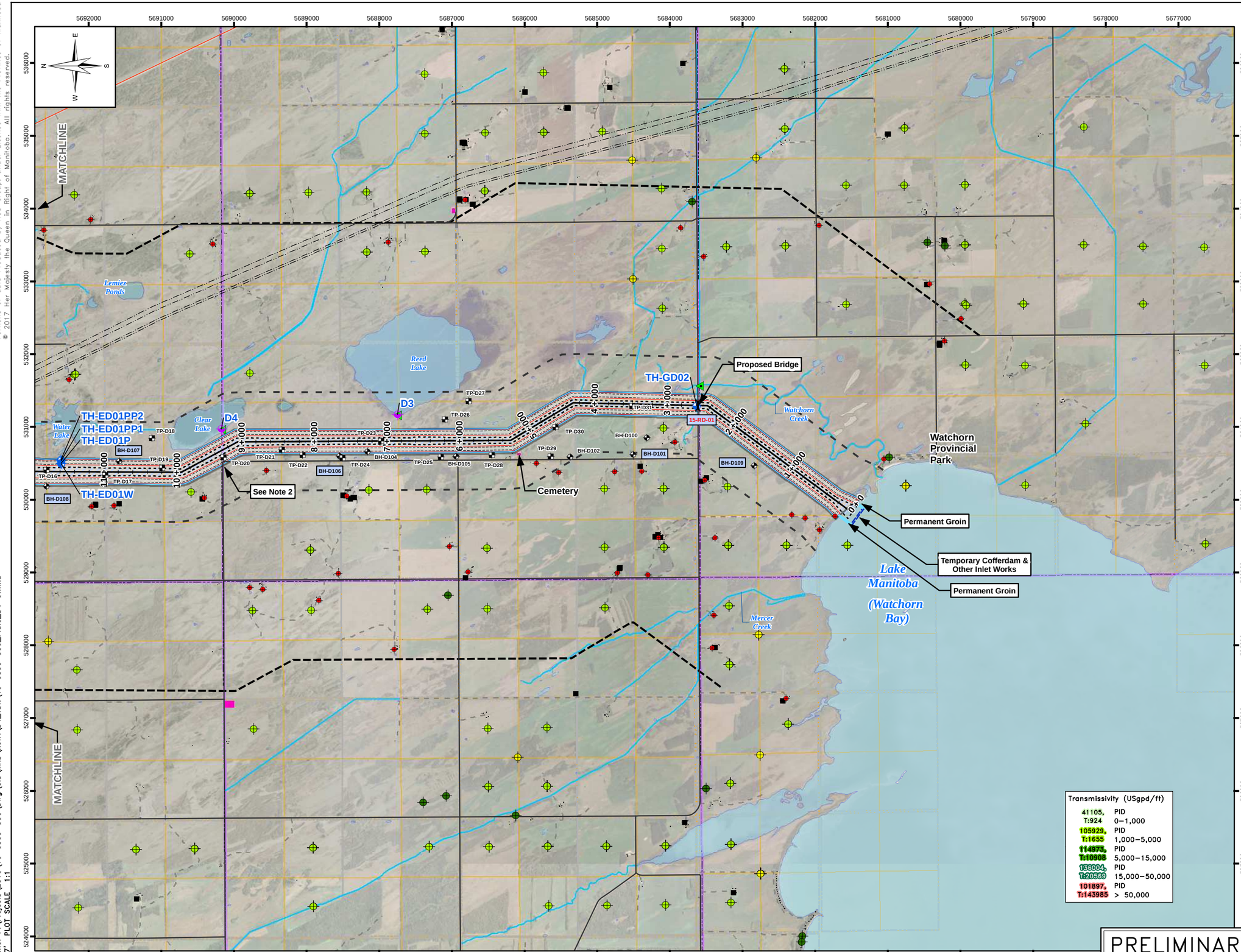
MAY 2017 | PLATE D4-8.2 | REV: 0

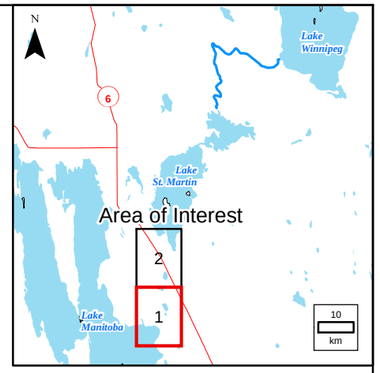
PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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145385 GW_Drill – PID

ACCURACY

- 1 Exact [<5M] [GPS]
- [Within 1/4–Section]
- [Within Section]

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0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

Transmissivity (USgpd/ft)

41105, T:924	PID 0–1,000
105929, T:1655	PID 1,000–5,000
114973, T:10908	PID 5,000–15,000
136004, T:20569	PID 15,000–50,000
101897, T:143985	PID > 50,000

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE D

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-9.1 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\RevA\D4_TDR\16-0300-006_Plate_D4-9.mxd
11"x17" PLOT SCALE 1:1

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TH-GD06
TH-GD05
TH-ED03
MATCHLINE
Clarks Drain
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Woodale Drain
Lake Winnipeg
Lake Manitoba
Area of Interest
D5
D6
D7
D8
D9
239
6

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- 145385 GW_Drill – PID
- ACCURACY
  - 1 Exact [<5M] [GPS]
  - [Within 1/4–Section]
  - [Within Section]
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0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE D

MAY 2017 | PLATE D4-9.2 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

APPENDIX IAAC-11A: DURATION CURVES

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-11A: Duration Curves
May 31, 2022

Manitoba
Transportation and Infrastructure

Stantec

Figure IAAC-11-1 Lake Manitoba Duration Curve - Pre-2011

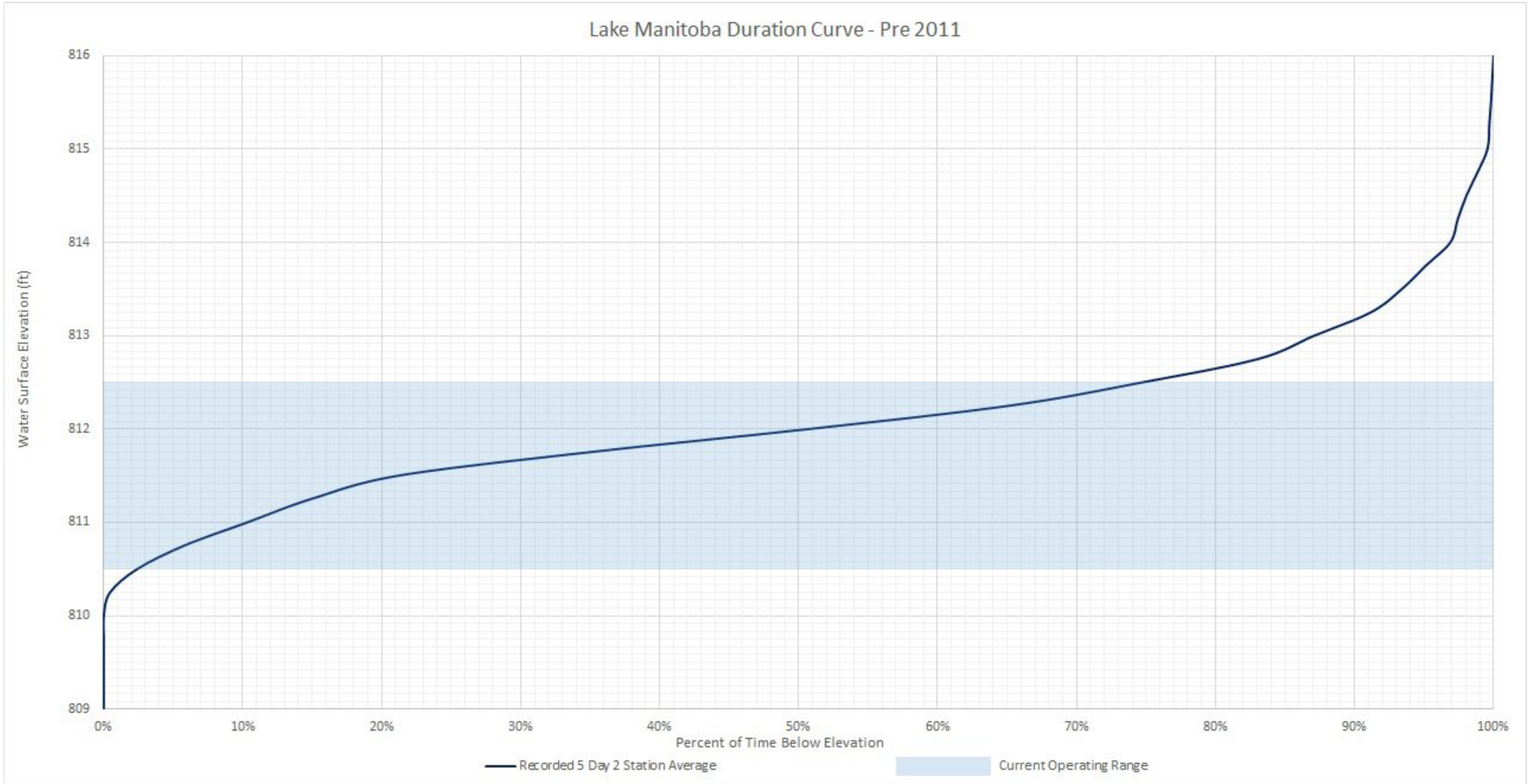


Figure IAAC-11-2 Lake St. Martin South Basin Duration Curve - Pre-2011

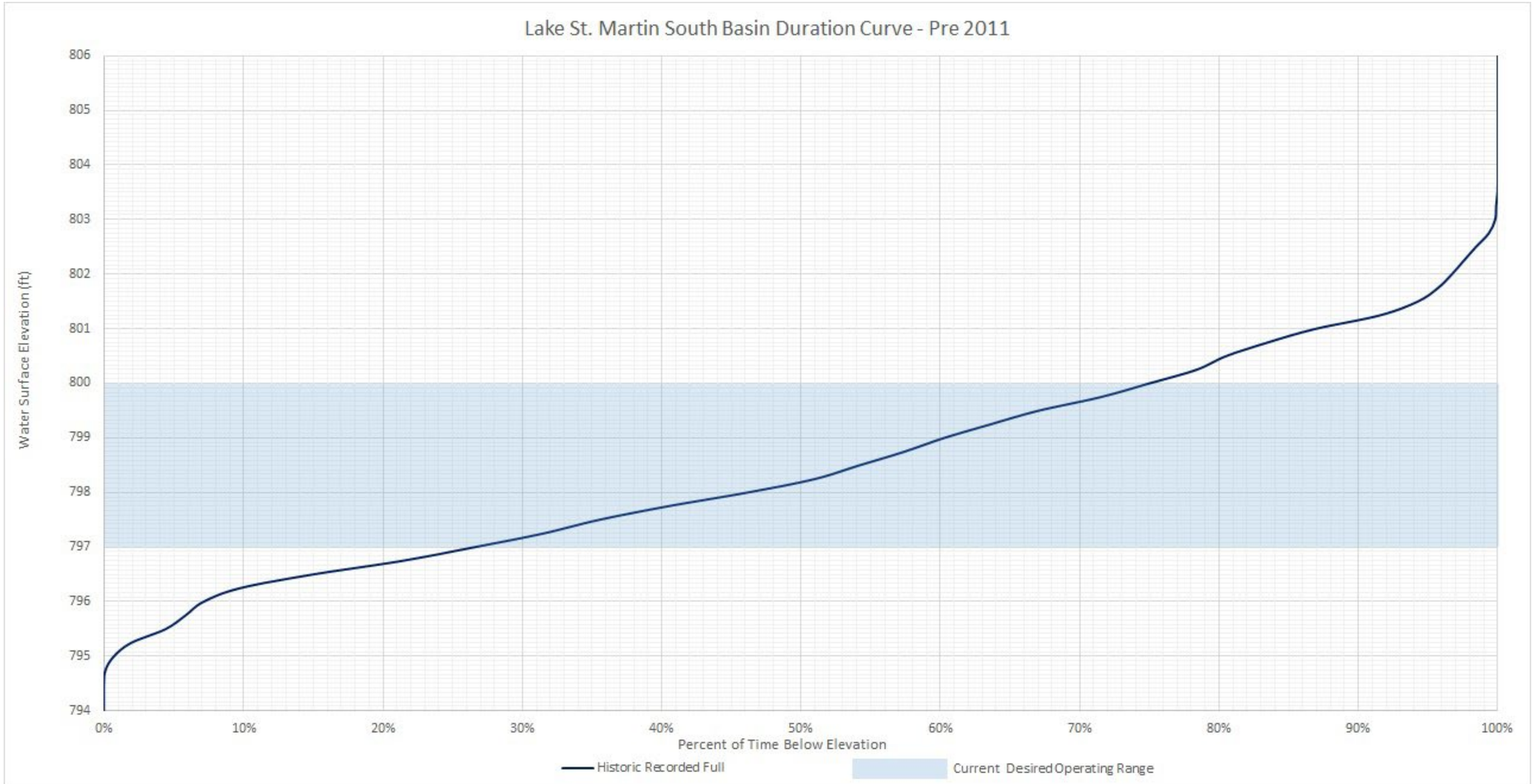


Figure IAAC-11-3 Fairford River Duration Curve - Recorded Pre-2011

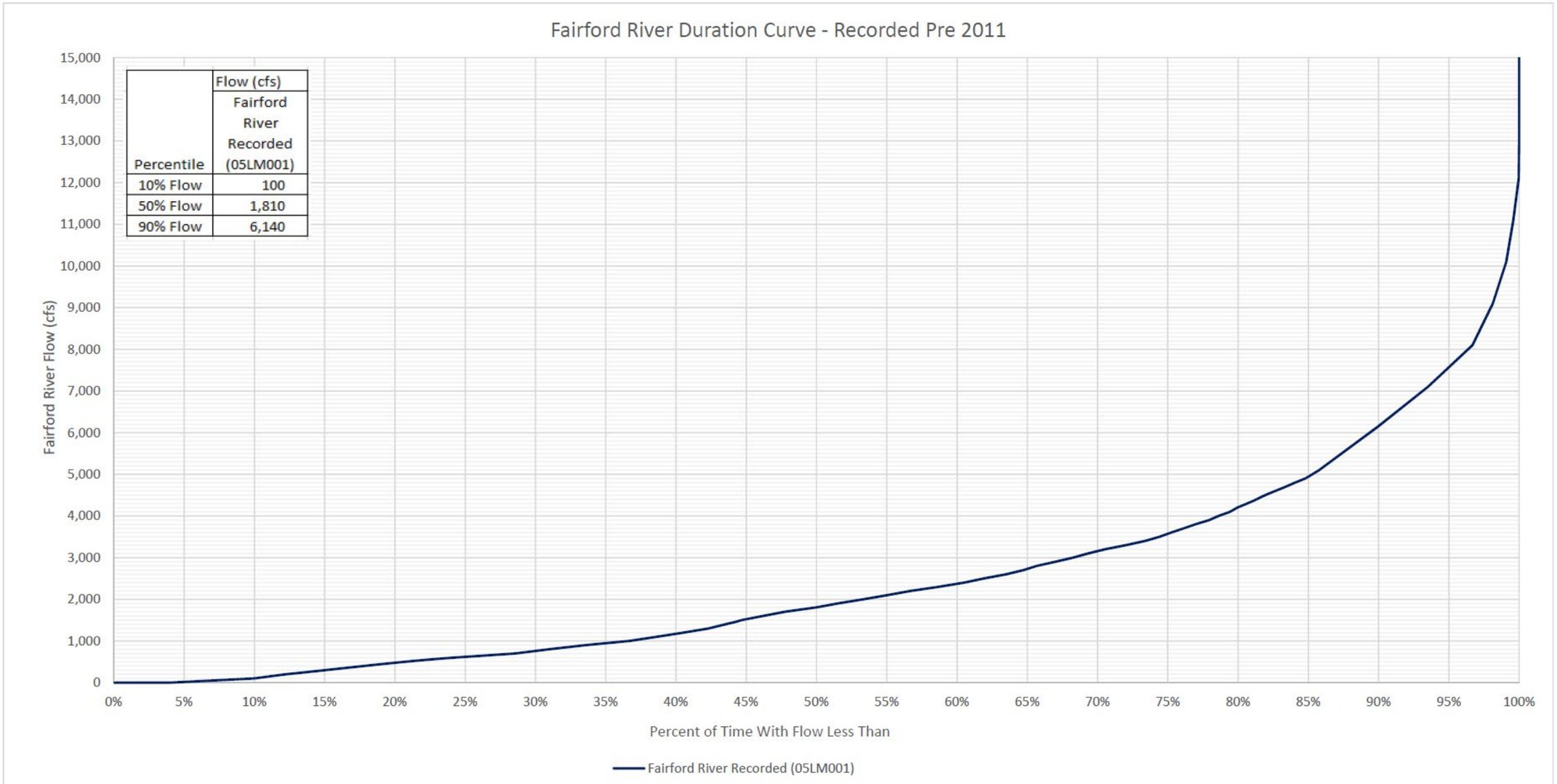


Figure IAAC-11-4 Fairford River Duration Curve - Recorded Pre-2011 - March through May

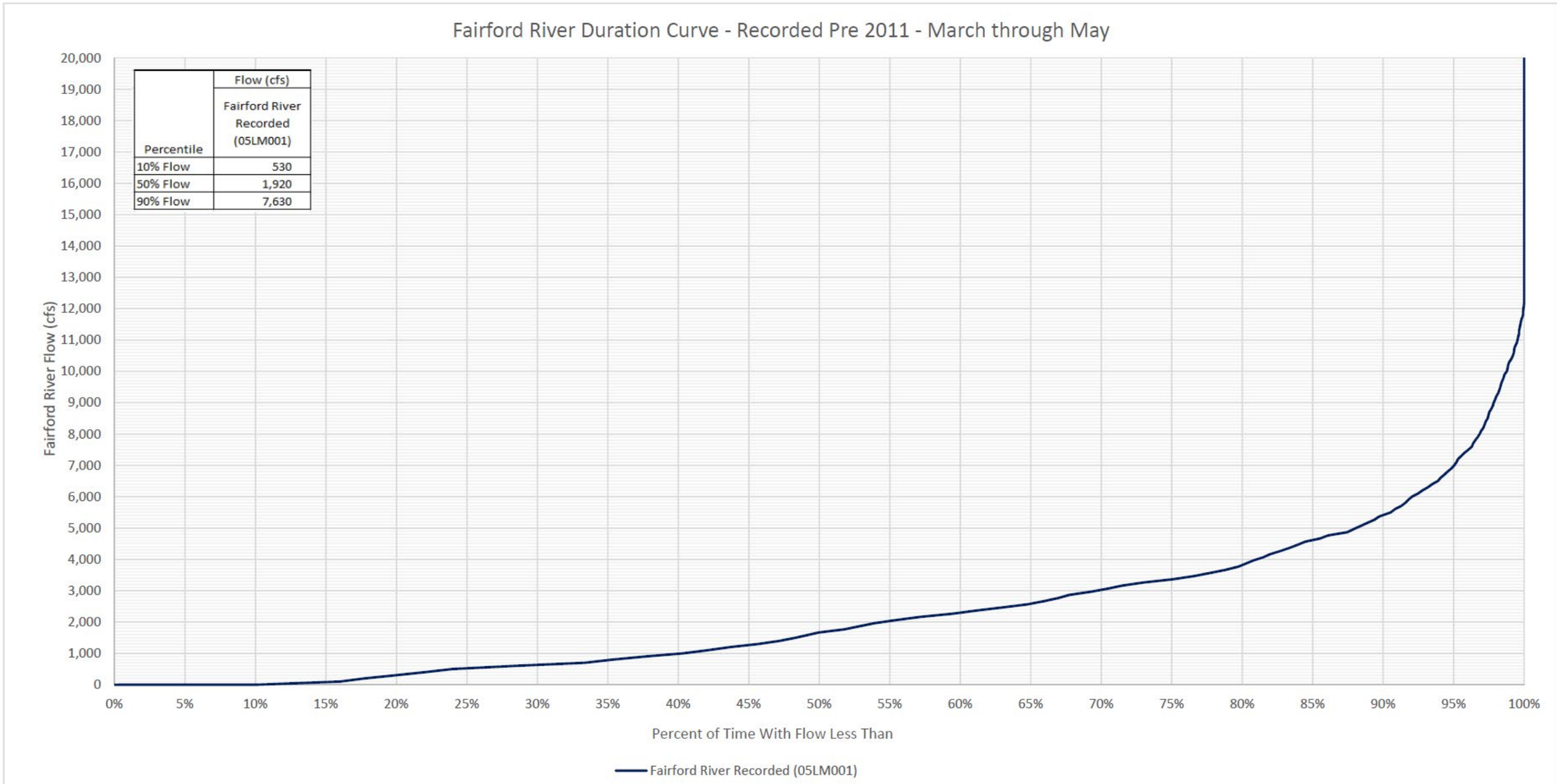


Figure IAAC-11-5 Fairford River Duration Curve - Recorded Pre-2011 - June through August

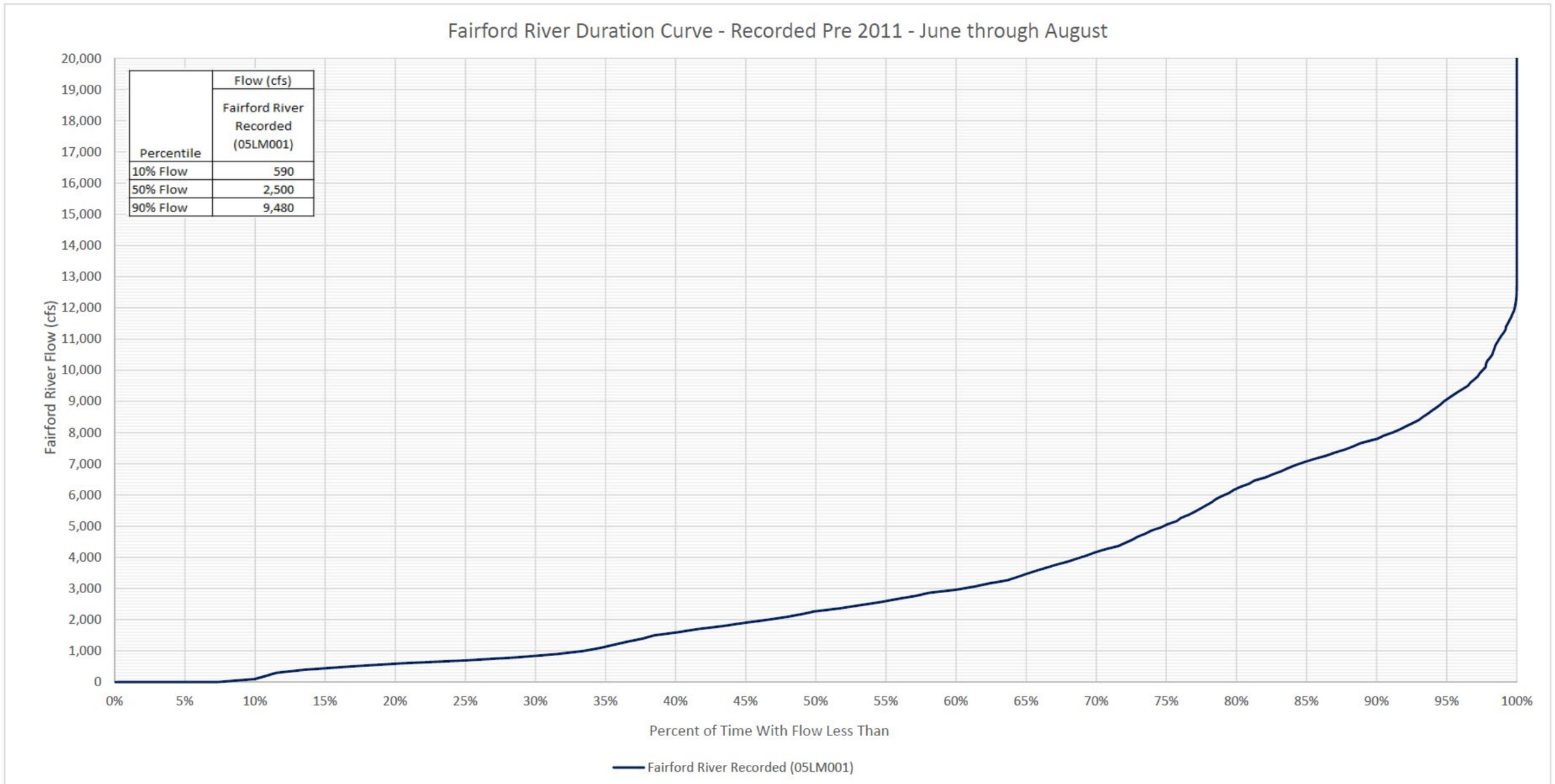


Figure IAAC-11-6 Fairford River Duration Curve - Recorded Pre-2011 - September through November

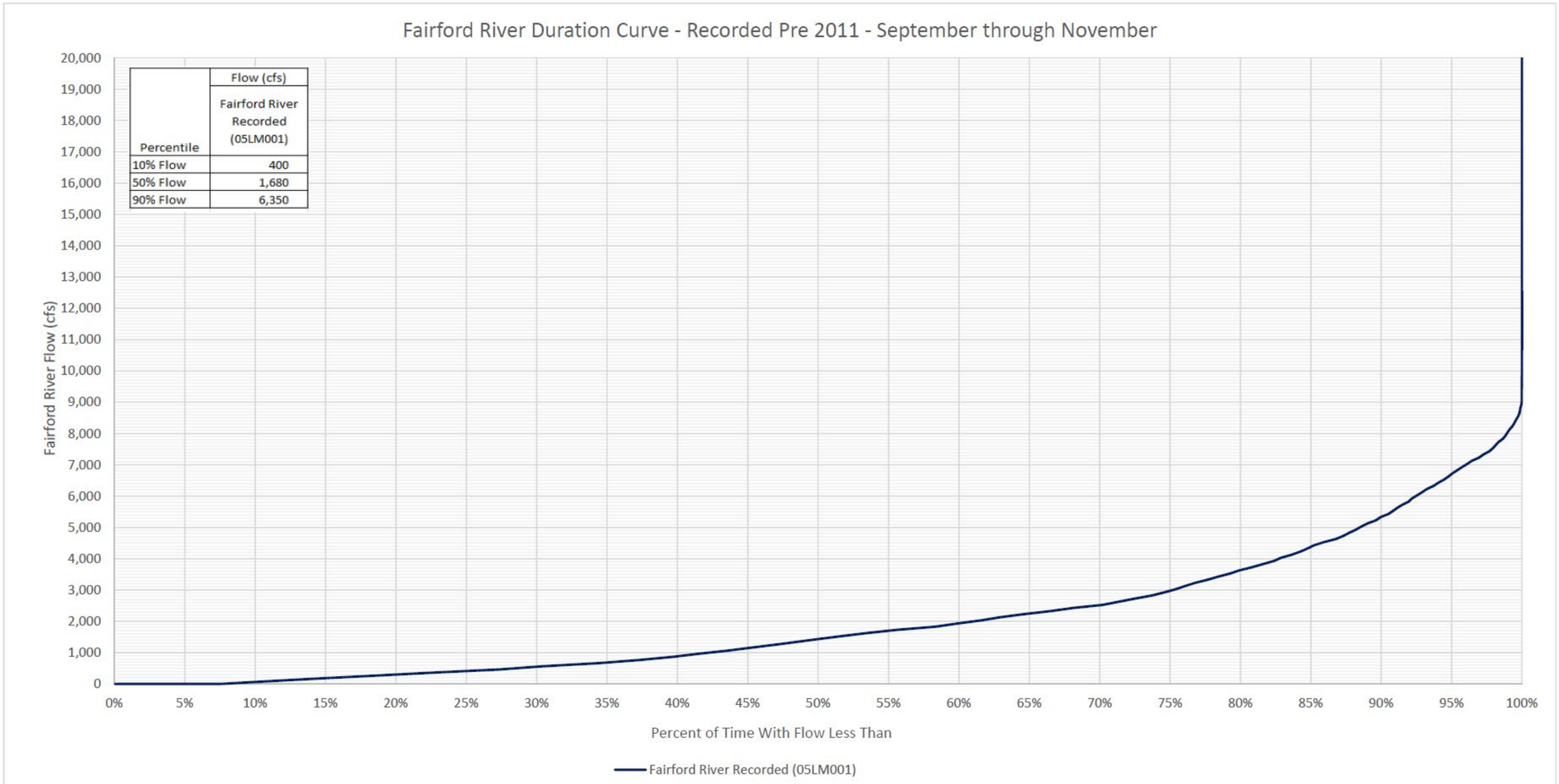


Figure IAAC-11-7 Fairford River Duration Curve - Recorded Pre-2011 - December through February

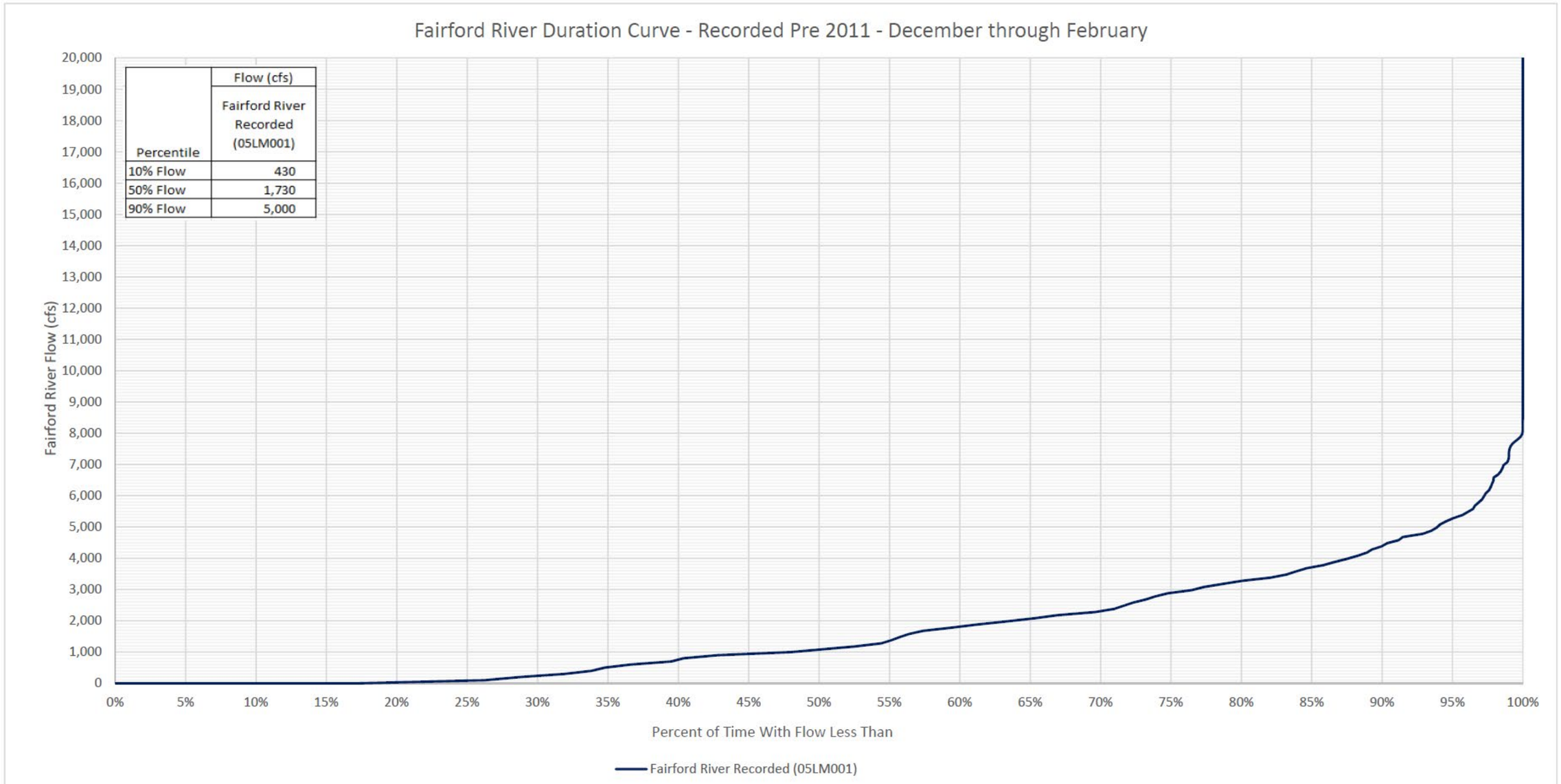


Figure IAAC-11-8 Dauphin River Duration Curve - Pre-2011

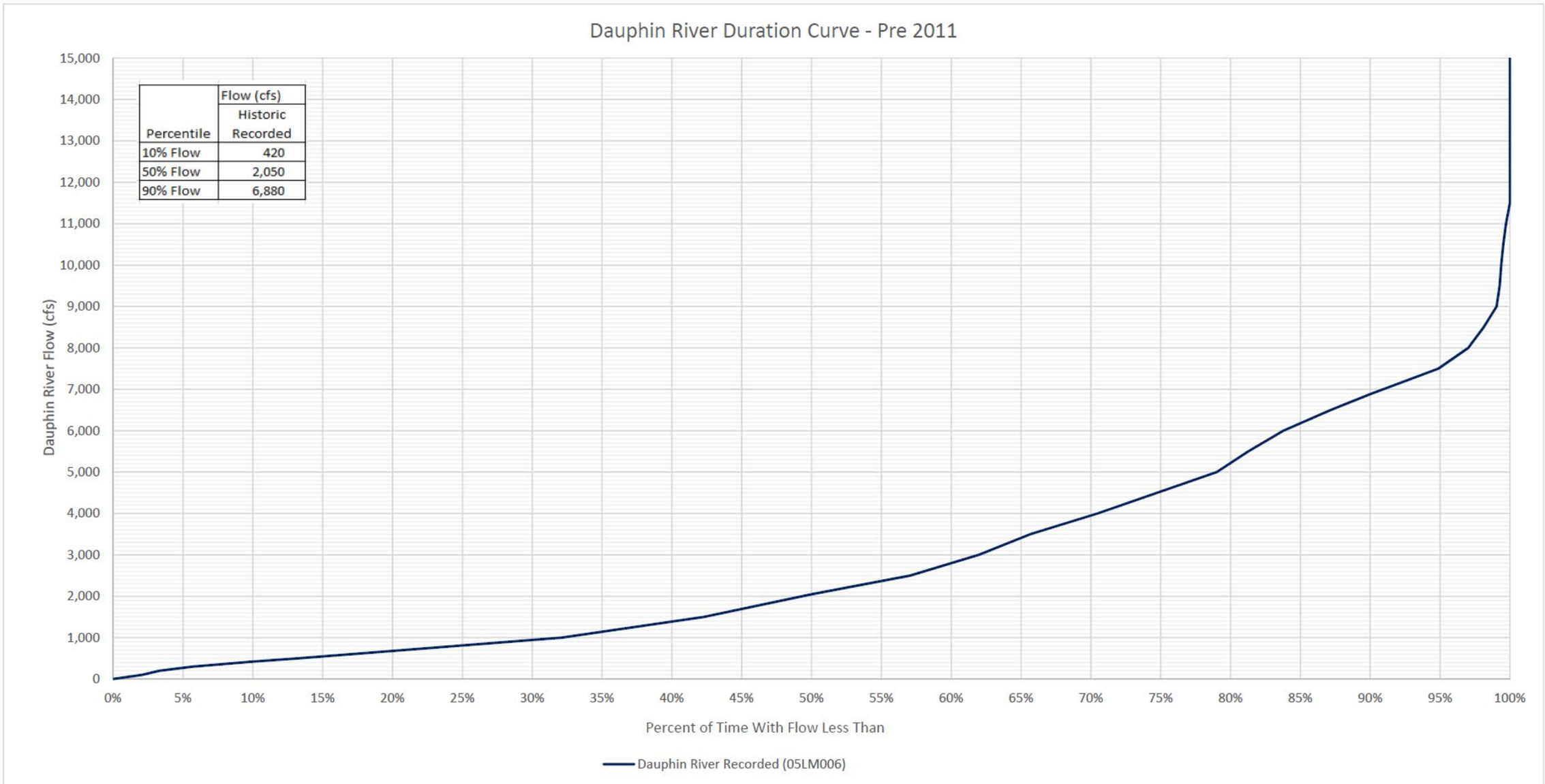


Figure IAAC-11-9 Dauphin River Duration Curve - Recorded Pre-2011 - March through May

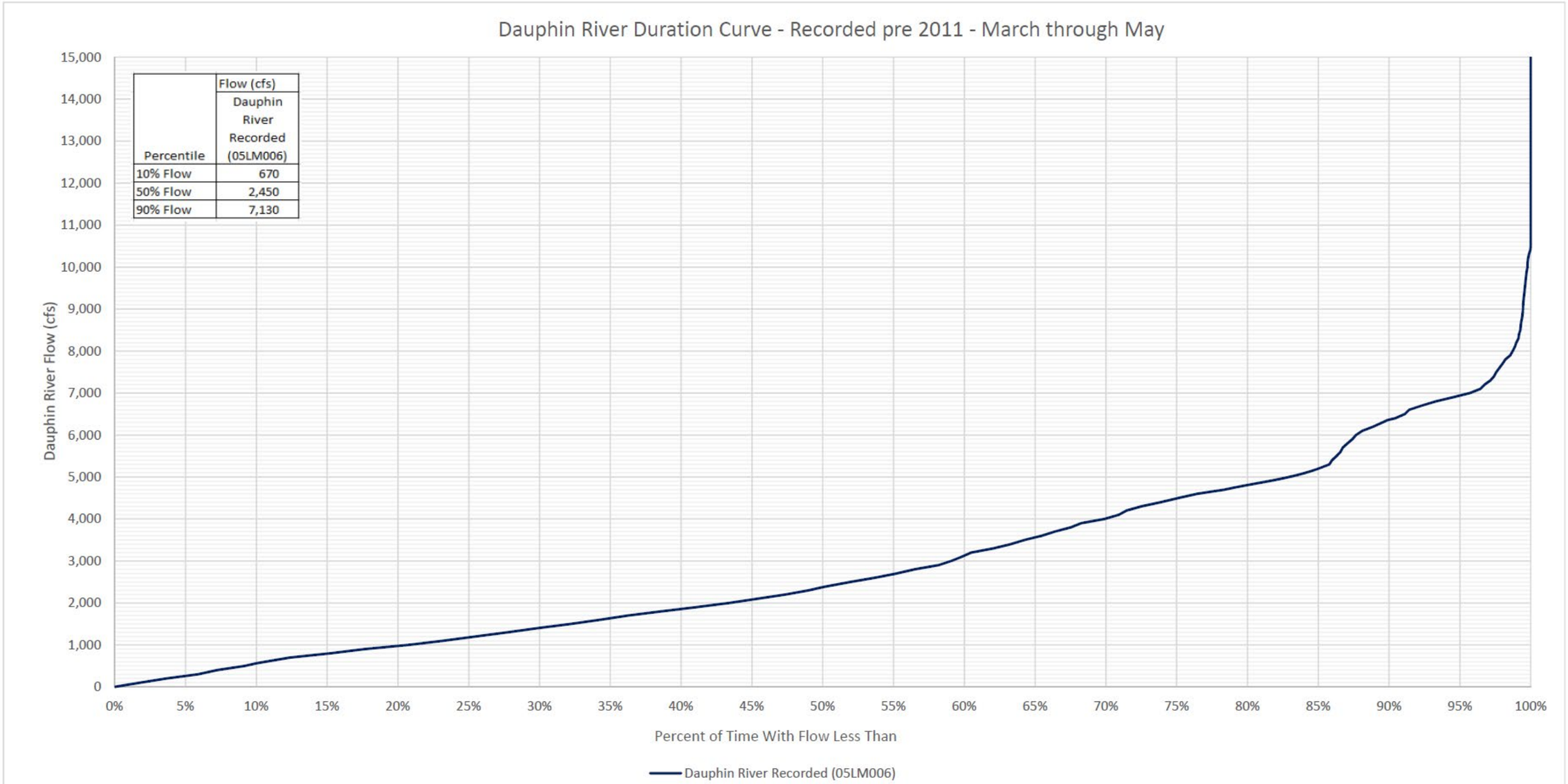


Figure IAAC-11-10 Dauphin River Duration Curve - Pre-2011 - June through August

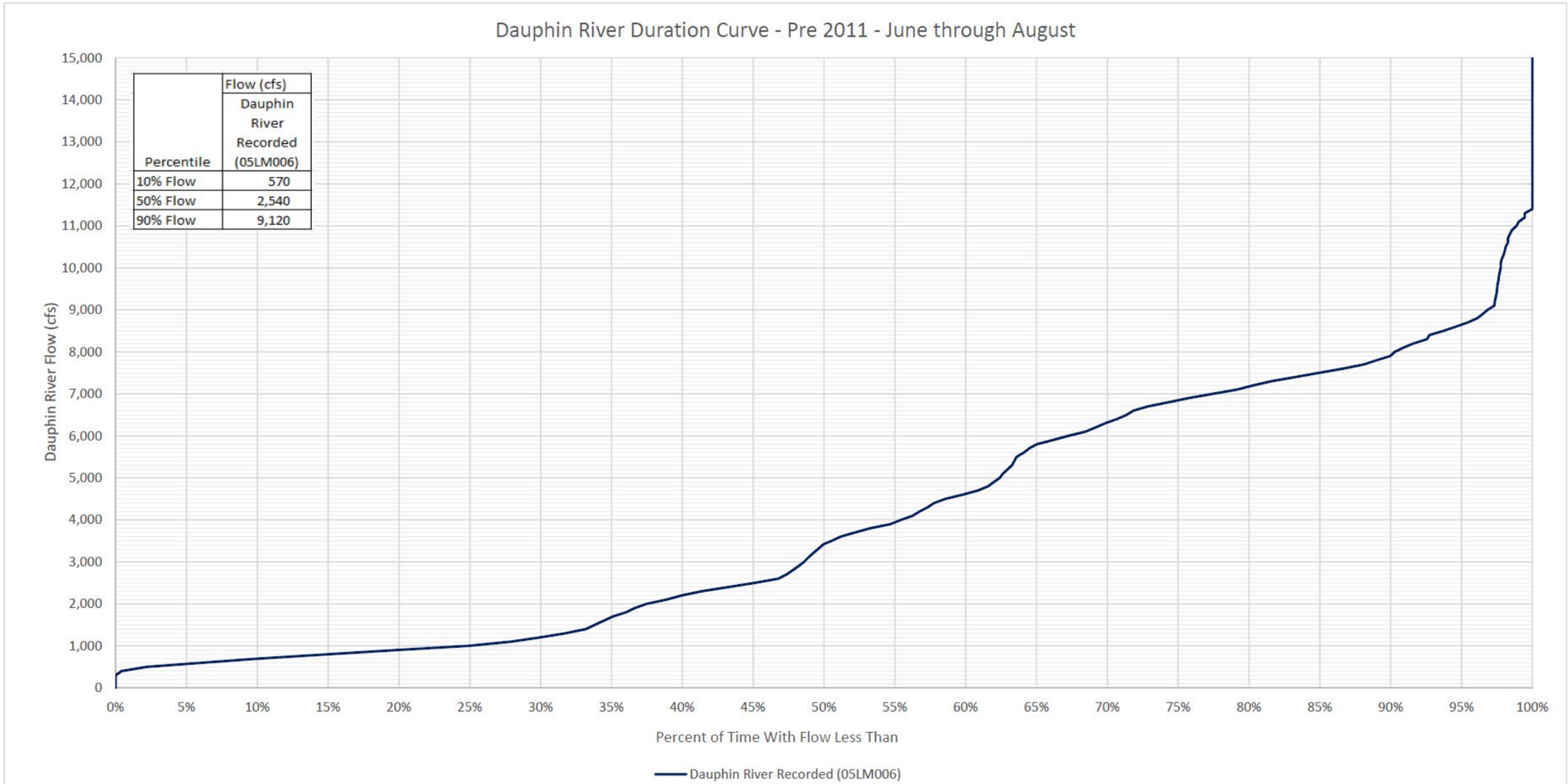


Figure IAAC-11-11 Dauphin River Duration Curve - Pre-2011 - September through November

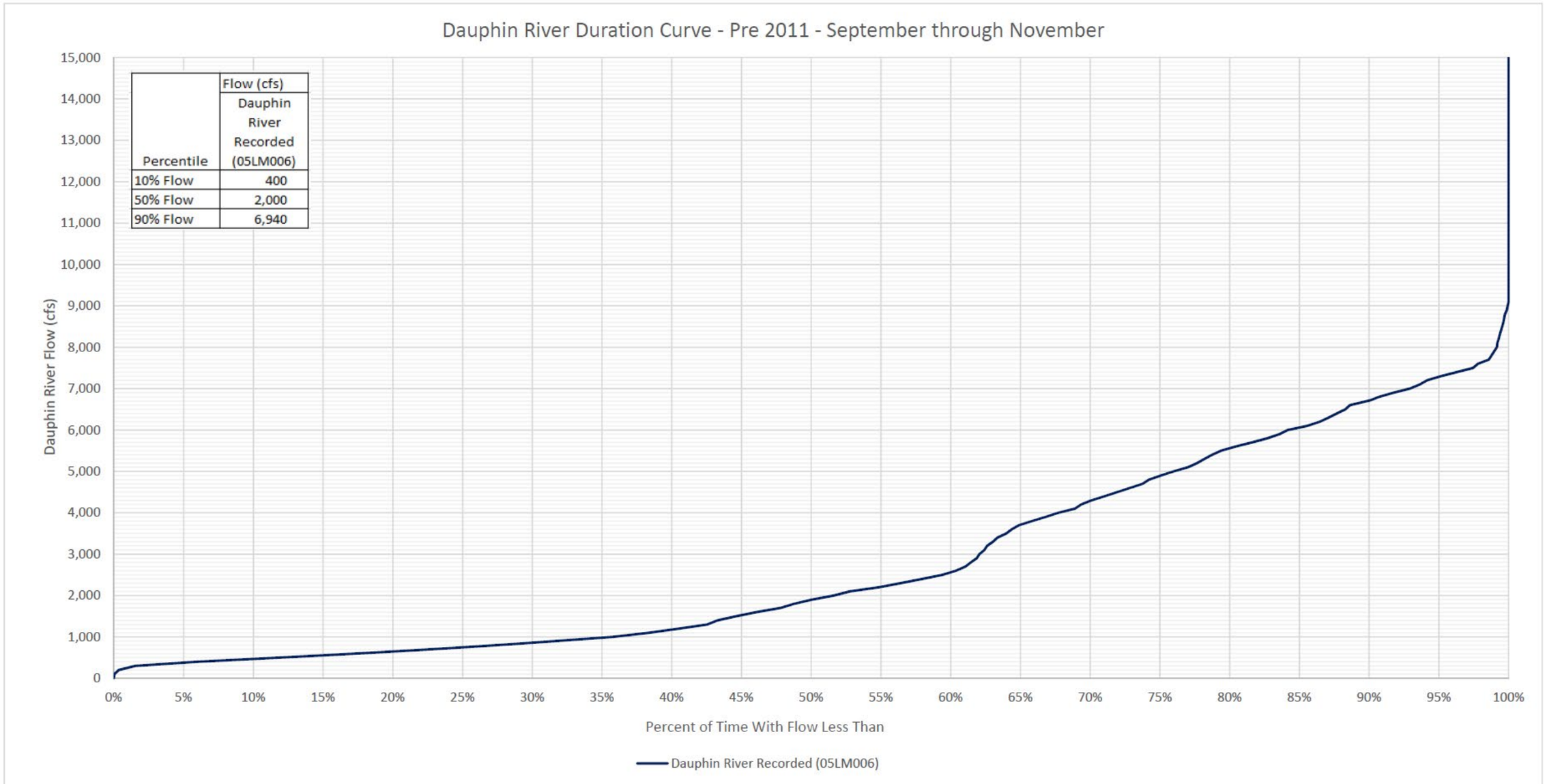
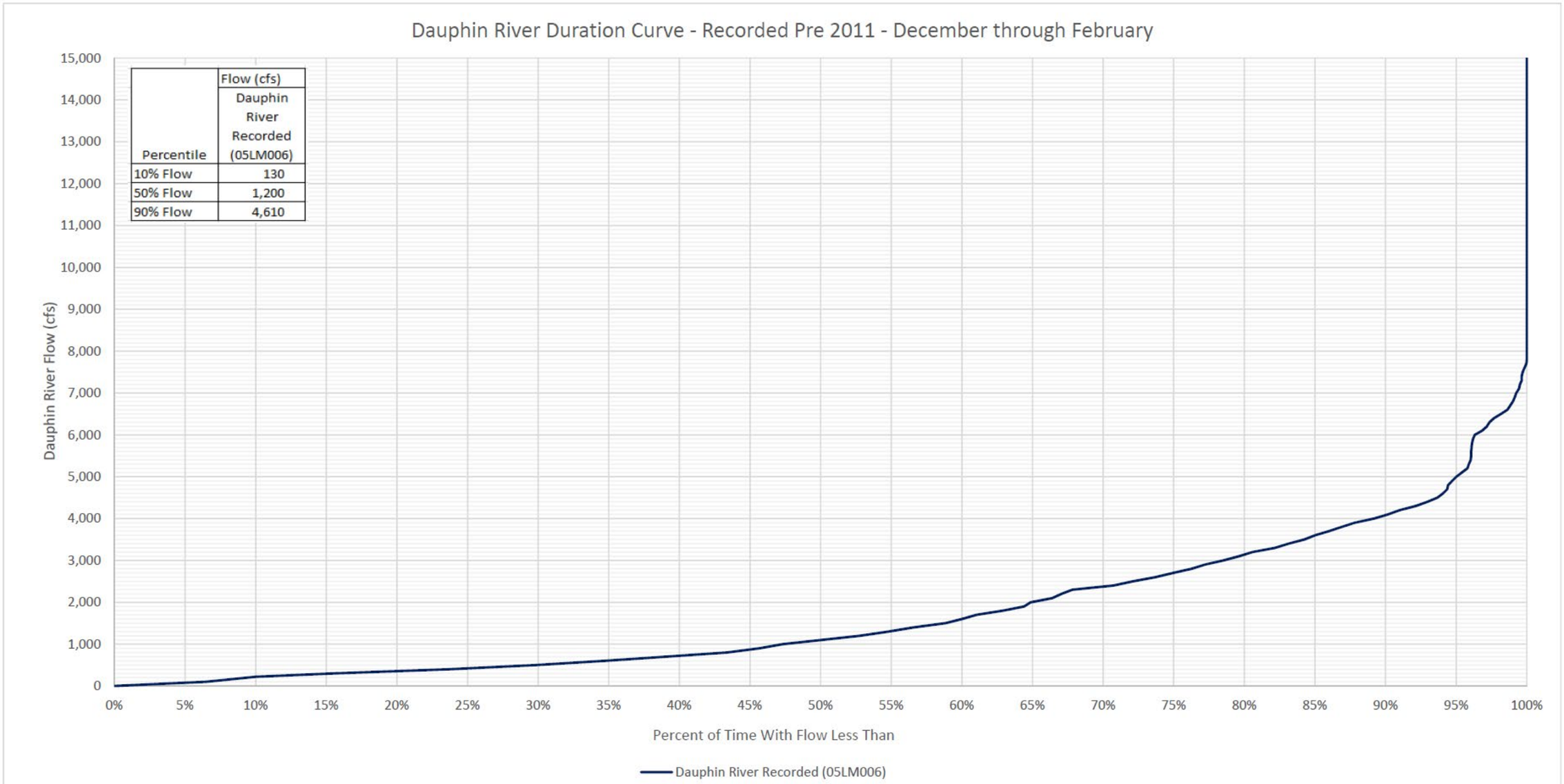


Figure IAAC-11-12 Dauphin River Duration Curve - Recorded Pre-2011 - December through February



APPENDIX IAAC-11B: PRE-2011 BASELINE SURFACE WATER QUALITY SUMMARY STATISTICS

(see excel file)

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-11B: Pre-2011 Baseline Surface Water Quality Summary Statistics
May 31, 2022

Manitoba
Transportation and Infrastructure

Stantec

APPENDIX IAAC-13A: REPORTS

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-13A: Reports
May 31, 2022

Manitoba
Transportation and Infrastructure

Stantec



Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

Aquatic Environment Monitoring - Fall 2011

REPORT

Prepared for Manitoba Infrastructure and Transportation · August 2013
By North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4

EMERGENCY REDUCTION OF LAKE MANITOBA AND LAKE ST. MARTIN WATER LEVELS

Aquatic Environment Monitoring
Fall 2011

August 2013

Prepared for
Manitoba Infrastructure and Transportation

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EXECUTIVE SUMMARY

Due to widespread record flooding throughout southern Manitoba in 2011, water levels in Lake Manitoba and Lake St. Martin staged several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and the long-term evacuation of four First Nations communities. If no action was taken, it was expected that high water levels and associated negative impacts would persist into 2012.

The Province of Manitoba (the Province) retained KGS Group and AECOM to investigate options to provide an emergency reduction of water levels in the two lakes. Water flows out of Lake Manitoba through the Fairford River and Lake Pineimuta to Lake St. Martin, and then through the Dauphin River to Lake Winnipeg (Figure 1-1). However, drainage through the Dauphin River to Lake Winnipeg was not sufficient to rapidly reduce the flood stage water levels on Lake Manitoba and Lake St. Martin. After reviewing numerous strategies, it was recommended that an emergency channel (Reach 1 Emergency Outlet Channel) be constructed to reduce the hydraulic flow restrictions out of Lake St. Martin to Lake Winnipeg (KGS and AECOM 2011). By improving the outflow capacity, the Fairford River Water Control Structure (FRWCS) could be operated at maximum capacity, thereby lowering water levels on Lake Manitoba, throughout winter 2011/12 without increasing flooding issues on Lake St. Martin.

The requirement to assess and monitor environmental effects associated with construction and operation of Reach 1 was recognized in the early stages of Project development. Monitoring initiated in 2011 will be ongoing into future years and will generate information required to assess the effects of operation of the Reach 1 Outlet Emergency Channel. The following summarizes results of initial monitoring activities, conducted during fall 2011.

Water Quality Monitoring

Water quality monitoring was conducted during fall 2011 to provide additional baseline information prior to operation of Reach 1, document changes in water quality during construction and operation of Reach 1, and to help determine the spatial extent over which changes to water quality may have occurred. Water quality data were collected from upstream of Lake Manitoba and throughout Lake St. Martin, the Reach 1 Emergency Outlet Channel System, and Sturgeon Bay prior to and during operation of Reach 1. Water quality data collections consisted of several components, each with discrete objectives. Water quality monitoring consisted of the following programs:

- Regional Water Quality Monitoring Program (RWQMP);
- Construction Environmental Monitoring Program (CEMP); and,
- *In situ* and TSS Monitoring in Sturgeon Bay.

RWQMP

During the conduct of the RWQMP, water quality information was collected from all major waterbodies and waterways within the study area that were affected by flooding and encompassed the major inputs

to the north basin of Lake Manitoba (i.e., Waterhen River and at the Lake Manitoba Narrows) downstream to and including Sturgeon Bay on Lake Winnipeg. The objectives of the program were to:

- provide baseline water quality information to assist with operational and post-project monitoring
- to provide information from locations where water quality data were lacking;
- supplement data sets at sites within the study area where Manitoba Conservation and Water Stewardship, Water Quality Management Branch (MCWS) conducts water quality monitoring; and,
- evaluate spatial differences in water quality within the study area.

An assessment of effect(s) of the construction and operation of Reach 1 on the water quality of the study area has not been undertaken for this report. A brief assessment will be included with the presentation of the results from the fall 2012 monitoring program with a thorough assessment including historical and project-related water quality data to follow.

RWQMP results indicate that water quality within the study area can be generally described as moderately nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated.

The water quality of Buffalo Creek differed from the other waterbodies sampled. Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll a, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

Both Lake St. Martin and Sturgeon Bay were isothermal in fall 2011. Other in situ variables, including DO, turbidity, pH, and specific conductance, were relatively consistent across depth in both lakes. Molar ratios of N:P indicated that all of the sampled waterbodies were phosphorus limited in fall 2011. Total phosphorus exceeded the MWQSOG guidelines at Lake Manitoba Narrows and several sites in Sturgeon Bay, but all other routine water quality variables for which there are MWQSOG and CCME guidelines, including DO, pH, ammonia, nitrate and nitrite were within PAL objectives and guidelines at all locations.

The water quality of Sturgeon Bay was also influenced by the Dauphin River such that sites closest to the river mouth exhibited water quality similar to upstream sites, including: higher alkalinity, conductivity, TDS, nitrogen and carbon concentrations and lower turbidity/TSS, colour, phosphorus and chlorophyll a.

Concentrations of major ions and metals were generally lower in Buffalo Creek, compared to other waterbodies in the study area. Conversely, mercury and methyl mercury concentrations were higher, and were consistently detected, at sites in Buffalo Creek than at other sites sampled. Additionally, concentrations of the major ions (i.e., calcium, chloride, magnesium, potassium, sodium, and sulphate) and hardness were higher at the sites closest to the Dauphin River outflow (LKW2 and 3) than at the other sites sampled in Sturgeon Bay, reflecting the higher concentration of these substances at upstream waterbodies in the region relative to Lake Winnipeg. Conversely, the Dauphin River contained

lower concentrations of total aluminum, copper, iron, manganese, titanium, and uranium than sites in Sturgeon Bay most distant from the Dauphin River mouth.

Aluminum, chloride, fluoride, iron, and selenium all exceeded PAL guidelines or objectives on at least one occasion within the study area. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL.

Of the 58 pesticides analysed for, only glyphosate was detected in the study area during fall 2011 and it did not exceed the federal and provincial guidelines for PAL.

CEMP

CEMP was conducted from September 2 to November 25, 2011. Additionally, following the opening of Reach 1 (November 1, 2011), water quality was monitored in the reach from November 1 to 25, 2011. The objective was to describe baseline water quality parameters and to monitor potential changes to water quality in Buffalo Creek and the lower Dauphin River during construction and early operation of Reach 1.

Construction EMP monitoring indicated that TSS concentrations had returned to near baseline conditions by the end of November following an initial increase measured during the opening of Reach 1 in early November (AECOM 2012). Immediately following the opening of Reach 1, the TSS concentrations exceeded CCME guidelines within Buffalo Creek and the Dauphin River immediately downstream of the creek, but fell below limits within two weeks.

Based on the data collected by AECOM (2012) there were no indications that the construction of Reach 1 or its initial operation resulted in changes to nutrient concentrations downstream. However, the mercury concentrations measured in two samples collected from the Dauphin River, one upstream and one downstream of Buffalo Creek, on October 14, 2011 exceeded the CCME guideline for PAL. There was no evidence of hydrocarbon contamination due to construction activities, as petroleum hydrocarbons were not detected during the monitoring program.

In situ and TSS Monitoring

In situ and TSS monitoring were conducted in Sturgeon Bay from September 30 to October 21, 2011. Objectives were to:

- collect baseline water quality information in Sturgeon Bay and the Dauphin River;
- help delineate the spatial extent over which suspended sediment inputs may be distributed in Sturgeon Bay and the Dauphin River; and,
- develop a reliable turbidity/TSS relationship for analysis of turbidity data.

In general, water quality near the surface was similar to that near the bottom at sites sampled in Sturgeon Bay. Turbidity was variable throughout Sturgeon Bay; however, since the measurements were collected on multiple days over a three week period, the ability to make spatial comparisons is limited to within transect comparisons. There was some evidence of higher turbidity at sites closer to shore along

several of the Sturgeon Bay transects. There was no difference in pH or DO from nearshore to offshore in Sturgeon Bay, and pH and DO were similar throughout the area sampled. Sturgeon Bay was well-oxygenated and all DO measurements exceeded the MWQSOGs objectives and the CCME guidelines for PAL. All pH measurements were within the MWQSOGs and CCME guidelines for PAL.

In the Dauphin River, in situ water quality was similar upstream and downstream of Buffalo Creek. Likewise, no difference in water quality was observed across transects. A small number of laboratory samples were used to establish a TSS/turbidity relationship for Sturgeon Bay. Additional samples will subsequently be used to strengthen the relationship.

Sediment Inputs to Sturgeon Bay

Sediment inputs to Sturgeon Bay were monitored during fall 2011 to determine baseline sediment quality, characterize substrates in the lower Dauphin River and in Sturgeon Bay and measure the Dauphin River sediment contributions into Sturgeon Bay. A sedimentation study was also initiated during fall 2011 and will continue into future years. The objectives of the programs were to:

- Determine the type and amount of sediment deposited into Sturgeon Bay during operation of Reach 1;
- Determine the bed load contribution of the Dauphin River into Sturgeon Bay, before operation, and the Dauphin River and Buffalo Creek, during operation of Reach 1;
- Collect sediment grab samples in the Dauphin River and Sturgeon Bay for particle grain size and organic content analysis to assess changes in substrate due to sedimentation. This information will also be used to validate substrate data collected through sonar during habitat mapping studies; and,
- Collect sediment samples from the Dauphin River and Sturgeon Bay to document baseline sediment quality and assess Project-related impacts.

Bed Load and Suspended Sediments

Bed load samples and in situ water quality were collected on October 16, 22 and November 6 at three sites in the Dauphin River. High water velocity in Buffalo Creek precluded collection of bed load samples from within the creek and, consequently, the program objectives could not be met. All samples from the Dauphin River were archived.

Laboratory analyses of water samples collected prior to and following the onset of Reach 1 operation indicated an increase in Buffalo Creek and the Dauphin River downstream of Buffalo Creek after Reach 1 became operational. These data will support results from other water quality sampling programs (see Section 3.0).

Sedimentation Rate

Thirty sediment traps were deployed in Sturgeon Bay on October 19, 2011 to determine the type and amount of sediment being deposited in the area. The traps remained deployed until summer 2012 and results from the program were to be provided in subsequent reports.

Substrate Classification

Substrate sampling was conducted at Sturgeon Bay from September 30-October 1 and October 20-21 along 12 transects and at three offshore extensive zone sites. Sediment quality samples were archived for future metals analysis. Carbon and particle size analysis results indicated that nearshore sites in Sturgeon Bay were typically sand and gravel while offshore sites were characterized as clay. Total organic carbon ranged from 0.2-3.91% with the relative proportion increasing with distance offshore.

Habitat and Fisheries Survey of the Buffalo Creek Watershed

Project design was that the Buffalo Creek watershed would be the initial receiving environment for flow diverted through Reach 1. A lack of information pertaining to the watershed was identified during a preliminary screening process conducted prior to operation of Reach 1 and it was determined that a basic understanding of fish resources and use of aquatic habitat within the Buffalo Creek watershed would be required to assist in assessing the effects of Reach 1 operation. Consequently, a series of investigations were conducted to collect information describing aquatic resources within the Buffalo Creek watershed. The investigations included:

- conducting a Construction Environmental Monitoring Program (CEMP) to document water quality conditions in Lake St. Martin at the entrance to Reach 1, along Buffalo Creek, and in the Dauphin River upstream and downstream of the Buffalo Creek confluence during construction and initial operation of Reach 1;
- a brief field program conducted from 15-17 August, 2011, to collect *in situ* water quality information, describe aquatic habitat, and identify fish presence/absence and distribution throughout the Buffalo Creek watershed; and,
- a desk top exercise to quantify the type and amount of aquatic habitat occurring within the Buffalo Creek watershed.

Water Quality

Water quality information specific to the Buffalo Creek watershed was collected through the CEMP program and a brief field investigation that provided information specific to Big Buffalo Lake.

As part of the CEMP, water quality was monitored in Lake St. Martin, Buffalo Creek, and in the Dauphin River from September 2 until 01 November, when Reach 1 became operational. Sampling included the collection of in situ water quality data, as well as samples for laboratory analysis. Following the onset of operation, water quality monitoring continued throughout the system until 25 November, 2011. Prior to 01 November, monitoring was conducted approximately twice a month. After Reach 1 was opened, sampling frequency increased to twice a week. Prior to operation of Reach 1, the water quality of Buffalo Creek differed from Lake St. Martin, the Dauphin River or Sturgeon Bay. Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll a, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

In situ water quality measurements were taken at four sites in Big Buffalo Lake on 17 August, 2011. Results indicated that the lake was not thermally stratified, was relatively well-oxygenated, and near-neutral. Turbidity was less than 7 NTU and Secchi disk depth ranged from 1.2-2.2 m. In situ measurements at the mouth of Buffalo Creek indicated that water at the creek mouth was slightly more turbid, acidic, less oxygenated, and warmer than measured at Big Buffalo Lake.

Aquatic Habitat

Prior to operation of Reach 1, aquatic habitat in Big Buffalo Lake and Buffalo Creek were characterized and quantified to describe pre-Project conditions. The habitat assessment was completed using information collected during a brief field program conducted in August 2011 and by interpreting habitat characteristics from aerial orthometric imagery and geo-referenced digital photographs to classify and quantify aquatic habitat within the watershed.

Big Buffalo Lake is a small lake (surface area of 55 ha) from which Buffalo Creek originates. Maximum water depth was 2.2 m and substrate was comprised of a deep layer of loosely compacted organic sediments. Aquatic vegetation occurred throughout much of the lake, although was considerably less dense in the central portion compared to nearshore areas. Lake shorelines were composed largely of shrub wetlands comprised of cattails and bulrushes, as well floating bog in some areas. Few areas surrounding the lake support trees.

Buffalo Creek originates at Buffalo Lake and flows for approximately 17 km to its confluence with the Dauphin River. For approximately the first 4 km downstream of Big Buffalo Lake, the creek flows through a sparsely treed wetland/bog complex and is characterized by a narrow channel (< 5 m wide) that becomes indeterminate in some locations. Upon leaving the wetland/bog complex, the creek enters an area of higher gradient and develops a meandering pattern where riffle/run/pool sequences flow over local deposits of cobble, gravel, and sand. Beaver dams were common.

A total of 901,981.9 m^2 (or 90.2 ha) of habitat in the Buffalo Creek watershed was classified from digital imagery. Six different habitat types were identified. The majority of habitat in the watershed was identified as peat pool habitat. This habitat type occurred exclusively in the upper reaches of the watershed within the confines of the wetland/bog complex, and included Big Buffalo Lake. Most of Buffalo Creek downstream of the wetland/bog complex was comprised of the run habitat (15% of available habitat within the watershed. Pool and riffle habitat accounted for about 6% of total available habitat within the watershed, and beaver dams and pools each comprised less than 1% of the total available habitat.

Fish Presence and Abundance

At least ten species of fish were captured in the Buffalo Creek watershed. Some small dace and sculpin could not be identified to species and the catch may include more than one species of each. Species diversity was greater in Buffalo Creek than in Big Buffalo Lake, and there was little overlap in community composition between the upstream and downstream reaches of the creek.

The fish community within Big Buffalo Lake was sampled using experimental gill nets. The catch totalled 315 fish representing four species. Yellow Perch was the most abundant species, comprising 86.7% of the total catch. The remainder of the catch included Northern Pike (6.3%), Golden Shiner (3.8%), and White Sucker (3.2%). Northern Pike and White Suckers captured within the lake were all juvenile fish. The absence of adults suggests that these species do not fulfill all of their life history requirements within the lake. In contrast, adult, juvenile and young-of-the-year Yellow Perch were captured in the lake. In particular, large numbers of young perch were captured, suggesting that the lake supports a resident population. The extent to which Golden Shiner use the is not known, although large numbers of small fish not susceptible to capture in the gill nets were observed. It is possible that these were young-of-the-year Golden Shiner.

Back pack electrofishing was conducted at 12 sites along Buffalo Creek to document fish presence and abundance. Fishing focussed on two general areas within the creek. The first originated where the creek exited the wetland/bog complex and extended downstream for approximately 1 km. The second originated at the creek's confluence with the Dauphin River and extended upstream for approximately 2 km.

More than 250 fish representing four species were observed or captured at the upstream reach. The majority of the fish were Central Mudminnows and dace species, some of which were identified as Pearl Dace, but most of which were unidentified. A small number of juvenile White Sucker were also captured.

Considerably fewer fish were captured in the downstream reach. Twenty individuals representing five species were captured. Species occurring in the downstream reach were different than that observed in the upstream reach. Northern Pike, Longnose Dace, Slimy Sculpin, Yellow Perch, and Logperch were observed in the downstream reach but not the upstream reach. Central mudminnows and dace species other than Longnose Dace were abundant in the upstream reach but were not observed in the downstream reach. This difference may be due to different habitat conditions between the two areas, or due to proximity to the Dauphin River.

Habitat Mapping in Dauphin River and Sturgeon Bay

It was thought that operation of Reach 1 could result in substrate changes in Sturgeon Bay due to increased sediment inputs. The intent of habitat mapping studies was to document pre-operation habitat conditions in Sturgeon Bay and the Dauphin River and provide a baseline to help assess post-project changes. Specific study objectives include:

- collect habitat information (water depth and substrate type) where data do not exist;
- determine baseline depth and substrate types in shallow water areas of Sturgeon Bay and in the Dauphin River mouth and surrounding area understood by local knowledge to be potential Walleye and Lake Whitefish spawning habitat;
- To identify potential Walleye and Lake Whitefish spawning habitat in the Dauphin River and in Sturgeon Bay; and,
- To characterize deep water substrate types in offshore areas of Sturgeon Bay.

A suite of methods were proposed to compile habitat information within the Dauphin River and Sturgeon Bay. These included the collection of bathymetric and substrate data in the Dauphin River and Sturgeon Bay using sonar technology, collection of substrate samples in Sturgeon Bay and slow water velocity areas of the Dauphin River to help validate interpretation of the sonar data, and the conduct of rebar drags in fast water velocity areas of the Dauphin River to help validate interpretation of the sonar data. Collected information was used to produce maps of aquatic habitat.

Bathymetric and substrate classification field activities along the Dauphin River were conducted between 11 and 17 October, 2011. Inclement weather (high wind conditions) throughout fall 2011 prevented access to Sturgeon Bay and, consequently, only limited sampling occurred in Sturgeon Bay during fall 2011. Sonar data could not be collected from Sturgeon Bay, but a series of substrate samples were collected.

Dauphin River

Substrate conditions were mapped for 2,114,121.7 m2 of riverbed habitat in the lower Dauphin River. Cobble/boulder and gravel/sand were most abundant, each comprising almost 28% of the area mapped. Gravel/cobble and bedrock were the next most common types.

Habitat conditions in the lower Dauphin River suitable to support spawning for many species of fish, including Lake Whitefish and Walleye, were documented during fall 2011. Fall fisheries conducted during late fall 2011 documented spawning by Lake Whitefish in the lower Dauphin River in the vicinity of the Buffalo Creek/Dauphin River confluence (Section 7.2). Ongoing fisheries studies at Dauphin River have continued to document use of habitat in the lower Dauphin River by fish.

Sturgeon Bay

Substrate samples were collected at 48 sites within Sturgeon Bay. Visual assessments were conducted for each location where grabs were obtained or, if a grab could not be obtained due to size or compaction of substrate (i.e., cobble, boulder etc.), substrate characteristics were assessed by probing the bottom with a steel pole or dragging the ponar across the bottom. An indication of substrate conditions was derived from this program, and suggested that substrate conditions suitable to support spawning (gravels, cobbles and, to a lesser extent, boulders) by Lake Whitefish, Walleye, and other species occurred at numerous locations in nearshore areas of Sturgeon Bay, including to the east and west of Willow Point.

Fall Fisheries Surveys in Dauphin River and Sturgeon Bay

Fisheries surveys were conducted in the Dauphin River and Sturgeon Bay during fall 2011 to provide information to supplement pre-existing aquatic environment information, and provide contemporary pre-project information to assist in determining project-related effects. Specific study objectives included:

- identification of fall fish utilization in the Dauphin River, between the confluence with Buffalo Creek and Sturgeon Bay;

- identification of Lake Whitefish spawning areas in the Dauphin River, between the confluence with Buffalo Creek and Sturgeon Bay;
- determination of fall fish utilization of nearshore habitat in Sturgeon Bay during late fall (emphasis on fall spawning fish, particularly Lake Whitefish); and,
- collection of information on fall Lake Whitefish movements into the Dauphin River prior to operation of Reach 1.

Water Temperature

Water temperature loggers were deployed on 19 October. Water temperature in the Dauphin River and Sturgeon Bay were between 6 and 7°C when the loggers were deployed and decreased to 0-1°C by mid-November.

Fish Utilization

Nine species of fish were captured, most of which occurred contiguously in the Dauphin River and Sturgeon Bay. Four standard experimental gillnet gangs in Sturgeon Bay captured 333 fish, comprising all nine species. Cisco, White Sucker, Northern Pike, and Lake Whitefish were the most abundant species. Species diversity and abundance were highest at two nets set near the mouth of the Dauphin River. Most captured Lake Whitefish were adults in pre-spawn condition, including those fish captured near Willow Point.

Twenty-seven boat electrofishing runs were conducted in the Dauphin River, the lower-most reach of Buffalo Creek, and Sturgeon Bay in the vicinity of the Dauphin River over three sampling sessions during fall 2011. A total of 765 fish, comprising seven fish species, were captured during the electrofishing surveys with Lake Whitefish accounting for almost 94% of the catch. Most Lake Whitefish were captured in the Dauphin River in velocity refugia, including the downstream lee of shoals, small islands and at the confluence with Buffalo Creek. Male and female Lake Whitefish in early pre-spawn condition were captured at the onset of sampling in mid-October and, by November 5, most were in late pre-spawn condition.

Lake Whitefish Spawning Activity

Twenty egg mats were deployed in the mouth of Buffalo Creek and in the Dauphin River during fall 2011. Ten of these mats were successfully retrieved and sampled, producing a catch of 5,961 Lake Whitefish eggs. Most eggs were captured at three sites in the Dauphin River immediately upstream of the confluence with Buffalo Creek. The eggs were first captured on mats sampled on 04 November when large numbers of ripe females were observed during electrofishing surveys of the same area and egg abundance peaked on mats sampled on 15 November. The bulk of Lake Whitefish spawning in this reach of the Dauphin River during fall 2011 is suspected to have occurred during the first two weeks of November.

Debris Monitoring

Debris levels were obtained from four experimental gill nets set in Sturgeon Bay from 14 – 21 October. Three nets contained low levels of debris and the fourth contained none. Debris consisted primarily of aquatic and terrestrial vegetation.

Mercury Concentration in fish Tissue

The bioaccumulation of mercury in fish tissue was studied in Sturgeon Bay during fall 2011 due to the potential for flooding of watercourses as a result of Reach 1 operation increasing the loading of mercury and organic carbon into project waterbodies. The objectives of the mercury study were to:

- Document baseline mercury concentrations in commercially important fish species in Sturgeon Bay, prior to operation of Reach 1; and,
- Monitor mercury concentrations in fish tissue during project operation and evaluate potential increases relative to baseline conditions.

A total of 33 Lake Whitefish, 45 Northern Pike, and 18 Walleye captured during fall gillnetting surveys were analysed for age. Northern Pike sampled for mercury had a mean length almost identical to the standard length of 550 mm, whereas Lake Whitefish were on average larger and Walleye were on average smaller than the standard length for those species. Pike, Walleye, and Whitefish for which mercury analyses were conducted had mean ages of 5.4, 3.9 years, and 7.6, respectively.

Mercury concentrations in fish from Sturgeon Bay were generally low and similar to those recently documented for other areas of Lake Winnipeg. Concentrations, even in the largest fish, were typically lower than the Health Canada standard for commercial marketing of freshwater fish in Canada and most were lower than the now unofficial “safe consumption limit” for people eating “large quantities of fish”.

Local Knowledge

Biological information collected during a community consultation meeting in Gypsumville, 06 October, 2011 identified several spawning locations and fish movements in the study area. Lake Whitefish and Walleye spawning locations were identified east and west of Willow Point in Sturgeon Bay. Lake Whitefish move from Sturgeon Bay to Lake St. Martin via the Dauphin River during late August to freeze up. Spawning occurs by Lake Whitefish occurs at several locations in Lake St. Martin. Post-spawning downstream movements have been noted from November to December, although some Lake Whitefish remain in Lake St. Martin overwinter. In Lake St. Martin, Lake Whitefish spawning has been identified at The Narrows and Walleye, Carp, sucker, and Northern Pike spawning have been observed in various tributaries of the lake. Several fish harvest locations have been identified throughout the study area for Lake Whitefish, Walleye, Carp, and Yellow Perch.

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1.0 INTRODUCTION

Due to widespread record flooding throughout southern Manitoba in 2011, water levels in Lake Manitoba and Lake St. Martin staged several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and the long-term evacuation of four First Nations communities.

The Province of Manitoba (the Province) retained KGS Group and AECOM to investigate options to provide an emergency reduction of water levels in the two lakes. Water flows out of Lake Manitoba through the Fairford River and Lake Pineimuta to Lake St. Martin, and then through the Dauphin River to Lake Winnipeg (Figure 1-1). However, drainage through the Dauphin River to Lake Winnipeg was not sufficient to rapidly reduce the flood stage water levels on Lake Manitoba and Lake St. Martin. After reviewing numerous strategies, it was recommended that an emergency channel (Reach 1 Emergency Outlet Channel) be constructed to reduce the hydraulic flow restrictions out of Lake St. Martin to Lake Winnipeg (KGS and AECOM 2011). By improving the outflow capacity, the Fairford River Water Control Structure (FRWCS) could be operated at maximum capacity, thereby lowering water levels on Lake Manitoba, throughout winter 2011/12 without increasing flooding issues on Lake St. Martin.

The proposed Reach 1 Emergency Outlet Channel (hereafter called Reach 1) included the excavation of a channel from Lake St. Martin to Big Buffalo Lake, a small lake located about 7 km northeast of Lake St. Martin (Figure 1-2). From Big Buffalo Lake, water would flow down Buffalo Creek and enter the Dauphin River about 4 km upstream of Sturgeon Bay on Lake Winnipeg. Construction of Reach 1 was initiated in late summer 2011 and water began flowing down the channel by 01 November 2011.

The requirement to assess and monitor environmental effects associated with construction and operation of Reach 1 was recognized in the early stages of Project development. KGS Group retained North/South Consultants Inc. to assist them with aquatic aspects of the environmental assessment and monitoring for the Project. Prior to completion of Reach 1, North/South Consultants Inc. produced an environmental scoping document that described, based on available information, the existing aquatic environmental conditions of waterbodies that might be affected by the Project, identified potential impacts that could result from construction and operation of the Project, and identified information needs to enhance the ability to mitigate and assess Project-related effects (North/South Consultants Inc. 2011a). As part of the screening process, a work plan was developed that detailed a suite of aquatic data collections to address identified information needs (North/South Consultants Inc. 2011b; Appendix 1-1). This report provides methods and results from aquatic investigations conducted during fall 2011.

Data collections will be ongoing throughout the operational and post-operational phase of Reach 1. Ultimately, the data presented in this report and collected subsequently will be used to produce an environmental effects assessment of the Project.

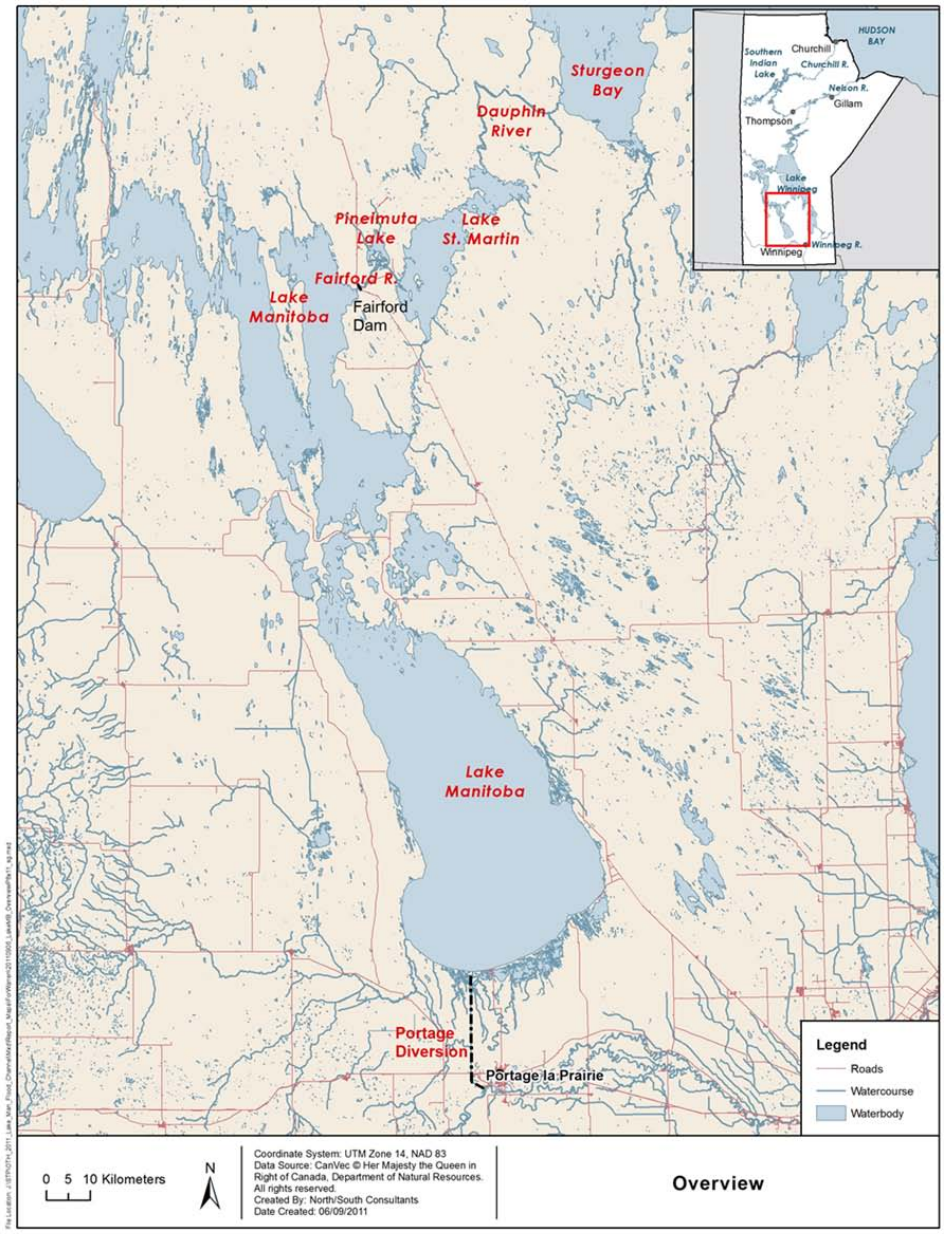


Figure 1-1. The location of major waterbodies and waterways affected by flooding in southern Manitoba during spring 2011.



Figure 1-2. Location of the Reach 1 Emergency Outlet Channel and Reach 3 Emergency Channel and the Buffalo Creek Drainage System in relation to Lake St. Martin, the Dauphin River and Sturgeon Bay.

2.0 STUDY AREA AND PROJECT DESCRIPTION

2.1 STUDY AREA

Construction and operation of Reach 1 and operation of the Fairford River Water Control Structure (FRWCS) at full capacity through the winter of 2011/2012 had the potential to affect aquatic environments in upstream waterbodies such as Lake Manitoba, the Fairford River, and Pineimuta Lake. However, the greatest potential impacts are expected on waterbodies in the vicinity and downstream of Reach 1, including Lake St. Martin, the Dauphin River, the Buffalo Creek Drainage System, and the Sturgeon Bay area of Lake Winnipeg (Figure 1-2). The emphasis of aquatic studies is on the area from Lake St. Martin downstream to Lake Winnipeg. Collectively, these waterways will be referred to as the "study area" throughout the remainder of this document.

The main water inflows into Lake Manitoba are from the Whitemud River, the Waterhen River (including Lake Winnipegosis and Dauphin Lake), and the Portage Diversion, which routes excess flows from the Assiniboine River into the south end of Lake Manitoba (Figure 1-1). Water flows out of Lake Manitoba through the Fairford River and Lake Pineimuta to Lake St. Martin, and then through the Dauphin River to Lake Winnipeg.

Big Buffalo Lake is a small lake (0.55 km2) located in a large wetland approximately 7 km north east of Lake St. Martin. The lake drains into Buffalo Creek, a small creek that discharges into the Dauphin River approximately 4 km upstream of Lake Winnipeg. Collectively, this area is referred to as the Buffalo Creek Drainage System. Prior to the construction and operation of Reach 1, the Buffalo Creek Drainage System did not receive water from the Lake Manitoba/Lake St. Martin watershed.

Construction of the Fairford Dam in 1961 allowed for the regulation of Lake Manitoba levels and in 1984 the Fairford Fishway was incorporated to provide passage of fish between Lake St. Martin, the Dauphin and Fairford rivers and Lake Manitoba. Dam design did not take into account impacts on downstream waterbodies and consequently, the Fairford River, Pineimuta Lake, Lake St. Martin, and the Dauphin River are subject to flooding during periods of high water levels in Lake Manitoba and levels lower than natural during low level periods. Following a study conducted by the Lake Manitoba Regulation Review Advisory Committee, it was decided that Lake Manitoba would be allowed to fluctuate closer to its pre-regulation state in order to sustain aquatic habitat along the lake shore (MWS 2010). However, downstream waterbodies continue to be impacted in extremely high water level years. Following construction of the Portage Diversion in 1970, water levels on Lake Manitoba rose higher than what was originally projected before the Fairford Dam was constructed. Consequently, its operation compounded the negative effects to downstream habitat that were produced by the Fairford Dam.

Additional descriptions of the biophysical environments and flow regulation on Lake Manitoba, Fairford River, Pineimuta Lake, Lake St. Martin, Dauphin River and Sturgeon Bay are provided in North/South Consultants Inc. (2011a).

2.2 PROJECT DESCRIPTION

The emergency reduction of Lake Manitoba and Lake St. Martin water levels includes the following project components:

2.2.1 Reach 1 Emergency Outlet Channel

The Reach 1 Emergency Outlet Channel is approximately 6 km in length, extending from Lake St. Martin to the bog area approximately 1.5 km south of Big Buffalo Lake to improve drainage from Lake St. Martin. The Reach 1 inlet is situated along the northeast shore of the north basin of Lake St. Martin. After flooding the bog area around Big Buffalo and Little Buffalo lakes, the drainage water will eventually flow into and follow Buffalo Creek for 14 km and discharge into the Dauphin River 3.8 km upstream of Sturgeon Bay. Buffalo Creek flows through a wide valley with relatively flat valley wall slopes. Buffalo Creek was not excavated to expand its capacity; therefore, the drainage water is expected overflow the natural banks of the creek in some areas.

In order to construct Reach 1, an access road, flanked by ditching to drain water from the peat, was constructed along each side of the channel. The area between the access road/ditches was cleared of trees and organic material prior to excavation.

The inlet of Reach 1 was constructed by widening and raising the invert to create a sill near the edge of the north basin of Lake St. Martin that water flows over into Reach 1. The sill was originally designed to be 120 m in length and have a bottom width of 60 m and 3:1 side slopes to convey the desired flow of 142 m3/s at a water level of 244.1 m. The invert of the inlet sill was designed to be at 243.1 m above sea level which is 0.3 m above the lower end of the desirable water level range for the lake at approximately the existing shoreline elevation. The original estimated flow upon initial operation of Reach 1 was approximately 255 m3/s based on Lake St. Martin water levels at an elevation substantially higher than 244.1 m.

2.2.2 Reach 3 Emergency Outlet Channel

As the Project developed, computer modeling of potential water levels at the mouth of the Dauphin River indicated that there was a substantial risk of major flooding of the Dauphin River communities in the spring of 2012 due to ice jam formations and unprecedented flows. It was determined that the construction of a Reach 3 Emergency Channel would divert flows away from the Dauphin River prior to the spring break up and, in combination with the dikes being constructed along the banks of the Dauphin River, substantially reduce the risk of flooding for the Dauphin River communities.

Five versions (3A to 3E) of the Reach 3 Emergency Channel were initially examined. Reach 3E was determined to be the most feasible option and is referred to simply as Reach 3 throughout the remainder of this report. The excavated Reach 3 would be terminated at an outlet approximately 3 km short of Lake Winnipeg as the slope of the natural ground surface increases fairly significantly at this point. The outlet and a length of approximately 300 m of Reach 3 leading up to the outlet would be overlaid with a riprap blanket to minimize erosion as the water exits the excavated channel. From the

outlet of Reach 3 the water would flow along the ground and through the natural ground cover before entering Lake Winnipeg. It was anticipated that the flow would initially be shallow and widespread over land west of Willow Point. It was expected that Reach 3 would only operate for a short period of time to effectively remove the threat of flooding during the freshet. However, an exceptionally mild winter allowed sufficient drainage from Lake Manitoba and Lake St. Martin to reduce water levels to a point where risk of ice jamming and flooding at Dauphin River became negligible. Consequently, Reach 3 was not operated and field investigations related to fish movements into Reach 3 were therefore not conducted.

3.0 WATER QUALITY

Changes in flow regimes (rate and seasonality of flow), flooding along the diversion route, and erosion and mobilization of sediments due to construction and operation of Reach 1 and enhanced flow in Buffalo Creek may result in potential temporary impacts to water quality in water bodies from Lake Manitoba downstream to Sturgeon Bay. A suite of water quality data collections were conducted to provide additional baseline information prior to operation of Reach 1, document changes in water quality during construction and operation of Reach 1, and to help determine the spatial extent over which changes to water quality may occur. The data collections were organized into the following programs:

- A Regional Water Quality Monitoring Program (RWQMP);
- An Environmental Monitoring Program (EMP) conducted during construction of Reach 1 (this component of the water quality sampling programs was conducted by AECOM and KGS Group); and,
- A water quality monitoring program based on in situ measurements and focussed on Sturgeon Bay.

The objectives, methods, and results of fall 2011 monitoring for each program are presented in the following sections. It should be noted that, in some cases, spatial or temporal overlaps in sampling requirements occurred between the RWQMP and the EMP. When this occurred, sampling efforts between the programs were coordinated to minimize sample replication and maximize sampling efficiency. Results were then shared between the two programs.

3.1 REGIONAL WATER QUALITY MONITORING

During the conduct of the RWQMP, water quality information was collected from all major waterbodies and waterways within the study area that were affected by flooding and encompassed the major inputs to the north basin of Lake Manitoba (i.e., Waterhen River and at the Lake Manitoba Narrows) downstream to and including Sturgeon Bay on Lake Winnipeg. The objectives were to provide baseline water quality information to assist with operational and post-project monitoring, to provide information from locations where water quality data were lacking, to supplement data sets at sites within the study area where Manitoba Conservation and Water Stewardship, Water Quality Management Section (MCWS) has conducted long term water quality monitoring, and to evaluate spatial differences in water quality within the study area. Monitoring in fall 2011 was comprised of a single sampling event that included *in situ* water quality measurements and the collection of water samples for laboratory analysis. Detailed methods and results from the fall 2011 sampling event are provided below.

3.1.1 Methods

3.1.1.1 Sampling Sites

Water quality samples and *in situ* measurements were collected at 13 sites throughout area, including the following:

- Waterhen River - one site at the bridge on PTH # 328 (MWS site MB05LHS002);
- Lake Manitoba - one site at Lake Manitoba Narrows (MWS site MB05LKS009);
- Fairford River - one site at or near the PTH # 6 bridge (MWS site MB05LMS001);
- Lake St. Martin - one site in the north basin;
- Dauphin River - two sites, including one site at or near the existing MWS site (MWS Site MB05LMS003), and one site at or near the outflow from Lake St. Martin; and,
- Sturgeon Bay - seven sites, including one at or near the existing MWS site (MWS Site MB05SES012).

Additionally, seven sites were sampled in conjunction with the construction EMP program, including:

- Lake St. Martin - one site near the Reach 1 inlet;
- Buffalo Creek - three sites along the creek; and,
- Dauphin River - three sites; including one upstream of the confluence of Buffalo Creek, one immediately downstream of the confluence of Buffalo Creek, and one site in the mouth of the Dauphin River and upstream of Sturgeon Bay.

Sampling for the RWQMP and one of the sampling sessions for the EMP was conducted concurrently. On that occasion, effort was made to ensure that sampling methods and water quality parameters sampled for were the same at all sites; on other sampling dates, the construction EMP included different parameters than the RWQMP. A list of all sampling sites and locations are provided in Table 3-1 and illustrated in Figure 3-1.

3.1.1.2 Water Quality Parameters

Water quality parameters included in the RWQMP were identified based on the potential linkages between the Project and water quality, including potential effects on TSS (and related variables), effects related to diversion, and potential effects of flooding and/or diversion on water quality (i.e., nutrients, dissolved oxygen, pH and metals), and/or variables that provide supporting information for interpretation of other data. Ultratrace mercury and methylmercury were included to facilitate comparison to the newly revised Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs; MWS 2011) and because both may be affected by flooding. A complete list of water quality parameters selected for laboratory analysis and *in situ* measurements are provided in Table 3-2.

Additionally, samples for the analysis of pesticides and *E. coli* were collected from selected sites. These parameters were included based on consultation with Manitoba Conservation and Water Stewardship, Water Management Section. A full list of pesticide parameters is provided in Table 3-3; this list is consistent with those measured by MCWS in their current water quality monitoring programs in southern/central Manitoba.

3.1.1.3 Field Methods

Sampling sites were accessed by truck, boat, or helicopter depending on site accessibility. Water quality sampling was conducted at the Waterhen River, Lake Manitoba Narrows, the Fairford River and Sturgeon Bay on October 28, 2011, and Lake St. Martin, Buffalo Creek and the Dauphin River on October

29, 2011. Insufficient sample volume was collected for pesticide analysis on October 28 and 29; therefore, additional samples were collected from the Fairford and Dauphin rivers on November 6 to supplement pesticide samples collected on October 28 and 29. A list of samples collected during water quality studies is provided in Appendix 3-1.

In situ measurements of water quality parameters were collected at all sampling sites using a Horiba® W22-XD water quality meter. Parameters included pH, specific conductance, dissolved oxygen (DO), turbidity, and water temperature. At river sites and those accessed from shore *in situ* parameters were measured at approximately 0.3 m below the water surface. At lake sites, *in situ* measurements were recorded both near the surface and at approximately 0.3 m above the lake bottom. Water depth at each site was measured with a handheld depth sounder and sample locations were recorded using a handheld Garmin GPS receiver. Sampling date and time were noted for each sampling site.

At each sampling site, grab samples were collected from approximately 0.3 m below the water surface into clean sample bottles supplied by ALS Laboratories. If thermal stratification was evident (based on *in situ* temperature measurements) at lake sampling sites, the sampling protocol included the collection water samples from approximately 0.3 m above the sediments using a Kemmerer sampler. However, as thermal stratification was not observed, the collection of bottom samples did not occur. Where necessary, samples were preserved according to instructions provided by the analytical laboratory. After collection, samples were placed in a cooler and kept cool using ice packs until submission (within 48 hours) to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. (CALA) accredited laboratory) for analysis.

3.1.1.4 Quality Assurance and Quality Control (QA/QC)

Standard QA/QC measures were followed during sample collection (e.g., use of latex gloves, standard labelling practices, meter calibration, etc.). Additionally, QA/QC samples were collected, including a field blank, a trip blank, and replicate samples.

Field Blanks

Field blanks are intended to provide information on sample contamination from atmospheric exposure and sample handling techniques (i.e., cleanliness of sampling equipment, carry-over contamination from site to site), as well as potential laboratory contamination and/or error (British Columbia Ministry of Environment, Lands, and Parks (BCMELP) 1998). Field blanks were prepared by filling sample bottles with deionized water (both provided by the analytical laboratory) in the field and submitting the blanks along with the environmental samples.

Trip Blanks

Trip blanks are used for evaluating the potential for sample contamination that may occur from the container or preservatives through transport and storage of the sample, as well as laboratory precision (BCMELP 1998). Trip blanks were prepared in the laboratory by filling sample bottles with deionized water. Trip blanks were transported to the field sampling sites, but remained sealed, and were then submitted to the analytical laboratory in conjunction with environmental samples for analysis.

Replicate Samples

Replicate samples were collected at randomly selected sites to provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses. One triplicate and one duplicate sample were collected.

QA/QC Assessment

All water quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as "suspect".

QA/QC samples were assessed according to standard criteria to evaluate precision and identify potential sample contamination issues (BCMELP 1998). Percent relative standard deviation (PRSD) was calculated for triplicate samples as follows:

$$\text{PRSD (\%)} = \text{standard deviation of the triplicate values} / \text{mean of the triplicate values} \times 100$$

The relative percent mean difference (RPMD) was calculated for duplicate samples as follows:

$$\text{RPMD (\%)} = \left| (\text{value 1} - \text{value 2}) / ((\text{value 1} + \text{value 2}) / 2) \right| \times 100$$

Precision of replicate samples was evaluated using the "rule of thumb" criteria for precision of 18% for triplicate samples and 25% for duplicate samples (BCMELP 1998). Where one or more of the replicate values were less than five times the analytical detection limit (DL), an analysis of precision was not undertaken, in accordance with guidance provided in BCMELP (1998).

Field and trip blank results were also evaluated for evidence of sample contamination. Values for any parameter that exceeded five times the DL were considered to be indicative of sample contamination and/or laboratory error.

3.1.1.5 Comparison to Water Quality Objectives and Guidelines

Results were compared to the MWQSOGs (MWS 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999; updated to 2012). Many of the MWQSOGs for PAL are identical to the CCME PAL guidelines for parameters measured; however, there are CCME guidelines for some parameters which lack a provincial guideline/objective and others for which the CCME guideline is different from the provincial one; typically the CCME guideline is more stringent than the MWQSOGs for those guidelines that differ.

Drinking water quality objectives and guidelines are intended to be applied to treated or finished water as it emerges from the tap and "are not intended to be applied directly to source waters" (CCME 1999, updated to 2012). However, comparison of water quality in the study area to drinking water quality objectives and guidelines is included to provide context. The MWQSOGs indicate that "all surface waters…are susceptible to uncontrolled microbiological contamination... [and] it is therefore assumed that all raw surface water supplies will be disinfected as the minimum level of treatment prior to consumption" (MWS 2011). Furthermore, it is indicated that the MWQSOGs "apply to finished drinking water, but can be extrapolated to provide protection to raw drinking water sources."

In general, water quality objectives and guidelines are more stringent for the protection of aquatic life and wildlife, relative to those established to protect various human usages (e.g., drinking water). A summary of relevant water quality objectives and guidelines is presented in Appendix 3-2.

3.1.2 Results

3.1.2.1 Routine Variables and Limnology

Results of the fall 2011 RWQMP for routine water quality parameters are presented in Tables 3-4 and 3-5, and Figures 3-2 and 3-3. Laboratory certificates of analysis are provided in Appendix 3-3.

Based on the results of the RWQMP conducted in fall, 2011, water quality of the study area can be generally described as moderately nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated. Not unexpectedly, both Lake St. Martin and Sturgeon Bay were isothermal in fall 2011. Other *in situ* variables, including DO, turbidity, pH, and specific conductance, were relatively consistent across depth in both lakes.

Total phosphorus (TP) concentrations in the study area were, with the exception of Buffalo Creek, composed primarily of particulate forms. Conversely, at the two upstream sites in Buffalo Creek (BC1 and BC2), TP was composed primarily of dissolved forms. The majority of total nitrogen (TN) was present in organic form at all sites, with ammonia generally comprising a greater amount of dissolved inorganic nitrogen (DIN) than nitrate/nitrite except at the two upstream sites on Buffalo Creek where the reverse

was true. On the basis of TN:TP molar ratios, all waterbodies sampled were phosphorus limited in fall 2011.

The water quality of Buffalo Creek differed from the other waterbodies sampled. Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll *a*, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

The water quality of Sturgeon Bay was influenced by the Dauphin River; sites closest to the mouth (i.e., LKW2 and 3) exhibited higher alkalinity, higher conductivity and TDS, higher concentrations of DIN and TN, dissolved and total organic carbon; and, lower turbidity/TSS and colour, and concentrations of TP and chlorophyll *a* than other sites sampled in Sturgeon Bay.

TP exceeded the MWQSOGs narrative guideline for phosphorus for lakes (i.e., 0.025 mg/L) at Lake Manitoba Narrows, and in Sturgeon Bay at all but the two sites closest to the Dauphin River mouth (i.e. LKW2 and 3). Additionally, the TP concentration at the downstream end of Buffalo Creek (BC3) exceeded the narrative guideline for streams (0.050 mg/L) in one of the replicate samples collected; however, the results for this sample are considered suspect (see page 14). The TP concentration measured in the other sample collected at BC3 was well below the guideline. All other routine water quality variables for which there are MWQSOGs and CCME guidelines, including dissolved oxygen, pH, ammonia, nitrate and nitrite were within PAL objectives and guidelines in fall 2011.

Colour exceeded the MWQSOGs aesthetic objective for drinking water (≤15 TCU) at all three sites in Buffalo Creek. The MWQSOGs aesthetic objective for drinking water for TDS (500 mg/L) was exceeded at the Waterhen River, Lake Manitoba Narrows, the Fairford River, Lake St. Martin, the Dauphin River, and in Sturgeon Bay at the two sites closest to the Dauphin River mouth (i.e., LKW2 and 3). Additionally, laboratory measured pH at Lake Manitoba Narrows and the Fairford River was above the range for the aesthetic objective for drinking water (6.5-8.5). All other routine water quality variables for which there are MWQSOGs for drinking water, including nitrate, nitrite, and nitrate/nitrite were within allowable limits. As discussed in Appendix 3-2, an assessment of the maximum acceptable concentration for drinking water for turbidity was not conducted.

3.1.2.2 Metals and Major Ions

Metal and major ion concentrations measured in the study area in fall 2011 are presented in Table 3-6. A number of metals (total and dissolved forms) were not detected at any site, including: beryllium; bismuth; nickel; silver; tellurium; thallium; tin; tungsten; and, zinc.

Additionally, several metals were not detected in dissolved form at any site, including: cesium; cobalt; lead; thorium; and, zirconium. Aluminum (total), arsenic, barium, calcium, chloride, fluoride, lithium, magnesium, manganese, potassium, rubidium, silicon, sodium, strontium, sulphate, titanium, and vanadium were consistently detected; the remaining metals and major ions were detected in some samples.

Concentrations of major ions and metals were generally lower in Buffalo Creek, compared to other waterbodies in the study area. Conversely, mercury and methyl mercury concentrations were higher, and were consistently detected, at sites in Buffalo Creek than at other sites sampled.

Additionally, concentrations of the major ions (i.e., calcium, chloride, magnesium, potassium, sodium, and sulphate) and hardness were higher at the sites closest to the Dauphin River outflow (LKW2 and 3) than at the other sites sampled in Sturgeon Bay, reflecting the higher concentration of these substances at upstream waterbodies in the region relative to Lake Winnipeg. Conversely, the Dauphin River contained lower concentrations of total aluminum, copper, iron, manganese, titanium, and uranium than sites in Sturgeon Bay most distant from the Dauphin River mouth.

Aluminum exceeded the MWQSOGs and CCME guideline for PAL (0.1 mg/L) at all but one site (LKW2) in Sturgeon Bay, and at one site in Buffalo Creek (BC3), but remained within guidelines in all other waterbodies sampled. Similarly, iron concentrations were above the MWQSOGs and CCME guideline for PAL (0.3 mg/L) at most sites in Sturgeon Bay (LKW1, LKW4 to 7). At most sites chloride concentrations exceeded the CCME long-term guideline for PAL (120 mg/L), including: the Waterhen River; Lake Manitoba Narrows; the Fairford River; Lake St. Martin; all sites on the Dauphin River; and, two sites in Sturgeon Bay (LKW2 and LKW3). Chloride concentrations in Buffalo Creek were consistently below the guideline. Chloride concentrations were well below the CCME short-term guideline for PAL (640 mg/L) at all sites. Fluoride concentrations exceeded the CCME guideline for PAL at the same locations as chloride. In addition, one sample collected at the mouth of the Dauphin River (DR1.1) was above the MWQSOGs and CCME guideline for PAL for selenium and the sample collected in Sturgeon bay nearest the Dauphin River (LK3) was at the PAL guideline; however, the analytical detection limit for selenium (0.001 mg/L) is equal to the guideline and these exceedances should be viewed with caution. All other metals and major ions for which there are MWQSOGs or CCME guidelines for PAL were within objectives and guidelines at each of the sampling sites in fall 2011.

Iron concentrations exceeded the MWQSOGs aesthetic objective for drinking water (0.3 mg/L) at most sites in Sturgeon Bay (LKW1, LKW4 to 7). All other metals and major ions for were within the existing MWQSOGs for drinking water.

3.1.2.3 Pesticides

Pesticides were only measured at selected sites, including: the Fairford River (FR1), Dauphin River (DR1 and DR3) and Sturgeon Bay (LKW7). The results of this analysis are presented in Table 3-7. Glyphosate was detected at all sites sampled on October 28 and 29; all other pesticides, for which sufficient sample was collected to conduct the analysis, were below analytical detection limits on these dates. Pesticides were consistently below the analytical detection limits in samples collected from the Fairford and Dauphin rivers on November 6, after Reach 1 was in operation. Glyphosate concentrations did not exceed the MWQSOGs or CCME guideline for PAL, or the MWQSOGs for drinking water in any samples collected in fall 2011.

3.1.2.4 QA/QC

Field and Trip Blanks

Field and trip blank results indicate high precision and no sample contamination. Measurements for all parameters (metals, dissolved metals and routine parameters) were below the threshold of five times the detection limit (Appendix 3-4).

Replicate Samples

PRSD and RPMD were not derived for several parameters due to low concentrations (i.e., concentrations less than five times the DL). In general, the results indicate good agreement between samples and acceptable levels of precision. The RPMD exceeded threshold values (25% RPMD) for three parameters including: total aluminum (36%); total titanium (26%); and dissolved organic carbon (28%; Appendix 3-4). The PRSD exceeded threshold values (18% PRSD) for two parameters including: dissolved aluminum (41%) and phaeophytin *a* (30%). Additionally, although an RPMD value was not derived, TP and TPP concentrations measured in the duplicate samples collected at BC3 were quite different (e.g., TP = 0.116 mg/L and 0.011 mg/L), and based on values for other parameters measured (e.g., TSS, TKN, and total metals) the TP and TPP results for Replicate 1 are considered suspect.

3.2 CEMP

During construction of Reach 1, water quality was also monitored at sites along the diversion route and at its points of entry (i.e., Lake St. Martin) and exit (i.e., Dauphin River). A detailed report of this sampling program including sites sampled, parameters measured, methods used, and a discussion of the results are presented in AECOM (2012; Appendix 3-5). A brief summary of this program is provided below.

3.2.1 Summary of Methods

As part of the CEMP, water quality was monitored in Lake St. Martin, Buffalo Creek, and in the Dauphin River from September 2 to November 25, 2011. Additionally, following the opening of Reach 1 (November 1, 2011), water quality was monitored in the reach from November 1 to 25, 2011. During Reach 1 construction, monitoring was conducted approximately twice a month. After Reach 1 was opened, sampling frequency increased to twice a week. Water quality parameters measured included: *in situ* measurements of turbidity, DO, pH, conductivity, and temperature; and laboratory analysis of water samples for TSS, nutrients (TP, dissolved P, ammonia, and TN), mercury, and petroleum hydrocarbons (benzene, toluene, ethylbenzene and xylene [BTEX]; and, hydrocarbons F1-F4).

3.2.2 Summary of Results

3.2.2.1 Total Suspended Solids

TSS concentrations increased downstream of Reach 1 after it was opened on November 1, with peak TSS concentrations occurring on November 4. Following Reach 1 operation, TSS concentrations exceeded CCME guidelines within Buffalo Creek and the Dauphin River immediately downstream of the creek; TSS

fell below CCME limits at all sites within two weeks of Reach 1 opening. Following the excavation of the remaining material from the south shore road, a second peak in TSS was observed within Reach 1 on November 17 and at downstream sites a few days later. TSS concentrations remained within CCME guidelines in Buffalo Creek and the Dauphin River during this second peak. TSS concentrations had not returned to baseline at the end of the monitoring period and AECOM (2012) recommended that monitoring continue.

3.2.2.2 Nutrients

AECOM (2012) concluded that ammonia concentrations exceeded CCME guidelines at several sites and times during the monitoring program. The CCME guideline for ammonia is dependent upon the specific temperature and pH of the water in question. In their assessment of the CCME guideline for ammonia, AECOM (2012) took a conservative approach and applied the most stringent value calculated for the sampling program to all sampling locations and dates. A reassessment of the results using sample specific guidelines (i.e., calculated based on the temperature and pH measured *in situ* at the time and location the sample was collected) indicated that all ammonia-N results were well below the CCME guidelines for PAL. Nitrate and nitrite were consistently below the CCME guidelines for PAL at all sites and times sampled. There are no CCME guidelines for PAL for other nutrients measured. Based on the data collected by AECOM (2012) there were no indications that the construction of Reach 1or its initial operation resulted in changes to nutrient concentrations downstream.

3.2.2.3 Mercury

The analytical detection limit applied to the majority of the samples collected for the analysis of mercury was typically higher than the CCME guideline for PAL (26 ng/L); as a result, a proper assessment of this guideline could not be conducted. However, the mercury concentrations measured in two samples collected from the Dauphin River, one upstream and one downstream of Buffalo Creek, on October 14, 2011 exceeded the CCME guideline for PAL.

3.2.2.4 Petroleum Hydrocarbons

There was no evidence of hydrocarbon contamination due to construction activities, as petroleum hydrocarbons were not detected during the monitoring program.

3.3 *In Situ* WATER QUALITY MONITORING

In addition to the RWQMP and the Construction EMP, an intensive *in situ* water quality monitoring program was conducted in Sturgeon Bay, and on the Dauphin River. The intent of the sampling was to gather spatial information on the water quality of Sturgeon Bay, and in particular to define the area of influence of the Dauphin River; as well as to determine what if any spatial differences exist in the water quality of the Dauphin River in relation to Buffalo Creek.

3.3.1 Methods

In Sturgeon Bay, eight transects were established extending approximately four kilometres out from shore (Figure 3-4); seven were located along the southwest shore (T-1 to -6 and T-11) and one was located on the southeast shore just north of Poplar Point (T-9). Five sites were located along each transect, as follows: nearshore (i.e., approximately 50-100 m from shore); and, 0.5 km, 1 km, 2 km, and 4 km from the nearshore site. Additionally, three sites were located in the offshore extensive zone (EZ-1 to -3). The Sturgeon Bay *in situ* water quality sites correspond to the substrate classification sites presented in Section 3.6.

In the Dauphin River, three transects were established across the channel width. Transects were located upstream from Buffalo Creek, immediately downstream from Buffalo Creek and at the Dauphin River mouth (Figure 3-4). Three sampling sites were located along each transect at approximately 25%, 50% and 75% of the wetted width.

In situ measurements were collected at all sampling sites using a Horiba® W22-XD water quality meter. Parameters measured included: pH, specific conductance, DO, turbidity, and temperature. In Sturgeon Bay, *in situ* measurements were recorded both near the surface (i.e., approximately 0.3 m) and at approximately 0.3 m above the lake bottom. At Dauphin River sites, measurements were recorded only near the surface due to high velocities. Water depth at each site was measured with a handheld depth sounder and sample locations were recorded using a handheld Garmin GPS receiver. Sampling date and time were noted for each sampling site. All sites were accessed by boat.

3.3.2 Results

Due to adverse weather, *in situ* sampling was completed over a three week period from September 30 to October 21, 2011. Results of the *In situ* water quality monitoring program are presented in Table 3-8. As a result of the extended time period over which the data were collected, the ability to make spatial comparisons is limited to data collected on the same day.

3.3.2.1 Sturgeon Bay

In general, water quality near the surface was similar to that near the bottom at sites sampled in Sturgeon Bay (Table 3.8). Turbidity (Figure 3-5), DO, and pH were consistent between surface and bottom at all sites, and with the exception of Transects 1 and 2, this was also true for specific conductance (Figure 3-6)Figure . Along Transect 1, specific conductance near the surface was increasingly lower relative to the bottom starting at approximately 1 km offshore, this trend extended out to 4 km offshore. Specific conductance was also lower near the surface than near the bottom at the most offshore site along Transect 2.

Turbidity was variable throughout Sturgeon Bay; however, since the measurements were collected on multiple days over a three week period, the ability to make spatial comparisons is limited to within transect comparisons. Turbidity was generally consistent along Transects 2, 3 and 9 (Figure 3-5). At Transects 4 and 11, turbidity was higher nearshore than offshore. There was also some indication of this

trend of higher turbidity closer to shore at Transects 1 and 6, though the differences were smaller. Turbidity was consistent between sites in the offshore extensive zone.

The ability to make absolute comparisons of specific conductance is limited to measurements collected on the same day; however, specific conductance is typically a variable that is relatively consistent with time and can be useful in determining the extent of the mixing zone between two water masses. Measureable changes in specific conductance were observed due to inflows from the Dauphin River (Figure 3-6). At the majority of transects, there was a slight decrease in specific conductance at the offshore sites (Figure 3-6). Overall, specific conductance was higher along transects located closer to the Dauphin River mouth (i.e., T-2, T-3, T-4 and T-5) than along transects located in the southern area of the bay (i.e., T-1, T-11, T-9). Transect 6, which was located along the northern edge of the river plume, showed an increase in specific conductance from nearshore to 1 km offshore, followed by a decrease in specific conductance to 4 km offshore. Based on specific conductance measurements, the mixing zone of the Dauphin River in Sturgeon Bay extended offshore at least five kilometers and down the south shore of the bay as far as Willow Point.

There was no difference in pH or DO from nearshore to offshore in Sturgeon Bay, and pH and DO were similar throughout the area sampled. Sturgeon Bay was well-oxygenated and all DO measurements exceeded the MWQSOGs objectives and the CCME guidelines for PAL. All pH measurements were within the MWQSOGs and CCME guidelines for PAL.

3.3.2.2 Dauphin River

In the Dauphin River, *in situ* water quality was similar upstream and downstream of Buffalo Creek (Table 3-8). Likewise, no difference in water quality was observed across transects.

3.4 SUMMARY

RWQMP

During the conduct of the RWQMP, water quality information was collected from all major waterbodies and waterways within the study area that were affected by flooding and encompassed the major inputs to the north basin of Lake Manitoba (i.e., Waterhen River and at the Lake Manitoba Narrows) downstream to and including Sturgeon Bay on Lake Winnipeg. The objectives of the program were to:

- provide baseline water quality information to assist with operational and post-project monitoring
- to provide information from locations where water quality data were lacking;
- supplement data sets at sites within the study area where Manitoba Conservation and Water Stewardship, Water Quality Management Branch (MCWS) conducts water quality monitoring; and,
- evaluate spatial differences in water quality within the study area.

RWQMP results indicate that water quality within the study area can be generally described as moderately nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated.

The water quality of Buffalo Creek differed from the other waterbodies sampled. Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll a, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

Both Lake St. Martin and Sturgeon Bay were isothermal in fall 2011. Other in situ variables, including DO, turbidity, pH, and specific conductance, were relatively consistent across depth in both lakes. Molar ratios of N:P indicated that all of the sampled waterbodies were phosphorus limited in fall 2011. Total phosphorus exceeded the MWQSOG guidelines at Lake Manitoba Narrows and several sites in Sturgeon Bay, but all other routine water quality variables for which there are MWQSOG and CCME guidelines, including DO, pH, ammonia, nitrate and nitrite were within PAL objectives and guidelines at all locations.

The water quality of Sturgeon Bay was also influenced by the Dauphin River such that sites closest to the river mouth exhibited water quality similar to upstream sites, including: higher alkalinity, conductivity, TDS, nitrogen and carbon concentrations and lower turbidity/TSS, colour, phosphorus and chlorophyll a.

Concentrations of major ions and metals were generally lower in Buffalo Creek, compared to other waterbodies in the study area. Conversely, mercury and methyl mercury concentrations were higher, and were consistently detected, at sites in Buffalo Creek than at other sites sampled. Additionally, concentrations of the major ions (i.e., calcium, chloride, magnesium, potassium, sodium, and sulphate) and hardness were higher at the sites closest to the Dauphin River outflow (LKW2 and 3) than at the other sites sampled in Sturgeon Bay, reflecting the higher concentration of these substances at upstream waterbodies in the region relative to Lake Winnipeg. Conversely, the Dauphin River contained lower concentrations of total aluminum, copper, iron, manganese, titanium, and uranium than sites in Sturgeon Bay most distant from the Dauphin River mouth.

Aluminum, chloride, fluoride, iron, and selenium all exceeded PAL guidelines or objectives on at least one occasion within the study area. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL.

Of the 58 pesticides analysed for, only glyphosate was detected in the study area during fall 2011 and it did not exceed the federal and provincial guidelines for PAL.

Construction EMP Monitoring

Construction EMP monitoring was conducted from September 2 to November 25, 2011. Additionally, following the opening of Reach 1 (November 1, 2011), water quality was monitored in the reach from November 1 to 25, 2011. The objective was to describe baseline water quality parameters and to monitor potential changes to water quality in Buffalo Creek and the lower Dauphin River during construction and early operation of Reach 1.

Construction EMP monitoring indicated that TSS concentrations had returned to near baseline conditions by the end of November following an initial increase measured during the opening of Reach 1 in early November (AECOM 2012). Immediately following the opening of Reach 1, the TSS concentrations exceeded CCME guidelines within Buffalo Creek and the Dauphin River immediately downstream of the creek, but fell below limits within two weeks.

Based on the data collected by AECOM (2012) there were no indications that the construction of Reach 1 or its initial operation resulted in changes to nutrient concentrations downstream. However, the mercury concentrations measured in two samples collected from the Dauphin River, one upstream and one downstream of Buffalo Creek, on October 14, 2011 exceeded the CCME guideline for PAL. There was no evidence of hydrocarbon contamination due to construction activities, as petroleum hydrocarbons were not detected during the monitoring program.

In situ and TSS Monitoring

In situ and TSS monitoring were conducted in Sturgeon Bay from September 30 to October 21, 2011. Objectives were to:

- collect baseline water quality information in Sturgeon Bay and the Dauphin River;
- help delineate the spatial extent over which suspended sediment inputs may be distributed in Sturgeon Bay and the Dauphin River; and,
- develop a reliable turbidity/TSS relationship for analysis of turbidity data.

In general, water quality near the surface was similar to that near the bottom at sites sampled in Sturgeon Bay. Turbidity was variable throughout Sturgeon Bay; however, since the measurements were collected on multiple days over a three week period, the ability to make spatial comparisons is limited to within transect comparisons. There was some evidence of higher turbidity at sites closer to shore along several of the Sturgeon Bay transects. There was no difference in pH or DO from nearshore to offshore in Sturgeon Bay, and pH and DO were similar throughout the area sampled. Sturgeon Bay was well-oxygenated and all DO measurements exceeded the MWQSOGs objectives and the CCME guidelines for PAL. All pH measurements were within the MWQSOGs and CCME guidelines for PAL.

In the Dauphin River, in situ water quality was similar upstream and downstream of Buffalo Creek. Likewise, no difference in water quality was observed across transects.

Table 3-1. Location of sites sampled as part of the RWQMP conducted during fall 2011.

Waterbody	Location Description	Site ID	MWS Site	Location [1]	
				Easting	Northing
Waterhen River	at PTH #328	WHR1	MB05LHS002	462204	5742368
Lake Manitoba	at Lake Manitoba Narrows	NARR1	MB05LKS009	515348	5658969
Fairford River	near PTH #6	FR1	MB05LMS001	518838	5715229
Lake St. Martin	North basin	LSM1	-	550136	5736730
	Near the inlet to Reach 1	LSM2[2]	-	552303	5738143
Buffalo Creek [2]		BC1	-	562544	5745653
		BC2	-	564247	5747173
		BC3	-	562318	5454770
Dauphin River	River inlet at Lake St. Martin	DR1.1	-	547332	5741774
	Between Gypsumville and Anama Bay	DR1.3	MB05LMS003	546106	5757242
		DR1[2]	-	561896	5754959
		DR3[2]	-	562432	5754831
	River mouth at Lake Winnipeg	DR02[2]	-	564025	5756392
Sturgeon Bay		LKW1	-	578400	5750390
		LKW2	-	571480	5754215
		LKW3	-	569032	5759095
		LKW4	-	566327	5765369
		LKW5	-	577144	5758612
		LKW6	-	573290	5762611
		LKW7	MB05SES012	574055	5771081

1 - UTM coordinates; Datum NAD 83, Zone 14U

2 - Sample collected as part of the construction EMP program. LSM2 is known as site LM01 in the 2011 EMP program (AECOM 2012).

Table 3-2. Water quality parameters measured as part of the RWQMP conducted during fall, 2011.

Routine Parameters	Metals and Major Ions
Alkalinity	Metals (Total and Dissolved)
Dissolved Organic Carbon	Antimony (Sb)
Total Inorganic Carbon	Arsenic (As)
Total Organic Carbon	Barium (Ba)
Colour, True	Beryllium (Be)
Conductivity (at 25°C)	Bismuth (Bi)
Hardness (Calculated from metals)	Boron (B)
Total Kjeldahl Nitrogen	Cadmium (Cd)
Ammonia-N	Calcium (Ca)
Nitrate+Nitrite- N	Cesium (Cs)
Nitrite-N	Chromium (Cr)
Nitrate-N	Chloride (dissolved)
Phosphorus, Total	Cobalt (Co)
Phosphorus, Total Dissolved	Copper (Cu)
Phosphorus Total Particulate (Calculated)	Fluoride (dissolved)
pH	Iron (Fe)
Total Dissolved Solids	Lead (Pb)
Total Suspended Solids	Lithium (Li)
Turbidity	Magnesium (Mg)
	Manganese (Mn)
In Situ Parameters	Molybdenum (Mo)
pH	Mercury (Hg)
Temperature	Nickel (Ni)
Dissolved oxygen	Potassium (K)
Turbidity	Rubidium (Rb)
Specific Conductance	Selenium (Se)
	Silicon (Si)
	Silver (Ag)
	Sodium (Na)
	Strontium (Sr)
	Tellurium (Te)
	Sulphate (dissolved)
	Thallium (Tl)
	Thorium (Th)
	Tin (Sn)
	Titanium (Ti)
	Tungsten (W)
	Uranium (U)
	Vanadium (V)
	Zinc (Zn)
	Zirconium (Zr)
	Methylmercury

Table 3-3. Pesticide parameters analyzed from selected sites as part of the RWQMP conducted during fall, 2011.

Parameter	
2,4,6-Tribromophenol	Eptam
2,4-D	Ethalfluralin
2,4-DB	Fenoxaprop
2,4-Dichlorophenylacetic Acid	g-chlordane
2,4-DP	Glyphosate
2-Fluorobiphenyl	Imazamethabenz-methyl
2-Fluorobiphenyl	Lindane
a-chlordane	Malathion
Alachlor	MCPA
alpha-BHC	Mecoprop
Atrazine	Methoxychlor
Atrazine Desethyl	Methyl Parathion
Azinphos-methyl	Metribuzin
Benomyl	Metsulfuron-methyl
beta-BHC	Parathion
Bromacil	Pentachlorophenol
Bromoxynil	Picloram
Carbofuran	Propachlor
Carboxin	Propanil
Chlorothalonil	Propoxur
Chlorpyrifos	Quizalofop
Cyanazine	Sethoxydim
d14-Terphenyl	Simazine
d14-Terphenyl	Terbufos
delta-BHC	Thifensulfuron-methyl
Deltamethrin	Tralkoxydim
Diazinon	Triallate
Dicamba	Tribenuron-methyl
Diclofop-methyl	Triclopyr
Dimethoate	Trifluralin
Dinoseb	Trifluralin
Diuron	

Table 3-4. *In situ* water quality measurements recorded as part of the RWQMP conducted in fall 2011.

Sample Location	Location ID	Sample Date	Water Depth (m)	Measurement Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Waterhen	WHR1	28-Oct-11	-	0.3	4.4	11.87	1290	20.4	7.75
Lake Manitoba Narrows	NARR1	28-Oct-11	-	0.3	4.7	10.76	1290	39.0	7.88
Fairford River	FR1	28-Oct-11	-	0.3	5.5	11.46	1310	70.4	8.04
Lake St. Martin	LSM1	29-Oct-11	3.6	0.3	5.2	11.98	1360	17.3	8.18
		29-Oct-11	-	3.3	5.2	11.97	1360	17.8	8.18
	LSM2	29-Oct-11	-	0.3	4.6	13.09	1190	4.82	8.49
Dauphin River	DR1.1	29-Oct-11	3.1	0.3	5.1	12.08	136.0	18.9	8.18
				2.8	5.0	11.90	136.0	19.4	8.18
		6-Nov-11	-	0.3	3.8	12.17	130.0	23.0	8.18
	DR1.3	29-Oct-11	-	0.3	4.7	11.32	1370	18.5	8.07
	DR1	29-Oct-11	-	0.3	4.8	14.10	1200	5.86	8.38
	DR3	29-Oct-11	-	0.3	4.6	10.81	1140	5.49	8.32
	DR02	29-Oct-11	3.0	0.3	4.7	11.84	1370	31.5	8.16
		6-Nov-11	-	0.3	3.5	11.66	1300	18.4	8.05
Sturgeon Bay	LKW1	28-Oct-11	4.7	0.3	5.3	12.32	418	88.1	8.14
				4.4	5.3	12.36	417	93.2	8.14
	LKW2	28-Oct-11	4.4	0.3	4.9	12.12	1340	23.0	8.11
				4.1	4.9	12.90	1340	26.4	8.12
	LKW3	28-Oct-11	7.1	0.3	5.1	11.60	1300	25.1	8.06
				6.8	5.1	11.67	1300	25.9	8.07
	LKW4	28-Oct-11	7.8	0.3	5.5	12.02	702	37.2	7.87
				7.5	5.5	11.97	705	36.3	8.02

Table 3-4. (continued).

Sample Location	Location ID	Sample Date	Water Depth (m)	Measurement Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Sturgeon Bay	LKW5	28-Oct-11	8.4	0.3	5.6	11.89	558	56.2	8.05
				8.0	5.1	11.83	700	58.3	7.00
	LKW6	28-Oct-11	9.1	0.3	5.5	11.78	734	37.0	8.11
				8.8	5.4	11.60	749	40.1	8.09
	LKW7	28-Oct-11	6.7	0.3	5.9	11.96	555	47.4	8.01
				6.4	5.8	11.93	559	50.0	8.03
Buffalo Creek	BC1	29-Oct-11	-	0.3	3.5	11.96	186	0.79	7.42
	BC2	29-Oct-11	-	0.3	3.1	11.56	194	2.96	7.84
	BC3	29-Oct-11	-	0.3	2.6	11.99	254	5.93	7.77

Table 3-5. Laboratory results for routine water quality parameters analyzed as part of the RWQMP conducted in fall 2011.

Sample Location	Location ID	Sample Date	Lab pH	Alkalinity			
				as Bicarbonate (HCO_3^-) (mg/L)	as $CaCO_3$ (mg/L)	as Carbonate (CO_3^{2-}) (mg/L)	as Hydroxide (OH^-) (mg/L)
Analytical Detection Limits			*0.10*	*2.0*	*1.0*	*0.60*	*0.40*
Waterhen River	WHR1	28-Oct-11	8.29	217	178	<0.60	<0.40
Lake Manitoba Narrows	NARR1	28-Oct-11	8.54	246	218	8.97	<0.40
Fairford River	FR1	28-Oct-11	8.51	225	199	7.33	<0.40
Lake St. Martin	LSM1	29-Oct-11	8.47	230	201	6.42	<0.40
	LSM2	29-Oct-11	8.46	234	204	6.22	<0.40
Dauphin River	DR1.1	29-Oct-11	8.46	232	202	5.96	<0.40
	DR1.3	29-Oct-11	8.40	236	203	4.38	<0.40
	DR1	29-Oct-11	8.46	233	203	6.15	<0.40
	DR3	29-Oct-11	8.43	231	200	5.17	<0.40
	DR02	29-Oct-11	8.40	236	203	4.32	<0.40
Sturgeon Bay	LKW1	28-Oct-11	8.37	136	117	2.42	<0.40
	LKW2	28-Oct-11	8.42	232	200	4.45	<0.40
	LKW3	28-Oct-11	8.39	228	195	3.73	<0.40
	LKW4	28-Oct-11	8.38	173	148	2.88	<0.40
	LKW5	28-Oct-11	8.36	154	132	2.29	<0.40
	LKW6	28-Oct-11	8.38	177	151	2.99	<0.40
	LKW7	28-Oct-11	8.35	152	129	2.16	<0.40
Buffalo Creek	BC1	29-Oct-11	8.12	151	124	<0.60	<0.40
	BC2	29-Oct-11	8.19	152	124	<0.60	<0.40
	BC3	29-Oct-11	8.19	160	131.5	<0.60	<0.40

Table 3-5. (continued).

Sample Location	Location ID	Sample Date	Nitrogen					Phosphorus		
			Dissolved Ammonia (mg/L N)	Nitrate/ nitrite (mg/L N)	Nitrate-N (mg/L N)	Nitrite-N (mg/L N)	TKN (mg/L N)	Total (mg/L P)	Dissolved (mg/L P)	Total Particulate (mg/L P)
Analytical Detection Limits			*0.010*	*0.0051*	*0.0050*	*0.0010*	*0.20*	*0.010*	*0.0020/0.010*	*0.010/0.014*
Waterhen River	WHR1	28-Oct-11	0.016	0.0054	0.0054	<0.0010	0.83	0.014	<0.0020	0.012
Lake Manitoba	NARR-1	28-Oct-11	0.017	<0.0051	<0.0050	<0.0010	1.13	0.028	0.0049	0.023
Fairford River	FR1	28-Oct-11	0.023	<0.0051	<0.0050	<0.0010	1.31	0.029	0.0039	0.025
Lake St. Martin	LSM1	29-Oct-11	0.052	0.0139	0.0122	0.0017	1.14	0.013	<0.0020	0.012
	LSM2	29-Oct-11	0.044	0.0086	0.0086	<0.0010	1.11	0.016	<0.010	<0.014
Dauphin River	DR1.1	29-Oct-11	0.060	0.0272	0.0251	0.0021	1.06	0.013	0.003	0.01
	DR1.3	29-Oct-11	0.069	0.0152	0.0130	0.0022	1.10	0.014	<0.0020	0.012
	DR1	29-Oct-11	0.069	0.0174	0.0148	0.0026	1.09	0.017	<0.010	<0.014
	DR3	29-Oct-11	0.068	0.0168	0.0146	0.0022	1.08	0.017	<0.010	<0.014
	DR02	29-Oct-11	0.067	0.0166	0.0141	0.0025	1.11	0.018	<0.0020	0.017
Sturgeon Bay	LKW1	28-Oct-11	<0.010	<0.0051	<0.0050	<0.0010	0.68	0.043	0.0156	0.027
	LKW2	28-Oct-11	0.035	0.0177	0.0164	0.0013	1.07	0.018	0.0037	0.014
	LKW3	28-Oct-11	0.033	0.0173	0.0161	0.0012	1.05	0.022	0.0021	0.020
	LKW4	28-Oct-11	0.012	0.0063	0.0063	<0.0010	0.76	0.031	0.0047	0.027
	LKW5	28-Oct-11	<0.010	<0.0051	0.0050	<0.0010	0.62	0.029	0.0122	0.016
	LKW6	28-Oct-11	0.013	0.0119	0.0116	<0.0010	0.79	0.029	0.0039	0.025
	LKW7	28-Oct-11	<0.010	0.0230	0.0230	<0.0010	0.72	0.036	0.0140	0.022
Buffalo Creek	BC1	29-Oct-11	<0.010	0.0308	0.0308	<0.0010	0.81	0.024	0.020	<0.014
	BC2	29-Oct-11	<0.010	0.0063	0.0063	<0.0010	0.80	0.025	0.022	<0.014
	BC3	29-Oct-11	<0.010	<0.0051	<0.0050	<0.0010	0.76	0.064	0.016	0.051

Table 3-5. (continued).

Sample Location	Location ID	Sample Date	Carbon			Conductivity (µmhos/cm)	TDS (mg/L)
			Total Inorganic (mg/L)	Total Organic (mg/L)	Dissolved Organic (mg/L)		
Analytical Detection Limits			*1.0*	*1.0*	*1.0*	*20*	*5.0*
Waterhen River	WHR1	28-Oct-11	39.3	12.5	12.6	1040	646
Lake Manitoba	LMBNARR1	28-Oct-11	47.6	13.4	13.2	1030	696
Fairford River	FR1	28-Oct-11	43.3	14.9	13.4	1060	676
Lake St. Martin	LSM1	29-Oct-11	45.0	13.5	12.0	1080	652
	LSM2	29-Oct-11	30.2	14.8	13.7	1060	704
Dauphin River	DR1.1	29-Oct-11	45.8	14.0	12.8	1080	692
	DR1.3	29-Oct-11	46.5	14.3	12.5	1090	676
	DR1	29-Oct-11	37.5	13.3	13.0	1060	704
	DR3	29-Oct-11	32.3	13.9	13.0	1030	726
	DR02	29-Oct-11	46.5	14.6	13.8	1090	656
Sturgeon Bay	LKW1	28-Oct-11	25.7	8.9	8.4	410	230
	LKW2	28-Oct-11	45.4	14.5	12.7	1070	658
	LKW3	28-Oct-11	44.5	13.8	12.0	1040	614
	LKW4	28-Oct-11	33.2	10.8	9.8	678	380
	LKW5	28-Oct-11	29.9	9.7	8.7	546	310
	LKW6	28-Oct-11	34.0	10.6	9.9	706	398
	LKW7	28-Oct-11	28.9	9.3	8.5	540	286
Buffalo Creek	BC1	29-Oct-11	22.3	20.7	20.8	217	164
	BC2	29-Oct-11	23.5	19.1	16.9	217	166
	BC3	29-Oct-11	21.3	19.6	17.3	237	177

Table 3-5. (continued).

Sample Location	Location ID	Sample Date	Water Clarity			Algal Pigments	
			TSS (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll *a* (µg/L)	Phaeophyton a (µg/L)
Analytical Detection Limits			*2.0*	*0.10*	*5.0*	*0.10*	*0.10*
Waterhen River	WHR1	28-Oct-11	2.4	2.5	6.4	3.37	1.42
Lake Manitoba	NARR1	28-Oct-11	13.2	8.8	7.4	9.16	2.37
Fairford River	FR1	28-Oct-11	26.4	21.0	7.4	11.4	1.95
Lake St. Martin	LSM1	29-Oct-11	4.0	3.8	6.9	6.85	1.83
	LSM2	29-Oct-11	5.8	3.3	8.4	6.98	1.92
Dauphin River	DR1.1	29-Oct-11	2.9	3.9	8.1	7.93	1.38
	DR1.3	29-Oct-11	2.8	3.4	10.8	6.97	1.62
	DR1	29-Oct-11	8.0	4.7	8.5	5.83	1.79
	DR3	29-Oct-11	7.5	4.5	10.4	5.98	1.80
	DR02	29-Oct-11	7.6	5.1	6.4	5.75	2.04
Sturgeon Bay	LKW1	28-Oct-11	24.0	30.0	9.5	14.7	2.61
	LKW2	28-Oct-11	7.2	5.6	9.0	7.33	1.95
	LKW3	28-Oct-11	6.8	6.6	9.5	7.04	1.60
	LKW4	28-Oct-11	10.4	14.1	11.8	13.3	1.90
	LKW5	28-Oct-11	8.8	16.5	10.5	11.0	1.32
	LKW6	28-Oct-11	10.7	14.9	11.1	8.62	1.75
	LKW7	28-Oct-11	8.8	19.3	12.5	10.6	1.48
Buffalo Creek	BC1	29-Oct-11	<2.0	0.7	52.3	0.51	0.57
	BC2	29-Oct-11	<2.0	0.9	51.5	0.37	0.61
	BC3	29-Oct-11	4.2	4.8	53.2	0.52	0.77

Table 3-6. Concentrations of metals and major ions measured as part of the RWQMP conducted in fall 2011. Units are mg/L unless otherwise indicated.

Sample Location	Location ID	Sample Date	Hardness as $CaCO_3$	Aluminum		Antimony		Arsenic	
				Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.30*	*0.0020*	*0.0050*	*0.00020*	*0.00020*	*0.00020*	*0.00020*
Waterhen River	WHR1	28-Oct-11	260	<0.0020	0.0124	<0.00020	<0.00020	0.00187	0.00207
Lake Manitoba	NARR1	28-Oct-11	296	0.0023	0.0528	0.00020	0.00021	0.00383	0.0037
Fairford River	FR1	28-Oct-11	323	<0.0020	0.0651	<0.00020	<0.00020	0.00283	0.00289
Lake St. Martin	LSM1	29-Oct-11	341	<0.0020	0.0388	<0.00020	<0.00020	0.00296	0.00275
	LSM2	29-Oct-11	328	0.0041	0.0346	<0.00020	<0.00020	0.00269	0.00260
Dauphin River	DR1.1	29-Oct-11	319	<0.0020	0.0355	<0.00020	<0.00020	0.00312	0.00262
	DR1.3	29-Oct-11	308	<0.0020	0.0291	<0.00020	<0.00020	0.00287	0.00274
	DR1	29-Oct-11	358	0.0039	0.0621	<0.00020	<0.00020	0.00293	0.00251
	DR3	29-Oct-11	337	0.0036	0.0369	<0.00020	<0.00020	0.00273	0.00243
	DR02	29-Oct-11	332	<0.0020	0.0773	<0.00020	<0.00020	0.00328	0.00271
Sturgeon Bay	LKW1	28-Oct-11	163	0.117	1.1000	<0.00020	<0.00020	0.00163	0.00173
	LKW2	28-Oct-11	300	0.0023	0.0949	<0.00020	<0.00020	0.00275	0.00255
	LKW3	28-Oct-11	324	0.0029	0.1690	<0.00020	<0.00020	0.00286	0.00254
	LKW4	28-Oct-11	218	0.0629	0.5190	<0.00020	<0.00020	0.00212	0.00205
	LKW5	28-Oct-11	193	0.101	0.7100	<0.00020	<0.00020	0.00191	0.00191
	LKW6	28-Oct-11	230	0.0578	0.5150	<0.00020	<0.00020	0.00246	0.00210
	LKW7	28-Oct-11	185	0.172	0.9030	<0.00020	<0.00020	0.00209	0.00194
Buffalo Creek	BC1	29-Oct-11	166	0.0052	0.0307	<0.00020	<0.00020	0.00048	0.00045
	BC2	29-Oct-11	166	0.0043	0.0550	<0.00020	<0.00020	0.00050	0.00048
	BC3	29-Oct-11	159	0.0103	0.2185	<0.00020	<0.00020	0.00059	0.00055

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Barium		Beryllium		Bismuth	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00020*	*0.00020*	*0.00020*	*0.00020*	*0.00020*	*0.00020*
Waterhen River	WHR1	28-Oct-11	0.0366	0.0387	<0.00020	<0.00020	<0.00020	<0.00020
Lake Manitoba	NARR1	28-Oct-11	0.0635	0.0690	<0.00020	<0.00020	<0.00020	<0.00020
Fairford River	FR1	28-Oct-11	0.0491	0.0539	<0.00020	<0.00020	<0.00020	<0.00020
Lake St. Martin	LSM1	29-Oct-11	0.0498	0.0535	<0.00020	<0.00020	<0.00020	<0.00020
	LSM2	29-Oct-11	0.0482	0.0508	<0.00020	<0.00020	<0.00020	<0.00020
Dauphin River	DR1.1	29-Oct-11	0.0495	0.0499	<0.00020	<0.00020	<0.00020	<0.00020
	DR1.3	29-Oct-11	0.0495	0.0538	<0.00020	<0.00020	<0.00020	<0.00020
	DR1	29-Oct-11	0.0483	0.0506	<0.00020	<0.00020	<0.00020	<0.00020
	DR3	29-Oct-11	0.0472	0.0486	<0.00020	<0.00020	<0.00020	<0.00020
	DR02	29-Oct-11	0.0497	0.0530	<0.00020	<0.00020	<0.00020	<0.00020
Sturgeon Bay	LKW1	28-Oct-11	0.0317	0.0406	<0.00020	<0.00020	<0.00020	<0.00020
	LKW2	28-Oct-11	0.0493	0.0510	<0.00020	<0.00020	<0.00020	<0.00020
	LKW3	28-Oct-11	0.0478	0.0501	<0.00020	<0.00020	<0.00020	<0.00020
	LKW4	28-Oct-11	0.0397	0.0430	<0.00020	<0.00020	<0.00020	<0.00020
	LKW5	28-Oct-11	0.0355	0.0428	<0.00020	<0.00020	<0.00020	<0.00020
	LKW6	28-Oct-11	0.0397	0.0452	<0.00020	<0.00020	<0.00020	<0.00020
	LKW7	28-Oct-11	0.0374	0.0412	<0.00020	<0.00020	<0.00020	<0.00020
Buffalo Creek	BC1	29-Oct-11	0.00734	0.00780	<0.00020	<0.00020	<0.00020	<0.00020
	BC2	29-Oct-11	0.00751	0.00804	<0.00020	<0.00020	<0.00020	<0.00020
	BC3	29-Oct-11	0.00922	0.01032	<0.00020	<0.00020	<0.00020	<0.00020

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Boron		Cadmium		Calcium	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.010*	*0.010*	*0.000010*	*0.000010*	*0.050*	*0.10*
Waterhen River	WHR1	28-Oct-11	0.086	0.076	<0.000010	<0.000010	51.2	49.8
Lake Manitoba	NARR1	28-Oct-11	0.098	0.113	<0.000010	0.000012	47.6	47.2
Fairford River	FR1	28-Oct-11	0.115	0.096	<0.000010	0.000010	44.2	48.0
Lake St. Martin	LSM1	29-Oct-11	0.119	0.106	<0.000010	0.000049	44.7	54.8
	LSM2	29-Oct-11	0.089	0.096	0.000016	<0.000010	46.0	53.7
Dauphin River	DR1.1	29-Oct-11	0.107	0.112	<0.000010	<0.000010	46.0	45.6
	DR1.3	29-Oct-11	0.098	0.114	<0.000010	<0.000010	47.6	45.1
	DR1	29-Oct-11	0.125	0.117	0.000013	<0.000010	46.4	54.3
	DR3	29-Oct-11	0.122	0.113	<0.000010	<0.000010	46.5	52.1
	DR02	29-Oct-11	0.097	0.113	<0.000010	<0.000010	45.4	54.7
Sturgeon Bay	LKW1	28-Oct-11	0.045	0.034	<0.000010	0.000011	30.9	34.6
	LKW2	28-Oct-11	0.099	0.103	<0.000010	0.000010	48.5	44.0
	LKW3	28-Oct-11	0.098	0.113	<0.000010	0.000010	47.2	54.2
	LKW4	28-Oct-11	0.070	0.061	<0.000010	<0.000010	36.7	39.4
	LKW5	28-Oct-11	0.052	0.048	<0.000010	0.000012	32.5	38.1
	LKW6	28-Oct-11	0.073	0.063	<0.000010	<0.000010	36.1	42.0
	LKW7	28-Oct-11	0.055	0.046	<0.000010	0.000010	33.0	35.9
Buffalo Creek	BC1	29-Oct-11	<0.010	<0.010	<0.000010	<0.000010	22.9	27.2
	BC2	29-Oct-11	<0.010	<0.010	<0.000010	<0.000010	23.3	27.1
	BC3	29-Oct-11	0.014	<0.010	<0.000010	<0.000010	25.9	28.8

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Cesium		Chloride	Chromium		Cobalt	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00010*	*0.00010*	*0.20*	*0.0020*	*0.0010*	*0.00020*	*0.00020*
Waterhen River	WHR1	28-Oct-11	<0.00010	<0.00010	216	<0.0020	<0.0010	<0.00020	<0.00020
Lake Manitoba	NARR1	28-Oct-11	<0.00010	<0.00010	154	<0.0020	<0.0010	<0.00020	<0.00020
Fairford River	FR1	28-Oct-11	<0.00010	<0.00010	197	<0.0020	<0.0010	<0.00020	<0.00020
Lake St. Martin	LSM1	29-Oct-11	<0.00010	<0.00010	205	<0.0020	<0.0010	<0.00020	<0.00020
	LSM2	29-Oct-11	<0.00010	<0.00010	209	<0.0020	<0.0010	<0.00020	<0.00020
Dauphin River	DR1.1	29-Oct-11	<0.00010	<0.00010	204	<0.0020	<0.0010	<0.00020	<0.00020
	DR1.3	29-Oct-11	<0.00010	<0.00010	205	<0.0020	<0.0010	<0.00020	<0.00020
	DR1	29-Oct-11	<0.00010	<0.00010	206	<0.0020	<0.0010	<0.00020	<0.00020
	DR3	29-Oct-11	<0.00010	<0.00010	198	<0.0020	<0.0010	<0.00020	<0.00020
	DR02	29-Oct-11	<0.00010	<0.00010	205	0.0020	<0.0010	<0.00020	<0.00020
Sturgeon Bay	LKW1	28-Oct-11	<0.00010	0.00010	41.3	<0.0020	0.0015	<0.00020	0.00041
	LKW2	28-Oct-11	<0.00010	<0.00010	201	<0.0020	<0.0010	<0.00020	<0.00020
	LKW3	28-Oct-11	<0.00010	<0.00010	194	<0.0020	<0.0010	<0.00020	<0.00020
	LKW4	28-Oct-11	<0.00010	<0.00010	104	<0.0020	<0.0010	<0.00020	<0.00020
	LKW5	28-Oct-11	<0.00010	<0.00010	72.6	<0.0020	<0.0010	<0.00020	0.00025
	LKW6	28-Oct-11	<0.00010	<0.00010	110	0.0022	<0.0010	<0.00020	<0.00020
	LKW7	28-Oct-11	<0.00010	<0.00010	72.3	<0.0020	<0.0010	<0.00020	0.00029
Buffalo Creek	BC1	29-Oct-11	<0.00010	<0.00010	4.07	<0.0020	<0.0010	<0.00020	<0.00020
	BC2	29-Oct-11	<0.00010	<0.00010	4.00	<0.0020	<0.0010	<0.00020	<0.00020
	BC3	29-Oct-11	<0.00010	<0.00010	6.11	<0.0020	<0.0010	<0.00020	<0.00020

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Copper		Fluoride	Iron		Lead	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00020*	*0.00020*	*0.020*	*0.010/0.10*	*0.010/0.10*	*0.000090*	*0.000090*
Waterhen River	WHR1	28-Oct-11	0.00054	0.00041	0.138	<0.010	0.026	<0.000090	<0.000090
Lake Manitoba	NARR1	28-Oct-11	0.00077	0.00071	0.166	<0.010	0.11	<0.000090	0.00018
Fairford River	FR1	28-Oct-11	0.00063	0.00063	0.154	<0.010	0.13	<0.000090	0.000295
Lake St. Martin	LSM1	29-Oct-11	0.00055	0.00050	0.159	<0.010	0.040	<0.000090	0.000288
	LSM2	29-Oct-11	0.00048	0.00051	0.160	<0.10	<0.10	<0.000090	0.000095
Dauphin River	DR1.1	29-Oct-11	0.00067	0.00054	0.160	<0.010	0.045	<0.000090	0.000114
	DR1.3	29-Oct-11	0.00057	0.00046	0.156	<0.010	0.024	<0.000090	0.000095
	DR1	29-Oct-11	0.00054	0.00054	0.153	<0.10	0.12	<0.000090	0.000099
	DR3	29-Oct-11	0.00062	0.00051	0.158	<0.10	<0.10	<0.000090	0.000107
	DR02	29-Oct-11	0.00066	0.00050	0.153	<0.010	0.12	<0.000090	0.000108
Sturgeon Bay	LKW1	28-Oct-11	0.00136	0.00221	0.100	0.010	0.84	<0.000090	0.000416
	LKW2	28-Oct-11	0.00064	0.00055	0.158	<0.010	0.13	<0.000090	0.000174
	LKW3	28-Oct-11	0.00067	0.00065	0.152	<0.010	0.18	<0.000090	0.000137
	LKW4	28-Oct-11	0.00112	0.00137	0.119	<0.010	0.34	<0.000090	0.000210
	LKW5	28-Oct-11	0.00132	0.00176	0.109	0.013	0.47	<0.000090	0.000241
	LKW6	28-Oct-11	0.00112	0.00138	0.121	<0.010	0.34	<0.000090	0.000212
	LKW7	28-Oct-11	0.00154	0.00185	0.105	0.021	0.54	<0.000090	0.000267
Buffalo Creek	BC1	29-Oct-11	<0.00020	<0.00020	0.060	<0.10	<0.10	<0.000090	<0.000090
	BC2	29-Oct-11	<0.00020	0.00021	0.061	<0.10	<0.10	<0.000090	<0.000090
	BC3	29-Oct-11	0.00028	0.000365	0.069	<0.10	0.15	<0.000090	<0.000090

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Lithium		Magnesium		Manganese	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.0020*	*0.0020*	*0.010*	*0.010*	*0.00010*	*0.00030*
Waterhen River	WHR1	28-Oct-11	0.0265	0.0289	26.0	32.9	0.00038	0.00707
Lake Manitoba	NARR1	28-Oct-11	0.0495	0.0510	45.8	43.3	0.00036	0.00764
Fairford River	FR1	28-Oct-11	0.0361	0.0385	37.7	49.3	0.00019	0.01110
Lake St. Martin	LSM1	29-Oct-11	0.0361	0.0411	41.7	49.5	0.00018	0.00491
	LSM2	29-Oct-11	0.0363	0.0371	40.2	47.1	0.00036	0.00540
Dauphin River	DR1.1	29-Oct-11	0.0383	0.0353	43.1	49.7	0.00020	0.00526
	DR1.3	29-Oct-11	0.0386	0.0413	45.0	47.5	0.00030	0.00569
	DR1	29-Oct-11	0.0387	0.0379	41.1	54.0	0.00120	0.00666
	DR3	29-Oct-11	0.0371	0.0355	41.5	50.4	0.00132	0.00648
	DR02	29-Oct-11	0.0363	0.0386	42.0	47.4	0.00033	0.00682
Sturgeon Bay	LKW1	28-Oct-11	0.0141	0.0134	18.8	18.6	0.00047	0.01740
	LKW2	28-Oct-11	0.0382	0.0358	47.7	46.2	0.00026	0.00684
	LKW3	28-Oct-11	0.0375	0.0341	44.3	45.7	0.00022	0.00743
	LKW4	28-Oct-11	0.0218	0.0224	27.6	29.0	0.00045	0.00894
	LKW5	28-Oct-11	0.0170	0.0173	21.2	23.8	0.00047	0.00985
	LKW6	28-Oct-11	0.0219	0.0233	26.3	30.4	0.00034	0.00823
	LKW7	28-Oct-11	0.0162	0.0175	21.7	23.3	0.00066	0.00925
Buffalo Creek	BC1	29-Oct-11	0.0081	0.0059	16.6	23.9	0.00432	0.00574
	BC2	29-Oct-11	0.0071	0.0059	17.3	23.9	0.00318	0.00491
	BC3	29-Oct-11	0.0072	0.0064	17.7	22.5	0.00695	0.01080

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Mercury (ng/L)		Methyl Mercury (ng/L)		Molybdenum	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*1.0*	*1.0*	*0.050*	*0.050*	*0.00010*	*0.00020*
Waterhen River	WHR1	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00189	0.00206
Lake Manitoba	NARR1	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00255	0.00272
Fairford River	FR1	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00216	0.00226
Lake St. Martin	LSM1	29-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00226	0.00242
	LSM2	29-Oct-11	<1.0	1.5	<0.050	<0.050	0.00219	0.00229
Dauphin River	DR1.1	29-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00224	0.00230
	DR1.3	29-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00219	0.00247
	DR1	29-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00217	0.00219
	DR3	29-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00207	0.00211
	DR02	29-Oct-11	<1.0	1.1	<0.050	<0.050	0.00220	0.00240
Sturgeon Bay	LKW1	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00086	0.00088
	LKW2	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00221	0.00207
	LKW3	28-Oct-11	<1.0	1.1	<0.050	<0.050	0.00203	0.00207
	LKW4	28-Oct-11	<1.0	1.1	<0.050	<0.050	0.00135	0.00130
	LKW5	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00105	0.00110
	LKW6	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00137	0.00143
	LKW7	28-Oct-11	<1.0	<1.0	<0.050	<0.050	0.00106	0.00105
Buffalo Creek	BC1	29-Oct-11	1.6	1.9	0.050	0.057	<0.00010	<0.00020
	BC2	29-Oct-11	1.3	1.6	<0.050	0.056	<0.00010	<0.00020
	BC3	29-Oct-11	1.7	2.1	0.052	0.067	<0.00010	<0.00020

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Nickel		Potassium		Rubidium	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.0010*	*0.0020*	*0.020*	*0.020*	*0.00020*	*0.00020*
Waterhen River	WHR1	28-Oct-11	<0.0010	<0.0020	7.51	9.40	0.00347	0.00393
Lake Manitoba	NARR1	28-Oct-11	<0.0010	<0.0020	12.2	12.9	0.00358	0.00372
Fairford River	FR1	28-Oct-11	<0.0010	<0.0020	10.2	10.4	0.00335	0.00411
Lake St. Martin	LSM1	29-Oct-11	<0.0010	<0.0020	10.2	10.8	0.00361	0.00409
	LSM2	29-Oct-11	<0.0010	<0.0020	10.4	10.5	0.00359	0.00406
Dauphin River	DR1.1	29-Oct-11	<0.0010	<0.0020	10.8	11.0	0.00357	0.00385
	DR1.3	29-Oct-11	<0.0010	<0.0020	9.94	10.9	0.00361	0.00412
	DR1	29-Oct-11	<0.0010	<0.0020	10.6	10.5	0.00354	0.00391
	DR3	29-Oct-11	<0.0010	<0.0020	10.3	10.0	0.00352	0.00377
	DR02	29-Oct-11	<0.0010	<0.0020	10.4	10.6	0.00362	0.00417
Sturgeon Bay	LKW1	28-Oct-11	<0.0010	<0.0020	3.63	4.29	0.00148	0.00355
	LKW2	28-Oct-11	<0.0010	<0.0020	10.9	9.80	0.00364	0.00384
	LKW3	28-Oct-11	<0.0010	<0.0020	10.3	9.65	0.00346	0.00391
	LKW4	28-Oct-11	<0.0010	<0.0020	6.24	6.96	0.00227	0.00317
	LKW5	28-Oct-11	<0.0010	<0.0020	4.69	5.71	0.00180	0.00301
	LKW6	28-Oct-11	<0.0010	<0.0020	6.32	7.74	0.00229	0.00330
	LKW7	28-Oct-11	<0.0010	<0.0020	4.92	5.57	0.00199	0.00324
Buffalo Creek	BC1	29-Oct-11	<0.0010	<0.0020	0.91	1.10	0.00164	0.00177
	BC2	29-Oct-11	<0.0010	<0.0020	0.98	0.994	0.00164	0.00177
	BC3	29-Oct-11	<0.0010	<0.0020	1.18	1.37	0.00146	0.00187

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Selenium		Silicon		Silver		Sodium	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.001*	*0.0010*	*0.05*	*0.050*	*0.0001*	*0.00010*	*0.020*	*0.030*
Waterhen River	WHR1	28-Oct-11	<0.0010	<0.0010	4.28	4.29	<0.00010	<0.00010	122	135
Lake Manitoba	NARR1	28-Oct-11	<0.0010	<0.0010	4.81	3.49	<0.00010	<0.00010	105	110
Fairford River	FR1	28-Oct-11	<0.0010	<0.0010	3.56	4.63	<0.00010	<0.00010	121	125
Lake St. Martin	LSM1	29-Oct-11	<0.0010	<0.0010	5.01	4.93	<0.00010	<0.00010	132	132
	LSM2	29-Oct-11	<0.0010	<0.0010	5.01	4.75	<0.00010	<0.00010	138	131
Dauphin River	DR1.1	29-Oct-11	<0.0010	<0.0010	5.17	4.99	<0.00010	<0.00010	134	135
	DR1.3	29-Oct-11	<0.0010	<0.0010	5.02	4.70	<0.00010	<0.00010	131	136
	DR1	29-Oct-11	<0.0010	<0.0010	5.00	5.59	<0.00010	<0.00010	140	147
	DR3	29-Oct-11	<0.0010	0.0011	4.93	5.80	<0.00010	<0.00010	135	144
	DR02	29-Oct-11	<0.0010	<0.0010	5.00	4.73	<0.00010	<0.00010	135	132
Sturgeon Bay	LKW1	28-Oct-11	<0.0010	<0.0010	1.14	2.77	<0.00010	<0.00010	29.5	30.5
	LKW2	28-Oct-11	<0.0010	<0.0010	4.80	4.53	<0.00010	<0.00010	122	130
	LKW3	28-Oct-11	<0.0010	0.0010	5.03	4.87	<0.00010	<0.00010	122	128
	LKW4	28-Oct-11	<0.0010	<0.0010	2.88	3.29	<0.00010	<0.00010	68.1	70.1
	LKW5	28-Oct-11	<0.0010	<0.0010	2.27	3.23	<0.00010	<0.00010	46.8	51.8
	LKW6	28-Oct-11	<0.0010	<0.0010	3.09	3.51	<0.00010	<0.00010	74.3	74.5
	LKW7	28-Oct-11	<0.0010	<0.0010	3.22	4.05	<0.00010	<0.00010	51.2	51.3
Buffalo Creek	BC1	29-Oct-11	<0.0010	<0.0010	7.33	7.72	<0.00010	<0.00010	3.53	5.67
	BC2	29-Oct-11	<0.0010	<0.0010	7.32	7.66	<0.00010	<0.00010	3.62	4.57
	BC3	29-Oct-11	<0.0010	<0.0010	6.67	6.74	<0.00010	<0.00010	6.02	7.59

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Strontium		Sulphate Dissolved	Tellurium		Thallium	
			Dissolved	Total		Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00010*	*0.00010*	*0.50*	*0.00020*	*0.00020*	*0.00010*	*0.00010*
Waterhen River	WHR1	28-Oct-11	0.274	0.291	59.2	<0.00020	<0.00020	<0.00010	<0.00010
Lake Manitoba	NARR1	28-Oct-11	0.307	0.325	138	<0.00020	<0.00020	<0.00010	<0.00010
Fairford River	FR1	28-Oct-11	0.292	0.318	93.5	<0.00020	<0.00020	<0.00010	<0.00010
Lake St. Martin	LSM1	29-Oct-11	0.302	0.315	93.9	<0.00020	<0.00020	<0.00010	<0.00010
	LSM2	29-Oct-11	0.289	0.301	91.9	<0.00020	<0.00020	<0.00010	<0.00010
Dauphin River	DR1.1	29-Oct-11	0.300	0.301	94.2	<0.00020	<0.00020	<0.00010	<0.00010
	DR1.3	29-Oct-11	0.304	0.323	93.7	<0.00020	<0.00020	<0.00010	<0.00010
	DR1	29-Oct-11	0.293	0.300	93.9	<0.00020	<0.00020	<0.00010	<0.00010
	DR3	29-Oct-11	0.283	0.287	90.6	<0.00020	<0.00020	<0.00010	<0.00010
	DR02	29-Oct-11	0.302	0.315	93.5	<0.00020	<0.00020	<0.00010	<0.00010
Sturgeon Bay	LKW1	28-Oct-11	0.143	0.141	38.2	<0.00020	<0.00020	<0.00010	<0.00010
	LKW2	28-Oct-11	0.300	0.283	90.5	<0.00020	<0.00020	<0.00010	<0.00010
	LKW3	28-Oct-11	0.290	0.285	87.5	<0.00020	<0.00020	<0.00010	<0.00010
	LKW4	28-Oct-11	0.204	0.190	57.6	<0.00020	<0.00020	<0.00010	<0.00010
	LKW5	28-Oct-11	0.167	0.174	47.6	<0.00020	<0.00020	<0.00010	<0.00010
	LKW6	28-Oct-11	0.206	0.213	59.7	<0.00020	<0.00020	<0.00010	<0.00010
	LKW7	28-Oct-11	0.171	0.163	46.3	<0.00020	<0.00020	<0.00010	<0.00010
Buffalo Creek	BC1	29-Oct-11	0.0332	0.0323	1.44	<0.00020	<0.00020	<0.00010	<0.00010
	BC2	29-Oct-11	0.0336	0.0322	1.42	<0.00020	<0.00020	<0.00010	<0.00010
	BC3	29-Oct-11	0.0438	0.0418	4.95	<0.00020	<0.00020	<0.00010	<0.00010

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Thorium		Tin		Titanium		Tungsten	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00010*	*0.00010*	*0.00020*	*0.00020*	*0.00020*	*0.00020*	*0.00020*	*0.0010*
Waterhen River	WHR1	28-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	0.00034	<0.00020	<0.0010
Lake Manitoba	NARR1	28-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00063	0.00140	<0.00020	<0.0010
Fairford River	FR1	28-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00032	0.00204	<0.00020	<0.0010
Lake St. Martin	LSM1	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00054	0.00098	<0.00020	<0.0010
	LSM2	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00034	0.00085	<0.00020	<0.0010
Dauphin River	DR1.1	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00041	0.00117	<0.00020	<0.0010
	DR1.3	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00048	0.00089	<0.00020	<0.0010
	DR1	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00046	0.00413	<0.00020	<0.0010
	DR3	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00037	0.00142	<0.00020	<0.0010
	DR02	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00064	0.00248	<0.00020	<0.0010
Sturgeon Bay	LKW1	28-Oct-11	<0.00010	0.00028	<0.00020	<0.00020	0.00221	0.04030	<0.00020	<0.0010
	LKW2	28-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00038	0.00360	<0.00020	<0.0010
	LKW3	28-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00042	0.00619	<0.00020	<0.0010
	LKW4	28-Oct-11	<0.00010	0.00013	<0.00020	<0.00020	0.00147	0.01780	<0.00020	<0.0010
	LKW5	28-Oct-11	<0.00010	0.00018	<0.00020	<0.00020	0.00207	0.02410	<0.00020	<0.0010
	LKW6	28-Oct-11	<0.00010	0.00012	<0.00020	<0.00020	0.00139	0.01707	<0.00020	<0.0010
	LKW7	28-Oct-11	<0.00010	0.00020	<0.00020	<0.00020	0.00369	0.02730	<0.00020	<0.0010
Buffalo Creek	BC1	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	0.00098	<0.00020	<0.0010
	BC2	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00021	0.00168	<0.00020	<0.0010
	BC3	29-Oct-11	<0.00010	<0.00010	<0.00020	<0.00020	0.00057	0.00735	<0.00020	<0.0010

Table 3-6. (continued).

Sample Location	Location ID	Sample Date	Uranium		Vanadium		Zinc		Zirconium	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical Detection Limits			*0.00010*	*0.00010*	*0.00020*	*0.00020*	*0.0020*	*0.0050*	*0.00040*	*0.00040*
Waterhen River	WHR1	28-Oct-11	0.00136	0.00145	0.00110	0.00092	<0.0020	<0.0050	<0.00040	<0.00040
Lake Manitoba	NARR1	28-Oct-11	0.00235	0.00231	0.00265	0.00251	0.0089	<0.0050	<0.00040	<0.00040
Fairford River	FR1	28-Oct-11	0.00164	0.00168	0.00164	0.00181	<0.0020	<0.0050	<0.00040	<0.00040
Lake St. Martin	LSM1	29-Oct-11	0.00169	0.00177	0.00220	0.00270	<0.0020	<0.0050	<0.00040	<0.00040
	LSM2	29-Oct-11	0.00157	0.00166	0.00165	0.00135	<0.0020	<0.0050	<0.00040	<0.00040
Dauphin River	DR1.1	29-Oct-11	0.00166	0.00174	0.00200	0.00250	<0.0020	<0.0050	<0.00040	<0.00040
	DR1.3	29-Oct-11	0.00167	0.00179	0.00210	0.00240	<0.0020	<0.0050	<0.00040	<0.00040
	DR1	29-Oct-11	0.00162	0.00170	0.00202	0.00260	<0.0020	<0.0050	<0.00040	<0.00040
	DR3	29-Oct-11	0.00158	0.00163	0.00165	0.00134	<0.0020	<0.0050	<0.00040	<0.00040
	DR02	29-Oct-11	0.00167	0.00178	0.00220	0.00260	<0.0020	<0.0050	<0.00040	<0.00040
Sturgeon Bay	LKW1	28-Oct-11	0.00078	0.00084	0.00134	0.00282	<0.0020	<0.0050	<0.00040	0.00063
	LKW2	28-Oct-11	0.00163	0.00160	0.00176	0.00154	<0.0020	<0.0050	<0.00040	<0.00040
	LKW3	28-Oct-11	0.00154	0.00156	0.00190	0.00230	<0.0020	<0.0050	<0.00040	<0.00040
	LKW4	28-Oct-11	0.00110	0.00109	0.00169	0.00197	<0.0020	<0.0050	<0.00040	<0.00040
	LKW5	28-Oct-11	0.00091	0.00100	0.00147	0.00228	<0.0020	<0.0050	<0.00040	0.00043
	LKW6	28-Oct-11	0.00110	0.00119	0.00170	0.00233	<0.0020	<0.0050	<0.00040	<0.00040
	LKW7	28-Oct-11	0.00094	0.00098	0.00172	0.00263	<0.0020	<0.0050	<0.00040	0.00043
Buffalo Creek	BC1	29-Oct-11	<0.00010	<0.00010	0.00028	0.00023	<0.0020	<0.0050	<0.00040	<0.00040
	BC2	29-Oct-11	<0.00010	<0.00010	0.00040	0.00025	<0.0020	<0.0050	<0.00040	<0.00040
	BC3	29-Oct-11	<0.00010	<0.00010	0.00040	0.00058	<0.0020	<0.0050	<0.00040	<0.00040

Table 3-7. Concentrations of pesticides measured at selected sites as part of the RWQMP conducted in fall 2011.

Location	Location ID	Sample Date	Bromacil (µg/L)	Glyphosate and AMPA		Carboxin (µg/L)	Diuron (µg/L)	Eptam (µg/L)	Fenoxaprop (µg/L)	Imazamethabenz-methyl (µg/L)
				AMPA (µg/L)	Glyphosate (µg/L)					
Analytical Detection Limit			*0.10*	*0.20*	*0.20*	*0.10*	*0.018*	*0.20*	*0.10*	*0.010*
Fairford River	FR1	28-Oct-11	-	<0.20	0.45	<0.10	<0.018	<0.20	<0.10	<0.020
		06-Nov-11	<0.10	<0.20	<0.20	<0.10	<0.018	<0.20	<0.10	<0.010
Dauphin River	DR1.1	29-Oct-11	-	<0.20	0.42	<0.10	<0.018	<0.20	<0.10	<0.010
		06-Nov-11	<0.10	<0.20	<0.20	<0.10	<0.018	<0.20	<0.10	<0.010
	DR02	29-Oct-11	-	<0.20	0.39	<0.10	<0.018	<0.20	<0.10	<0.010
		06-Nov-11	<0.10	<0.20	<0.20	<0.10	<0.018	<0.20	<0.10	<0.010
Sturgeon Bay	LKW7	29-Oct-11	-	<0.20	0.23	<0.10	<0.018	<0.20	<0.10	<0.010

Table 3-7. (continued).

Location	Location ID	Sample Date	Metsulfuron-methyl (µg/L)	Propachlor (µg/L)	Propanil (µg/L)	Propoxur (µg/L)	Quizalofop (µg/L)	Sethoxydim (µg/L)	Thifensulfuron-methyl (µg/L)
Analytical Detection Limit			*0.010*	*0.20*	*0.20*	*0.20*	*0.10*	*0.10*	*0.010*
Fairford River	FR1	28-Oct-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
		06-Nov-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
Dauphin River	DR1.1	29-Oct-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
		06-Nov-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
	DR02	29-Oct-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
		06-Nov-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010
Sturgeon Bay	LKW7	29-Oct-11	<0.010	<0.20	<0.20	<0.20	<0.10	<0.10	<0.010

Table 3-7. (continued).

Location	Location ID	Sample Date	Tralkoxydim (µg/L)	Chlorothalonil (µg/L)	Triclopyr (µg/L)	Benomyl (µg/L)	Deltamethrin (µg/L)	Tribenuron-methyl (µg/L)	Ethalfluralin (µg/L)
Analytical Detection Limit			*0.10*	*0.060*	*0.050*	*0.10*	*0.040*	*0.010*	*0.020*
Fairford River	FR1	28-Oct-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
		06-Nov-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
Dauphin River	DR1.1	29-Oct-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
		06-Nov-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
	DR02	29-Oct-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
		06-Nov-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020
Sturgeon Bay	LKW7	29-Oct-11	<0.10	<0.060	<0.050	<0.10	<0.040	<0.010	<0.020

Table 3-7. (continued).

Location	Location ID	Sample Date	Trifluralin (µg/L)	Alachlor (µg/L)	Atrazine (µg/L)	Atrazine Desethyl (µg/L)	Azinphos-methyl (µg/L)	Carbofuran (µg/L)	Chlorpyrifos (µg/L)	Cyanazine (µg/L)
Analytical Detection Limit			*0.030*	*0.10*	*0.10*	*0.10*	*0.10*	*0.20*	*0.020*	*0.10*
Fairford River	FR1	28-Oct-11	<0.030	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.020	<0.10
Dauphin River	DR1.1	29-Oct-11	<0.030	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.020	<0.10
	DR02	29-Oct-11	<0.030	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.020	<0.10
Sturgeon Bay	LKW7	29-Oct-11	<0.030	-	-	-	-	-	-	-

Table 3-7. (continued).

Location	Location ID	Sample Date	Diazinon (µg/L)	Diclofop-methyl (µg/L)	Dimethoate (µg/L)	Malathion (µg/L)	Methyl Parathion (µg/L)	Metribuzin (µg/L)	Parathion (µg/L)	Simazine (µg/L)
Analytical Detection Limit			*0.030*	*0.10*	*0.10*	*0.10*	*0.10*	*0.20*	*0.10*	*0.10*
Fairford River	FR1	28-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10
Dauphin River	DR1.1	29-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10
	DR02	29-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.030	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10
Sturgeon Bay	LKW7	29-Oct-11	-	-	-	-	-	-	-	-

Table 3-7. (continued).

Location	Location ID	Sample Date	Terbufos (µg/L)	Triallate (µg/L)	Trifluralin (µg/L)	Organochlorine Pesticides				
						alpha-BHC (µg/L)	beta-BHC (µg/L)	delta-BHC (µg/L)	a-chlordane (µg/L)	g-chlordane (µg/L)
Analytical Detection Limit			*0.10*	*0.10*	*0.030*	*0.10*	*0.10*	*0.10*	*0.010*	*0.010*
Fairford River	FR1	28-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.10	<0.030	<0.10	<0.10	<0.10	<0.010	<0.010
Dauphin River	DR1.1	29-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.10	<0.030	<0.10	<0.10	<0.10	<0.010	<0.010
	DR02	29-Oct-11	-	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.10	<0.030	<0.10	<0.10	<0.10	<0.010	<0.010
Sturgeon Bay	LKW7	29-Oct-11	-	-	-	-	-	-	-	-

Table 3-7. (continued).

Location	Location ID	Sample Date	Organochlorine Pesticides		Pentachlorophenol (µg/L)	Phenoxy Acid Herbicides			
			Lindane (µg/L)	Methoxychlor (µg/L)		2,4-D (µg/L)	2,4-DB (µg/L)	2,4-DP (µg/L)	Bromoxynil (µg/L)
Analytical Detection Limit			*0.10*	*0.010*	*0.020*	*0.050*	*0.050*	*0.050*	*0.020*
Fairford River	FR1	28-Oct-11	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.010	<0.020	<0.050	<0.050	<0.050	<0.020
Dauphin River	DR1.1	29-Oct-11	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.010	<0.020	<0.050	<0.050	<0.050	<0.020
	DR02	29-Oct-11	-	-	-	-	-	-	-
		06-Nov-11	<0.10	<0.010	<0.020	<0.050	<0.050	<0.050	<0.020
Sturgeon Bay	LKW7	29-Oct-11	-	-	-	-	-	-	-

Table 3-7. (continued).

Location	Location ID	Sample Date	Phenoxy Acid Herbicides			Mecoprop (µg/L)	Picloram (µg/L)
			Dicamba (µg/L)	Dinoseb (µg/L)	MCPA (µg/L)		
Analytical Detection Limit			*0.0060*	*0.050*	*0.025*	*0.050*	*0.20*
Fairford River	FR1	28-Oct-11	-	-	-	-	-
		06-Nov-11	<0.0060	<0.050	<0.025	<0.050	<0.20
Dauphin River	DR1.1	29-Oct-11	-	-	-	-	-
		06-Nov-11	<0.0060	<0.050	<0.025	<0.050	<0.20
	DR02	29-Oct-11	-	-	-	-	-
		06-Nov-11	<0.0060	<0.050	<0.025	<0.050	<0.20
Sturgeon Bay	LKW7	29-Oct-11	-	-	-	-	-

Table 3-8. *In situ* water quality results measured along transects in Sturgeon Bay and the Dauphin River, fall 2011. Data for Sturgeon Bay are ordered from nearshore to offshore within each transect, and Dauphin River sites are listed from left to right bank when facing upstream. See Figure 3-4 for more detail.

Transect Location	Site ID	Sample Date	Depth (m)		Temperature (°C)	Dissolved Oxygen		Sp. Cond (µS/cm)	Turbidity (NTU)	pH
			Total	Measurement		(mg/L)	(% Saturation)			
Sturgeon Bay	T1-5	12-Oct-11	0.9	0.3	11.9	10.36	97.3	1280	37.6	8.13
				0.7	11.9	10.33	97.0	1280	34.6	8.15
	T1-4	12-Oct-11	4.0	0.3	12.1	10.36	97.7	1290	26.1	8.17
				3.0	12.1	10.32	97.3	1290	24.1	8.19
	T1-3	12-Oct-11	4.5	0.3	12.1	10.41	98.2	1170	17.3	8.15
				3.5	12.1	10.31	97.2	1220	18.8	8.19
	T1-2	12-Oct-11	6.1	0.3	12.2	10.19	96.3	1140	17.5	8.17
				5.1	12.1	10.01	94.4	1200	17.1	8.18
	T1-1	12-Oct-11	6.8	0.3	12.1	10.10	95.3	1040	21.4	8.16
				5.8	12.0	9.00	84.7	1220	30.6	8.14
	T2-5	2-Oct-11	2.0	0.3	12.3	10.16	96.2	1460	39.2	8.24
				1.3	12.3	10.13	95.9	1460	38.1	8.25
	T2-4	2-Oct-11	4.5	0.3	12.4	9.91	94.0	1490	27.4	8.24
				4.0	12.4	9.92	94.1	1490	26.3	8.25
	T2-3	2-Oct-11	6.0	0.3	12.3	10.04	95.1	1410	31.4	8.22
				5.5	12.3	9.90	93.7	1410	32.0	8.24
	T2-2	2-Oct-11	6.9	0.3	12.4	10.03	95.2	1440	28.5	8.18
				6.4	12.3	9.92	93.9	1440	29.1	8.19
	T2-1	2-Oct-11	7.3	0.3	12.4	9.92	94.1	1360	37.3	8.12
				6.6	12.4	9.77	92.7	1410	31.1	8.12
	T3-5	1-Oct-11	1.1	0.3	12.3	10.23	96.9	1510	26.6	8.25
				1.0	12.3	10.19	96.5	1510	27.7	8.25
	T3-4	1-Oct-11	3.4	0.3	12.0	10.02	94.3	1520	28.4	8.24
				3.1	12.0	9.94	93.6	1520	26.8	8.24
	T3-3	1-Oct-11	5.0	0.3	12.2	10.06	95.1	1520	28.4	8.22
				4.0	12.1	9.90	93.4	1520	29.6	8.21
	T3-2	1-Oct-11	5.2	0.3	12.4	9.66	91.7	1510	25.1	8.13
				4.7	12.3	9.56	90.5	1510	26.1	8.13
	T3-1	1-Oct-11	7.1	0.3	12.5	9.96	94.7	1450	43.8	8.00
				6.5	12.4	9.73	92.3	1450	32.7	8.01

Table 3-8. (continued).

Transect Location	Site ID	Sample Date	Depth (m)		Temperature (°C)	Dissolved Oxygen		Sp. Cond (µS/cm)	Turbidity (NTU)	pH
			Total	Measurement		(mg/L)	(% Saturation)			
Sturgeon Bay	T4-5	30-Sep-11	1.1	0.3	12.7	10.13	96.7	1480	75.6	8.25
				0.7	12.7	10.13	96.7	1480	78.9	8.26
	T4-4	30-Sep-11	2.7	0.3	12.6	9.86	93.9	1500	44.1	8.22
				2.2	12.5	9.79	93.1	1500	48.4	8.22
	T4-3	30-Sep-11	3.7	0.3	13.1	9.78	94.1	1490	24.8	8.18
				3.2	13.1	9.76	93.9	1490	28.7	8.19
	T4-2	30-Sep-11	5.2	0.3	12.9	9.13	87.5	1510	24.0	8.10
				4.7	12.9	9.02	86.5	1510	22.1	8.10
	T4-1	30-Sep-11	6.1	0.3	13.1	9.31	89.6	1420	31.3	8.05
				5.7	13.1	9.20	88.5	1420	30.9	8.08
	T5-5	1-Oct-11	1.2	0.3	13.4	10.35	100.2	1510	33.2	8.22
				1.0	13.4	10.33	100.0	1510	31.6	8.22
	T5-4	1-Oct-11	2.5	0.3	13.0	10.16	97.6	1510	35.6	8.21
				1.8	13.0	10.06	96.6	1510	34.7	8.21
	T5-3	1-Oct-11	3.8	0.3	12.9	9.96	95.5	1470	39.6	8.19
				3.1	12.8	9.84	94.1	1480	36.6	8.18
	T5-2	1-Oct-11	6.7	0.3	12.8	9.78	93.6	1440	46.3	8.14
				6.0	12.2	9.63	91.0	1500	48.2	8.14
	T5-1	1-Oct-11	7.0	0.3	12.8	9.84	94.1	1510	35.1	8.20
				6.5	12.7	9.69	92.5	1510	38.9	8.17
	T6-5	30-Sep-11	1.7	0.3	11.7	9.52	89.1	1060	43.4	8.02
				1.2	11.7	9.44	88.3	1060	63.7	8.03
	T6-4	30-Sep-11	4.1	0.3	12.3	9.25	87.6	1130	41.7	8.01
				3.5	12.3	9.16	86.7	1130	50.2	8.04
	T6-3	30-Sep-11	6.6	0.3	13.3	8.96	86.6	1470	31.9	8.03
				6.0	13.3	8.76	84.7	1480	31.4	7.97
	T6-2	30-Sep-11	6.8	0.3	12.9	9.27	88.9	1310	33.8	8.03
				6.5	12.9	9.20	88.2	1320	33.4	8.06
	T6-1	30-Sep-11	7.4	0.3	12.7	9.20	87.8	1240	40.3	8.00
				7.0	12.7	8.02	76.6	1240	39.8	8.02
	T9-5	12-Oct-11	1.6	0.3	12.2	10.20	96.4	1260	19.0	8.25
				1.2	12.2	10.19	96.3	1260	19.2	8.25

Table 3-8. (continued).

Transect Location	Site ID	Sample Date	Depth (m)		Temperature (°C)	Dissolved Oxygen		Sp. Cond (µS/cm)	Turbidity (NTU)	pH
			Total	Measurement		(mg/L)	(% Saturation)			
Sturgeon Bay	T9-4	12-Oct-11	4.5	0.3	12.1	10.31	97.2	1240	15.6	8.27
				3.5	12.1	10.31	97.2	1240	16.8	8.27
	T9-3	12-Oct-11	4.9	0.3	12.1	10.09	95.2	1230	16.9	8.24
				3.9	12.1	10.07	95.0	1230	17.7	8.24
	T9-2	12-Oct-11	6.3	0.3	12.2	10.16	96.0	1220	17.0	8.21
				5.3	12.2	10.16	96.0	1220	17.5	8.22
	T9-1	12-Oct-11	6.8	0.3	12.2	9.81	92.7	1040	23.6	8.17
				5.8	12.2	9.61	90.8	1060	26.0	8.16
	T11-5	21-Oct-11	1.5	0.3	4.8	12.78	103.9	1190	129.0	7.80
				1.2	4.6	12.70	102.9	1160	121.0	7.93
	T11-4	21-Oct-11	2.0	0.3	6.0	12.25	102.1	1220	35.1	7.97
				1.7	5.9	12.27	102.1	1220	34.2	7.98
	T11-3	21-Oct-11	3.7	0.3	6.0	12.32	102.7	1200	39.1	7.95
				3.4	5.9	12.32	102.5	1220	44.1	7.98
	T11-2	21-Oct-11	6.0	0.3	5.9	12.08	100.5	1110	50.4	7.86
				5.7	5.9	12.14	101.0	1110	55.4	7.91
Extensive Zone (offshore)										
	EZ-1	1-Oct-11	8.5	0.3	13.0	10.21	98.1	1220	37.6	8.22
				8.0	12.5	9.90	94.1	1220	40.4	8.19
	EZ-2	1-Oct-11	8.2	0.3	13.2	10.32	99.5	1210	35.4	8.23
				7.6	12.5	9.96	94.7	1190	37.6	8.19
	EZ-3	1-Oct-11	7.6	0.3	13.4	10.59	102.5	1140	37.3	8.25
				7.3	12.2	9.83	92.9	1200	42.2	8.19
Dauphin River										
Upstream from Buffalo Cr.	DR-T1-1	30-Sep-11	3.1	0.3	13.1	9.10	87.6	1560	18.8	8.12
	DR-T1-2	30-Sep-11	2.5	0.3	13.1	8.94	86.0	1560	20.9	8.10
	DR-T1-3	30-Sep-11	2.3	0.3	13.1	9.14	88.0	1560	20.4	8.10
Downstream from Buffalo Cr.	DR-T2-1	30-Sep-11	1.7	0.3	13.2	9.17	88.4	1550	19.0	8.11
	DR-T2-2	30-Sep-11	1.4	0.3	13.1	8.94	86.0	1540	17.7	8.10
	DR-T2-3	30-Sep-11	2.1	0.3	13.1	9.12	87.8	1550	18.9	8.09
Mouth	DR-T3-1	30-Sep-11	3.4	0.3	13.2	9.05	87.3	1560	18.8	8.08
	DR-T3-2	30-Sep-11	3.4	0.3	13.2	9.01	86.9	1540	19.7	8.08
	DR-T3-3	30-Sep-11	3.9	0.3	13.2	9.18	88.5	1500	19.2	8.07

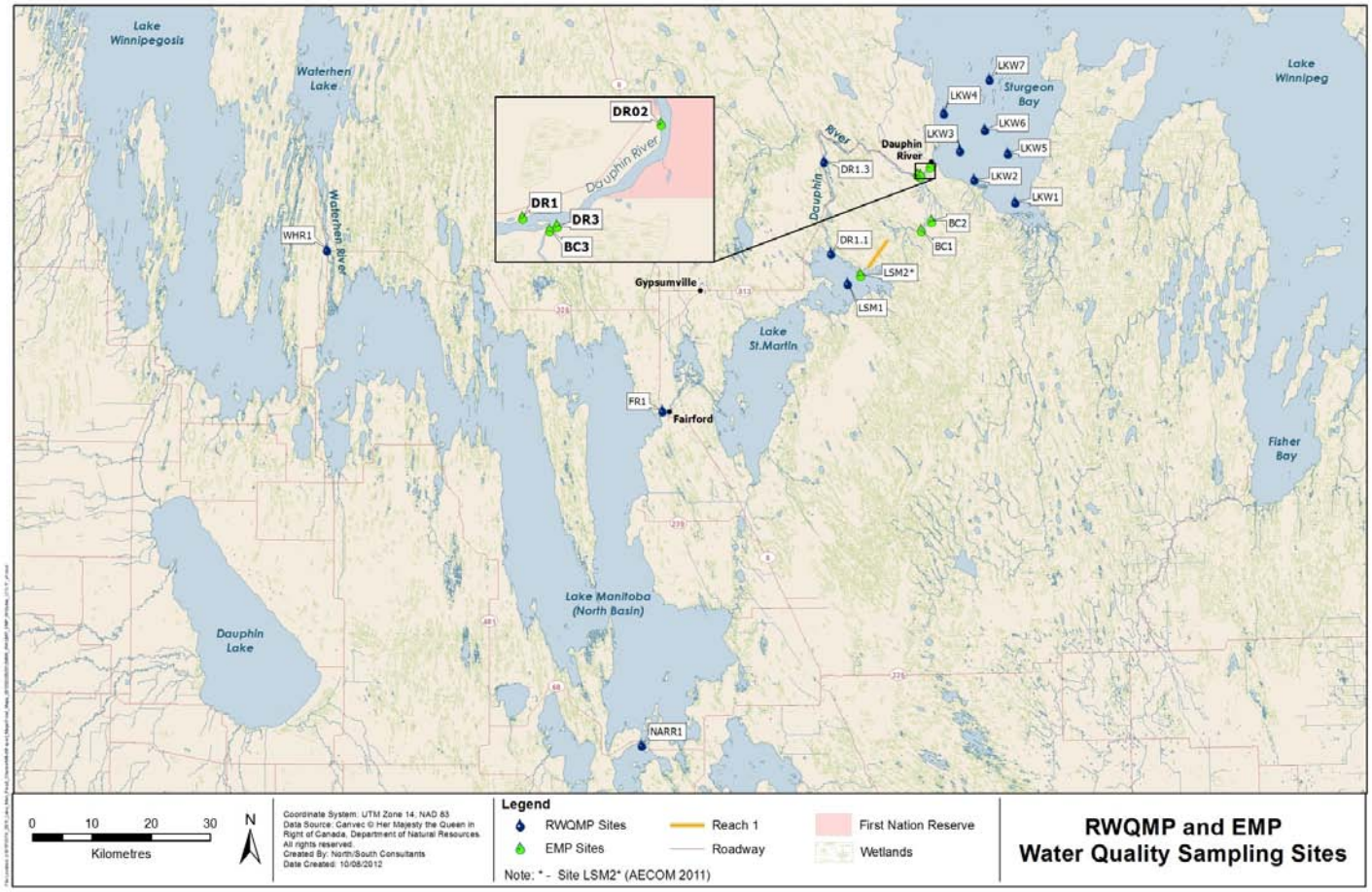


Figure 3-1. Location of sites sampled as part of the RWQMP and EMP conducted during fall 2011.

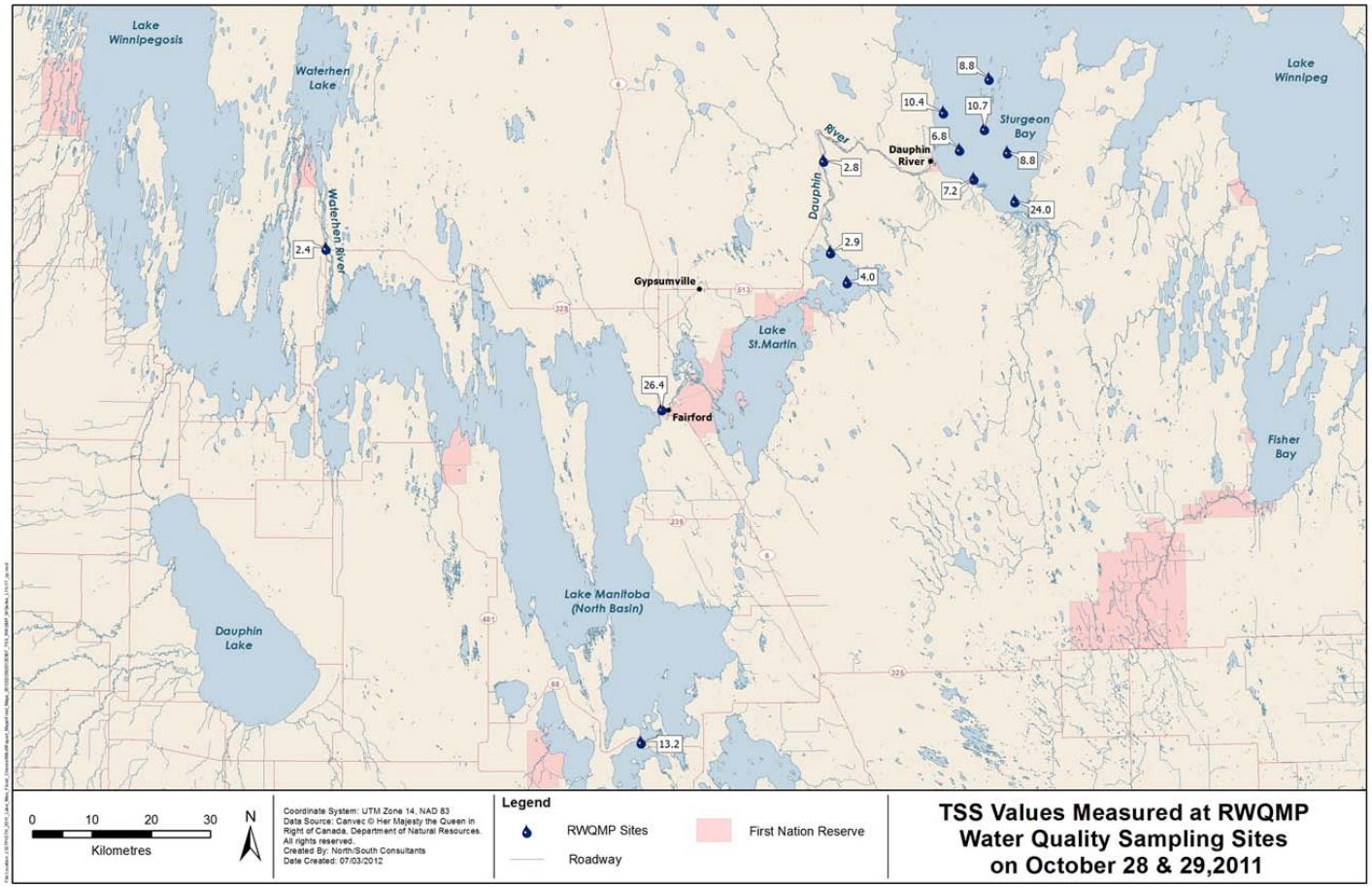


Figure 3-2. Total suspended solids (TSS) values measured at RWQMP sites on 28-29 October, 2011.

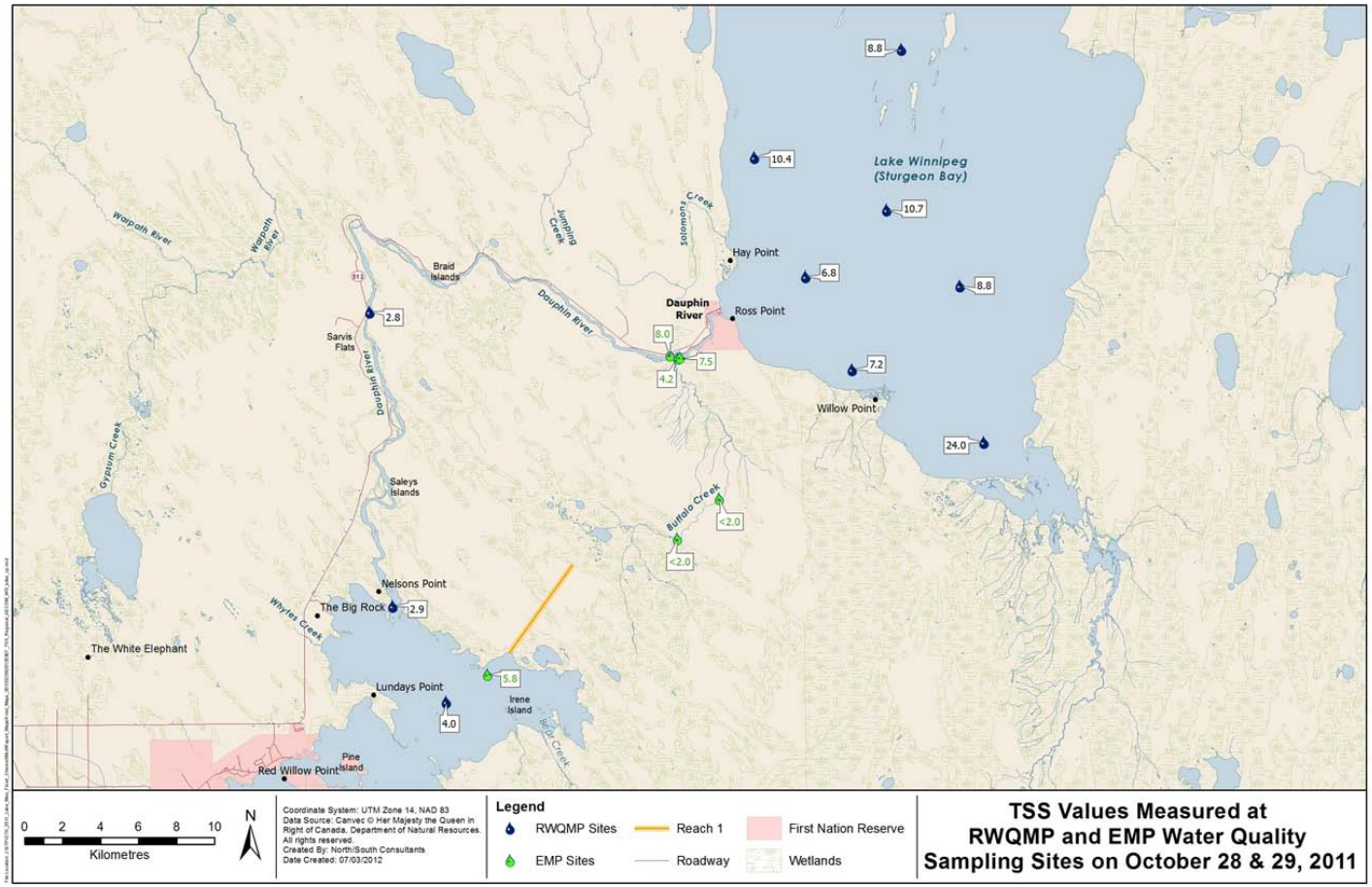


Figure 3-3. Total suspended solids (TSS) values measured at RWQMP and EMP sites on 28-29 October, 2011.

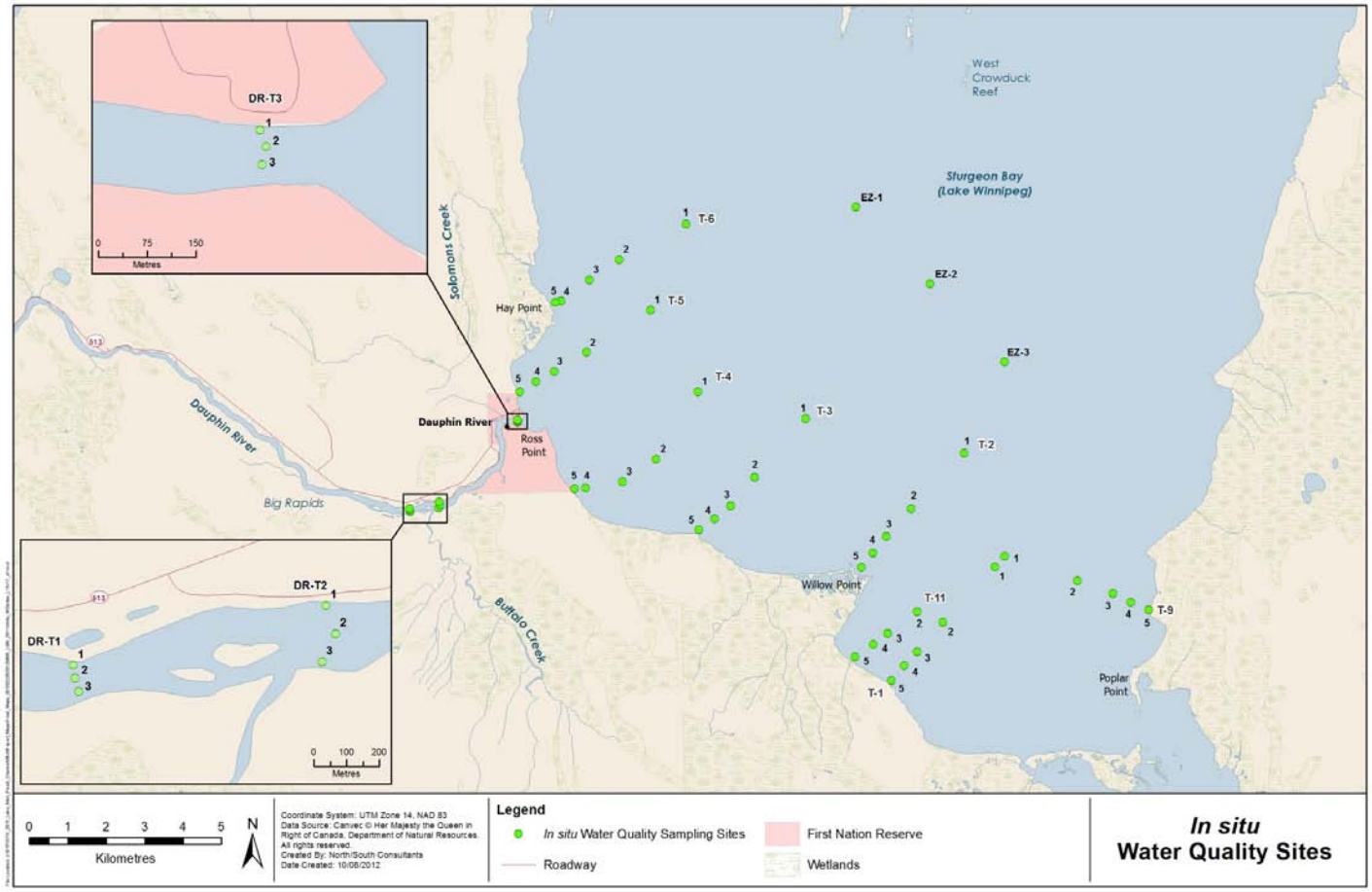


Figure 3-4. Location of sites where *in situ* water quality measurements were recorded during fall 2011.

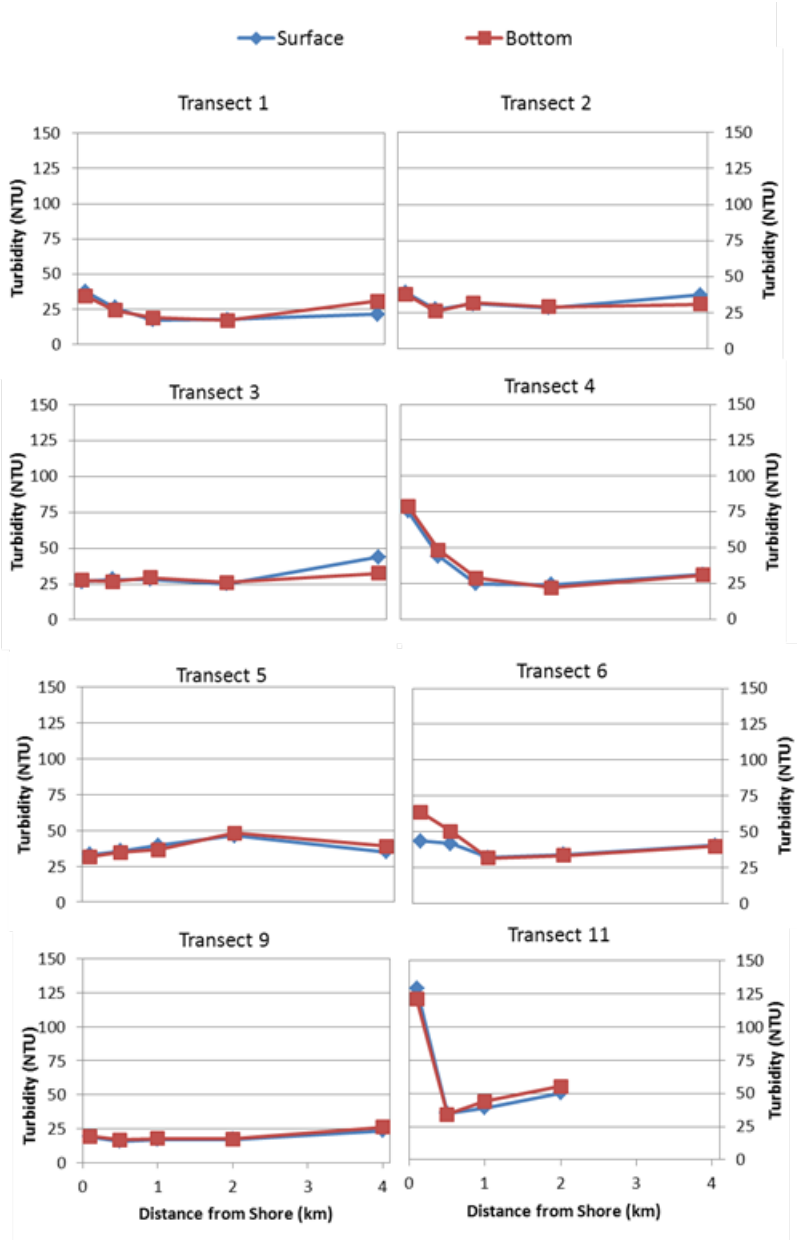


Figure 3-5. *In situ* turbidity measured along transects extending out from shore in Sturgeon Bay, fall 2011.

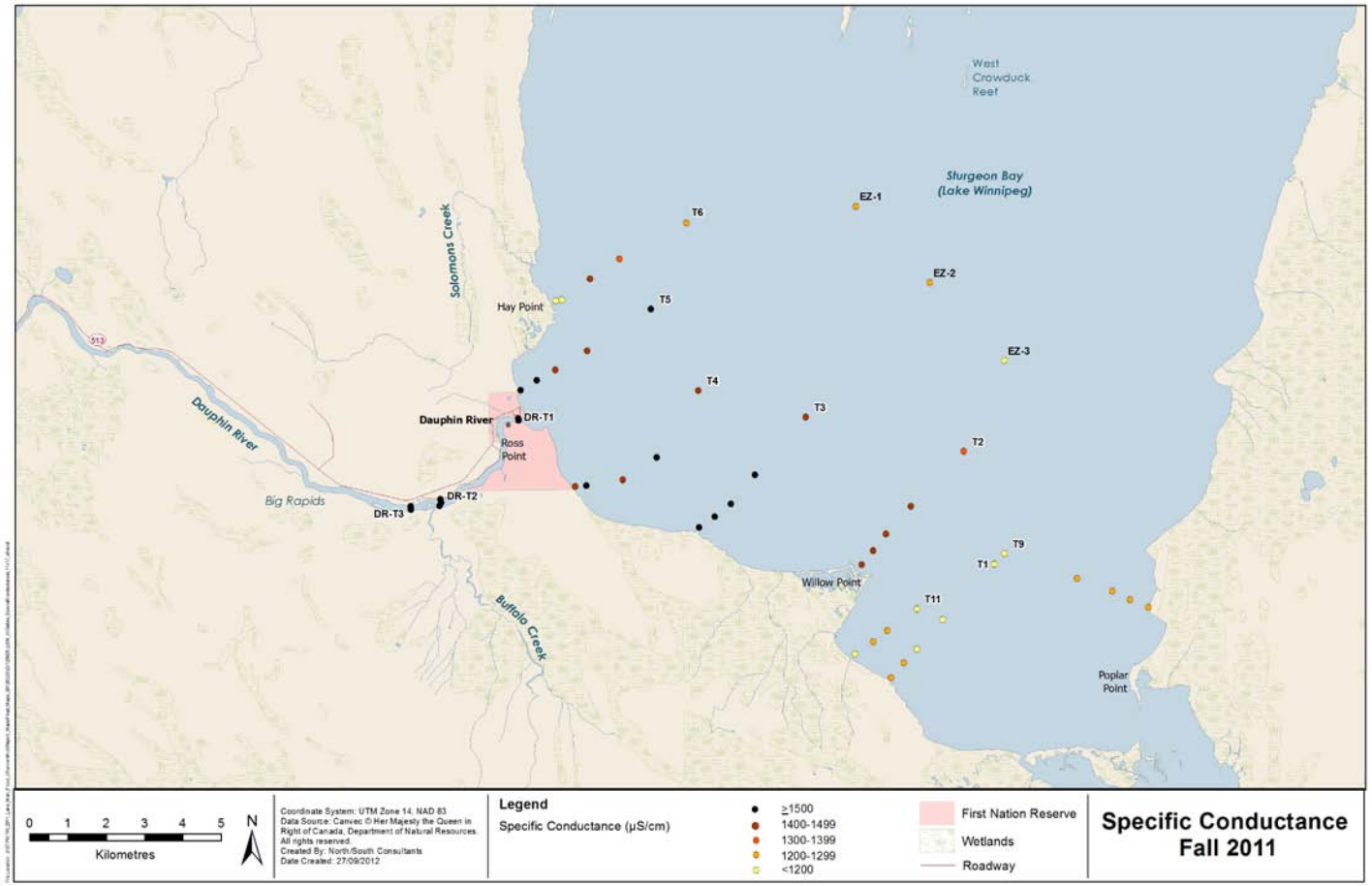


Figure 3-6. Map of specific conductance values measured near the surface in the Dauphin River and Sturgeon Bay, fall 2011.

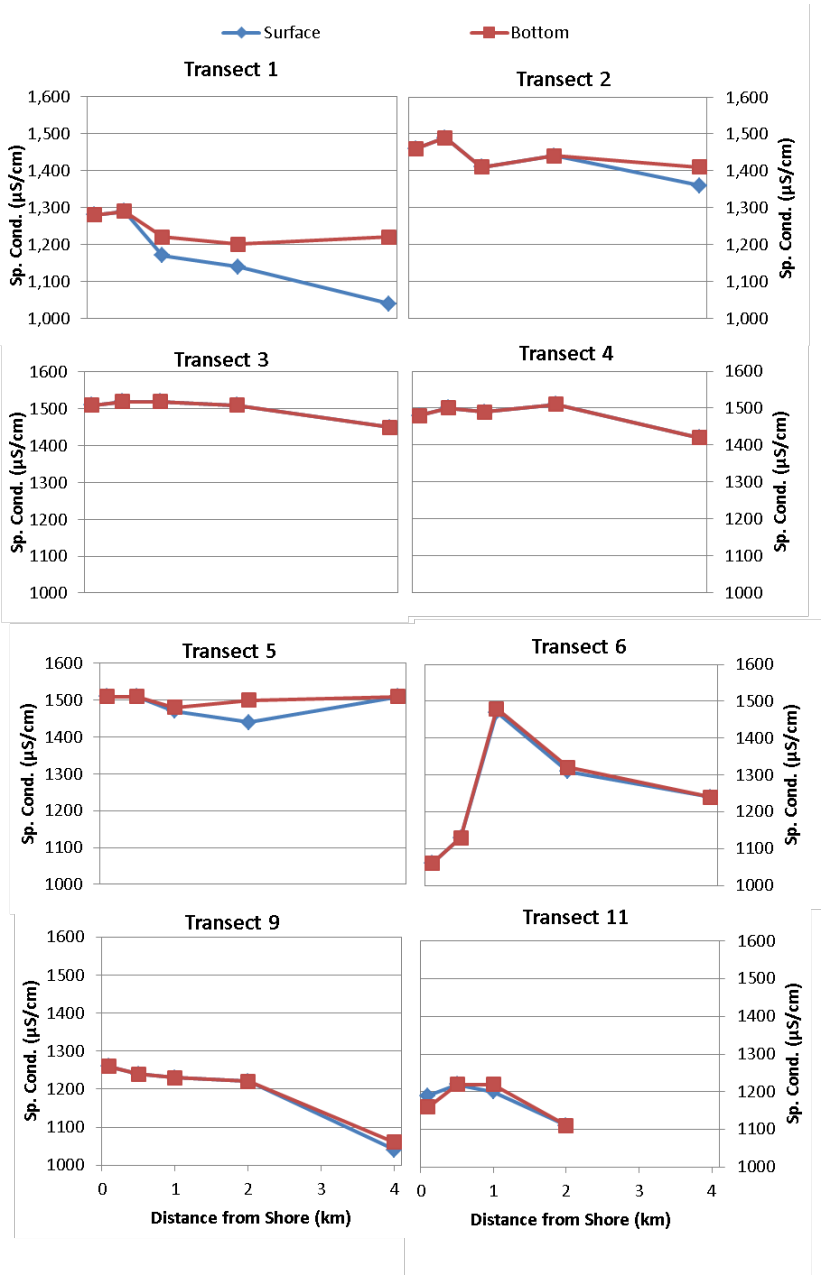


Figure 3-7. *In situ* specific conductance measured along transects extending out from shore in Sturgeon Bay, fall 2011.

4.0 SEDIMENT INPUTS TO STURGEON BAY

It was anticipated that high flow along the Dauphin River and through the diversion route will result in an increase in bed load and suspended organic materials and sediments inputs to Sturgeon Bay. The intent of bed load and suspended sediment studies is to provide information to assess the extent to which increased sedimentation may affect habitat within Sturgeon Bay. Specific study objectives include:

- Determining the type and amount of sediment deposited into Sturgeon Bay during operation of Reach 1;
- Determining the bed load contribution of the Dauphin River into Sturgeon Bay, before operation, and the Dauphin River and Buffalo Creek, during operation of Reach 1;
- Collecting sediment grab samples in the Dauphin River and Sturgeon Bay for particle grain size and organic content analysis to assess changes in substrate due to sedimentation. This information will also be used to validate substrate data collected through sonar during habitat mapping studies; and,
- Collecting sediment samples from the Dauphin River and Sturgeon Bay to document baseline sediment quality and assess Project-related impacts.

Fall 2011 investigations focussed on determining baseline sediment quality, characterizing substrates in the lower Dauphin River and in Sturgeon Bay and measuring the Dauphin River bed load contributions into Sturgeon Bay. Additionally, a sedimentation study (sediment traps) was initiated in Sturgeon Bay in fall 2011 and will be ongoing throughout 2012.

4.1 BED LOAD AND SUSPENDED SEDIMENTS

4.1.1 Methods

Bed load samples were collected on October 16, 22 and November 6 at three sites in the Dauphin River (Figure 4-1). The sample sites were located:

- Approximately 1 km upstream from Buffalo Creek to determine the Dauphin River bed load; and
- 0.6 km and 0.9 km downstream from Buffalo Creek to determine the combined bed load from the Dauphin River and the diversion route.

Bed load samples were collected using a US BL-84 cable-suspended bed load sampler. The sampler consisted of a steel and aluminum frame with a 76 x 76 mm square opening and attached 46 cm long, 250 µm mesh bag. Three replicate samples were collected at each sample site. For each replicate, the sampler was lowered to the river bottom with the opening oriented into the current. The sampler was left for five or ten minutes to capture particles as they were transported along the streambed. Once retrieved the mesh bag was emptied directly into individually labelled 500 mL plastic sample jars. The samples were kept cool and transported to the North/South Consultants Laboratory in Winnipeg.

To supplement bed load sampling, *in situ* water quality was measured and laboratory water quality samples were collected at each bed load sample site (October 22 and November 6), the Buffalo Creek outflow and the Dauphin River mouth (November 6). *In situ* pH, specific conductance, DO, turbidity and temperature were measured at the water surface (approx. 0.30 m depth) using a Horiba® W22-XD water quality meter. Grab samples were collected approximately 0.30 m below the water surface in sample bottles provided by ALS Laboratories. Water samples were kept cool and transported to ALS Laboratories in Winnipeg where they were analysed for turbidity and TSS.

Water depth at each site was measured with a handheld depth sounder and sample locations were recorded using a handheld Garmin GPS receiver.

4.1.2 Results

Prior to the onset of Reach 1 operation, bed load sampling was conducted in the Dauphin River upstream and downstream of the confluence of Buffalo Creek. Following the onset of operation of Reach 1, the intent was to repeat the sampling in the Dauphin River and add another site within Buffalo Creek in order to determine the bed load being contributed to the Dauphin River by diversion flows down Buffalo Creek. However, high water velocity precluded the collection of bed load samples from within the creek once Reach 1 was operational. Consequently, the program objectives could not be met, and the program could not be completed. All bed load samples collected in the Dauphin River were archived (Appendix 3-2).

In situ water quality measurements and laboratory analyses of water quality samples collected at bed load sampling sites are presented in Table 4-1. Total suspended solids measured in the Dauphin River prior to operation of Reach 1 were similar at all locations and ranged from 5-6 mg/L. Similarly, AECOM (2012; Appendix 3-5) reported that TSS at the Buffalo Creek mouth ranged from <5.0-6.0 mg/L in September and October 2011 (six samples collected approximately every 1-2 weeks). Samples collected after Reach 1 became operational indicated that TSS in the Dauphin River was higher downstream of Buffalo Creek (8-17 mg/L) compared to upstream of the creek (< 5mg/L). Additional examination of TSS changes in the Dauphin River and Buffalo Creek associated with Reach 1 operation are provided in Section 3.0 and Appendix 3-5.

4.2 SEDIMENTATION RATE

4.2.1 Methods

Thirty sediment traps were deployed in Sturgeon Bay on October 19, 2011 to determine the type and amount of sediment being deposited in the area. Twenty-seven sediment traps were set along six transects extending from the southwest shore to a distance 6-12 kilometres offshore (Figure 4-2). Three additional single sediment trap sites were established in off shore areas.

Sediment traps consisted of three 0.50 m long plastic pipes with a 5.0 cm outer diameter, clamped together with cable ties (Figure 4-3). The bottom of each pipe was sealed. Foam was attached along the

length of the trap to keep the pipes upright in the water column. To anchor the trap, the bottom of the pipes was connected by a short rope (approx. 0.30 m) to a cinder block.

Water depth at each site was measured with a handheld depth sounder and sample locations were recorded using a handheld Garmin GPS receiver.

4.2.2 Results

Sediment traps remain deployed in Sturgeon Bay and were retrieved and sampled in summer 2012. Results are provided in a subsequent report.

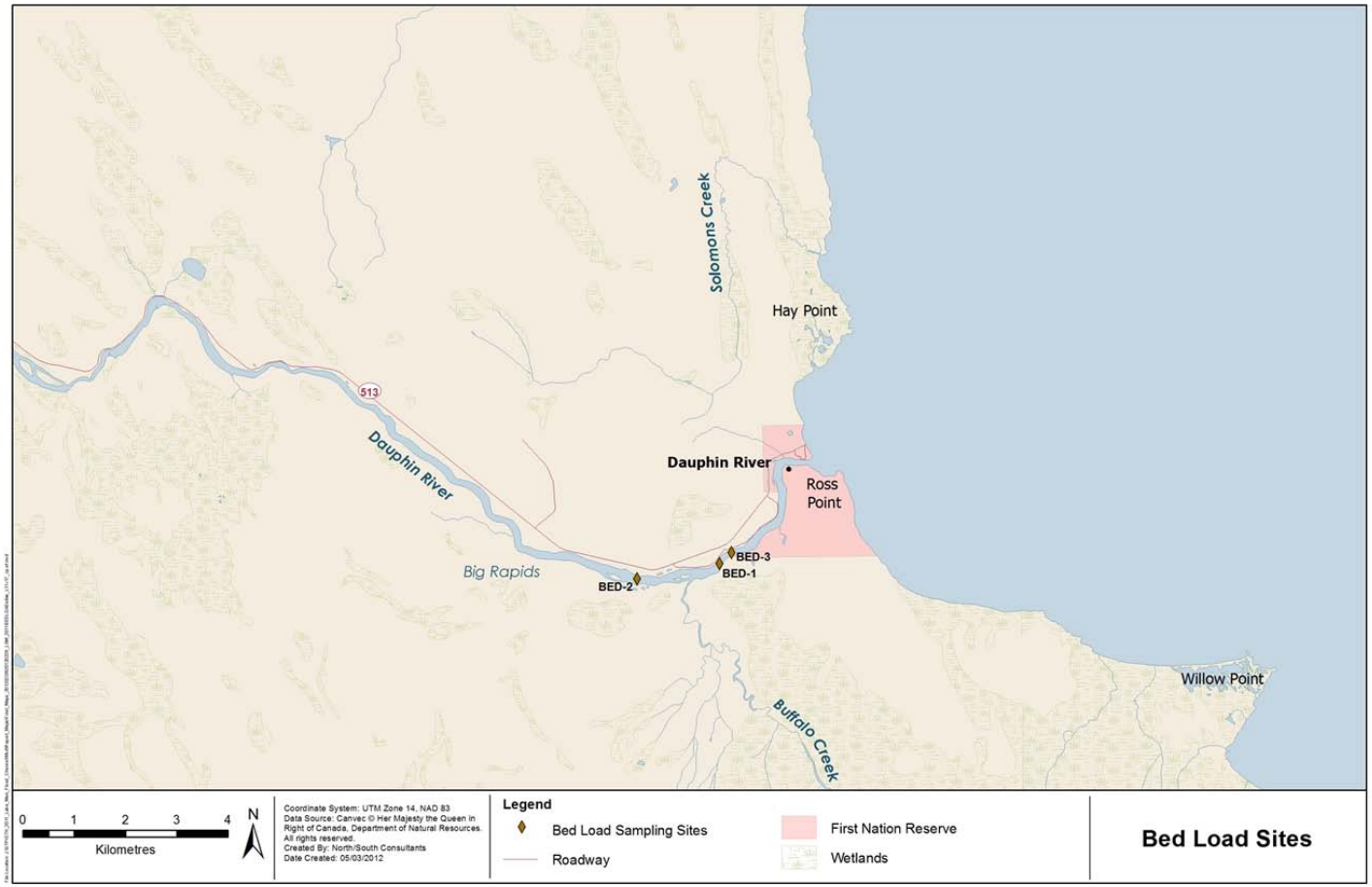


Figure 4-1. Location of sites in the Dauphin River where bed load samples were collected during fall 2011.

Table 4-1. In situ water quality and laboratory TSS results at bed load sampling sites.

Site	Date	Sample Time	*In Situ*						Laboratory	
			Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (mS/m)	Conductivity [1] (µS/cm)	Turbidity (NTU)	pH	TSS (mg/L)	Turbidity [2] (NTU)
BED-1	22-Oct-11	11:35	6.3	-	133	855	-	7.84	5.0	4.2
	06-Nov-11	10:05	3.5	11.44	130	766	41.6	8.08	<5.0	4.2
BED-2	22-Oct-11	11:59	6.2	-	134	859	-	7.96	5.0	5.0
	06-Nov-11	9:06	3.5	12.27	135	796	31.7	8.10	8.0	3.7
BED-3	22-Oct-11	10:25	6.4	-	133	857	35.6	7.73	6.0	4.9
	06-Nov-11	11:12	3.5	11.71	131	772	42.9	8.00	16.0	11.1

1 - Conductivity = Specific Conductance * (1 + 0.0191*(water temperature -25°C))

2 - Laboratory samples exceeded hold time for turbidity analysis

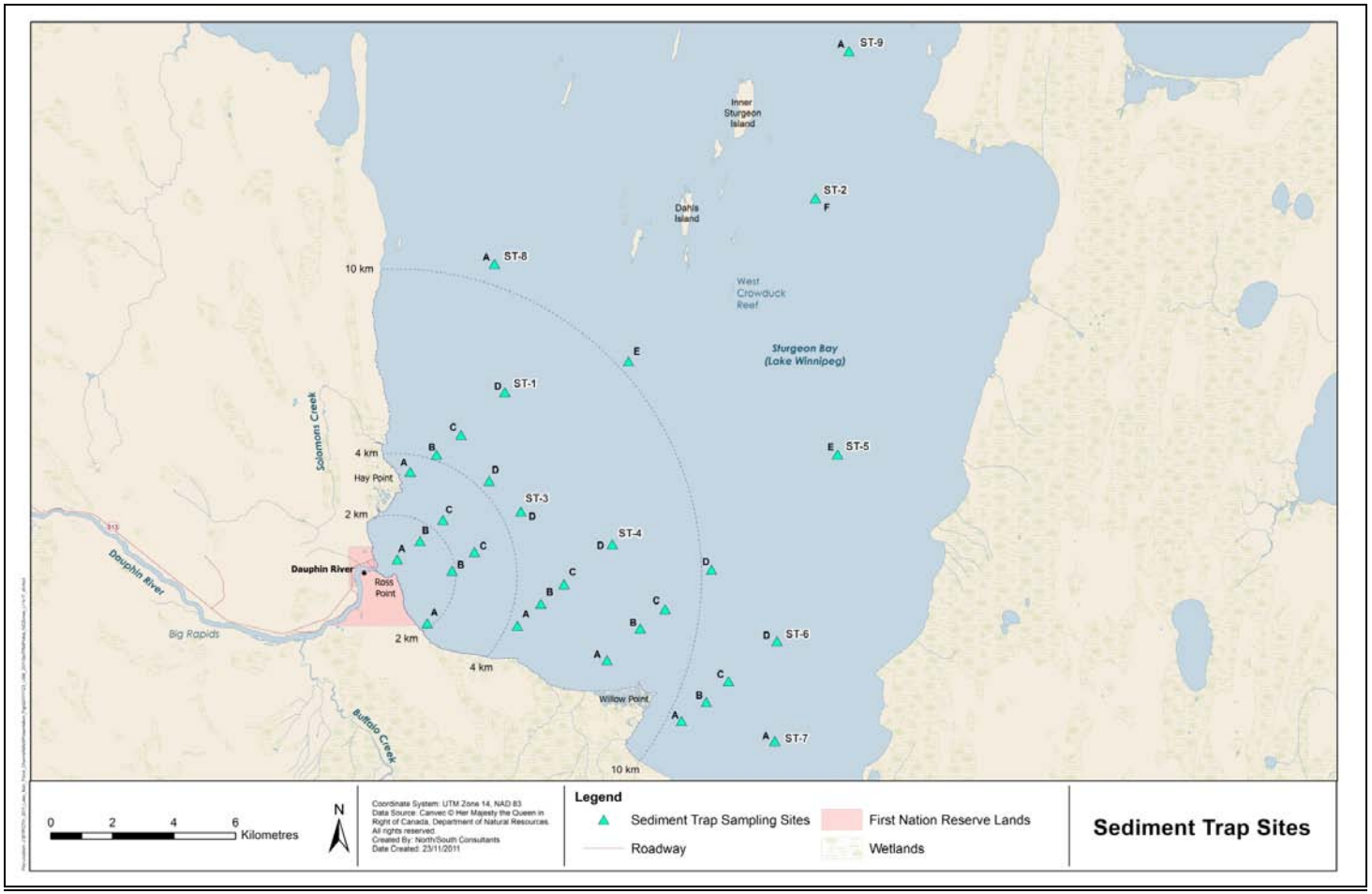


Figure 4-2. Location of sediment trap sites in Sturgeon Bay, fall 2011.



Figure 4-3. Example of sediment trap deployed in Sturgeon Bay.

4.3 SUBSTRATE CLASSIFICATION

4.3.1 Methods

Substrate sampling was conducted at Sturgeon Bay from September 30-October 1 and October 20-21. Twelve transects were established extending 3-4 km from the southwest (eight transects) and southeast shores (one transect) (Figure 4-4). Sediment sampling was conducted at four or five sites along each transect. Three additional sites were located in the offshore extensive zone.

Bottom substrates were sampled using a large (229 x 229 mm sample area) or petite ponar (152 mm x 152 mm). At each site, ponar penetration depth and relative proportion (%) of each substrate type within the sample was visually estimated and recorded. Substrate types were classified as: clay; silt; sand; gravel; small cobble; large cobble; boulder; and organics. Where substrate compaction (e.g., hard clay) or type (e.g., boulder, cobble) precluded ponar sample collection, substrate composition was estimated by probing with a 2.5 m steel pole.

Where ponar grabs were successful (34 sites), sediment quality samples were collected in individually labelled sample jars (metals) and/or clean polyethylene bags (total carbon [TOC] and particle size analysis). TOC and particle size samples were transported to ALS Laboratories in Winnipeg for analysis. The metals samples were transported to the North/South Consultants laboratory in Winnipeg and archived for future analysis.

Sediment core samples were also collected at five ponar grab sites (EZ-2, T3-1, T5-2, T5-1 and T2-1; Figure 4-4). Bottom substrates were collected using an Ekman Grab Sampler. A sub-sample of bottom substrates was collected directly from the Ekman Grab Sampler using a five centimeter (outer diameter) core tube (0.002 m^2 surface area). The core tube was pressed through the center of the grab sample penetrating its entire depth. Each end of the core tube was capped and stored upright in a cool storage container. The samples were transported to the North/South Consultants laboratory in Winnipeg, and archived for future analysis. Samples were handled and stored in such a way to avoid agitation.

At most sites, *in situ* water quality was measured with a using a Horiba® W22-XD water quality meter. *In situ* measurements were conducted in conjunction with *in situ* water quality sampling. Methods, parameters and results are discussed in Section 3.3.

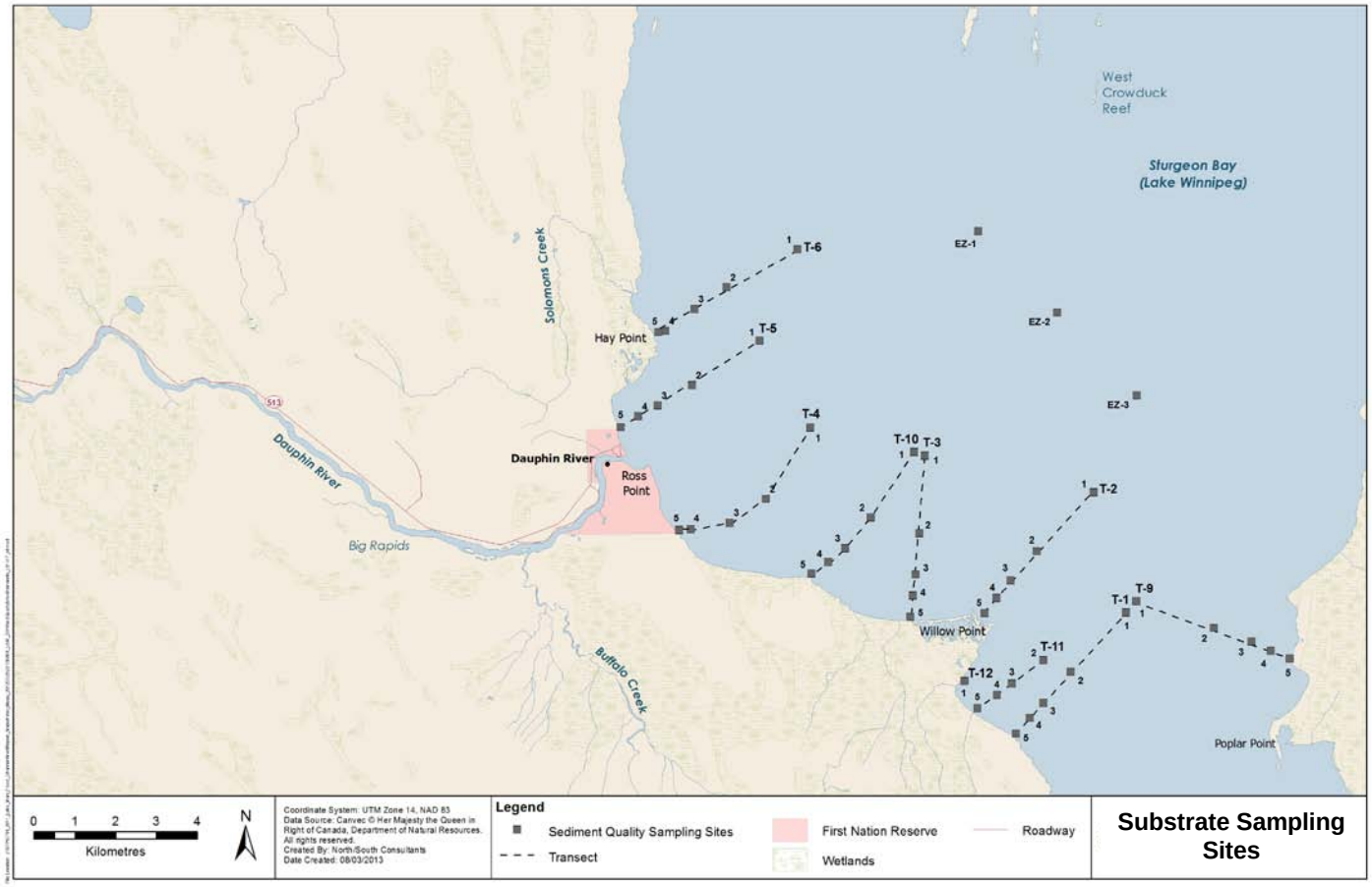


Figure 4-4. Location of substrate classification sites in Sturgeon Bay, fall 2011.

4.3.2 Results

Sediment quality samples have been archived and stored for future metals analysis. Carbon and particle size analysis results for sediment samples collected in Sturgeon Bay are presented in Table 4-2. Field estimates of substrate composition are presented in Table 4-3. Photographs of substrate samples are provided in Appendix 4-1.

Nearshore sites in Sturgeon Bay were typically sand and gravel; however rocky substrates (boulder, boulder/cobble) were dominant at nearshore sites near Hay Point and north of Poplar Point. Offshore sites were characterized as clay. Total organic carbon ranged from 0.2-3.91%. The relative proportion of organic carbon increased with distance offshore.

Within the Intensive Zone (within 2 km of the Dauphin River mouth), TOC was ranged from 0.2-0.75 %. Substrates were typically sand, gravel and/or cobble.

Table 4-2. Total carbon and particle size analysis results for sediment samples collected from Sturgeon Bay, fall 2011.

Transect	Sample ID	Sample Date	Total Carbon (%)				Particle Size (%)			Texture
			Inorganic	Organic	$CaCO_3$ Equivalent	by combustion	Sand (2.0mm-0.05mm)	Silt (0.05mm-2µm)	Clay (<2µm)	
Analytical Detection Limit			*0.10*	*0.10*	*0.80*	*0.1*	*0.10*	*0.10*	*0.10*	
1	T1-1	12-Oct-11	4.81	2.89	40.1	7.7	38.1	49	12.8	Silt loam / Loam
	T1-2	12-Oct-11	5.08	2.54	42.4	7.6	36.7	50.9	12.4	Silt loam
	T1-4	12-Oct-11	4.43	0.49	36.9	4.9	20.2	28.1	51.7	Clay
2	T2-1	2-Oct-11	2.31	3.68	19.2	6	3.21	39	57.8	Silty clay / Clay
	T2-2	2-Oct-11	3.02	3.79	25.1	6.8	5.68	44.7	49.6	Silty clay
	T2-3	2-Oct-11	4.21	1.07	35.1	5.3	63.9	28.5	7.65	Sandy loam
	T2-4	2-Oct-11	7.96	0.51	66.4	8.5	86.7	7.34	5.96	Loamy sand
3	T3-1	1-Oct-11	2.85	3.52	23.8	6.4	1.1	45.3	53.6	Silty clay
	T3-2	1-Oct-11	11.8	0.35	98	12.1	-	-	-	-
4	T4-1	30-Sep-11	3.33	3.91	27.8	7.2	2.95	53.3	43.7	Silty clay
	T4-2	30-Sep-11	4.71	1.24	39.3	6	64.4	25.1	10.5	Sandy loam
	T4-3	30-Sep-11	4.98	0.65	41.5	5.6	92	5.77	2.21	Sand
5	T5-1	1-Oct-11	2.31	3.72	19.2	6	0.48	31.9	67.6	Clay
	T5-2	1-Oct-11	3.54	2.55	29.5	6.1	36.3	39.3	24.4	Loam
	T5-3	1-Oct-11	7.64	0.75	63.7	8.4	80	10.3	9.71	Loamy sand
	T5-4	1-Oct-11	2.59	0.54	21.6	3.1	96.8	2.33	0.89	Sand
	T5-5	1-Oct-11	0.94	0.2	7.85	1.1	98.6	0.43	0.93	Sand
6	T6-1	30-Sep-11	2.04	3.48	17	5.5	0.8	38	61.2	Clay
	T6-2	30-Sep-11	1.98	3.74	16.5	5.7	0.51	37.9	61.6	Clay
	T6-3	30-Sep-11	2.1	3.89	17.5	6	0.43	38.4	61.2	Clay
	T6-4	30-Sep-11	5.84	0.57	48.7	6.4	87.5	9.39	3.1	Sand

Table 4-2. (continued).

Transect	Sample ID	Sample Date	Total Carbon (%)				Particle Size (%)			Texture
			Inorganic	Organic	$CaCO_3$ Equivalent	by combustion	Sand (2.0mm-0.05mm)	Silt (0.05mm-2µm)	Clay (<2µm)	
Analytical Detection Limit			*0.10*	*0.10*	*0.80*	*0.1*	*0.10*	*0.10*	*0.10*	
9	T9-1	12-Oct-11	4.4	2.87	36.7	7.3	27.3	48.9	23.8	Silt loam / Loam
	T9-2	12-Oct-11	3.08	0.73	25.7	3.8	9.09	65.3	25.6	Silt loam
	T9-5	12-Oct-11	0.9	0.35	7.51	1.3	99.7	0.22	<0.10	Sand
10	T10-1	19-Oct-11	3.97	3.12	33.1	7.1	4.34	58.9	36.7	Silty clay loam
	T10-4	19-Oct-11	4.09	0.49	34.1	4.6	55.2	11.3	33.5	Sandy clay loam
	T10-5	19-Oct-11	1.66	0.22	13.8	1.9	99.1	0.46	0.41	Sand
11	T11-2	19-Oct-11	4.57	2.43	38.1	7	24.2	56.4	19.4	Silt loam
	T11-3	19-Oct-11	4.75	0.86	39.6	5.6	78	11.1	11	Sandy loam
	T11-5	19-Oct-11	4.62	0.59	38.5	5.2	60	23.8	16.2	Sandy loam
12	T12-1	19-Oct-11	2.39	0.79	19.9	3.2	69.9	19.6	10.5	Sandy loam
Extensive Zone (offshore)	EZ-1	1-Oct-11	1.31	2.87	10.9	4.2	0.87	28.6	70.5	Clay
	EZ-2	1-Oct-11	1.27	3.02	10.6	4.3	2.48	30.4	67.1	Clay
	EZ-3	1-Oct-11	1.35	3.32	11.2	4.7	0.85	31.7	67.4	Clay

Table 4-3. Field estimates of substrate composition (%) at sediment sampling sites in Sturgeon Bay, fall 2011.

Transect	Site ID	Sample Date	Water Depth (m)	Penetration Depth (m)	Composition (%)								Sample collected				Comments
					Clay	Silt	Sand	Gravel	Small cobble	Large cobble	Boulder	Organics	PSA	Metals	Benthics	Core	
1	T1-1	12-Oct-11	6.8	0.06	70	30	0	0	0	0	0	0	Y	Y	Y	-	medium compaction, brown clay with black silt throughout
	T1-2	12-Oct-11	6.1	0.06	70	30	0	0	0	0	0	0	Y	Y	Y	-	medium compaction, brown clay with black silt throughout
	T1-3	12-Oct-11	4.5	0.01	25	0	5	0	70	0	0	0	-	-	-	-	insufficient material for metals or PSA (substrate too compact)
	T1-4	12-Oct-11	4.0	0.01	90	0	10	0	0	0	0	0	Y	-	-	-	insufficient sample for metals- substrate too compact
	T1-5	12-Oct-11	0.9	n/a	0	0	0	5	15	0	80	0	-	-	-	-	No grabs possible; substrate probed with metal pole
2	T2-1	2-Oct-11	7.3	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	Y	consolidated, very soft
	T2-2	2-Oct-11	6.9	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	-	consolidated, very soft
	T2-3	2-Oct-11	6.0	0.05	90	0	10	0	0	0	0	0	Y	Y	Y	-	un-consolidated, medium compaction
	T2-4	2-Oct-11	4.5	0.01	0	0	90	10	0	0	0	0	Y	-	-	-	insufficient sample for metals- substrate too compact
	T2-5	2-Oct-11	2.0	n/a	~0	0	5	25	70	0	0	0	-	-	-	-	No grabs possible ;substrate probed with metal pole; hard clay found beneath rock
3	T3-1	1-Oct-11	7.1	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	Y	consolidated, soft
	T3-2	1-Oct-11	5.2	n/a	0	0	0	1	99	0	0	0	Y	-	-	-	insufficient sample for metals - ponar picking up cobble only
	T3-3	1-Oct-11	5.0	n/a	0	0	0	5	90	5	0	0	-	-	-	-	Ponar picking up cobble/gravel only
	T3-4	1-Oct-11	3.4	n/a	0	0	0	99	1	0	0	0	-	-	-	-	Ponar picking up cobble/gravel only
	T3-5	1-Oct-11	1.1	n/a	2	0	3	94	1	0	0	0	-	-	-	-	Ponar picking up cobble/gravel only

Table 4-3. (continued).

Transect	Site ID	Sample Date	Water Depth (m)	Penetration Depth (m)	Composition (%)								Sample collected				Comments
					Clay	Silt	Sand	Gravel	Small cobble	Large cobble	Boulder	Organics	PSA	Metals	Benthics	Core	
4	T4-1	30-Sep-11	6.1	0.08	95	5	0	0	0	0	0	0	Y	Y	Y	-	consolidated, soft
	T4-2	30-Sep-11	5.2	0.04	90	0	5	5	0	0	0	0	Y	Y	Y	-	consolidated, medium compaction
	T4-3	30-Sep-11	3.7	0.04	0	0	35	60	5	0	0	0	Y	-	-	-	insufficient sample for metals- substrate too compact
	T4-4	30-Sep-11	2.7	n/a	~0	0	15	20	65	0	0	0	-	-	-	-	No grabs possible, substrate probed with metal pole; clay found beneath rock substrates
	T4-5	30-Sep-11	1.1	n/a	0	0	0	5	95	0	0	0	-	-	-	-	No grabs possible; substrate probed with metal pole; clay found beneath rock substrates
5	T5-1	1-Oct-11	7.0	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	Y	consolidated, soft
	T5-2	1-Oct-11	6.7	0.08	80	3	17	0	0	0	0	0	Y	Y	Y	Y	consolidated, soft; layers of silt over clay over sand
	T5-3	1-Oct-11	3.8	0.02	0	40	40	20	0	0	0	0	Y	-	-	-	insufficient sample for metals- substrate too compact
	T5-4	1-Oct-11	2.5	0.06	30	5	60	0	0	0	0	5	Y	Y	Y	-	medium compaction
	T5-5	1-Oct-11	1.2	0.06	1	1	98	0	0	0	0	0	Y	Y	Y	-	medium compaction
6	T6-1	30-Sep-11	7.4	0.08	100	0	0	0	0	0	0	0	Y	Y	Y	-	consolidated, soft
	T6-2	30-Sep-11	6.8	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	-	consolidated, soft
	T6-3	30-Sep-11	6.6	0.08	98	2	0	0	0	0	0	0	Y	Y	Y	-	consolidated, soft
	T6-4	30-Sep-11	4.1	0.02	0	0	10	90	~0	0	0	0	Y	Y	-	-	
	T6-5	30-Sep-11	1.7	n/a	~0	0	0	10	10	30	50	0	-	-	-	-	No grabs possible; substrate probed with metal pole; clay found beneath rock substrates

Table 4-3. (continued).

Transect	Site ID	Sample Date	Water Depth (m)	Penetration Depth (m)	Composition (%)								Sample collected				Comments
					Clay	Silt	Sand	Gravel	Small cobble	Large cobble	Boulder	Organics	PSA	Metals	Benthics	Core	
9	T9-1	12-Oct-11	6.8	0.10	90	10	0	0	0	0	0	0	Y	Y	Y	-	medium compaction; clay is gray with brown silt throughout
	T9-2	12-Oct-11	6.3	0.03	95	0	5	0	0	0	0	0	Y	-	-	-	substrate too compact to collect sufficient sample
	T9-3	12-Oct-11	4.9	0.02	20	0	5	15	60	0	0	0	-	-	-	-	substrate too compact to collect sufficient sample
	T9-4	12-Oct-11	4.5	0.02	50	0	10	20	20	0	0	0	-	-	-	-	substrate too compact to collect sufficient sample
	T9-5	12-Oct-11	1.6	0.06	0	0	100	0	0	0	0	0	Y	Y	Y	-	medium compaction
10	T10-1	19-Oct-11	7.0	n/a	100	0	0	0	0	0	0	0	Y	Y	Y	-	soft/smooth clay
	T10-2	19-Oct-11	4.8	n/a	0	0	10	20	40	30	0	0	-	-	-	-	hard bottom; no grabs
	T10-3	19-Oct-11	4.7	n/a	0	0	0	20	60	20	0	0	-	-	-	-	hard bottom; no grabs
	T10-4	19-Oct-11	3.8	n/a	0	0	80	20	0	0	0	0	Y	-	-	-	hard sand/gravel bottom
	T10-5	19-Oct-11	1.5	n/a	0	0	90	10	0	0	0	0	Y	Y	-	-	Hard sand/gravel bottom, large ponar
11	T11-2	21-Oct-11	6.0	n/a	95	5	0	0	0	0	0	0	Y	Y	Y	-	soft clay with a thin layer of fine silt on top
	T11-3	21-Oct-11	3.7	n/a	0	0	50	30	20	0	0	0	Y	N	-	-	underlying clay covered with sand/gravel/cobble
	T11-4	21-Oct-11	2.0	n/a	0	0	0	30	60	10	0	0	N	N	-	-	Substrate too compact; probed with metal pole
	T11-5	21-Oct-11	1.5	n/a	70	0	25	5	0	0	0	0	Y	Y	-	-	
12	T12-1	21-Oct-11	1.3	n/a	0	0	90	0	0	0	0	10	Y	Y	-	-	1-2 cm layer of coarse brown sand over darker, finer sand and organics

Table 4-3. (continued).

Transect	Site ID	Sample Date	Water Depth (m)	Penetration Depth (m)	Composition (%)								Sample collected				Comments
					Clay	Silt	Sand	Gravel	Small cobble	Large cobble	Boulder	Organics	PSA	Metals	Benthics	Core	
Extensive Zone (offshore)																	
	EZ-1	1-Oct-11	8.5	0.10	95	5	0	0	0	0	0	0	Y	Y	Y	-	consolidated, very soft
	EZ-2	1-Oct-11	8.2	0.10	95	5	0	0	0	0	0	0	Y	Y	-	Y	consolidated, very soft
	EZ-3	1-Oct-11	7.6	0.10	95	5	0	0	0	0	0	0	Y	Y	-	-	consolidated, very soft

4.4 SUMMARY

Bed Load and Suspended Sediments

Bed load samples and *in situ* water quality were collected on October 16, 22 and November 6 at three sites in the Dauphin River. High water velocity in Buffalo Creek precluded collection of bed load samples from within the creek and, consequently, the program objectives could not be met. All samples from the Dauphin River were archived.

Laboratory analyses of water samples collected prior to and following the onset of Reach 1 operation indicated an increase in Buffalo Creek and the Dauphin River downstream of Buffalo Creek after Reach 1 became operational. These data will support results from other water quality sampling programs (see Section 3.0).

Sedimentation Rate

Thirty sediment traps were deployed in Sturgeon Bay on October 19, 2011 to determine the type and amount of sediment being deposited in the area. The traps remained deployed until summer 2012 and results from the program were to be provided in subsequent reports.

Substrate Classification

Substrate sampling was conducted at Sturgeon Bay from September 30-October 1 and October 20-21 along 12 transects and at three offshore extensive zone sites. Sediment quality samples were archived for future metals analysis. Carbon and particle size analysis results indicated that nearshore sites in Sturgeon Bay were typically sand and gravel while offshore sites were characterized as clay. Total organic carbon ranged from 0.2-3.91% with the relative proportion increasing with distance offshore.

5.0 FISHERIES AND HABITAT SURVEY OF THE BUFFALO CREEK WATERSHED

Project design was that the Buffalo Creek watershed would be the initial receiving environment for flow diverted through Reach 1 (see Figure 1-2). A lack of information pertaining to the watershed was identified during a preliminary screening process conducted prior to operation of Reach 1 (North/South Consultants Inc. 2011a) and it was determined that a basic understanding of fish resources and use of aquatic habitat within the Buffalo Creek watershed would be required to assist in assessing the effects of Reach 1 operation. Consequently, a series of investigations were conducted to collect information describing aquatic resources within the Buffalo Creek watershed. The investigations included:

- conducting a Construction Environmental Monitoring Program (CEMP) to document water quality conditions in Lake St. Martin at the entrance to Reach 1, along Buffalo Creek, and in the Dauphin River upstream and downstream of the Buffalo Creek confluence during construction and initial operation of Reach 1;
- a brief field program conducted from 15-17 August, 2011, to collect *in situ* water quality information, describe aquatic habitat, and identify fish presence/absence and distribution throughout the Buffalo Creek watershed; and,
- a desk top exercise to quantify the type and amount of aquatic habitat occurring within the Buffalo Creek watershed.

The following sections provide the methods and results of the various investigations.

5.1 WATER QUALITY

Water quality information specific to the Buffalo Creek watershed was collected during the CEMP and during a brief field program conducted in Buffalo Creek watershed during August 2011.

5.1.1 CEMP

The CEMP was conducted to document water quality conditions in Lake St. Martin at the entrance to Reach 1, along Buffalo Creek, and in the Dauphin River upstream and downstream of the Buffalo Creek confluence during construction and initial operation of Reach 1. A detailed report of this sampling program including sites sampled, parameters measured, methods used, and a discussion of the results are presented in AECOM (2012; Appendix 3-5). A brief summary of methods and results pertinent to the Buffalo Creek watershed is provided below.

5.1.1.1 Summary of Methods

As part of the CEMP, water quality was monitored in Lake St. Martin, Buffalo Creek, and in the Dauphin River from September 2 until 01 November, when Reach 1 became operational. Sampling included the collection of *in situ* water quality data, as well as samples for laboratory analysis. Following the onset of operation, water quality monitoring continued throughout the system until 25 November, 2011. Prior

to 01 November, monitoring was conducted approximately twice a month. After Reach 1 was opened, sampling frequency increased to twice a week. Water quality parameters measured included: *in situ* measurements of turbidity, DO, pH, conductivity, and temperature; and laboratory analysis of water samples for TSS, nutrients (TP, dissolved P, ammonia, and TN), mercury, and petroleum hydrocarbons (benzene, toluene, ethylbenzene and xylene [BTEX]; and, hydrocarbons F1-F4).

5.1.1.2 Summary of Results

Total Suspended Solids and Turbidity

TSS concentration measured at sites along Buffalo Creek prior to operation of Reach 1 was low, remaining at or below the laboratory analytical detection limit of 5.0 mg/L at all sites on most sampling occasions. Similarly, turbidity at most sites and on most occasions was low (< 4 NTUs), except at the downstream most location (BC03), where turbidity was consistently higher, ranging from 6-13 NTUs.

Shortly after Reach 1 became operational, TSS concentrations in Buffalo Creek exceeded the Canadian Council of Ministers of the Environment (CCME) guidelines, but fell below the CCME limits at all sites within two weeks of Reach 1 opening. Following the excavation of the remaining material from the south shore road, a second peak in TSS was observed within Reach 1 on November 17 and at downstream sites a few days later. TSS concentrations remained within CCME guidelines in Buffalo Creek during this second peak. TSS concentrations had not returned to baseline at the end of the monitoring period and AECOM (2012) recommended that monitoring continue.

Nutrients and Routine Variables

Based on the results of the CEMP sampling and the RWQMP sampling (see Section 3.1 in this report), conducted in fall, 2011, water quality in Buffalo Creek prior to operation of Reach 1 could generally have been described as moderately nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated.

Total phosphorus (TP) concentrations in Buffalo Creek, composed primarily of dissolved forms. The majority of total nitrogen (TN) was present in organic form at all sites, with nitrate/nitrite generally comprising a greater amount of dissolved inorganic nitrogen (DIN) than ammonia. On the basis of TN:TP molar ratios, Buffalo Creek was considered to be phosphorus limited in fall 2011.

The TP concentration at the downstream end of Buffalo Creek (BC3) exceeded the Manitoba Water Quality Standards, Objectives, and Guidelines (MSWQSOGs; MWS 2011) narrative guideline for streams (0.050 mg/L) in one of the replicate samples collected; however, the results for this sample were considered suspect (see Section 3.1.2.4). The TP concentration measured in the other sample collected at BC3 was well below the guideline. All other routine water quality variables for which there are MWQSOGs and CCME guidelines, including dissolved oxygen, pH, ammonia, nitrate and nitrite were within PAL objectives and guidelines.

Colour exceeded the MWQSOGs aesthetic objective for drinking water (≤15 TCU) at all three sites in Buffalo Creek sampled during the RWQMP.

Mercury

The analytical detection limit applied to the majority of the samples collected for the analysis of mercury was typically higher than the CCME guideline for PAL (26 ng/L); as a result, a proper assessment of this guideline could not be conducted.

Summary

Prior to operation of Reach 1, the water quality of Buffalo Creek differed from Lake St. Martin, the Dauphin River or Sturgeon Bay (see Section 3.1 for descriptions of Lake St. Martin, Dauphin River, and Sturgeon Bay water quality descriptions). Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll *a*, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

5.1.2 *In situ* Field Measurements

In situ measurements of water quality parameters were taken in Big Buffalo Lake and at one location in Buffalo Creek during August 2011.

5.1.2.1 Methods

In situ water quality measurements were collected using a Horiba® W-22XD water quality meter. The following parameters were measured:

- dissolved oxygen (DO; mg/L);
- temperature (^{o}C);
- specific conductance (mS/m);
- pH; and,
- turbidity (NTUs).

Depth profiles (every 0.5 m) of *in situ* parameters were measured at lake sites and a single surface measurement was taken from the bank at the creek site. In addition, Secchi disk depth was measured at each site in Big Buffalo Lake. Secchi disk depth is defined as the average of two depth readings:

1) the depth at which a circular black and white disk 30 cm in diameter can no longer be seen when lowered into the water column; and,
2) the depth at which the disk becomes visible again, when raised.

Location of each sampling site was recorded with a Garmin GPSMap 76S global positioning system.

The unit of measure for specific conductance (mS/m) was converted to µS/cm by multiplying the field measurements by 10. Conductivity was then calculated using the following formula:

Conductivity = Specific Conductance (µS/cm) * (1 + 0.0191*(water temperature -25^{o}C))

5.1.2.2 Results

In situ water quality measurements were taken at four sites in Big Buffalo Lake on 17 August, 2011 (Figure 5-1). Water depth at the sampling locations ranged from 1.2-2.1 m deep (Table 5-1).

In situ measurements collected from four sites in Big Buffalo Lake indicated that the lake was not thermally stratified, was relatively well-oxygenated, and near-neutral. Turbidity was less than 7 NTU and Secchi disk depth ranged from 1.2-2.2 m. For comparison, Secchi disk depths measured in Sturgeon Bay from 2008 to 2010 (open-water season) ranged from 0.3-1.7 m (MWS unpublished data).

Surface water quality was measured at the mouth of Buffalo Creek immediately upstream of its confluence with the Dauphin River. Sampling location and results are presented in Table 5-1. *In situ* measurements at the creek mouth indicated that water at the creek mouth was slightly more turbid, acidic, less oxygenated, and warmer than measured at Big Buffalo Lake. Also, parameter values measured at this location in August varied slightly from comparable measurements collected along Buffalo Creek and in the Dauphin River during fall 2011 (prior to operation of Reach 1; AECOM 2012; see Appendix 3-5).

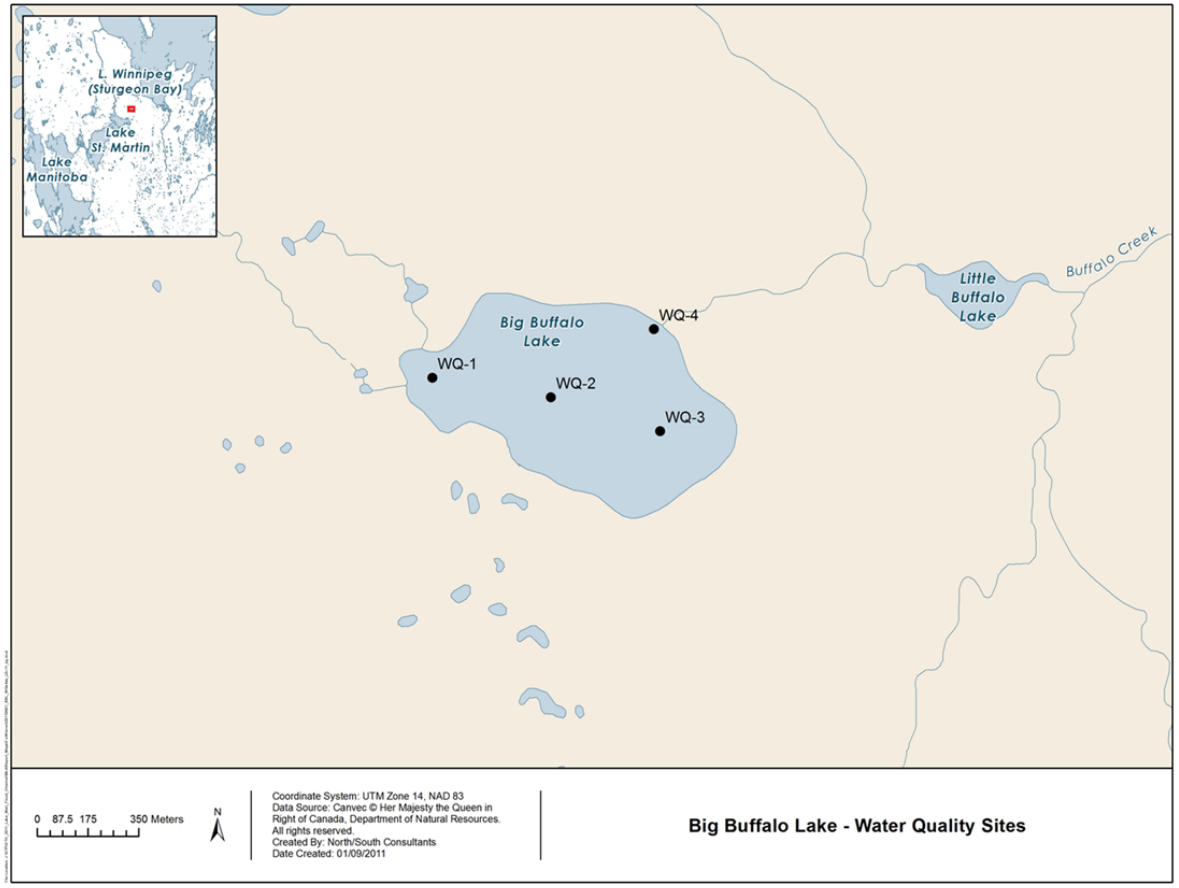


Figure 5-1. Location of water quality sampling sites on Big Buffalo Lake, 17 August, 2011.

Table 5-1. *In situ* water quality data measured in Big Buffalo Lake and Buffalo Creek during August, 2011 [1].

Site	Coordinates [2]		Depth (m)			Temperature (°C)	Dissolved Oxygen		Specific conductance (µS/cm)	Conductivity (µS/cm)	Turbidity (NTU)	pH
	Easting	Northing	Total	Measurement	Secchi		(mg/L)	(% Saturation)				
Big Buffalo Lake												
WQ-1	557773	5745614	1.2	0.3	1.2	19.5	8.0	88.3	180	161.1	4.7	7.49
				1		19.5	8.1	88.7	180	161.1	5.2	7.50
WQ-2	558182	5745547	2.2	0.3	2.2	19.7	8.0	88.6	180	161.8	4.2	7.40
				1		19.6	8.1	89.3	180	161.4	4.0	7.44
				1.5		19.6	8.2	90.0	179	160.5	4.9	7.48
				2		19.7	8.3	91.1	179	160.9	4.7	7.52
WQ-3	558559	5745430	2.1	0.3	2.1	19.8	8.2	90.8	179	161.2	6.2	7.47
				1		19.6	8.3	91.1	179	160.5	4.6	7.52
				1.5		19.6	8.3	91.6	179	160.5	4.6	7.53
				2		19.6	8.3	91.3	179	160.5	3.5	7.49
WQ-4	558537	5745782	1.2	0.3	1.2	18.8	8.3	90.2	178	156.9	3.7	7.29
				1		18.8	8.3	90.2	178	156.9	4.5	7.28
		Minimum	*1.2*	*0.3*	*1.2*	*18.8*	*8.0*	*88.3*	*178*	*156.9*	*3.5*	*7.28*
		Maximum	*2.2*	*2*	*2.2*	*19.8*	*8.3*	*91.6*	*180*	*162.1*	*6.2*	*7.53*
Buffalo Creek												
T-7	562243	5754664	> 1.0	surface	-	19.7	6.9	77.2	283	254.4	17.8	6.88

1 - all field measurements taken on17 August, 2011.

2 - water quality sampling sites are illustrated in Figures 5-1 and 5-2.

5.2 AQUATIC HABITAT

Prior to operation of Reach 1, aquatic habitat in Big Buffalo Lake and Buffalo Creek were characterized and quantified to describe pre-Project conditions. The habitat assessment was completed using information collected during a brief field program conducted in August 2011 and by interpreting habitat characteristics from aerial orthometric imagery and geo-referenced digital photographs to classify and quantify aquatic habitat within the watershed. Habitat information collected during the field program was used to help validate interpretations from the digital imagery.

5.2.1 Methods

5.2.1.1 Field Program

Big Buffalo Lake

Aquatic habitat occurring in Big Buffalo Lake was characterized by collecting depth measurements and describing substrate compaction and size characteristics at a series of locations across the lake. Location of sampling sites was recorded using a Garmin GPSMap 76S GPS receiver.

Substrate compaction was a qualitative assessment of the firmness of the substrate. Two compaction categories, hard or soft, where used. Substrate size classification was based on Wentworth (1922), and included the following size categories:

- Boulder > 256 mm
- Cobble 64-256 mm
- Gravel (aggregate) 2-64 mm
- Sand (aggregate) 62.5 µm – 2 mm
- Silt 3.9-62.5 µm
- Clay < 3.9 µm

Lake area was determined from orthometric aerial imagery (see Section 5.2.1.2).

Buffalo Creek

Habitat information was collected from a series of locations within Buffalo Creek. Location of sampling sites was recorded using a Garmin GPSMap 76S GPS receiver. At each location, the following habitat parameters were measured, categorized, or described:

- Habitat category (riffle, pool, run; after Bisson et al. 1982);
- Wetted width (m);
- Water depth at 5 locations across the creek (m);
- Substrate composition;
- Substrate compaction; and,

- Presence/absence and type of instream vegetation.

Substrate compaction was a qualitative assessment of the firmness of the substrate. Two compaction categories, hard or soft, where used. Substrate size classification was based on Wentworth (1922), and included the following size categories:

- Boulder > 256 mm
- Cobble 64-256 mm
- Gravel (aggregate) 2-64 mm
- Sand (aggregate) 62.5 µm – 2 mm
- Silt 3.9-62.5 µm
- Clay < 3.9 µm

At each location, other habitat attributes of interest such as the occurrence of beaver dams were noted.

5.2.1.2 Habitat Classification and Quantification

Aquatic habitat classification and quantification in the Buffalo Creek watershed was conducted through visual assessment from two data sources:

1) A high resolution (30 cm pixel) mosaic assembled from orthometric imagery of the Buffalo Creek watershed and Reach 1 alignment collected during July 2011; and,
2) A series (n = 262) geo-referenced digital photographs taken on 16 August 2011. Photographic coverage extended from the creek mouth at the Dauphin River upstream to and including Big Buffalo Lake.

Habitat information collected during the field program was used to help validate imagery interpretations.

Habitat classification and quantification was completed in three main steps. These included the following:

1) Aquatic habitat type delineation;
2) Aquatic habitat boundary extraction; and,
3) Habitat quantification.

Habitat Type Delineation

The high resolution orthometric mosaic was examined in ArcGIS to delineate polygons of discrete aquatic habitat types within the watershed. Six habitat types were delineated (all adapted from Bisson et al. 1982, with the exception of Peat Pool), including:

1) Riffle - Characterized by moderate to high gradients and ,stream velocities ; moderate to high and turbulence; and the presence of hard and fine to coarse substrates such as gravel, pebble and cobbles and below average depths;

2) Pool - Characterized by relatively low gradients with substratum of fine materials (i.e., silt or sand); below average water velocities and turbulence and above average depth;
3) Run - Characterized by moderate gradients with substrata consisting of small gravel and/or cobble; average depth and velocities with controlled channel boundaries; low turbulence and absence of any stream obstructions;
4) Beaver Pool - Characterized by water impounded upstream from a complete or nearly complete channel obstruction typical of beaver dams. Pool locations reflect the present (photo date) location of beaver dams which can shift from year to year.
5) Beaver Dam - Characterized as a full or partial obstruction of a stream consisting of woody debris and mud; and,
6) Peat Pool - Characterized by low to stagnant velocities, organic substrates, and the absence/paucity of defined channel boundaries.

Habitat polygons were stored in a centroid file, and the boundary of each polygon was manually digitized in ArcGIS to generate a mosaic of habitat polygons representing the distribution of various habitat types within the watershed. The geo-referenced digital photographs and field data were used to help validate the assignment of habitat type to each polygon.

Aquatic Habitat Boundary Extraction

In order to quantify the composition of aquatic habitat, stream channel boundaries needed to be derived and combined with the habitat polygons to calculate areas of each type listed above.

Aquatic habitat boundaries were derived from the high resolution orthometric aerial imagery. The first step included a multivariate, unsupervised spectral classification of the blue green and red visible bands of the orthometric mosaic, completed using ArcGIS software. This classification approach allows the user to specify the number of clustered spectral classes into which the image should be segmented. After the image has been classified, the user can then interpret the classes and assign them to a land cover type. In this case, a general classification of land and water was all that was required to delineate the land and water boundary. Once the imagery was reclassified into land and water cover types, it was converted from a raster to a vector GIS format. A smoothing algorithm (polynomial approximation with exponential kernel; PAEK) was used to remove the relic grid pattern remaining in the vector shoreline data set.

In areas where shadows were confused with the open water class, a manual interpretation of the shoreline was required, which involves 'heads up' digitization of the creek banks using ArcGIS software. After the digitization was completed the polylines representing the shorelines where converted to polygons.

Habitat Quantification

Habitat quantification was conducted by combining the habitat polygon mosaic, the centroid file and the aquatic habitat boundary file to produce a final polygon mosaic. The areas for each habitat type were then summed and tabulated.

5.2.2 Results

5.2.2.1 Field Program

Aquatic habitat information was collected in the Buffalo Creek watershed during a short field program conducted 15-17 August 2011. Data collections focussed on Big Buffalo Lake, the largest lake in the watershed, and in two general areas along Buffalo Creek.

Big Buffalo Lake

Big Buffalo Lake is a small lake (surface area of 55 ha) from which Buffalo Creek originates. During the field program, maximum measured water depth was 2.2 m (Figure 5-2) and substrate was comprised of a deep layer of loosely compacted organic sediments. Aquatic vegetation (primarily *Potamogeton* sp.) occurred throughout much of the lake, although was considerably less dense in the central portion compared to nearshore areas. Lake shorelines were composed largely of shrub wetlands (Figure 5-3) comprised of cattails and bulrushes, as well floating bog in some areas. Few areas surrounding the lake support trees (Figure 5-4). Lake inflow is comprised of local run off from surrounding wetlands. Outflow is through Buffalo Creek (Figure 1-2).

Buffalo Creek

Buffalo Creek originates at Buffalo Lake and flows for approximately 17 km to its confluence with the Dauphin River. For approximately the first 4 km downstream of Big Buffalo Lake, the creek flows through a sparsely treed wetland/bog complex and is characterized by a narrow channel (< 5 m wide) that becomes indeterminate in some locations (Figures 1-2 and 5-5). Topography in the area is very flat.

Upon leaving the wetland/bog complex, the creek enters an area of better-drained soils, and develops a meandering pattern where riffle/run/pool sequences flow over local deposits of cobble, gravel, and sand (Figure 5-6). Gradient increases along this portion of the creek and beaver dams were common. The lower-most kilometer or so of the creek was characterized by a well-defined channel.

During the conduct of the field program, habitat information was collected at two general reaches along the creek. The first originated where the creek exited the wetland/bog complex and extended downstream for approximately 1 km (Figure 5-7). The second originated at the creek's confluence with the Dauphin River and extended upstream for approximately 2 km. Habitat information was collected at six sites at the upstream-most reach and from six locations in the downstream area (Table 5-2; Figure 5-7).

At the upstream reach, where Buffalo Creek leaves the bog complex, the wetted width of the creek ranged from 7.1-12.2 m and water depth ranged 0.1-> 1 m deep, depending upon habitat type (Table 5-2). Substrate compaction was generally hard, but a layer of loose compacted organic material occurred on top of underlying hard compacted substrate in peripheral areas where velocity was reduced, as well as upstream of beaver dams and in pool areas. Substrate type varied between organic materials, clays and sands to larger materials such as gravel, cobble and boulder (Table 5-2). Instream vegetation was sparse in this area, and consisted of inundated grasses and sedges grasses growing along the periphery of the stream.

The portion of creek surveyed near the creek mouth at the Dauphin River was characterized by low flow, caused largely by backwater effects due to high water level on the Dauphin River. Substrate materials were comprised of highly compacted sands, gravels, cobbles and boulders in the central portion of the channel (Table 5-2). Hard compacted clay was predominant in peripheral areas of the channel (Table 5-2). Little instream vegetation was observed at most sampling sites within this reach, although bank vegetation such as grasses and shrubs were inundated due to high water level caused by backwater effects from the Dauphin River. Large and dense beds of lily pads were observed upstream of a large beaver dam at the upstream-most portion of this reach.

5.2.2.2 Habitat Classification and Quantification

It should be noted that several beaver dams occurring along Buffalo Creek were removed prior to conduct of the field program. However, on only two transects at two locations were field measurements of habitat parameters collected where a beaver dam was recently removed. The orthometric imagery used to conduct the habitat classification and quantification was collected prior to removal of the beaver dams, so field measurements collected from the areas where beaver dams were removed were not used to help interpret the orthometric imagery.

A total of 901,981.9 m^2 (or 90.2 ha) of habitat in the Buffalo Creek watershed was classified into six different habitat types (Table 5-3). The majority of habitat in the watershed was identified as peat pool habitat. This habitat type occurred exclusively in the upper reaches of the watershed within the confines of the wetland/bog complex, and included Big Buffalo Lake and Little Buffalo Lake (Figure 5-8). Most of Buffalo Creek downstream of the wetland/bog complex was comprised of the run habitat (15% of available habitat within the watershed; Table 5-3 and Figure 5-8). Pool and riffle habitat accounted for about 6% of total available habitat within the watershed, and beaver dams and pools each comprised less than 1% of the total available habitat (Table 5-3). Twenty-one beaver dams, partial or complete obstructions of the creek, were identified from the aerial imagery.

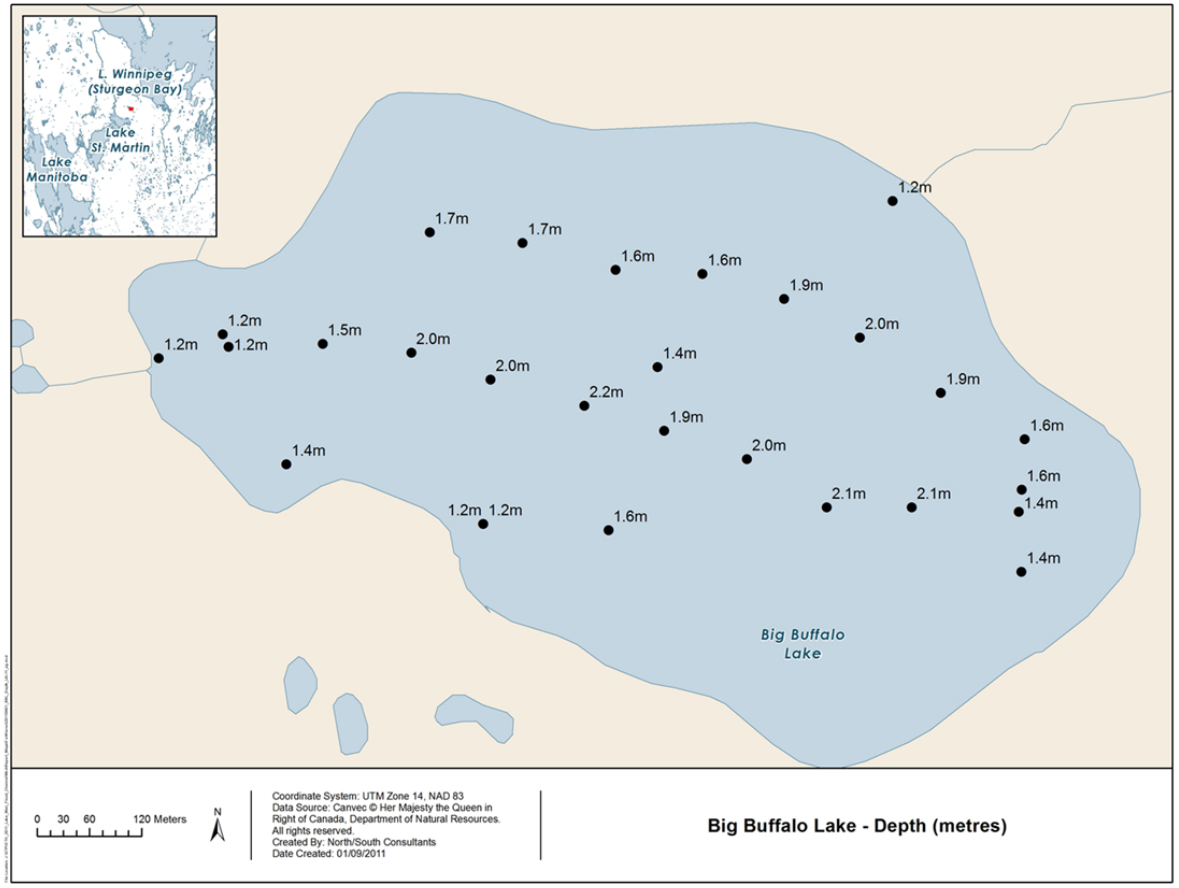


Figure 5-2. Point depth measurements in Big Buffalo Lake, 17 August, 2011.

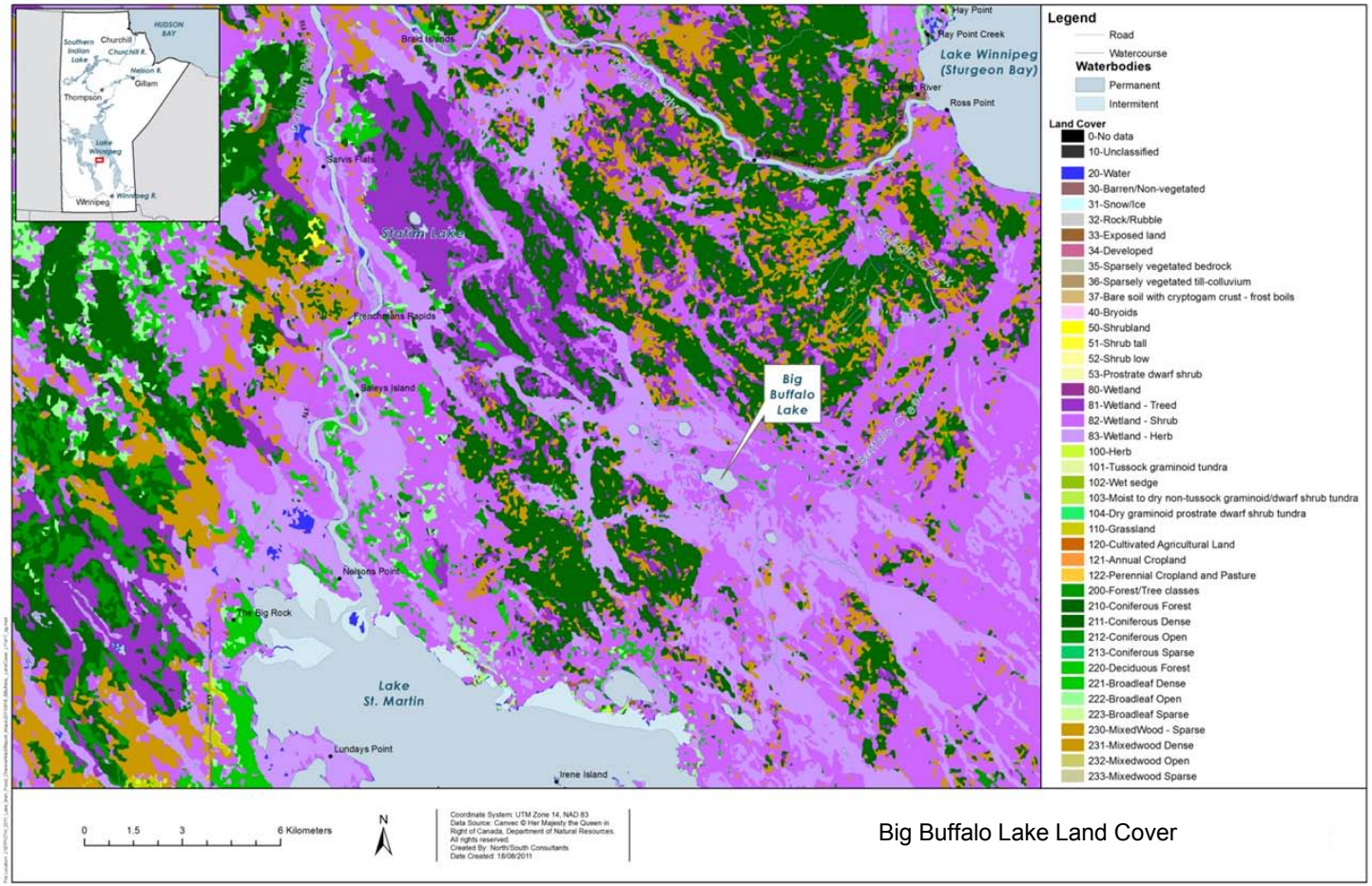


Figure 5-3. Land cover surrounding Big Buffalo Lake. Data from GeoBase (2000; www.geobase.ca)



Figure 5-4. Big Buffalo Lake and associated shoreline, August, 2011.



Figure 5-5. Buffalo Creek downstream of Big Buffalo Lake, illustrating wetland/bog complex through which the creek flows.



Figure 5-6. Buffalo Creek showing riffle/pool/run sequences and meandering pattern, August, 2011.

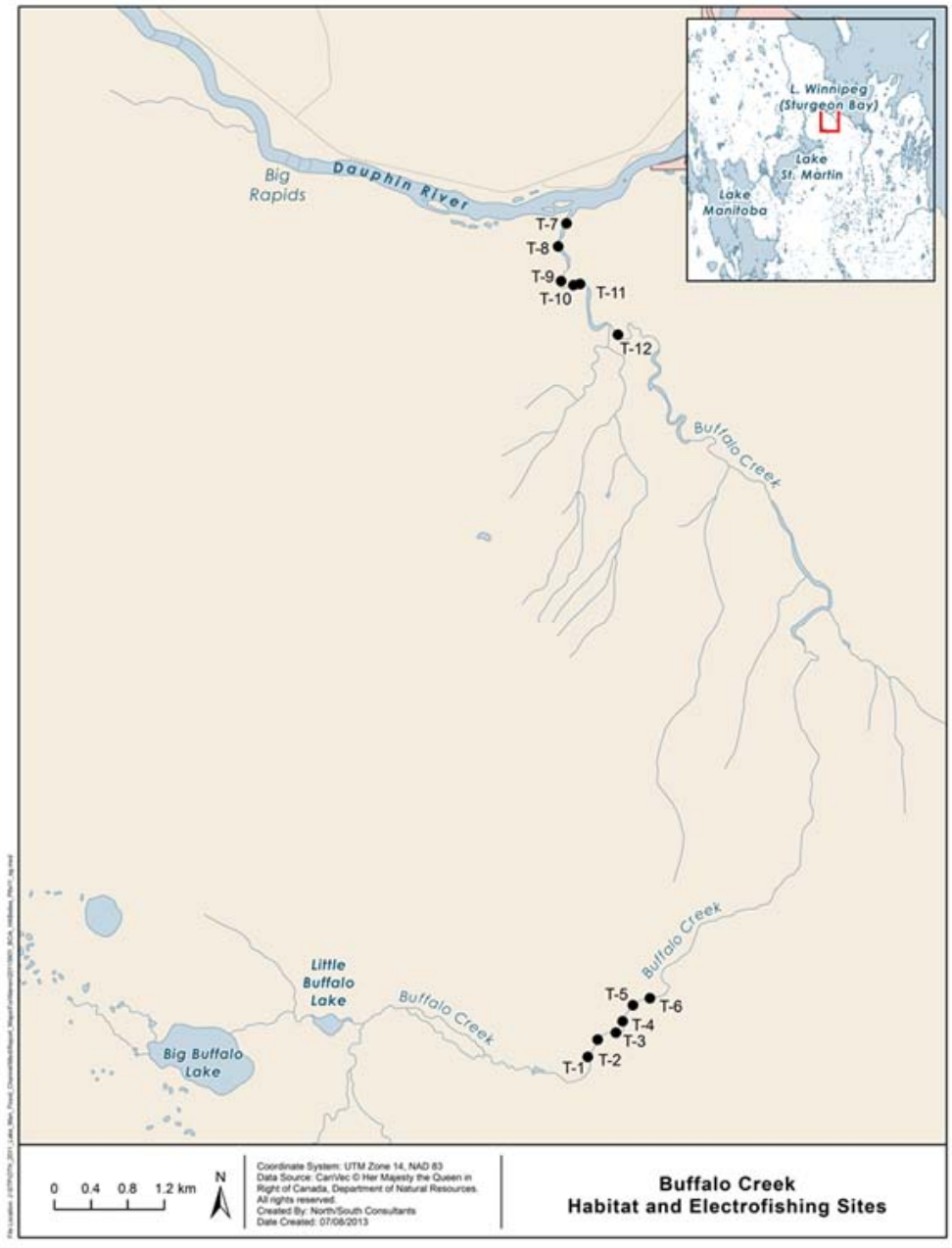


Figure 5-7. Location of habitat sampling and back pack electrofishing sites along Buffalo Creek.

Table 5-2. Habitat information recorded at locations along Buffalo Creek during August, 2011.

Site	Date	Location [1]		Type	Wetted Width (m)	Water Depth (m)	Substrate [2]	Compaction	Instream Vegetation	Comments
		Easting	Northing							
T-1	15-Aug	562476	5745548	run (pool)	7.2	0.1-0.2	sand and gravel, some cobble	Loose, non-compacted organic debris overlying hard compacted substrate	grasses, sedges	recently drained beaver dam
T-2	15-Aug	562585	5745737	run (pool)	7.1	0.2-0.3	clay	Hard	grasses, sedges	recently drained beaver dam
T-3	15-Aug	562784	5745814	pool	7.5	> 1.0	clay	Hard	grasses, sedges	upstream of existing beaver dam
T-4	15-Aug	562858	5745938	riffle/pool	12.2	0.-0.3	cobble/boulder in riffle gravel/boulder overlain by organic debris in pool	riffle - hard pool - loose non-compacted organic debris overlying hard compacted substrate	none	downstream of newly constructed beaver dam
T-5	15-Aug	562969	5746115	run (pool)	8.1	0.2-0.3	cobble, gravel , and sand; scattered boulders overlain by organic debris	loose non-compacted organic debris overlying hard compacted substrate	none	recently drained beaver dam
T-6	15-Aug	563155	5746191	riffle/run	8.5	0.1-0.3	cobble, boulder	hard compaction		
T-7	17-Aug	562243	5754664	backwater	22	> 1.5	gravel cobble boulders	hard compaction	grasses, sedges	water ponding influence from Dauphin River
T-8	17-Aug	562153	5754413	backwater	10	1.2	clay along stream edges, gravel and boulder in middle	Hard	grasses, sedges	water ponding influence from Dauphin River
T-9	17-Aug	562185	5754034	backwater	12	0.3-0.7	sand and gravel, some boulders	Hard	None	water ponding influence from Dauphin River
T-10	17-Aug	562319	5753988	riffle/run	11	0.3-0.5	sand, gravel, some cobble and boulder	Hard	None	low flow
T-11	17-Aug	562391	5754002	riffle	7	0.1-0.3	cobble/boulder	Hard	None	low flow
T-12	17-Aug	562806	5753448	pool	29	< 1.0	clay and organic debris	Hard	Dense beds of lily pads	upstream of existing beaver dam

1 - UTM coordinates; Datum NAD 83, Zone 14U; locations illustrated on Figure 5-3

2 - Substrate size classification based on Wentworth (1922); described in Section 5.2.1.1

Table 5-3. Stream habitat classification in Buffalo Creek, August 2011.

Habitat Type	Area (m^2)	Area (ha)	Proportion (%)
Beaver Dams	1,588.0	0.16	0.2
Beaver Pools	7,626.4	0.76	0.8
Riffle	20,610.7	2.06	2.3
Run	133,706.6	13.37	14.8
Pool	37,323.2	3.73	4.1
Peat Pool	701,127.0	70.11	77.7
Grand Total	901,981.9	90.20	100.00

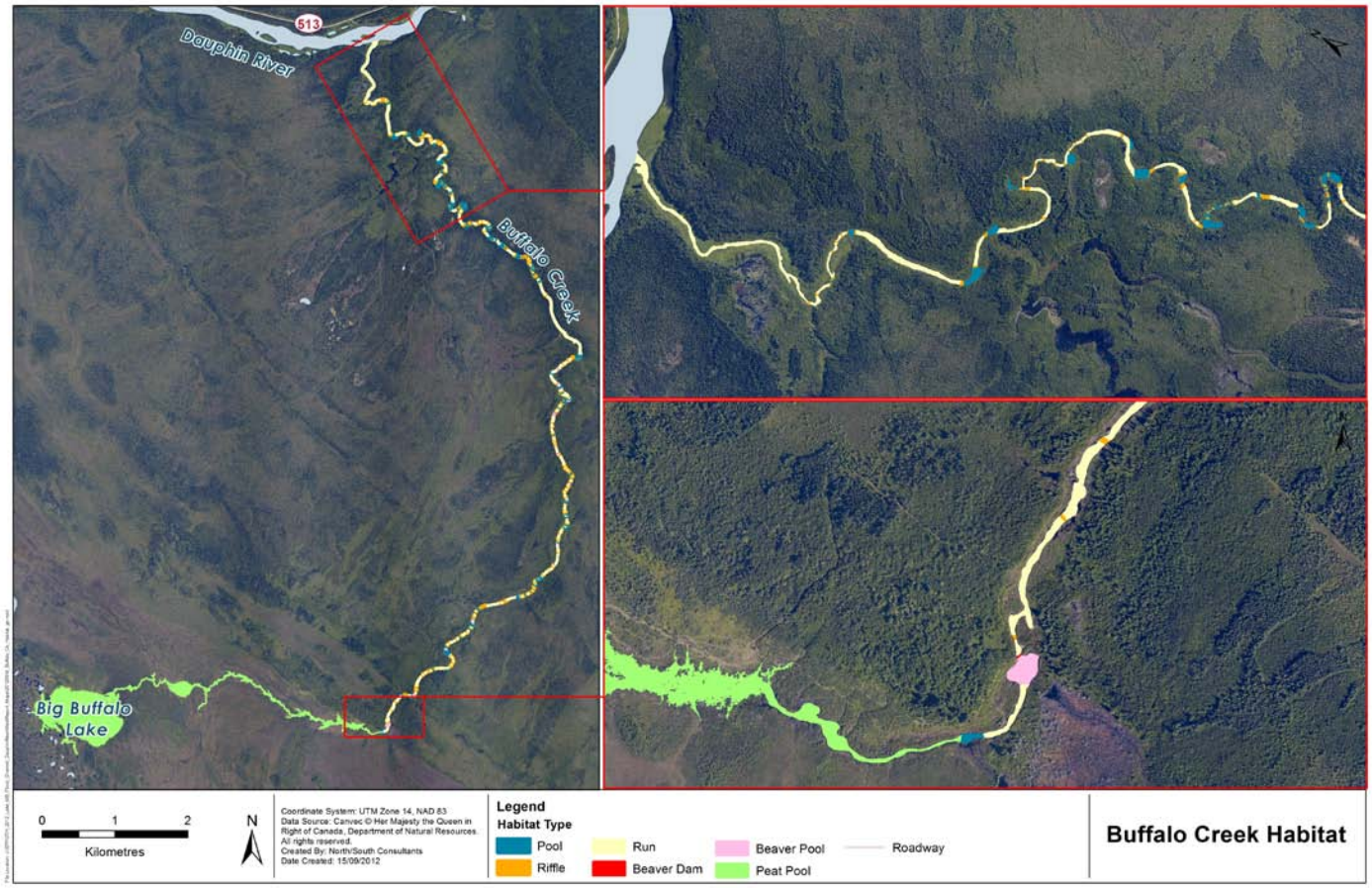


Figure 5-8. Habitat types in the Buffalo Creek watershed, August 2011.

5.3 FISH PRESENCE AND DISTRIBUTION

Information to describe the presence, abundance, and species composition of fish occurring throughout the Buffalo Creek watershed was collected during August 2011, prior to operation of Reach 1.

5.3.1 Methods

5.3.1.1 Big Buffalo Lake

Experimental and small mesh gillnet gangs were used to sample fish in Big Buffalo Lake. Each experimental gillnet gang consisted of three 22.9 m long by 1.8 m deep panels of either 38, 51, and 76 mm stretched twisted nylon mesh or 95, 108, and 127 mm stretched mesh. Small mesh gangs were 30 m long and consisted of three 10 m long by 1.8 m deep panels of 16, 20, and 25 mm twisted nylon stretched mesh.

Net set and retrieval dates and times were recorded for each gang. Net set locations were recorded with a handheld Garmin GPSmap 76S GPS receiver. Water depth (± 0.1 m) was measured at each end of the net with a hand-held SM-5 (Speedtech Instruments) depth sounder, and surface water temperature was recorded with a handheld thermometer (±0.5 °C).

All fish captured were enumerated by species and sampling location. Each fish (mortalities and live released fish) was measured for fork length (± 1 mm) and round weight (± 25 g). All live fish were released following sampling. The gonads of fish that died while in the gill nets were examined internally to determine spawning status. The following sexual maturity codes were used:

Females (F)	Males (M)
2 - maturing to spawn (pre-spawn)	7 - maturing to spawn (pre-spawn)
3 - ripe (immediate pre-spawn)	8 - ripe (immediate pre-spawn)
4 - spend (post-spawn)	9 - spend (post-spawn)

5.3.1.2 Buffalo Creek

A Smith-Root model LR-24 back pack electrofisher was used to sample for fish along Buffalo Creek. Electrofishing was conducted at numerous sites within two general reaches along the creek.

At each sampling site, single passes were conducted with the electrofisher to document presence of fish. Immobilized fish were captured using a hand-held dip net held in a water-filled bucket on shore. At the conclusion of the electrofishing pass, all captured fish were identified to species, enumerated, and released back into the creek. In many instances, large numbers of individuals of the same fish species would be observed in a very small location. Rather than capture all of them, a subsample would be captured to confirm species identification and the total number observed would be estimated.

The duration of electrofishing effort was recorded for each sampling site, the location of each site was recorded with a handheld Garmin GPSmap 76S GPS receiver, and aquatic habitat characteristics were noted (see Section 5.2).

5.3.1.3 Data Analyses

Gillnetting and electrofishing catches were tabulated by species and capture location. Catch-per-unit-effort (CPUE) was calculated for the overall catch and for each species, by site. For gill nets, CPUE was calculated as the number of fish caught per 100 m of net per 24 hours of sampling. Total CPUE was calculated by averaging all net set CPUE values.

Mean fork length (mm) was calculated for each species from the gillnetting catch. Length-frequency distributions were plotted for each species where more than 15 fish were captured and measured. Length intervals of 10 mm were used for smaller-bodied species (e.g., Yellow Perch; 80-89 mm). A 25 mm interval was used for larger-bodied species (e.g., Northern Pike).

5.3.2 Results

At least ten species of fish were captured in the Buffalo Creek watershed (Table 5-4). Some small dace and sculpin could not be identified to species and the catch may include more than one species of each. Species diversity was greater in Buffalo Creek than in Big Buffalo Lake, and there was little overlap in community composition between the upstream and downstream reaches of the creek.

5.3.2.1 Big Buffalo Lake

Six experimental gillnet gangs and one standard small mesh gillnet gang were set in Big Buffalo Lake during fall 2011 (Table 5-5; Figure 5-9). All nets were set in water depths less than 2 m. Water temperature was approximately 19^{o}C at the time of sampling (Table 5-1). Four of the experimental gangs and the small mesh net were set for 20-23 hours. Two additional experimental gangs were set for approximately 5 hours (Table 5-5).

The catch totalled 315 fish representing four species (Table 5-6). Yellow Perch was the most abundant species, comprising 86.7% of the total catch (n = 273). The remainder of the catch included Northern Pike (n = 20; 6.3%), Golden Shiner (n = 12; 3.8%), and White Sucker (n = 10; 3.2%). Species diversity and abundance was greatest in the smaller mesh nets. The two experimental gangs consisting of three smaller mesh panels (38, 51, and 76 mm) captured 68 fish while the four experimental gangs consisting of larger mesh sizes (95, 108, and 127 mm) captured only a single Northern Pike. The CPUE ranged from 0.0 fish/100 m gang/24 hours in nets GN-1, 2, and 5 to 926.1 fish/100 m/24 hours in the small mesh net (Table 5-7).

Species Accounts

The following sections present size and condition information for selected fish species captured.

Golden Shiner

Golden Shiners (n = 12) were captured exclusively in the small mesh net set in Big Buffalo Lake (Table 5-6). Catch-per-unit-effort was 45.2 fish/100m/24hrs (Table 5-7). Mean length of captured Golden Shiner was 77 mm (Table 5-8).

Northern Pike

Northern Pike was the second most abundant species (n = 20) captured in gill nets set in Big Buffalo Lake (Table 5-6). Mean CPUE for Northern Pike was 5.2 fish/100m/24hrs in the experimental gangs and was and 15.1 fish/100m/24hrs for the small mesh gang (Table 5-7). The Northern Pike catch was comprised larger juvenile fish, ranging in size from 243-486 mm in fork length (Table 5-8). Mean fork length was 359 mm and the modal fork length interval was 425-449 mm (Figure 5-10).

White Sucker

White Sucker were the least abundant species (n = 10) in the gillnetting catch (Table 5-6). Mean CPUE for Northern Pike was 5.2 fish/100m/24hrs in the experimental gangs and was and 15.1 fish/100m/24hrs for the small mesh gang (Table 5-7). The White Sucker catch was comprised of juvenile fish with a size range of 121-209 mm and a mean fork length of 165 mm (Table 5-8).

Yellow Perch

Yellow Perch were, by far, the most abundant species captured in Big Buffalo Lake (Table 5-6). Mean CPUE for Yellow Perch was 132.9 fish/100m/24hrs (Table 5-7). The Yellow Perch catch was a mixture of juveniles and adults, ranging in size from 50-245 mm with a mean fork length of 86 mm (Table 5-8). The modal length interval was 60-69 mm (Figure 5-11). More than 80% of the Perch captured were 50-89 mm in length.

Table 5-4. Distribution of fish species captured in the Buffalo Creek watershed.

Species	Scientific Name	Big Buffalo Lake	Buffalo Creek	
			Upstream Reach [1]	Downstream Reach [1]
Central Mudminnow	*Umbra limi*	-	✓	-
Dace [2]	*Phoxinus* sp.	✓	✓	-
Golden Shiner	*Notemigonus chrysoleucas*	✓	-	-
Logperch	*Percina caprodes*	-	✓	✓
Longnose Dace	*Rhinichthys cataractae*	-	-	✓
Northern Pike	*Esox lucius*	✓	-	✓
Sculpin [3]	*Cottus* sp.	-	-	✓
Brook Stickleback	*Culaea inconstans*	-	-	-
Stickleback [4]		-	✓	-
White Sucker	*Catostomus commersonii*	✓	✓	-
Yellow Perch	*Perca flavescens*	✓	-	✓

1 - sampling locations illustrated in Figure 5-7; Upstream Reach includes sites T1 to T6, Downstream Reach includes sites T7 to T12

2 - all young-of-the-year fish; one of or perhaps both of Finescale Dace (*Phoxinus neogaeus*) or Northern Redbelly Dace (*Phoxinus eos*)

3 - one of or perhaps both of Mottled Sculpin (*Cottus bairdi*) or Slimy Sculpin (*Cottus cognatus*)

4 - dead and partially decomposed specimen found; either Brook Stickleback or Ninespine Stickleback (*Pungitius pungitius*)

Table 5-5. Location and set information for gill nets set in Big Buffalo Lake during August, 2011.

Site [1]	Start UTM [2]		End UTM [2]		Water Depth (m)	Set Date	Set Time	Pull Date	Pull Time	Duration (hrs)	Mesh Sizes [3]
	Easting	Northing	Easting	Northing							
GN-1	558685	5745356	558682	5745424	1.4	15-Aug	13:40	16-Aug	10:00	20.3	2
GN-2	558210	5745403	558214	5745489	1.6	15-Aug	13:50	16-Aug	10:15	20.4	2
GN-3	557839	5745479	557837	5745571	1.4	15-Aug	14:10	16-Aug	10:30	20.3	1
GN-4	558266	5745591	558242	5745673	1.4	15-Aug	14:45	16-Aug	13:20	22.6	1
GN-5	558689	5745508	558685	5745450	1.6	16-Aug	10:10	16-Aug	15:30	5.3	2
GN-6	557692	5745601	557766	5745628	1.2	16-Aug	10:20	16-Aug	15:35	5.3	2
SM-1	558066	5745411	558024	5745459	1.2	15-Aug	14:00	16-Aug	11:15	21.2	3

1 - Net locations are illustrated in Figure 5-9.

2 - NAD83 datum, Zone 14U

3 - 1: standard experimental net gang; three panels; one each of 38, 51, and 76 mm stretched mesh;
2: standard experimental net gang; three panels; one each of 95, 108, and 127 mm stretched mesh; and,
3: Swedish-style small mesh net; three panels; one each of 16, 20, and 25 mm stretched mesh

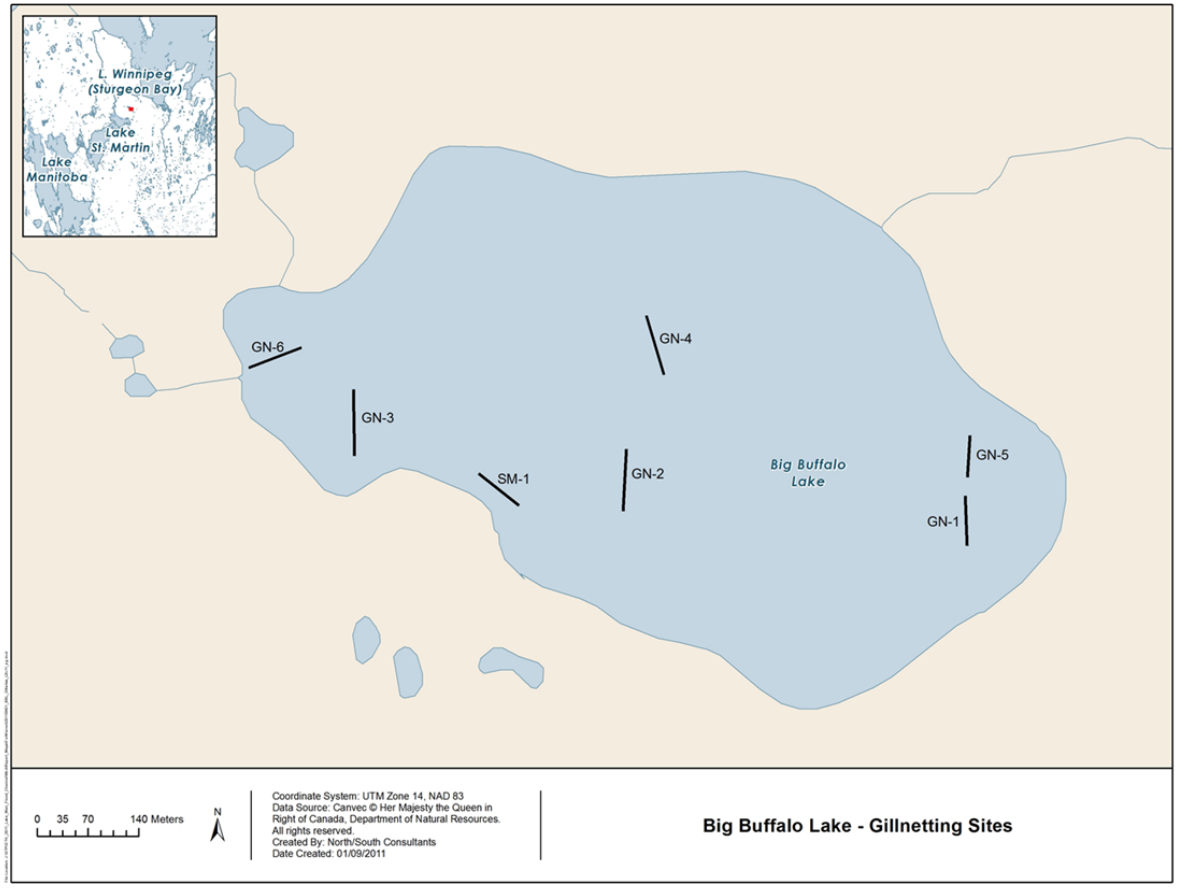


Figure 5-9. Location of gillnetting sites on Big Buffalo Lake, August, 2011.

Table 5-6. Summary of the gillnetting catch from Big Buffalo Lake by net location, August 2011.

Site [1]	Species				All Species
	Golden Shiner	Northern Pike	White Sucker	Yellow Perch	
Experimental Gangs					
GN-1	0	0	0	0	0
GN-2	0	0	0	0	0
GN-3	0	6	2	24	32
GN-4	0	9	5	22	36
GN-5	0	0	0	0	0
GN-6	0	1	0	0	1
Small Mesh Gang					
SM-1	12	4	3	227	246
Total	12	20	10	273	315
Frequency (%) [2]	3.8	6.3	3.2	86.7	100.0

1 - Net locations are illustrated on Figure 5-9.

2 - Frequency of occurrence calculated as a percentage of the total catch

Table 5-7. Catch-per-unit-effort (#fish /100 m/24 hrs) for each fish species captured in gill nets set in Big Buffalo Lake, August 2011.

Site	Duration (hrs)	Species				Total
		Golden Shiner	Northern Pike	White Sucker	Yellow Perch	
Experimental Gangs						
GN-1	20.33	0.0	0.0	0.0	0.0	0.0
GN-2	20.42	0.0	0.0	0.0	0.0	0.0
GN-3	20.33	0.0	10.3	3.4	41.3	55.1
GN-4	22.58	0.0	14.0	7.8	34.1	55.8
GN-5	5.33	0.0	0.0	0.0	0.0	0.0
GN-6	5.25	00	6.7	0.0	0.0	6.7
	Average	0.0	5.2	1.9	12.6	19.6
	SD [1]	0.0	6.1	3.2	19.6	27.9
Small Mesh Gang						
SM-1	21.3	45.2	15.1	11.3	854.6	926.1

1 - SD = standard deviation

Table 5-8. Fork length (mm) for fish species captured in gill nets set in Big Buffalo Lake, August 2011.

Species	n [1]	Length (mm)		
		Average	SD [2]	Range
Golden Shiner	12	77	8	67-92
Northern Pike	20	359	85	243-486
White Sucker	10	165	22	121-209
Yellow Perch	273	86	48	50-245

1 - n = the number of fish measured; may not equal the total number captured
2 - SD = standard deviation

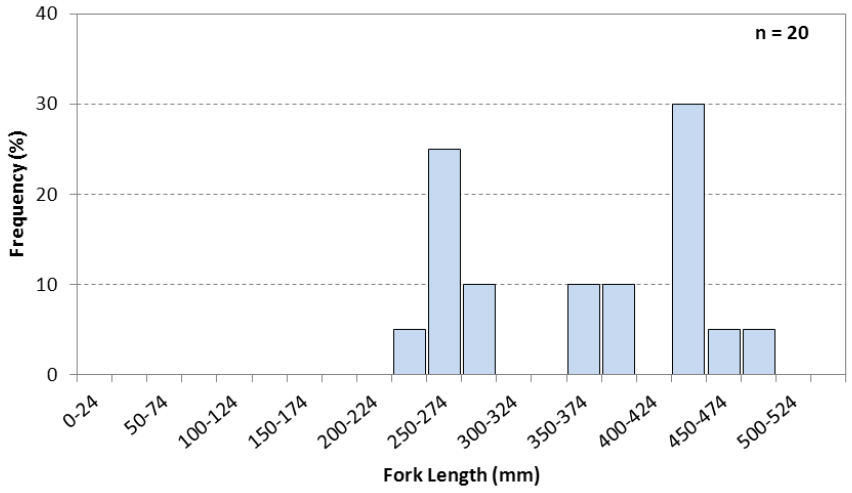


Figure 5-10. Length-frequency distribution for Northern Pike captured in gill nets set in Big Buffalo Lake, August 2011.

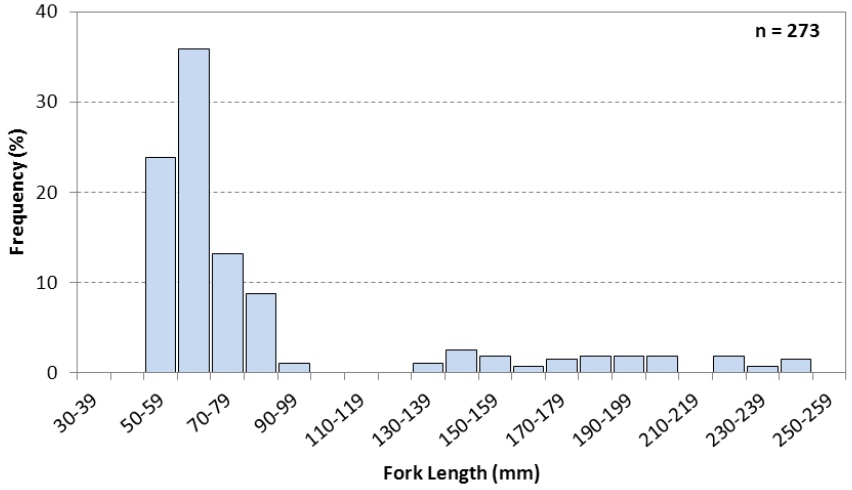


Figure 5-11. Length-frequency distribution for Yellow Perch captured in gill nets set in Big Buffalo Lake, August 2011.

5.3.2.2 Buffalo Creek

Back pack electrofishing was conducted at 12 sites along Buffalo Creek during mid-August, 2011 (Table 5-9; Figure 5-7). Fishing effort ranged from 87 to 644 seconds per site (Table 5-9). In many instances, large numbers of individuals of a given species were observed. When this occurred, the number of fish observed was estimated but most were not captured. Only a small subsample was captured to confirm species identity.

Fishing focussed on two general areas within the creek. The first originated where the creek exited the wetland/bog complex and extended downstream for approximately 1 km (Figure 5-7). The second originated at the creek's confluence with the Dauphin River and extended upstream for approximately 2 km (Figure 5-7).

More than 250 fish representing four species were observed or captured at the upstream reach (Table 5-9). The majority of the fish were Central Mudminnows (>140 fish) and dace (>120 fish), some of which were identified as Pearl Dace, but most of which were unidentified to species (Table 5-9). A small number of juvenile White Sucker (n = 11; Table 5-9) were also captured. Captured White Suckers ranged in length from 20-150 mm (Table 5-9).

Considerably fewer fish were captured in the downstream reach. Twenty individuals representing five species were captured (Table 5-9). Species occurring in the downstream reach were different than that observed in the upstream reach. Northern Pike, Longnose Dace, Slimy Sculpin, Yellow Perch, and Logperch were observed in the downstream reach but not the upstream reach. Central mudminnows and dace species other than Longnose Dace were abundant in the upstream reach but were not observed in the downstream reach (Table 5-9). This difference may be due to different habitat conditions between the two areas, or due to proximity to the Dauphin River.

Table 5- 9. Results of back pack electrofishing conducted along Buffalo Creek during August, 2011.

Site	Date	Location [1]		Fishing Effort (seconds)	Species										Numbers Observed
		Easting	Northing		Brook Stickleback	Central Mudminnow	Dace	Logperch	Longnose Dace	Northern Pike	Pearl Dace	Slimy Sculpin	White Sucker	Yellow Perch	
Upstream Reach															
1	15-Aug	562476	5745548	305	-	> 20	> 50	-	-	-	-	-	-	-	> 70
2	15-Aug	562585	5745737	366	-	> 20	> 50	-	-	-	-	-	4 (70, 80, 100, 150)	-	> 74
3	15-Aug	562784	5745814	177	-	> 20	-	-	-	-	> 20	-	-	-	> 40
4	15-Aug	562858	5745938	269	1	> 50	-	-	-	-	1	-	4 (20, 40, 40, 120)	-	> 52
5	15-Aug	562969	5746115	400	-	> 20	-	1	-	-	-	-	-	-	> 21
6	15-Aug	563155	5746191	644	1	> 50	-	-	-	-	-	-	3 (30, 40, 80)	-	> 74
Downstream Reach															
7	17-Aug	562243	5754664	87	-	-	-	-	-	-	-	-	-	-	0
8	17-Aug	562153	5754413	NF	-	-	-	-	-	-	-	-	-	-	
9	17-Aug	562185	5754034	284	-	-	-	-	-	-	-	-	-	1 (110)	1
10	17-Aug	562319	5753988	451	-	-	-	3	-	1 (220)	-	-	-	-	4
11	17-Aug	562391	5754002	394	-	-	-	2	4	3 (100, 100, 120)	-	9	-	-	15
12	17-Aug	562806	5753448	183	-	-	-	-	-	-	-	-	-	-	0

1 - Sampling locations are illustrated on Figure 5-7

5.4 SUMMARY

Water Quality

Water quality information specific to the Buffalo Creek watershed was collected through the CEMP program and a brief field investigation that provided information specific to Big Buffalo Lake.

As part of the CEMP, water quality was monitored in Lake St. Martin, Buffalo Creek, and in the Dauphin River from September 2 until 01 November, when Reach 1 became operational. Sampling included the collection of in situ water quality data, as well as samples for laboratory analysis. Following the onset of operation, water quality monitoring continued throughout the system until 25 November, 2011. Prior to 01 November, monitoring was conducted approximately twice a month. After Reach 1 was opened, sampling frequency increased to twice a week. Prior to operation of Reach 1, the water quality of Buffalo Creek differed from Lake St. Martin, the Dauphin River or Sturgeon Bay. Buffalo Creek had lower turbidity/TSS, lower conductivity and total dissolved solids (TDS), lower chlorophyll a, higher concentrations of organic carbon, greater colour, and a higher amount of phosphorus in dissolved form than the other waterbodies in the study area.

In situ water quality measurements were taken at four sites in Big Buffalo Lake on 17 August, 2011. Results indicated that the lake was not thermally stratified, was relatively well-oxygenated, and near-neutral. Turbidity was less than 7 NTU and Secchi disk depth ranged from 1.2-2.2 m. In situ measurements at the mouth of Buffalo Creek indicated that water at the creek mouth was slightly more turbid, acidic, less oxygenated, and warmer than measured at Big Buffalo Lake.

Aquatic Habitat

Prior to operation of Reach 1, aquatic habitat in Big Buffalo Lake and Buffalo Creek were characterized and quantified to describe pre-Project conditions. The habitat assessment was completed using information collected during a brief field program conducted in August 2011 and by interpreting habitat characteristics from aerial orthometric imagery and geo-referenced digital photographs to classify and quantify aquatic habitat within the watershed.

Big Buffalo Lake is a small lake (surface area of 55 ha) from which Buffalo Creek originates. Maximum water depth was 2.2 m and substrate was comprised of a deep layer of loosely compacted organic sediments. Aquatic vegetation occurred throughout much of the lake, although was considerably less dense in the central portion compared to nearshore areas. Lake shorelines were composed largely of shrub wetlands comprised of cattails and bulrushes, as well floating bog in some areas. Few areas surrounding the lake support trees.

Buffalo Creek originates at Buffalo Lake and flows for approximately 17 km to its confluence with the Dauphin River. For approximately the first 4 km downstream of Big Buffalo Lake, the creek flows through a sparsely treed wetland/bog complex and is characterized by a narrow channel (< 5 m wide) that becomes indeterminate in some locations. Upon leaving the wetland/bog complex, the creek

enters an area of higher gradient and develops a meandering pattern where riffle/run/pool sequences flow over local deposits of cobble, gravel, and sand. Beaver dams were common.

A total of 901,981.9 m^2 (or 90.2 ha) of habitat in the Buffalo Creek watershed was classified from digital imagery. Six different habitat types were identified. The majority of habitat in the watershed was identified as peat pool habitat. This habitat type occurred exclusively in the upper reaches of the watershed within the confines of the wetland/bog complex, and included Big Buffalo Lake. Most of Buffalo Creek downstream of the wetland/bog complex was comprised of the run habitat (15% of available habitat within the watershed. Pool and riffle habitat accounted for about 6% of total available habitat within the watershed, and beaver dams and pools each comprised less than 1% of the total available habitat.

Fish Presence and Abundance

At least ten species of fish were captured in the Buffalo Creek watershed. Some small dace and sculpin could not be identified to species and the catch may include more than one species of each. Species diversity was greater in Buffalo Creek than in Big Buffalo Lake, and there was little overlap in community composition between the upstream and downstream reaches of the creek.

The fish community within Big Buffalo Lake was sampled using experimental gill nets. The catch totalled 315 fish representing four species. Yellow Perch was the most abundant species, comprising 86.7% of the total catch. The remainder of the catch included Northern Pike (6.3%), Golden Shiner (3.8%), and White Sucker (3.2%). Northern Pike and White Suckers captured within the lake were all juvenile fish. The absence of adults suggests that these species do not fulfill all of their life history requirements within the lake. In contrast, adult, juvenile and young-of-the-year Yellow Perch were captured in the lake. In particular, large numbers of young perch were captured, suggesting that the lake supports a resident population. The extent to which Golden Shiner use the is not known, although large numbers of small fish not susceptible to capture in the gill nets were observed. It is possible that these were young-of-the-year Golden Shiner.

Back pack electrofishing was conducted at 12 sites along Buffalo Creek to document fish presence and abundance. Fishing focussed on two general areas within the creek. The first originated where the creek exited the wetland/bog complex and extended downstream for approximately 1 km. The second originated at the creek's confluence with the Dauphin River and extended upstream for approximately 2 km.

More than 250 fish representing four species were observed or captured at the upstream reach. The majority of the fish were Central Mudminnows and dace species, some of which were identified as Pearl Dace, but most of which were unidentified. A small number of juvenile White Sucker were also captured.

Considerably fewer fish were captured in the downstream reach. Twenty individuals representing five species were captured. Species occurring in the downstream reach were different than that observed in the upstream reach. Northern Pike, Longnose Dace, Slimy Sculpin, Yellow Perch, and Logperch were

observed in the downstream reach but not the upstream reach. Central mudminnows and dace species other than Longnose Dace were abundant in the upstream reach but were not observed in the downstream reach. This difference may be due to different habitat conditions between the two areas, or due to proximity to the Dauphin River.

6.0 HABITAT MAPPING IN DAUPHIN RIVER AND STURGEON BAY

It was thought that operation of Reach 1 could result in substrate changes in Sturgeon Bay due to increased sediment inputs. The intent of habitat mapping studies was to document pre-operation habitat conditions in Sturgeon Bay and the Dauphin River and provide a baseline to help assess post-project changes. Specific study objectives include:

- collect habitat information (water depth and substrate type) where data do not exist;
- determine baseline depth and substrate types in shallow water areas of Sturgeon Bay and in the Dauphin River mouth and surrounding area understood by local knowledge to be potential Walleye and Lake Whitefish spawning habitat;
- To identify potential Walleye and Lake Whitefish spawning habitat in the Dauphin River and in Sturgeon Bay; and,
- To characterize deep water substrate types in offshore areas of Sturgeon Bay.

6.1 METHODS

It was proposed that a suite of methods be used to compile habitat information within the Dauphin River and Sturgeon Bay. These included the following:

- Collection of bathymetric and substrate data in the Dauphin River and Sturgeon Bay using sonar technology;
- Collection of substrate samples in Sturgeon Bay and slow water velocity areas of the Dauphin River to help validate interpretation of the sonar data; and,
- Conduct of rebar drags in fast water velocity areas of the Dauphin River to help validate interpretation of the sonar data.

6.1.1 Data Collection

6.1.1.1 Survey Areas

The survey area within the lower Dauphin River extended from approximately 750 m upstream of the confluence of the Dauphin River and Buffalo Creek downstream and approximately 1 km into Sturgeon Bay (Figure 6-1). The riverine survey consisted of longitudinal shoreline and centre channel transects followed by a zig-zag, bank-to-bank, transect pattern (Figure 6-1).

The Sturgeon Bay portion of the survey was to consist of a series of transects oriented perpendicular to the shoreline and extending from shore to approximately 5 km offshore. Transects were to be spaced approximately 250m apart and were to cover the area extending along the Sturgeon Bay shoreline from approximately 3 km north of the Dauphin River mouth to south and east of Willow Point.

6.1.1.2 Sonar Data Collection

Bathymetric and bottom-typing surveys throughout the area were conducted from a 22 foot boat operated at ~5 to 10 km/h. Depth, positional data, and bottom-type data were acquired concurrently using a Quester Tangent Corporation (QTC) Series 5.5 scientific-grade 50 kHz echosounder paired with a Trimble Pro-XRS real-time differential global positioning system (DGPS). The echosounder's transducer was positioned 0.61 m below the surface of the water adjacent to the hull in the middle of the boat. The DGPS receiver National Marine Electronics Association (NMEA) GGA output coordinates, and time stamps were logged to a notebook computer along with the QTC sonar depth and bottom-type data at one second intervals, using QTC's QTRT acquisition software.

6.1.1.3 Substrate Validation

Substrate samples were collected from Sturgeon Bay and low water velocity areas of the lower Dauphin River to provide information used to validate the interpretation of the sonar data. Substrate samples were collected using a petit ponar grab (152 mm x 152 mm mouth opening). At each site, ponar penetration depth and relative proportion (%) of each substrate type within the sample was visually estimated and recorded. Substrate size classification was based on Wentworth (1922), and included the following size categories:

- Boulder > 256 mm
- Cobble 64-256 mm
- Gravel (aggregate) 2-64 mm
- Sand (aggregate) 62.5 µm – 2 mm
- Silt 3.9-62.5 µm
- Clay < 3.9 µm

In areas where high water velocity precluded the use of the ponar grab, validation of bottom substrates and structure in the riverine study reach was conducted through a series of rebar drags (Figure 6-1). Steel rebar was attached on one end with a rope and dragged along the river bed. The vibration and movement of the rebar on the river bed provides some indication of the substrate material. Soft, fine substrate areas have very little vibration and jump, whereas complicated and hard bottoms have increased levels of vibration and jump. For each rebar drag transect, aggregate size was estimated and noted (aided by visual assessment where possible).

6.1.1.4 Digital Photography

GPS-linked digital photography was used to document shoreline conditions and to aid in the development of the substrate map. GPS-linked digital photography allows each image taken to be imprinted with geographic coordinates so that they can be mapped and displayed accordingly post-survey. The locations of the acquired GPS-linked digital photography are illustrated in Figure 6-2.

6.1.2 Data Analysis and Mapping

6.1.2.1 Bathymetry

The sonar depth and GPS records were merged and exported to an ASCII comma separated values format using QTC Impact software. The depth and position data were then imported into Microsoft Excel for additional processing, including correction for transducer depth. A geographic vector shoreline file was provided by KGS Group for use in mapping and bathymetric analysis. The corrected sonar depths were combined with vertices extracted from the shoreline polyline file, which had been assigned zero depth values using ArcGIS 10 software. The merged shapefile was imported into Surfer® 9 (Golden Software) and a Kriging spherical variogram model interpolation was used to produce a 5 m pixel resolution depth grid. The raster grid was imported back into ArcGIS 10 for vector contouring at 0.5 metre intervals and final cartographic presentation for the report.

6.1.2.2 Substrate

The QTC acoustic data were exported from QTC Impact and imported to and analyzed with the statistical package SPSS. A multivariate principal components analysis (PCA) was used to reduce the 166 acoustic waveform variables related to bed roughness and hardness down to 5 principal component variables representing over 90 % of the variability within the data set. An unsupervised classification K-means clustering approach was used to produce 5 discrete acoustic classes, representing 5 different substrate types. The classified acoustic tracks were imported into ArcGIS 10 to identify the acoustic classes that co-occurred with the bottom-type validation classes. In addition the GPS-linked digital shoreline photographs were used to validate the acoustic bottom-type classes and increase mapping resolution in the near-shore zone. Substrate classes were digitized as polygons from the classified acoustic tracks, and a final substrate data set was mapped and class areas calculated in ArcGIS 10.

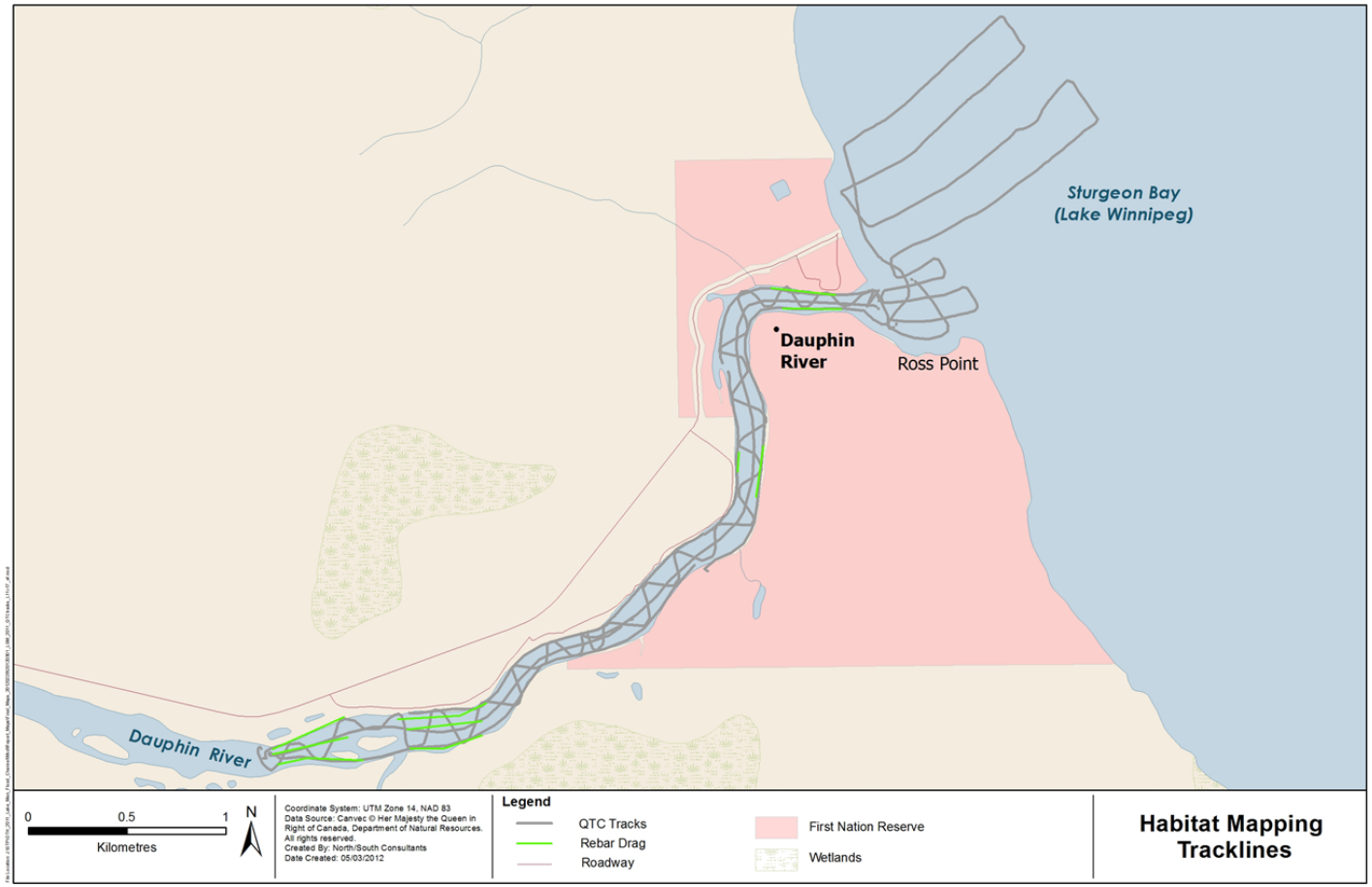


Figure 6-1. Survey track lines (QTC tracks) and substrate validation transects (Rebar Drag) conducted along the Dauphin River during fall 2011.

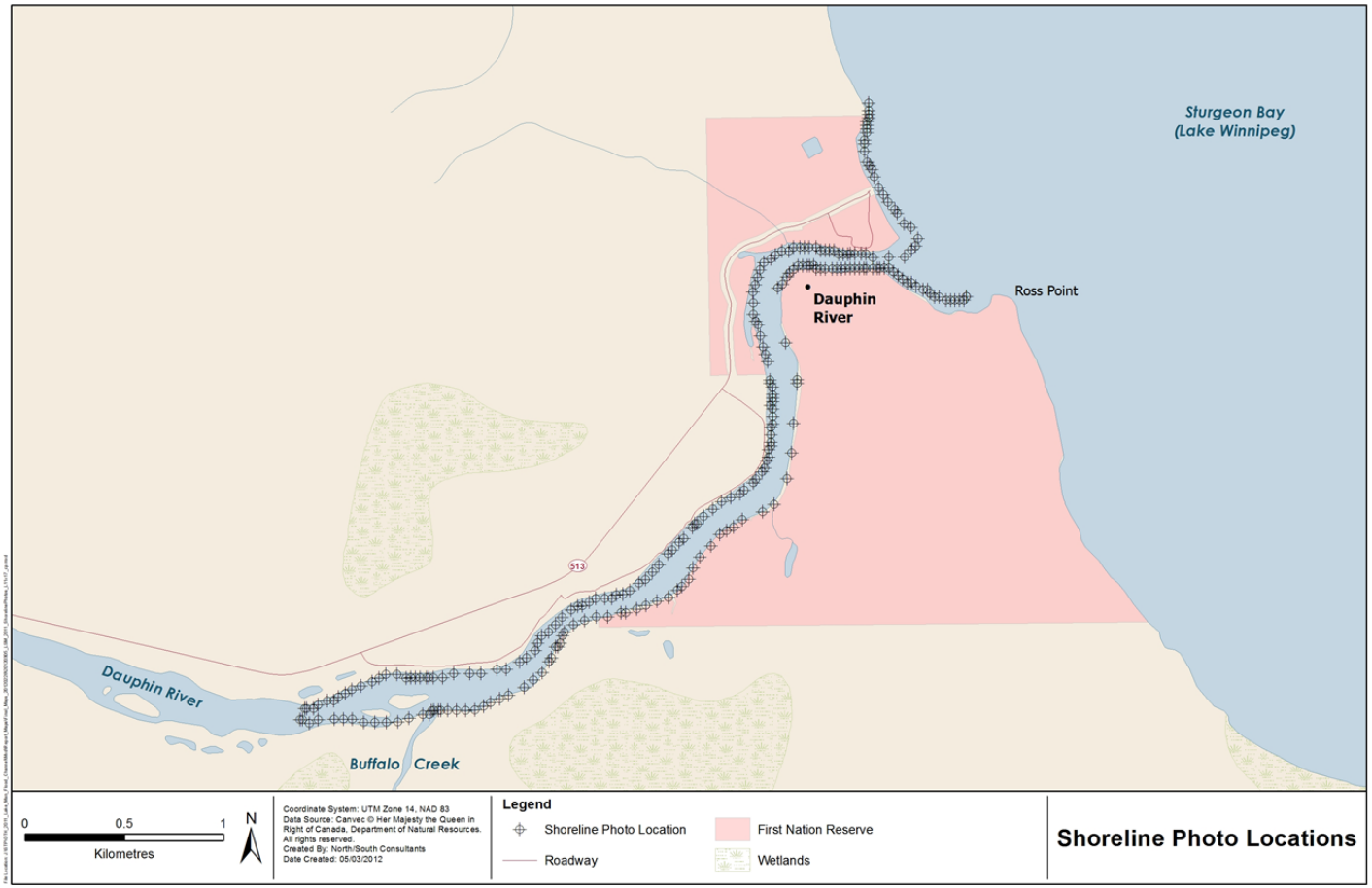


Figure 6-2. Locations where geo-referenced digital photographs were collected along the lower Dauphin River during fall 2011.

6.2 RESULTS

Bathymetric and substrate classification field activities along the Dauphin River were conducted between 11 and 17 October, 2011. Inclement weather (high wind conditions) throughout fall 2011 prevented access to Sturgeon Bay and, consequently, only limited sampling occurred in Sturgeon Bay during fall 2011. Sonar data could not be collected, but a series of substrate samples were collected during from Sturgeon Bay. These data presented in Section 4.3.

6.2.1 Dauphin River

A total of 6,568 bathymetric soundings were collected during the October survey. Detailed bathymetry of the lower reaches of the Dauphin River and portions of Sturgeon Bay are illustrated in Figure 6-3. Within the surveyed area, the shallowest depths (0-2 m) were generally located in the vicinity of the confluence with Buffalo Creek and along portions of the south shore. Depths were typically higher along the north shore and increased to 4-5 m towards the mouth of the river.

Substrate conditions were mapped for 2,114,121.7 m^2 of riverbed habitat in the lower Dauphin River (Table 6-1). Cobble/boulder and gravel/sand were most abundant, each comprising almost 28% of the area mapped. Gravel/cobble and bedrock were the next most common types.

Figure 6-4 shows examples of the GPS-linked digital photographs that were used to document shoreline habitat and assist with development of a substrate map. The distribution of substrate types in the lower reaches of the Dauphin River is illustrated in Figure 6-5. In the vicinity of the Buffalo Creek confluence, bedrock-limestone shelves occurred, with patches of sand and cobble/boulder upstream of the creek mouth. Downstream of the confluence, predominantly gravel/cobble substrate occurs until approximately 1 km upstream of Sturgeon Bay. The remainder of river substrate downstream to Sturgeon Bay consists largely of gravel/sand (Figure 6-5).

Habitat conditions in the lower Dauphin River suitable to support spawning for many species of fish, including Lake Whitefish and Walleye, were documented during fall 2011. Fall fisheries conducted during late fall 2011 documented spawning by Lake Whitefish in the lower Dauphin River in the vicinity of the Buffalo Creek/Dauphin River confluence (Section 7.2). Ongoing fisheries studies at Dauphin River have continued to document use of habitat in the lower Dauphin River by fish.

6.2.2 Sturgeon Bay

Inclement weather (winds) through late September and October severely hampered the ability to conduct boat-based work in Sturgeon Bay and, consequently, the Quester Tangent substrate and depth data collection program could not be completed.

However, substrate samples were collected at 48 sites within Sturgeon Bay (see Section 4.3). Visual assessments were conducted for each location where grabs were obtained or, if a grab could not be obtained due to size or compaction of substrate (i.e., cobble, boulder etc.), substrate characteristics

were assessed by probing the bottom with a steel pole or dragging the ponar across the bottom. Figure 6.6 illustrates locations where substrate composition was assessed.

An indication of habitat conditions was be derived from the substrate classification program. Sites highlighted in red indicate those locations where substrate (gravels, cobbles and, to a lesser extent, boulders) was suitable to support spawning by Lake Whitefish, Walleye, and other species.

Table 6-1. Habitat types in the lower Dauphin River, fall 2011 [1].

Habitat Type	Area (m^2)	Area (ha)	Proportion (%)
Bedrock - Limestone	243,189.3	24.32	11.5
Cobble/Boulder	588,959.0	58.90	27.9
Compacted Gravel	152,641.7	15.26	7.2
Gravel/Cobble	418,922.9	41.89	19.8
Gravel/Sand	585,047.4	58.50	27.7
Sand	125,361.4	12.54	5.9
Grand Total	2,114,121.7	211.41	100.0

1 - area sampled illustrated in Figures 6-1, 6-3, and 6-5

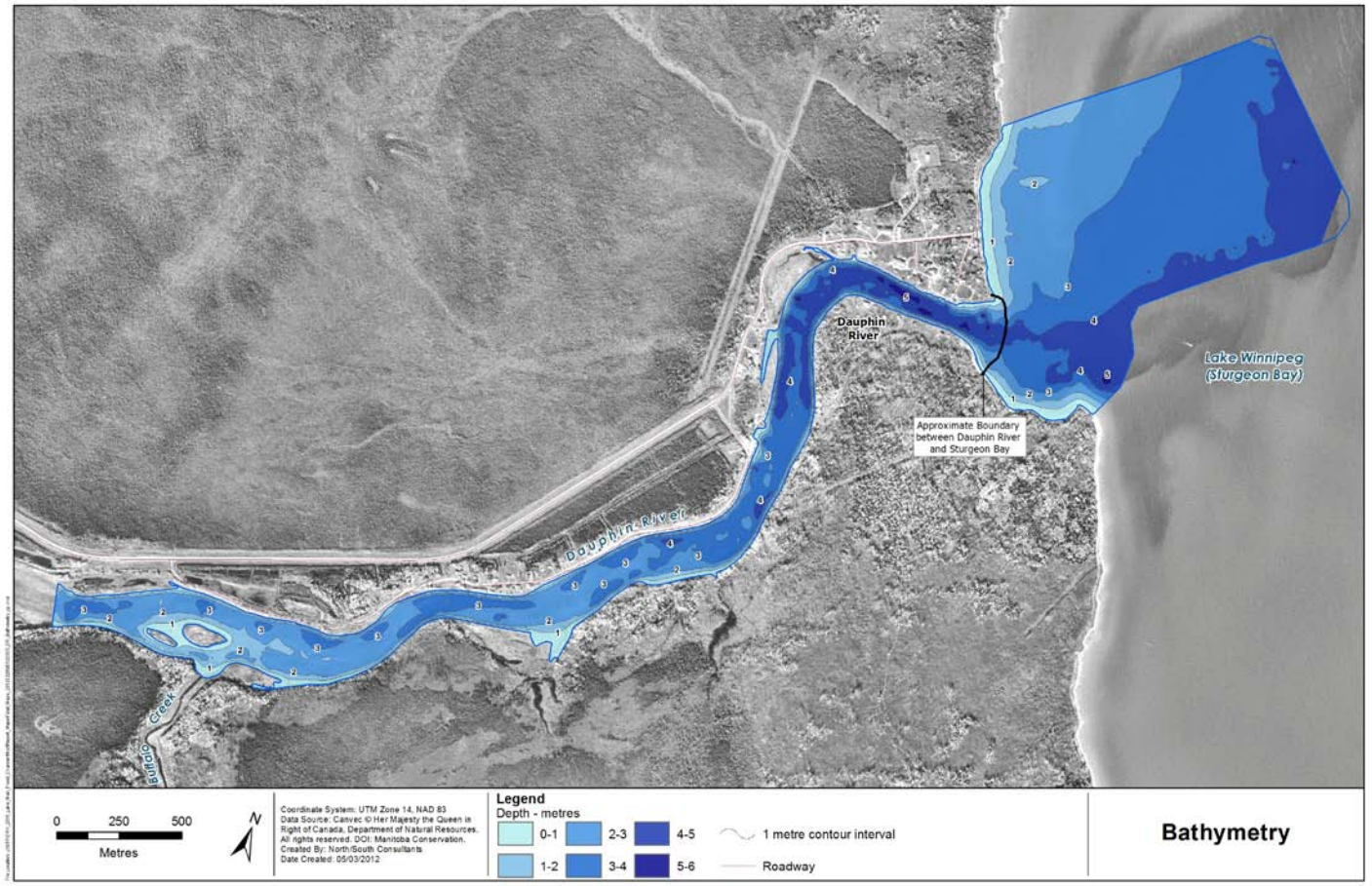


Figure 6-3. Bathymetric map of the lower reaches of the Dauphin River and portions of Sturgeon Bay.



Figure 6-4. Limestone bedrock outcrop overlain by till materials in areas along the Dauphin River (top) and cobble/boulder shoreline extending into the water along the Dauphin River near Sturgeon Bay (bottom).

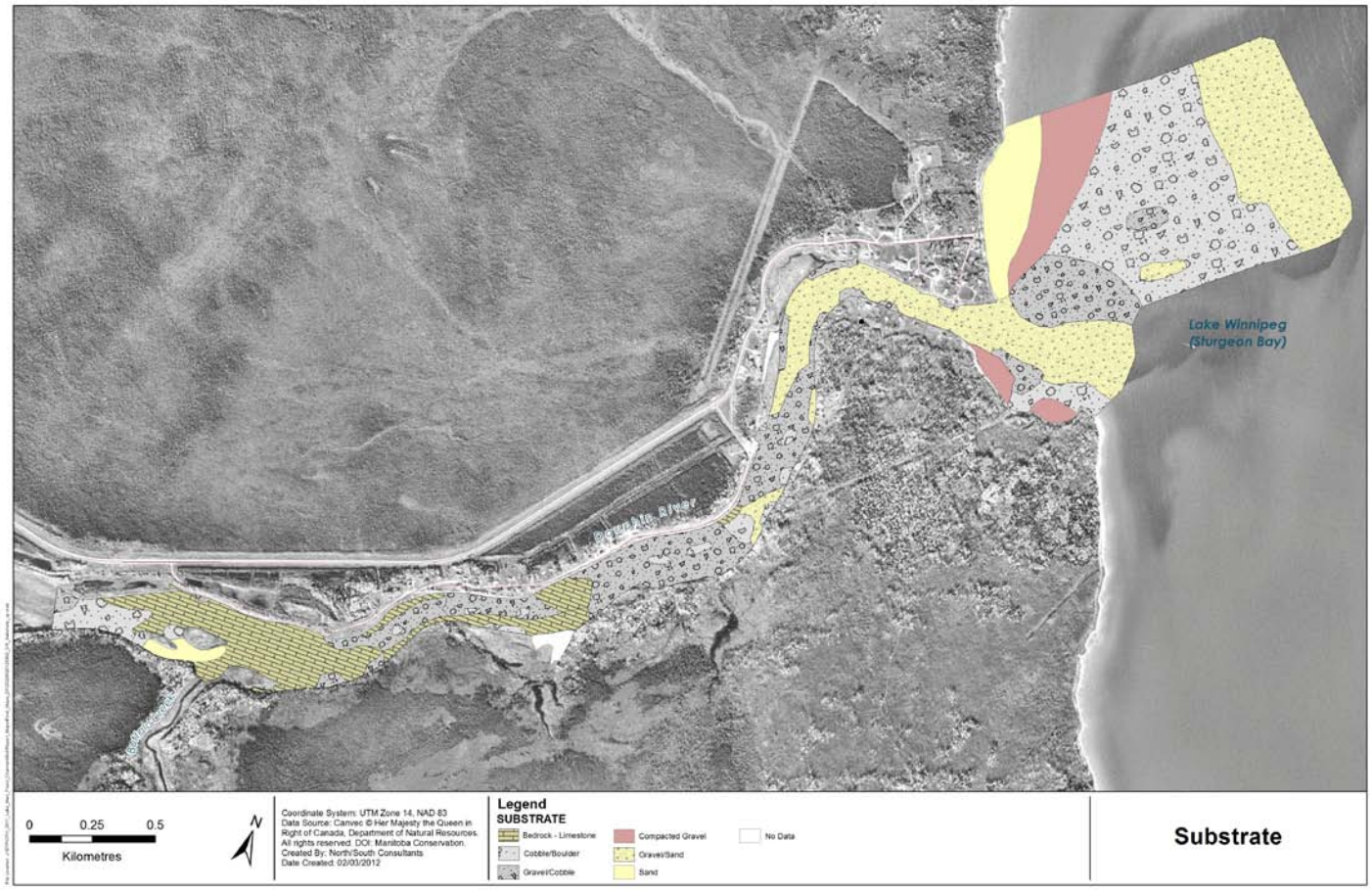


Figure 6-5. Substrate composition map of the lower reaches of the Dauphin River and portions of Sturgeon Bay.

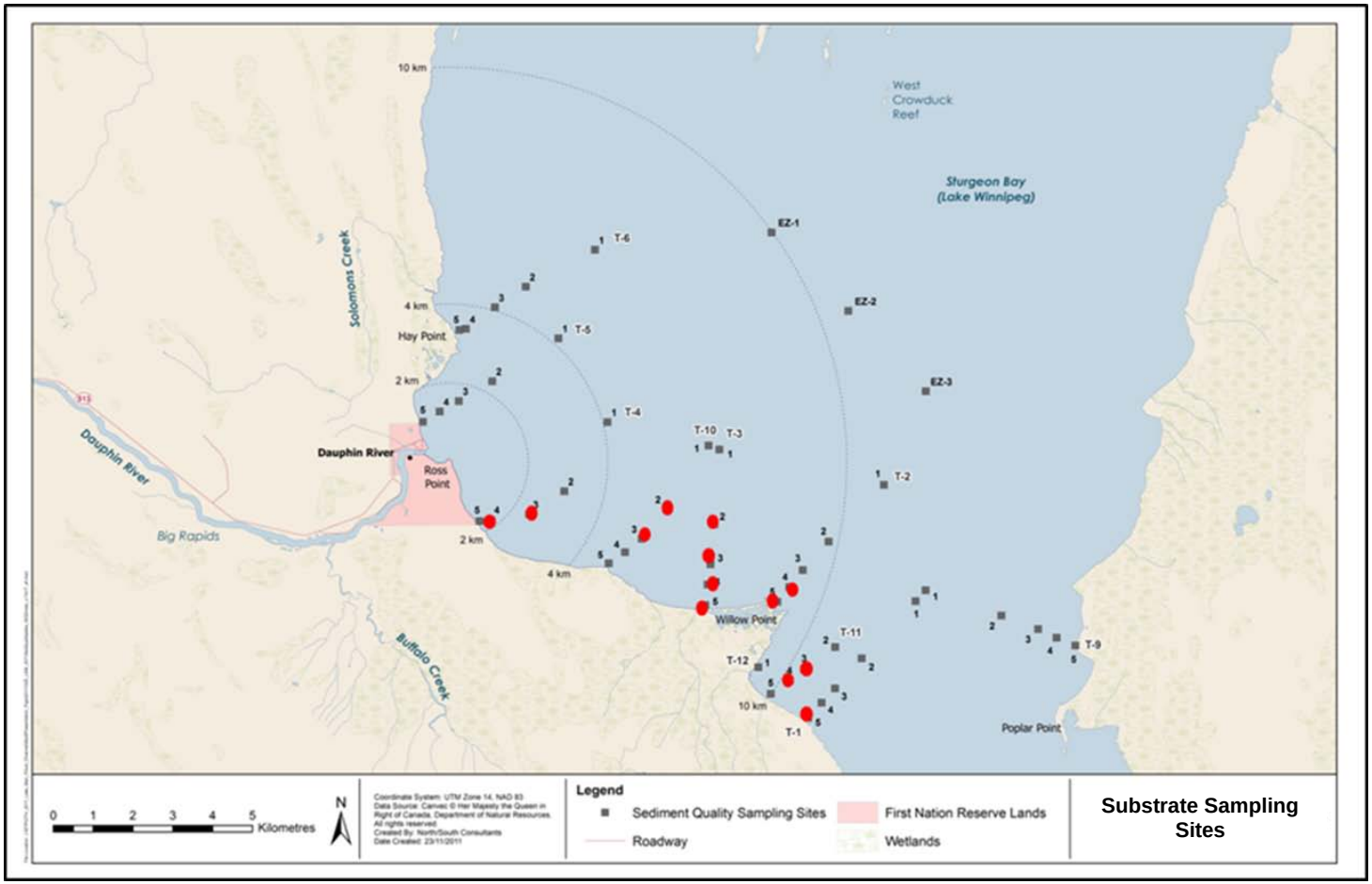


Figure 6-6. Sites where sediment samples were collected to determine sediment composition. Locations highlighted in red indicate sites where substrate type was most suitable to support Lake Whitefish and Walleye spawning (i.e., gravels and larger substrates).

6.3 SUMMARY

A suite of methods were proposed to compile habitat information within the Dauphin River and Sturgeon Bay. These included the collection of bathymetric and substrate data in the Dauphin River and Sturgeon Bay using sonar technology, collection of substrate samples in Sturgeon Bay and slow water velocity areas of the Dauphin River to help validate interpretation of the sonar data, and the conduct of rebar drags in fast water velocity areas of the Dauphin River to help validate interpretation of the sonar data. Collected information was used to produce maps of aquatic habitat.

Bathymetric and substrate classification field activities along the Dauphin River were conducted between 11 and 17 October, 2011. Inclement weather (high wind conditions) throughout fall 2011 prevented access to Sturgeon Bay and, consequently, only limited sampling occurred in Sturgeon Bay during fall 2011. Sonar data could not be collected from Sturgeon Bay, but a series of substrate samples were collected.

Dauphin River

Substrate conditions were mapped for 2,114,121.7 m^2 of riverbed habitat in the lower Dauphin River. Cobble/boulder and gravel/sand were most abundant, each comprising almost 28% of the area mapped. Gravel/cobble and bedrock were the next most common types.

Habitat conditions in the lower Dauphin River suitable to support spawning for many species of fish, including Lake Whitefish and Walleye, were documented during fall 2011. Fall fisheries conducted during late fall 2011 documented spawning by Lake Whitefish in the lower Dauphin River in the vicinity of the Buffalo Creek/Dauphin River confluence (Section 7.2). Ongoing fisheries studies at Dauphin River have continued to document use of habitat in the lower Dauphin River by fish.

Sturgeon Bay

Substrate samples were collected at 48 sites within Sturgeon Bay. Visual assessments were conducted for each location where grabs were obtained or, if a grab could not be obtained due to size or compaction of substrate (i.e., cobble, boulder etc.), substrate characteristics were assessed by probing the bottom with a steel pole or dragging the ponar across the bottom. An indication of substrate conditions was derived from this program, and suggested that substrate conditions suitable to support spawning (gravels, cobbles and, to a lesser extent, boulders) by Lake Whitefish, Walleye, and other species occurred at numerous locations in nearshore areas of Sturgeon Bay, including to the east and west of Willow Point.

7.0 FALL FISHERIES SURVEYS IN DAUPHIN RIVER AND STURGEON BAY

Habitat changes and altered flow regimes may impact fish distribution, community structure and habitat use in areas affected by the Project. Fall fisheries investigations focussed on the lower Dauphin River and nearshore areas of Sturgeon Bay. The intent was to provide information to supplement pre-existing aquatic environment information, and provide contemporary pre-project information to assist in determining project-related effects. Specific study objectives included:

- identification of fall fish utilization in the Dauphin River, between the confluence with Buffalo Creek and Sturgeon Bay;
- identification of Lake Whitefish spawning areas in the Dauphin River, between the confluence with Buffalo Creek and Sturgeon Bay;
- determination of fall fish utilization of nearshore habitat in Sturgeon Bay during late fall (emphasis on Lake Whitefish); and,
- collection of information on fall Lake Whitefish movements into the Dauphin River prior to operation of Reach 1.

7.1 METHODS

The timing and extent to which fish used nearshore areas of Sturgeon Bay and the Dauphin River were documented during a series of sampling campaigns conducted during fall 2011. Fish activities of interest, such as Lake Whitefish movement into the Dauphin River or the timing of Lake Whitefish spawning, can occur over a broad period of time, can occur abruptly, or, as is the case for spawning movements and spawning, occur sequentially. Conducting field activities in a series of field campaigns provided a better opportunity to capture the occurrence and timing of fish activities.

7.1.1 Water Temperature

Water temperature is an important factor that affects the timing of fish activities such as large-scale movements or spawning. Water temperature data was collected from a series of locations throughout the study area to support fisheries and engineering investigations.

Water temperature data was collected using HOBO V2 water temperature loggers (Onset Computer Corporation) programed to record water temperature on an hourly basis. A total of 8 water temperature loggers were deployed at the beginning of field fisheries investigations. Two moorings, each with three loggers recording temperature at different water depths, were deployed in Sturgeon Bay. Two loggers were deployed in the Dauphin River; one at a location downstream of the confluence of Buffalo Creek and one upstream of the confluence of Buffalo Creek. Logger locations and deployment information are provided in Table 7-1 and illustrated in Figure 7-3.

Table 7-1. Location and deployment information for water temperature loggers deployed in Sturgeon bay and the Dauphin River during fall, 2011.

Location	Logger ID	Date Deployed	Date Downloaded	Site Description	Water Depth (m)	Location [1, 2]	
						Easting	Northing
Sturgeon Bay (Mooring 1) [3]	DR-1	19-Oct-11	15-Nov-11	north of the Dauphin River mouth	0.9	565545	5758393
	DR-2	19-Oct-11	15-Nov-11		1.8		
	DR-3	19-Oct-11	15-Nov-11		2.7		
Sturgeon Bay (Mooring 2) [3]	DR-4	19-Oct-11	15-Nov-11	south of the Dauphin River mouth	0.9	566165	5756385
	DR-5	19-Oct-11	15-Nov-11		1.8		
	DR-6	19-Oct-11	15-Nov-11		2.7		
Dauphin River [4]	DR-7	19-Oct-11	29-Nov-11	downstream of Buffalo Creek	0.5	563634	5755782
Buffalo Creek [4]	DR-8	19-Oct-11	04-Nov-11	mouth of Buffalo Creek	0.5	562245	5754720

1 - UTM coordinates; Datum NAD 83, Zone 14U

2 - logger locations illustrated on Figure 7-1

3 - data downloaded and logger left in place to support on-going engineering studies

4 - logger removed

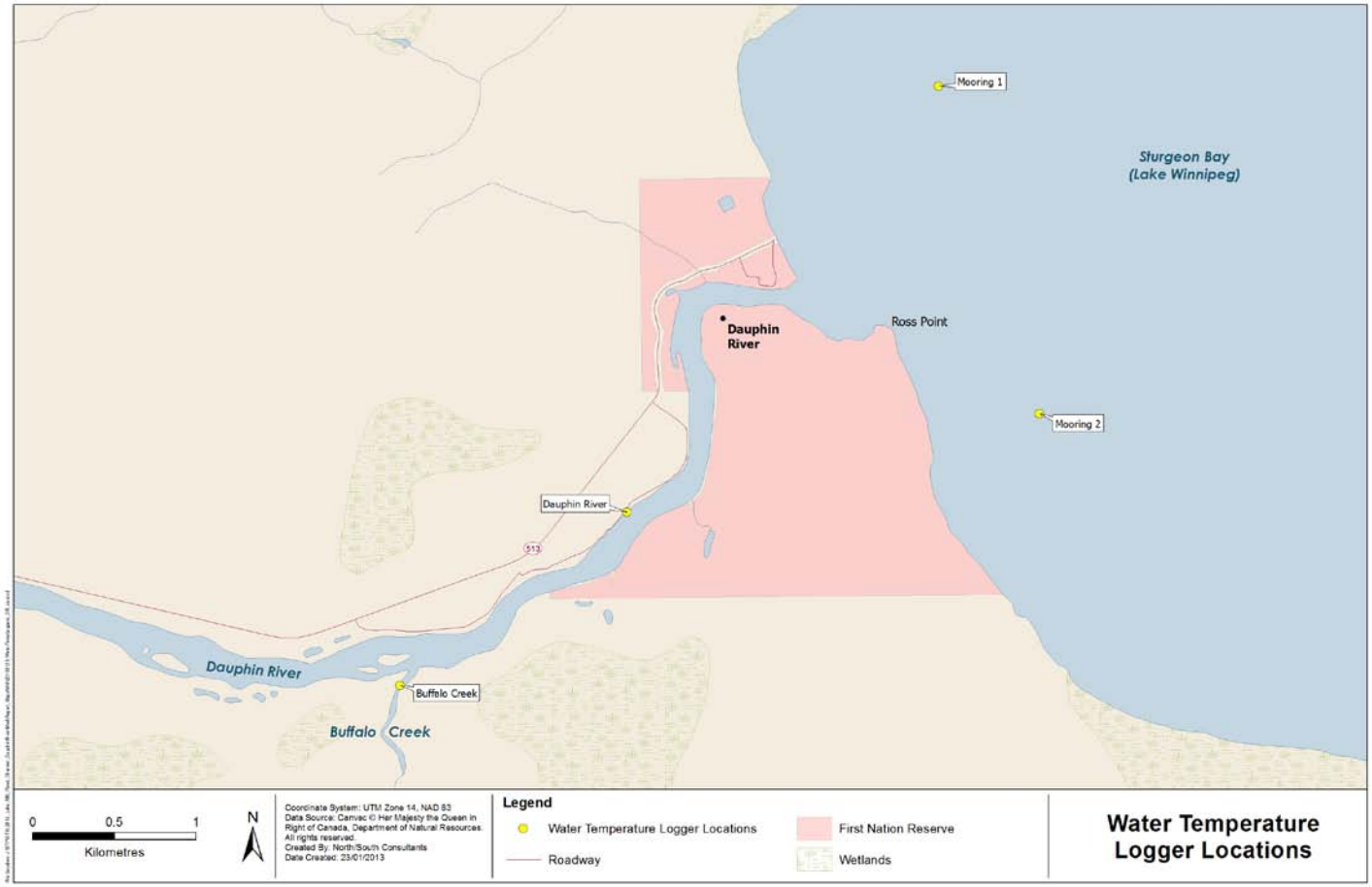


Figure 7-1. The location of water temperature loggers deployed in Sturgeon Bay and the Dauphin River during fall, 2011.

7.1.2 Fish Utilization

Two fish capture techniques were used to sample fish in the Dauphin River and Sturgeon Bay during fall 2011. The technique used varied based on sampling location. In general, standard experimental gillnet gangs were used to sample for fish in Sturgeon Bay and boat-based electrofishing was used to sample fish in the Dauphin River. Field and data analysis methods are discussed in the following sections.

7.1.2.1 Experimental Gillnetting

Standard index gillnet gangs were 137.2 m long and consisted of 22.9 m long by 1.8 m deep panels of 1.5, 2.0, and 3.0 inch stretched twisted nylon mesh and 3.75, 4.25, and 5.0 inch stretched twisted monofilament mesh. In general, nets sets were to be of short duration (<3 hours) to minimize fish mortality.

Set data and time, as well as net retrieval date and time, were recorded for each net set. Net set locations were recorded with a handheld Garmin Etrex® GPS receiver. Water depth (± 0.1 m) was measured at each end of the net with a hand-held SM-5 (Speedtech Instruments®) depth sounder, and surface water temperature was recorded with a handheld thermometer (±0.5 °C).

7.1.2.2 Boat Electrofishing

Boat electrofishing was conducted in Sturgeon Bay, Dauphin River and Buffalo Creek and targeted fall spawning migrations of Lake Whitefish). Fish were captured using a Smith-Root GPP 5.0 electrofisher with dual boom Smith-Root UAA-6 Umbrella anodes (0.91 m diameter), mounted two meters apart. Two crew members, positioned at the bow of the boat on the port and starboard side, captured fish as they swam toward the anodes. Fish were placed in live holds until they could be processed.

Numerous electrofishing runs were conducted during each sampling period. Effort was made to sample in various habitat types. The following information was collected for each electrofishing run:

- Date and time of day;
- GPS data - starting and end waypoint, as well a track log of the path followed by the electrofishing boat;
- Fishing effort (number of seconds the electrofisher operated);
- Electrofisher settings (volts, amperage, pulse width and frequency); and,
- A species-specific count of fish observed but not captured.

7.1.2.3 Biological Sampling

All fish captured were enumerated by species and location (gill net site or electrofishing run). Each fish was measured for fork length (± 1 mm) and round weight (±25 g using a pan balance). All lake whitefish were examined for sex and maturity by gamete extrusion. The following sexual maturity codes were used:

Females (F)	**Males (M)**
2 - maturing to spawn (pre-spawn)	7 - maturing to spawn (pre-spawn)
3 - ripe	8 - ripe
4 - spend (post-spawn)	9 - spend (post-spawn)

Lake Whitefish captured by during electrofishing runs were marked with individually numbered plastic Floy® FD-94 T-bar anchor tags. Floy® tags were inserted between the basal pterygiophores of the dorsal fin using a Dennison® Mark II tagging gun. All live fish were released at the original point of capture following sampling.

7.1.2.4 Data Analysis

Gillnetting and electrofishing catches were tabulated by species and capture location. Catch-per-unit-effort (CPUE) was calculated for the overall catch and for each species, by site. For gill nets, CPUE was calculated as the number of fish caught per 100 m of net per 24 hours. Total CPUE was calculated by averaging all net set CPUE values. CPUE for electrofishing catches were calculated as the number of fish caught per minute of electrofishing.

Mean fork length (mm), weight (g) and condition factor (K) were calculated for each species. Condition factor was calculated for fish where fork length and round weight were measured, using the following formula (after Fulton 1911, in Ricker 1975):

$$K = W \times 10^5 / L^3$$

Where: W = round weight (g); and

L = fork length (mm)

Length-frequency distributions were plotted for each species where more than 15 fish were captured. Length intervals of 25 mm were used for most species (e.g., 225-249 mm). A 50 mm interval was used for Northern Pike.

7.1.3 Spawning Activity

Egg mats have frequently been used to collect fish eggs in order to determine spawning habitat preferences and delineate spawning locations (La Haye et al. 2003; Manny et al. 2007; MacDougall and MacDonell 2009; Thompson 2009). Egg mats are set in or immediately downstream of areas where spawning is thought to occur and, as eggs settle onto the substrate or are stirred up from the river bottom, they readily adhere to the filter material of the egg mat (Figure 7-1). Egg mats used in this study were comparable to those used in lake sturgeon and and walleye spawning investigations at other locations (MacDougal and MacDonell 2009; Manny et al. 2007; Thompson 2009).

Egg mats consisted of 39 x 19 x 9 cm cinder blocks wrapped with air filter material (i.e., latex-coated horse hair or fiberglass; Figure 7-2). The filter material was held in place against the cinder block with sideline. Eggs mats were deployed by attaching a float and line to the cinder block and lowering the egg mat to the river or lake bottom. Date, time, and UTM coordinates were recorded for every egg mat that

was set. Egg mats were set in the mouth of Buffalo Creek and in the Dauphin River to identify Lake Whitefish spawning areas. Sites located in the Dauphin River were generally located near the mouth of Buffalo Creek and approximately 900 m downstream from Buffalo Creek. Sample locations were based on substrate, and water depth and velocity.

During retrieval, each air filter was removed and placed in an individually labelled bag. Samples were transported to the North/South Consultants laboratory in Winnipeg where they were examined for fish eggs. Lake Whitefish eggs were enumerated and placed into individually labeled sample containers and preserved in 10% formalin.



Figure 7-2. Lake Whitefish eggs collected on an egg mat set in the Dauphin River during fall, 2011.



Figure 7-3. An egg mat ready for deployment.

7.1.4 Debris Monitoring

The possibility that increases in flow through the bog/wetland complex surrounding Big Buffalo Lake and down Buffalo Creek could result in erosion and transport of large amounts of debris (organic and mineral materials, scoured peat bog, and terrestrial vegetation such as trees, etc.) that would ultimately be introduced into Sturgeon Bay was recognized prior to operation of Reach 1. Commercial fishers working Sturgeon Bay expressed concern that increased debris could negatively affect the commercial fishery by causing the destruction of fishing nets, increased effort to keep nets clean and fishing efficiently, and possibly by reducing fish stocks in Sturgeon Bay due to damage/alteration of spawning areas through increased sedimentation. The occurrence of debris in experimental gill nets set in Sturgeon Bay was recorded during fall 2011 to help address this concern.

Monitoring programs to document debris in gillnet gangs have previously been conducted in Manitoba. From 1993 to 1997, Manitoba Hydro, the Province of Manitoba, and the Norway House Fisherman's Cooperative conducted a monitoring program to document the effects that debris may have had on the commercial fishery in Playgreen Lake (Graveline and Horne 1998). The methods used in that study were followed for this program.

The quantity and type of debris were evaluated for each net set. The amount of debris in each gang was categorized based on the percentage of the gang area (surface area of mesh) fouled by debris. Categories for debris quantity were as follows:

- None (no debris in gang; nets were clean);
- Low (< 5% of gang area covered by debris);
- Medium (5-15% of gang area covered by debris);
- High (16-25% of gang area covered by debris); and,
- Very High (> 25% of gang area covered by debris).

The type of debris was then categorized as a percentage of the total amount of debris in the gang. By this method, the sum of the relative percentage of all debris types present always equalled 100%, regardless of the debris level. For example, if a gang contained only one stick, sticks would constitute 100% of the debris in the gang. Categories for debris composition were as follows:

- Terrestrial vegetation (trees, shrubs, grass, etc.);
- Terrestrial moss (muskeg);
- Sticks (driftwood or logs);
- Aquatic vegetation (weeds);
- Algae;
- Silt/mud; and,
- Other (rocks, shells, etc.).

The amount and type of debris that occurred in each gang was tabulated.

7.2 RESULTS

7.2.1 Water Temperature

Water temperature loggers were deployed on 19 October and data were either downloaded or the logger retrieved during November (Table 7-1). Continuous hourly water temperature recordings were obtained from all loggers during the period that they were deployed.

Data from loggers deployed in the Dauphin River, Buffalo Creek, and the surface logger at Mooring 1 (logger ID DR-1; Table 7-1) were plotted to illustrate water temperature conditions while fall 2011 fisheries monitoring programs were conducted. Logger DR-1 was considered to be representative of water temperature conditions in Sturgeon Bay; data from remaining loggers are presented elsewhere.

Water temperature in the Dauphin River and Sturgeon Bay were between 6 and 7^{O}C when the loggers were deployed on 19 October (Figure 7-4). Temperature remained fairly consistent between the two locations throughout the fall, rarely having more than 1^{o}C difference between the areas. Water temperature steadily decreased to 1^{o}C by 15 November in Sturgeon Bay and reached 0^{o}C in the Dauphin River by 16 November (Figure 7-4). Daily fluctuations in water temperature were observed at both locations, reflecting changes in air temperature throughout each day (Figure 7-4).

The temperature logger deployed in Buffalo Creek remained in place until 04 November, about three days after flow in the creek increased dramatically due to the onset of Reach 1 operation. High flows in the creek moved the logger downstream and onto the Dauphin River shore after 04 November and, consequently, temperatures recorded did not reflect those occurring in Buffalo Creek (i.e., because the logger was on shore, air temperature, rather than water temperature, was recorded).

Water temperature in Buffalo Creek was about 5°C on 19 October, at least one degree less than temperatures recorded in the Dauphin River or Sturgeon Bay. Larger daily fluctuations in temperature were also observed in Buffalo Creek compared to the Dauphin River and Sturgeon Bay (Figure 7-4). This is likely because the shallow waters in the Buffalo creek watershed would be more susceptible to changes in air temperature compared to the much larger volumes of water occurring in the Dauphin River and Sturgeon Bay.

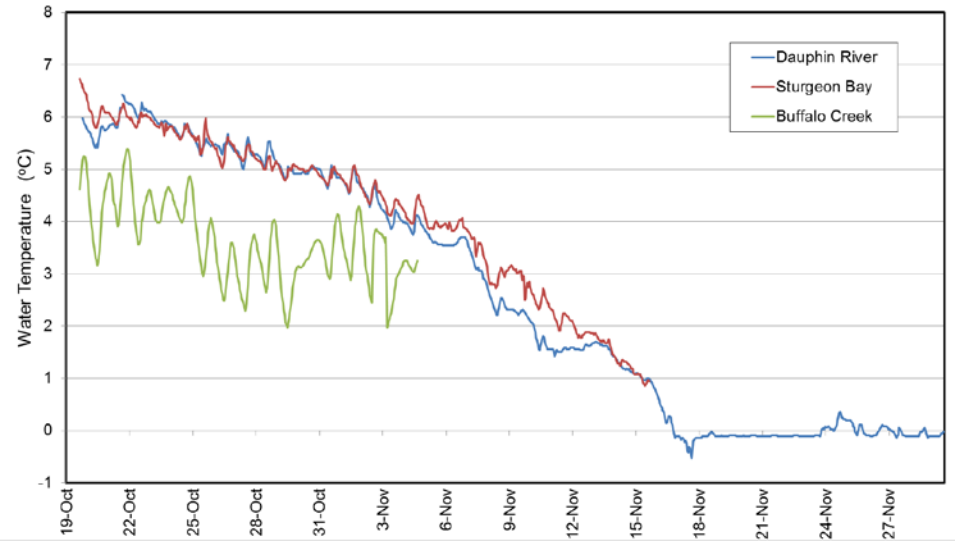


Figure 7-4. Daily water temperature in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

7.2.2 Fish Utilization

Information describing fish use of the lower-most portions of Buffalo Creek, the Dauphin River and Sturgeon Bay began in late September and continued into mid-November during 2011. Nine species of fish were captured, most of which occurred contiguously in the Dauphin River and Sturgeon Bay (Table 7.2). A detailed presentation of results is provided in the following sections.

Table 7-2. List of fish species captured in Sturgeon Bay, Dauphin River and Buffalo Creek during fall, 2011.

Common Name	Scientific Name	Sturgeon Bay		Dauphin River	Buffalo Creek
		GN [1]	EF [2]	EF [2]	EF [2]
Burbot	*Lota lota*	✓	-	-	-
Cisco	*Coregonus artedi*	✓	-	✓	-
Freshwater Drum	*Aplodinotus grunniens*	✓	-	✓	-
Lake Whitefish	*Coregonus clupeaformis*	✓	✓	✓	✓
Northern Pike	*Esox lucius*	✓	-	✓	✓
Shorthead Redhorse	*Moxostoma macrolepidotum*	✓	-	-	-
Walleye	*Sander vitreus*	✓	-	✓	-
White Sucker	*Catostomus commersonii*	✓	✓	✓	✓
Yellow Perch	*Perca flavescens*	✓	-	✓	✓

1 - experimental gillnet gang
2 - boat-based electrofishing

7.2.2.1 Experimental Gillnetting

Fisheries work on Sturgeon Bay was limited during fall 2011 by high wind conditions that persisted through October and early November. Four standard experimental gillnet gangs were set in Sturgeon Bay between 14 to 21 October (Table 7-3). Two gillnet gangs were set in the vicinity of Willow Point and two gangs were set near the mouth of the Dauphin River (Figure 7-5). Gang set durations ranged from two to 23 hours (Table 7-3).

A total of 333 fish, comprising nine fish species, were captured (Table 7-4). Lake Whitefish comprised 10.2% of the catch, and were captured at all sampling locations. Other species captured, in decreasing order of abundance, included Cisco (36.3%), White Sucker (22.8%), Northern Pike (13.5%), Yellow Perch (8.1%), Walleye (5.7%), Shorthead Redhorse (2.7%), Freshwater Drum (0.3%, and Burbot (0.3%). Species-specific mean catch-per-unit-effort is provided in Table 7-5.

Table 7-3. Location, water depth, water temperature, and set duration for experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

Site	Location [1, 2]		Water Depth (m)	Water Temperature (°C)	Set Date	Set Time	Pull Date	Pull Time	Duration (hrs)
	Easting	Northing							
GN-01	565363	5758049	3.4-3.7	9.0	14-Oct-11	14:44	15-Oct-11	9:30	18.8
GN-02	565477	5758742	-	-	15-Oct-11	10:20	16-Oct-11	9:37	23.3
GN-03	572052	5753631	3.3-3.7	4.0	19-Oct-11	15:10	20-Oct-11	9:17	18.1
GN-04	573143	5751611	1.5-2.0	5.0	21-Oct-11	10:10	21-Oct-11	12:15	2.1

1 - UTM coordinates; NAD 83, Zone 14U

2 - locations illustrated on Figure 7-5

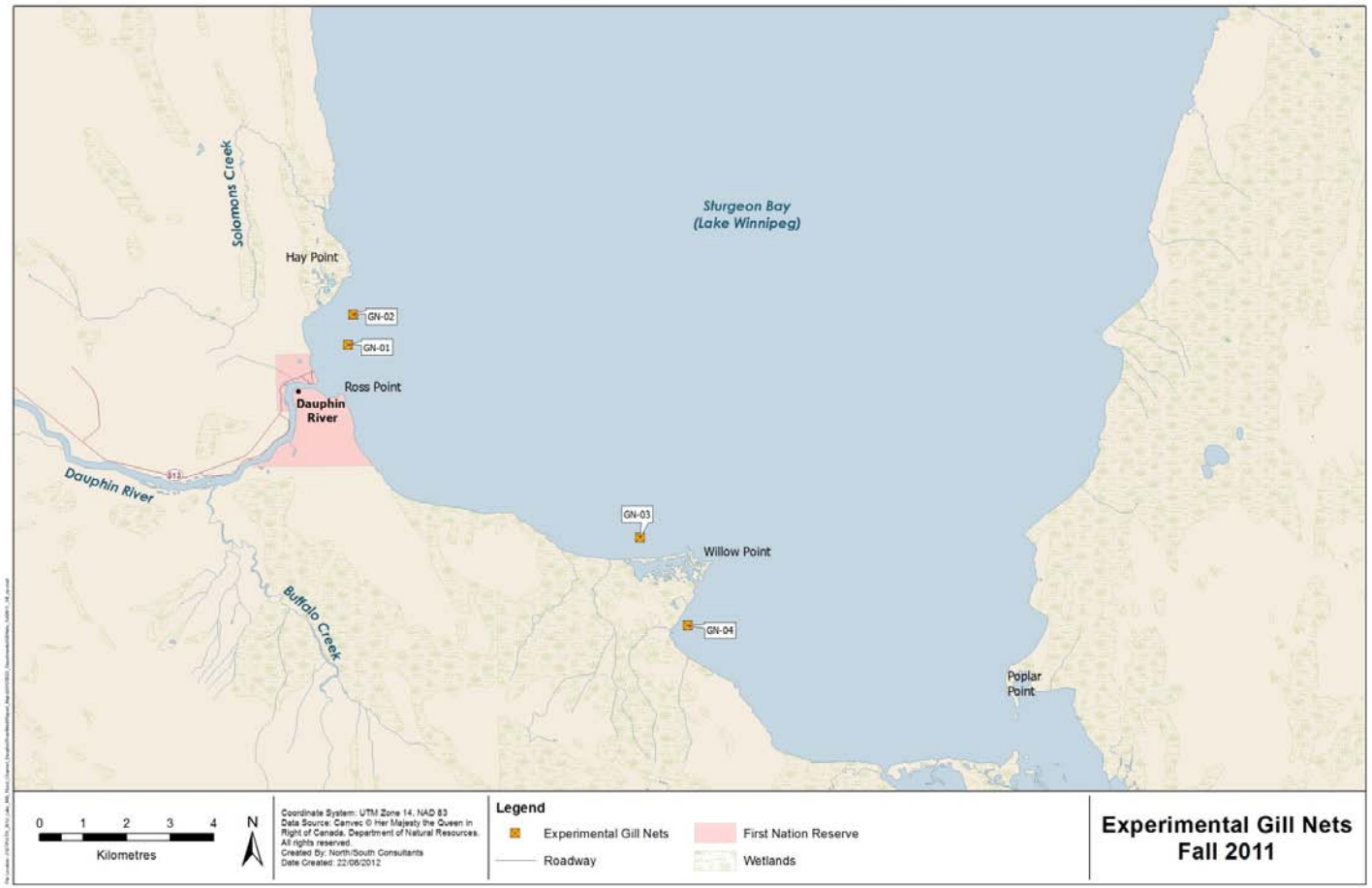


Figure 7-5. Locations where experimental gillnet gangs were set in Sturgeon Bay during fall, 2011.

Table 7-4. Number (n) and relative abundance (%) of each fish species captured in standard index gill nets set in Sturgeon Bay during fall, 2011.

Site		Species									Total
		Burbot	Cisco	Freshwater Drum	Lake Whitefish	Northern Pike	Shorthead Redhorse	Walleye	White Sucker	Yellow Perch	
GN-01	n	1	62	1	20	12	5	16	17	19	153
	%	0.7	40.5	0.7	13.1	7.8	3.3	10.5	11.1	12.4	45.9
GN-02	n	-	17	-	6	27	2	3	31	4	90
	%	-	18.9	-	6.7	30.0	2.2	3.3	34.4	4.4	27.0
GN-03	n	-	35	-	2	4	2	-	26	3	72
	%	-	48.6	-	2.8	5.6	2.8	-	36.1	4.2	21.6
GN-04	n	-	7	-	6	2	-	-	2	1	18
	%	-	38.9	-	33.3	11.1	-	-	11.1	5.6	5.4
Overall	n	1	121	1	34	45	9	19	76	27	333
	%	0.3	36.3	0.3	10.2	13.5	2.7	5.7	22.8	8.1	100.0

Table 7-5. Species- and gillnet gang-specific catch-per-unit-effort (CPUE) for fish species captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

Site	Species-specific CPUE (#fish/100m/24hrs)									Total
	Burbot	Cisco	Freshwater Drum	Lake Whitefish	Northern Pike	Shorthead Redhorse	Walleye	White Sucker	Yellow Perch	
GN-01	0.9	57.8	0.9	18.6	11.2	4.7	14.9	15.9	17.7	142.7
GN-02	0.0	12.8	0.0	4.5	20.3	1.5	2.3	23.3	3.0	67.6
GN-03	0.0	33.8	0.0	1.9	3.9	1.9	0.0	25.1	2.9	69.5
GN-04	0.0	58.8	0.0	50.4	16.8	0.0	0.0	16.8	8.4	151.2
Mean CPUE [1]	0.3	34.8	0.3	8.4	11.8	2.7	5.7	21.4	7.9	93.3
SD [2]	0.5	22.5	0.5	9.0	8.2	1.7	8.0	4.9	8.5	42.8

1 - GN-04 not included in the calculation of mean CPUE because the gang was set for only a short period of time (~2 hrs), whereas the remaining gangs were set for longer periods of time (>18 hrs)

2 - SD = standard deviation

Species diversity and abundance were highest at GN-01 (nine species; 153 fish) and GN-02 (seven species; 90 fish), both located near the mouth of the Dauphin River. The proportion of Lake Whitefish captured in gangs set in close proximity to the Dauphin River mouth was higher than those set near Willow Point (see Figure 7-5). Most Lake Whitefish captured were adult fish in a pre-spawn condition, including those fish captured near Willow Point.

Species Accounts

The following sections present size and condition information for selected fish species captured. Discussion is not provided for species where fewer than 10 individuals were captured.

Cisco

Cisco (n = 121) was the most abundant species captured in Sturgeon Bay. Individuals were captured at all four gillnet sites (Table 7-4). Mean Cisco CPUE (34.8 fish/100m/24hrs) was more than twice that of any other species (Table 7-5). Most Cisco captured were smaller, juvenile fish. Mean length of captured Cisco was 214 mm (Table 7-6) and the modal fork length interval was 175-199 mm (Figure 7-6). Few adult fish in a pre-spawning condition were captured.

Lake Whitefish

Lake Whitefish (n = 34) were captured at all gillnet sites in Sturgeon Bay (Table 7-4). Mean CPUE was 8.4 fish/100m/24hrs) (Table 7-5). The Lake Whitefish catch was comprised mostly of large, adult fish. Mean length was 386 mm (Table 7-6) and the modal fork length interval 375-399 mm (Figure 7-7). Pre-spawn male and female fish were identified at sites located at the mouth of the Dauphin River (GN-01 and GN-02; Figure 7-5), but not at gangs set near Willow Point.

Northern Pike

Northern Pike were the third most abundant species in the fall gillnetting catch. Forty-five Pike were captured at all locations (Table 7-4), but were most abundant in the catch from a gang set to the north of the Dauphin River (GN-02; Table 7-4; Figure 7-5). Mean CPUE for Northern Pike was 11.8 fish/100m/24hrs (Table 7-5). The Northern Pike catch was comprised mostly of larger adult fish, ranging in size from 550-650 mm in fork length. Mean fork length was 551 mm (Table 7-6) and the modal fork length interval was 600-649 mm, although a relatively high proportion of fish 500-549 mm were also captured (Figure 7-8).

Walleye

Walleye comprised only a small portion (5.7%) of the gillnetting catch (Table 7-4) and were only captured in gangs set near the mouth of the Dauphin River (GN-01 and GN-02; Figure 7-5). Mean CPUE was 5.7 fish/100m/24hrs (Table 7-5). Captured Walleye had a mean length of 350 mm (Table 7-6). The size distribution of Walleye in the fall gill netting catch is illustrated in Figure 7-9.

White Sucker

White Sucker were the second most frequently occurring species in the gillnetting catch, and were captured at all locations fished (Table 7-4; Figure 7.5). Seventy-six individuals were captured, comprising 22.8% of the total catch (Table 7-4). Mean CPUE was 21.4 fish/100m/24hrs (Table 7-5). The White Sucker catch was comprised of large, adult fish. All individuals were larger than 355 mm in fork length (Table 7-6), mean fork length was 416 mm (Table 7-6), and the modal length interval was 425-449 mm for the length-frequency distribution for the catch (Figure 7-10).

Yellow Perch

Yellow Perch were captured at all locations fished (Table 7-4; Figure 7.5). A total of 27 individuals were captured, comprising 8.1% of the total catch (Table 7-4). Mean CPUE for Yellow Perch was 7.9 fish/100m/24hrs (Table 7-5). Yellow Perch ranged in size from 134-261 mm in fork length, had a mean fork length of 164 mm (Table 7-6), and a modal length interval of 125-149 mm (Figure 7-10). More than 90% of the Perch captured were 125-199 mm in length (Figure 7-11).

Table 7-6. Mean size and relative condition factor (K) for species captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

Species	Length [1] (mm)				Weight (g)				K			
	N [2]	Mean	SD [3]	Range	n	Mean	SD	Range	n	Mean	SD	Range
Burbot	1	745	-	-	1	1800	-	-	1	0.44	-	-
Cisco	121	214	39.1	154-347	9	211	69.7	150-350	9	2.03	0.22	1.80-2.50
Freshwater Drum	1	342	-	-	1	500	-	-	1	1.25	-	-
Lake Whitefish	34	386	64.8	141-456	32	954	232	400-1500	32	1.48	0.18	1.16-2.00
Northern Pike	45	551	129	210-818	43	1573	912	75-4450	43	0.77	0.09	0.38-0.90
Shorthead Redhorse	9	392	29.2	342-425	6	1025	309	650-1350	6	1.66	0.09	1.52-1.76
Walleye	19	350	122	164-486	16	822	553	50-1600	16	1.21	0.17	0.75-1.46
White Sucker	76	416	28.5	355-480	69	1233	269	700-2100	69	1.69	0.20	1.28-2.23
Yellow Perch	27	164	28.8	134-261	-	-	-	-	-	-	-	-

1 - total length for Burbot and fork length for all other species.

2 - n = number of fish measured; may not equal number captured.

3 - SD = standard deviation.

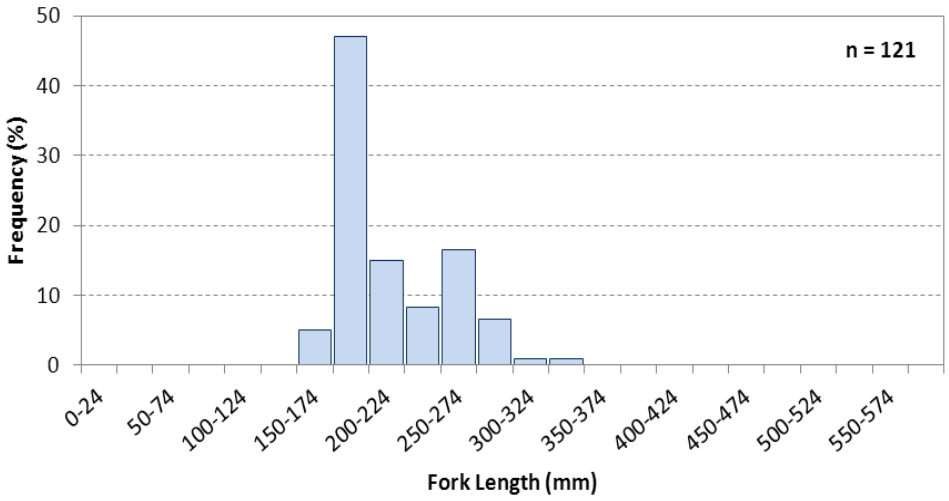


Figure 7-6. Length-frequency distribution for Cisco captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

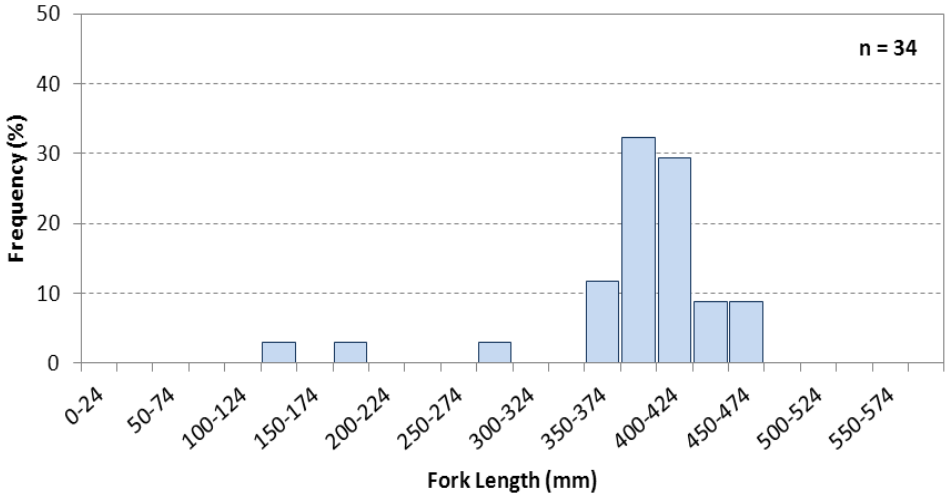


Figure 7-7. Length-frequency distribution for Lake Whitefish captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

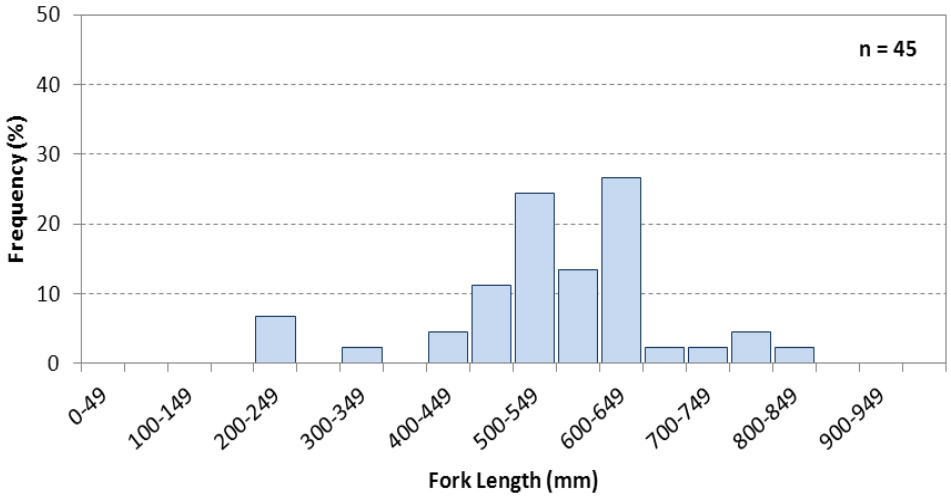


Figure 7-8. Length-frequency distribution for Northern Pike captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

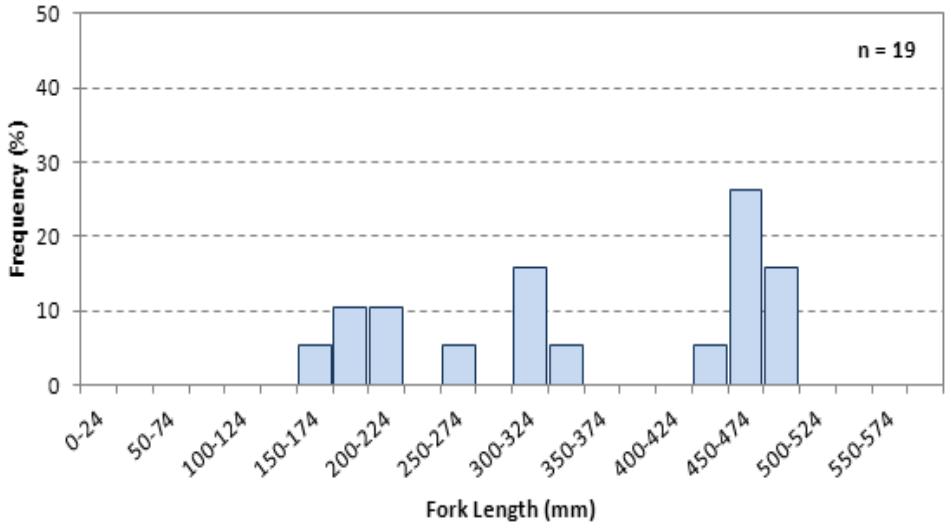


Figure 7-9. Length-frequency distribution for Walleye captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

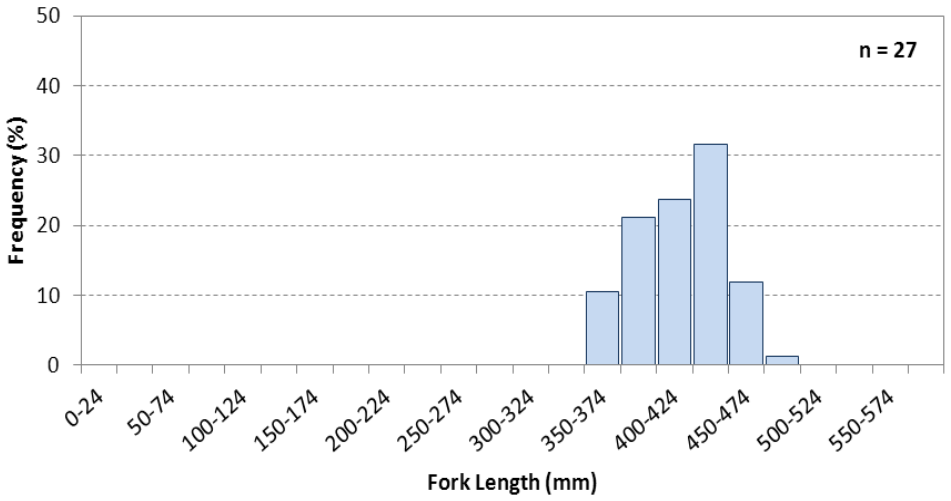


Figure 7-10. Length-frequency distribution for White Sucker captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

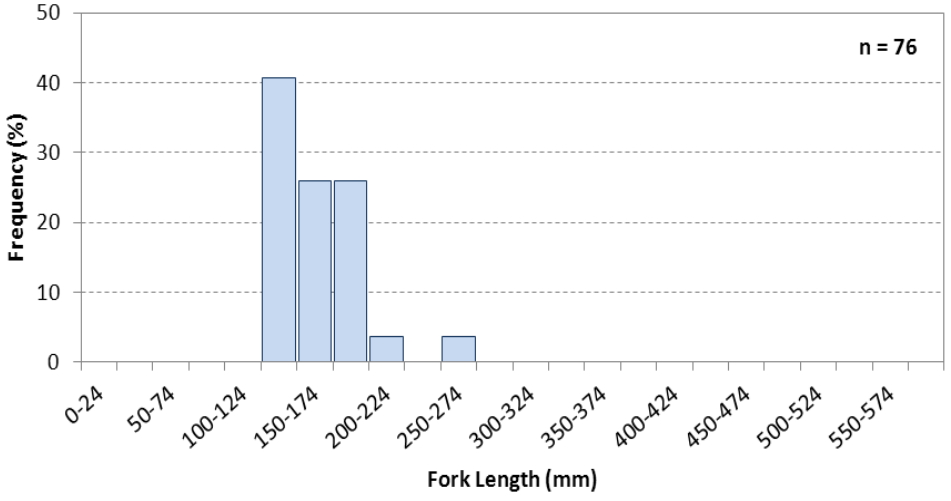


Figure 7-11. Length-frequency distribution for Yellow Perch captured in experimental gillnet gangs set in Sturgeon Bay during fall, 2011.

7.2.2.2 Boat Electrofishing

Boat electrofishing was conducted in the Dauphin River, the lower-most reach of Buffalo Creek, and Sturgeon Bay in the vicinity of the Dauphin River during three sampling sessions during fall 2011. Most effort was spent electrofishing in the Dauphin River (Table 7-7). Inclement weather restricted access to Sturgeon Bay through most of the fall, and the lower reaches of Buffalo Creek became in accessible once flow down Reach 1 began on 01 November.

Twenty-seven electrofishing runs were conducted from 14-15 October, 20-21 October, and on 05 November. Locations and fishing effort for each electrofishing run are described in Table 7-7 and illustrated in Figure 7-12.

A total of 765 fish, comprising seven fish species, were captured during the electrofishing surveys (Table 7-8). Lake Whitefish were the most abundant fish captured, accounting 93.5% (n = 715) of the total fall overall electrofishing catch (Table 7-8). Small numbers of Cisco (n = 26) and White Sucker (n = 16) were captured, while Freshwater Drum, Northern Pike, Yellow Perch and Walleye were only captured incidentally.

Species diversity and abundance were greatest in the Dauphin River catch with Lake Whitefish, Cisco, and White Sucker the dominant species. Lake Whitefish and White Sucker were the only species captured in Sturgeon Bay. In Buffalo Creek, Lake Whitefish, Northern Pike, White Sucker, and Yellow Perch were all captured in similar, relatively small numbers. Lake Whitefish were captured at all but one (EF-18 in the Dauphin River) electrofishing site (Table 7-8). The two most upstream sites in the Dauphin River (EF-18 and EF-19) and a site along the right side of an island produced the fewest Lake Whitefish despite an increased level of effort relative to most sites (Table 7-9), suggesting limited fall use of these areas by the species. Most Lake Whitefish were captured in velocity refugia, including the downstream lee of shoals, small islands and at the confluence with Buffalo Creek.

Lake Whitefish CPUE in the Dauphin River (20.3 fish/min) was several times higher than in Buffalo Creek (1.03) or Sturgeon Bay (1.84) (Table 7-10). Generally, CPUE in the Dauphin River was highest at sites in the vicinity of the confluence with Buffalo Creek (e.g., EF-1, EF-10-14, EF-16-17) or downstream of the confluence (e.g., EF-3). Large aggregations of Lake Whitefish were observed upstream of the confluence (as much as 9 km upstream), but typically at lower CPUE with increasing distance from Buffalo Creek. In addition, Lake Whitefish CPUE was highest during the first sampling period (14-15 Oct). Average CPUE at Dauphin River sites near the confluence with Buffalo Creek decreased from 102.5 fish/min during the earliest period to 51.6 fish/min from 20-21 October and 25.6 fish/min on 5 November (Table 7-10). In Sturgeon Bay, most Lake Whitefish were captured at the site nearest the outflow from the Dauphin River.

Table 7-7. Location, fishing effort, and electrofisher settings for boat electrofishing runs conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Electrofishing Run	Date	Start Location [1, 2]		End Location [3]		Fishing Effort (secs)	Electrofisher Settings		
		Easting	Northing	Easting	Northing		Voltage	Amps	Pulses per Second
Dauphin River									
EF-1	14-Oct	562252	5754833	-	-	33	300	8	30
EF-2	14-Oct	563875	5755855	564070	5756255	110	300	8	30
EF-3	14-Oct	564010	5756555	563999	5756622	33	300	8	30
EF-8	14-Oct	559825	5755194	560137	5755146	78	300	8	30
EF-9	14-Oct	560411	5755142	560691	5755080	78	300	8	30
EF-10 [4]	14-Oct	562315	5754827	-	-	51	300	8	30
EF-11 [4]	15-Oct	562319	5754782	-	-	38	300	8	30
EF-12 [4]	15-Oct	562274	5754729	-	-	44	300	8	30
EF-13 [4]	15-Oct	562327	5754816	-	-	8	300	8	30
Sturgeon Bay									
EF-4	14-Oct	564603	5757147	564813	5757156	93	300	8	30
EF-5	14-Oct	564699	5757312	564778	5757666	528	300	8	30
EF-6	14-Oct	564541	5757742	565022	5758148	683	300	8	30
Buffalo Creek									
EF-7	14-Oct	562229	5754137	562194	5754512	408	1000	3	30
Dauphin River									
EF-14	20-Oct	-	-	-	-	25	300	8	30
EF-15	20-Oct	562211	5754971	562276	5754970	194	300	8	30
EF-16	20-Oct	562423	5755015	562750	5755075	32	300	8	30
EF-17	20-Oct	562249	5754830	-	-	32	300	8	30
EF-18	21-Oct	554293	5759061	554401	5759017	144	300	8	30
EF-19	21-Oct	554766	5758877	555061	5758778	186	300	8	30
EF-20	21-Oct	555693	5758508	555542	5758645	178	300	8	30
EF-21	21-Oct	556346	5757999	556467	5757969	103	300	8	30
Dauphin River									
EF-22	05-Nov	555241	5758844	555539	5758644	92	300	8	30
EF-23	05-Nov	555682	5758523	555777	5758424	131	300	8	30
EF-24	05-Nov	562088	5754794	-	-	73	300	8	30
EF-25	05-Nov	562116	5754799	562211	5754813	70	300	8	30
EF-26	05-Nov	562451	5754848	562728	5754882	182	300	8	30
EF-27	05-Nov	562575	5754816	562696	5754881	82	300	8	30

1 - UTM coordinates; NAD 83 Zone 14U

2 - location of electrofishing runs illustrated in Figure 7-12

3 - fish abundance and capture was so high at some locations that the boat did not move; consequently, no end location or track was recorded

4 - electrofishing run conducted in an area of very low water velocity in the mouth of Buffalo Creek

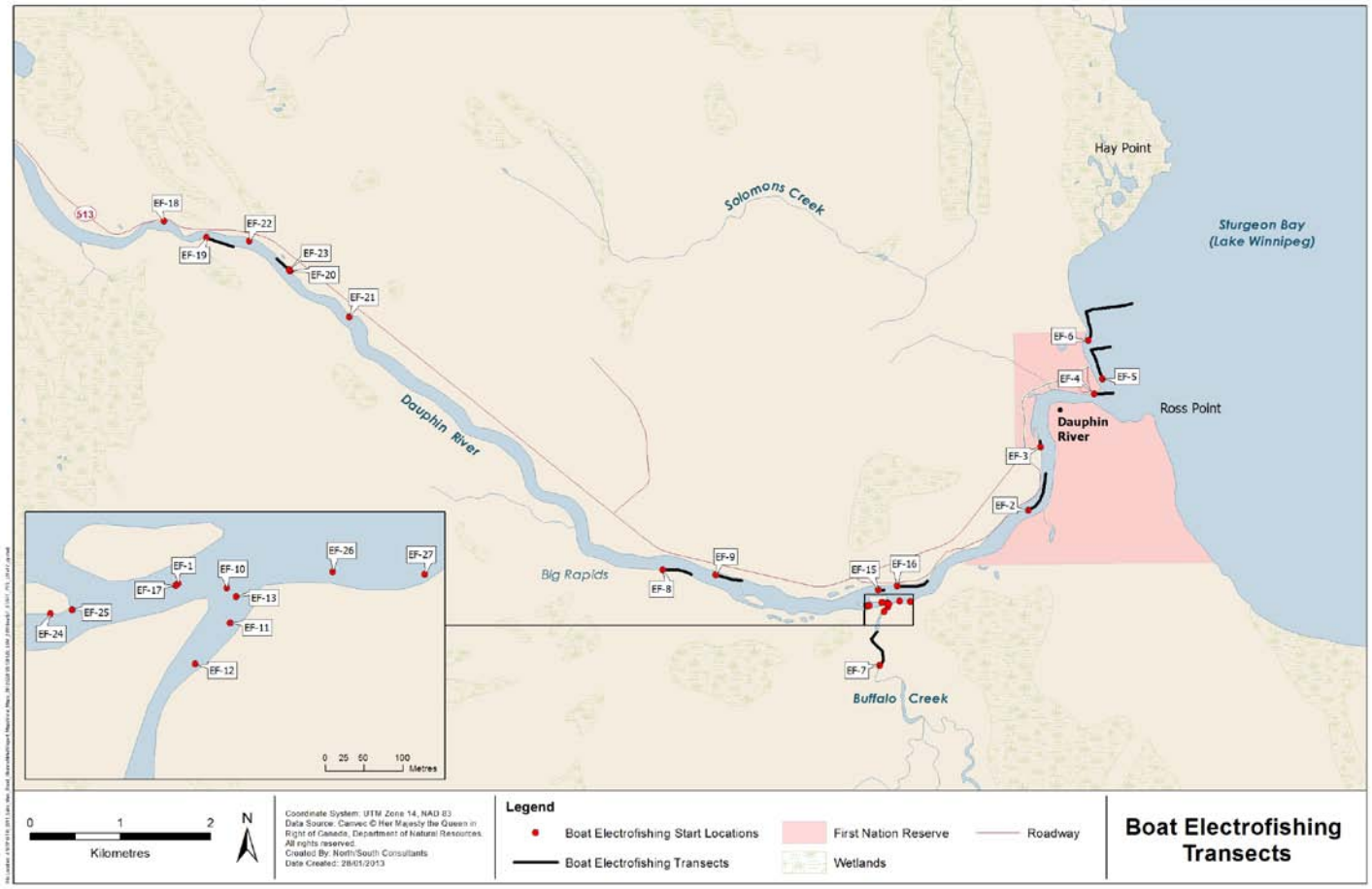


Figure 7-12. Location of boat electrofishing runs in conducted in eth Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Table 7-8. Number (n) and relative abundance (%) of fish species captured during boat electrofishing runs conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Species	Location						Overall	
	Dauphin River		Buffalo Creek		Sturgeon Bay			
	n	%	n	%	n	%	n	%
Cisco	26	3.6	-	-	-	-	26	3.4
Freshwater Drum	3	0.4	-	-	-	-	3	0.4
Lake Whitefish	675	94	2	29	38	95	715	93.5
Northern Pike	1	0.1	1	14	-	-	2	0.3
Walleye	1	0.1	-	-	-	-	1	0.1
White Sucker	12	1.7	2	29	2	5	16	2.1
Yellow Perch	0	0	2	29	-	-	2	0.3
Total	718	100	7	100	40	100	765	100

Table 7-9. Number of fish captured, by site, during boat electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Run	Date	Species							Overall
		Cisco	Freshwater Drum	Lake Whitefish	Northern Pike	Walleye	White Sucker	Yellow Perch	
Sampling Period 1									
Dauphin River									
EF-1	14-Oct	-	-	25	-	-	-	-	25
EF-2	14-Oct	4	-	29	-	-	1	-	34
EF-3	14-Oct	-	-	34	-	-	-	-	34
EF-8	14-Oct	1	3	21	-	-	-	-	25
EF-9	14-Oct	4	-	33	-	-	3	-	40
EF-10	14-Oct	-	-	23	-	-	-	-	23
EF-11	15-Oct	-	-	36	-	-	1	-	37
EF-12	15-Oct	-	-	39	-	-	-	-	39
EF-13	15-Oct	-	-	44	-	-	-	-	44
	Total	*9*	*3*	*284*	*0*	*0*	*5*	*0*	*301*
Sturgeon Bay									
EF-4	14-Oct	-	-	27	-	-	-	-	27
EF-5	14-Oct	-	-	4	-	-	2	-	6
EF-6	14-Oct	-	-	7	-	-	-	-	7
	Total	*0*	*0*	*38*	*0*	*0*	*2*	*0*	*40*
Buffalo Creek									
EF-7	14-Oct	-	-	2	1	-	2	2	7
	Total	*0*	*0*	*2*	*1*	*0*	*2*	*2*	*7*
Sampling Period 2									
Dauphin River									
EF-14	20-Oct	1	-	28	-	-	-	-	29
EF-15	20-Oct	4	-	1	-	1	-	-	6
EF-16	20-Oct	1	-	25	-	-	1	-	27
EF-17	20-Oct	1	-	49	-	-	-	-	50
EF-18	21-Oct	-	-	-	-	-	1	-	1
EF-19	21-Oct	-	-	2	-	-	-	-	2
EF-20	21-Oct	-	-	33	1	-	1	-	35
EF-21	21-Oct	-	-	19	-	-	2	-	21
	Total	*7*	*0*	*157*	*1*	*1*	*5*	*0*	*171*
Sampling Period 3									
Dauphin River									
EF-22	05-Nov	-	-	44	-	-	-	-	44
EF-23	05-Nov	-	-	45	-	-	1	-	46
EF-24	05-Nov	1	-	39	-	-	-	-	40
EF-25	05-Nov	2	-	39	-	-	-	-	41
EF-26	05-Nov	3	-	30	-	-	-	-	33
EF-27	05-Nov	4	-	37	-	-	1	-	42
	Total	10	0	234	0	0	2	0	246
All Sampling Periods		26	3	675	1	1	12	0	718

Table 7-10. Catch-per-unit-effort (CPUE; # fish/60 seconds of fishing effort) by site and fish species for boat electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Run	Date	Species							Overall
		Cisco	Freshwater Drum	Lake Whitefish	Northern Pike	Walleye	White Sucker	Yellow Perch	
Sampling Period 1									
Dauphin River									
EF-1	14-Oct	-	-	45.5	-	-	-	-	45.5
EF-2	14-Oct	2.2	-	15.8	-	-	0.5	-	18.5
EF-3	14-Oct	-	-	61.8	-	-	-	-	61.8
EF-8	14-Oct	0.8	2.3	16.2	-	-	-	-	19.2
EF-9	14-Oct	3.1	-	25.4	-	-	2.3	-	30.8
EF-10	14-Oct	-	-	27.1	-	-	-	-	27.1
EF-11	15-Oct	-	-	56.8	-	-	1.6	-	58.4
EF-12	15-Oct	-	-	53.2	-	-	-	-	53.2
EF-13	15-Oct	-	-	330.0	-	-	-	-	330.0
	Total	1.1	0.4	36.0	0.0	0.0	0.6	0.0	38.2
Sturgeon Bay									
EF-4	14-Oct	-	-	17.4	-	-	-	-	17.4
EF-5	14-Oct	-	-	0.5	-	-	0.2	-	0.7
EF-6	14-Oct	-	-	0.6	-	-	-	-	0.6
	Total	0	0.0	1.7	0.0	0.0	0.1	0.0	1.8
Buffalo Creek									
EF-7	14-Oct	-	-	0.3	0.1	-	0.3	0.3	1.0
	Total	0	0	0.3	0.1	0	0.3	0.3	1.0
Sampling Period 2									
Dauphin River									
EF-14	20-Oct	2.4	-	67.2	-	-	-	-	69.6
EF-15	20-Oct	1.2	-	0.3	-	0.3	-	-	1.9
EF-16	20-Oct	1.9	-	46.9	-	-	1.9	-	50.6
EF-17	20-Oct	1.9	-	91.9	-	-	-	-	93.8
EF-18	21-Oct	-	-	-	-	-	0.4	-	0.4
EF-19	21-Oct	-	-	0.6	-	-	-	-	0.6
EF-20	21-Oct	-	-	11.1	0.3	-	0.3	-	11.8
EF-21	21-Oct	-	-	11.1	-	-	1.2	-	12.2
	Total	0.5	0.0	10.5	0.1	0.1	0.3	0.0	11.5
Sampling Period 3									
Dauphin River									
EF-22	05-Nov	-	-	28.7	-	-	-	-	28.7
EF-23	05-Nov	-	-	20.6	-	-	0.5	-	21.1
EF-24	05-Nov	0.8	-	32.1	-	-	-	-	32.9
EF-25	05-Nov	1.7	-	33.4	-	-	-	-	35.1
EF-26	05-Nov	1	-	9.9	-	-	-	-	10.9
EF-27	05-Nov	2.9	-	27.1	-	-	0.7	-	30.7
	Total	1.0	0.0	22.3	0.0	0.0	0.2	0.0	23.4

Male and female Lake Whitefish in pre-spawn condition were captured at the onset of sampling in mid-October (October 14-15). Ripe males were identified the following week (October 20-21), comprising 62% of males captured during the time period. By November 5, almost all captured males were on the verge of spawning (95%). Ripe females were not abundant until November 5 (53% of females captured). The abundance of Lake Whitefish during the early sampling period in pre-spawn condition suggest these fish were possibly staging in velocity refugia prior to spawning in nearby habitat. Floy tags were applied to 691 Lake Whitefish (Appendix 7-1).

The following sections discuss the overall catch for each species where the number of fish captured was greater than ten. A summary of length, weight, condition factor and CPUE for all captured species are presented in Table 7-11.

Cisco

Cisco (n = 26) was the second most abundant species captured during fall electrofishing surveys, all of which were captured in the Dauphin River (Table 7-8). Relatively equal numbers of Cisco were captured during each sampling period in the Dauphin River (Table 7-9) with CPUE values ranging from 0.5 fish/minute during the October 20-21 survey to 1.1 fish/minute on the October 14-15 survey (Table 7-10). Mean length, weight and condition factor for Cisco were 250 mm, 339 g and 2.02, respectively (Table 7-11). The modal fork length interval of captured Cisco was 250-274 mm (Figure 7-13).

Lake Whitefish

Lake Whitefish (n = 715) was, by far, the most abundant species captured during fall electrofishing surveys, accounting for almost 94% of the total catch (Table 7-8). Most of these fish were captured in the Dauphin River, but small numbers were also captured in Buffalo Creek and Sturgeon Bay (Table 7-9). Peak catch and CPUE of Lake Whitefish in the Dauphin River occurred during the October 14-15 period while the fewest were captured in the October 20-21 period despite almost double the effort (Tables 7-9 and 7-10). Mean length, weight and condition factor for Lake Whitefish were 404 mm, 989 g and 1.49, respectively (Table 7-11). The modal fork length interval of captured Lake Whitefish was 400-424 mm with more than 75% of the catch in the 375-424 mm range (Figure 7-14).

White Sucker

White Sucker (n = 16) was the third most abundant species captured during fall electrofishing surveys (Table 7-8). Twelve were captured in the Dauphin River, primarily during the first two sampling periods, and two each were captured in Buffalo Creek and Sturgeon Bay (Table 7-9). The CPUE for White Sucker ranged from 0.2-0.6 fish/minute (Table 7-10). Mean length, weight and condition factor for White Sucker were 368 mm, 1086 g and 1.69, respectively (Table 7-11). The modal fork length interval of captured White Sucker was 400-424 mm (Figure 7-15).

Table 7-11. Fork length (mm), weight and condition factor (K) for species captured during electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

Species	Length (mm)				Weight				K			
	n[1]	Mean	SD[2]	Range	n	Mean	SD	Range	n	Mean	SD	Range
Cisco	26	250	32.8	176-312	21	339	126	100-600	21	2.02	0.38	1.11-2.75
Freshwater Drum	3	567	20.9	543-581	3	2867	153	2700-3000	3	1.58	0.10	1.51-1.69
Lake Whitefish	715	404	26.6	113-511	714	989	208	550-1900	714	1.49	0.17	0.74-2.12
Northern Pike	2	227	61.5	183-270	-	-	-	-	-	-	-	-
Walleye	1	500	-	-	1	1500	-	-	1	1.20	-	-
White Sucker	16	368	80.8	163-435	14	1086	302	200-1350	14	1.69	0.26	0.86-1.97
Yellow Perch	2	104	3.54	101-106	-	-	-	-	-	-	-	-

1 - n = number of fish measured; may not equal number captured.

2 - SD = standard deviation.

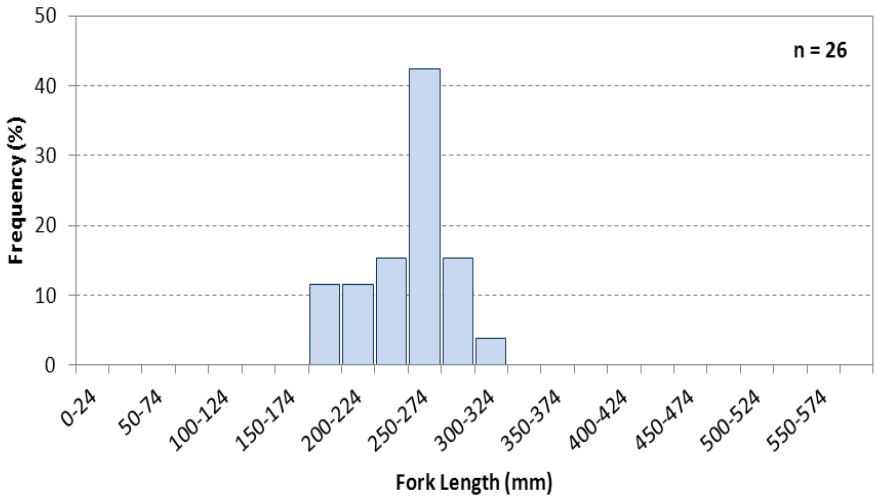


Figure 7-13. Length-frequency distribution for Cisco captured during boat electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

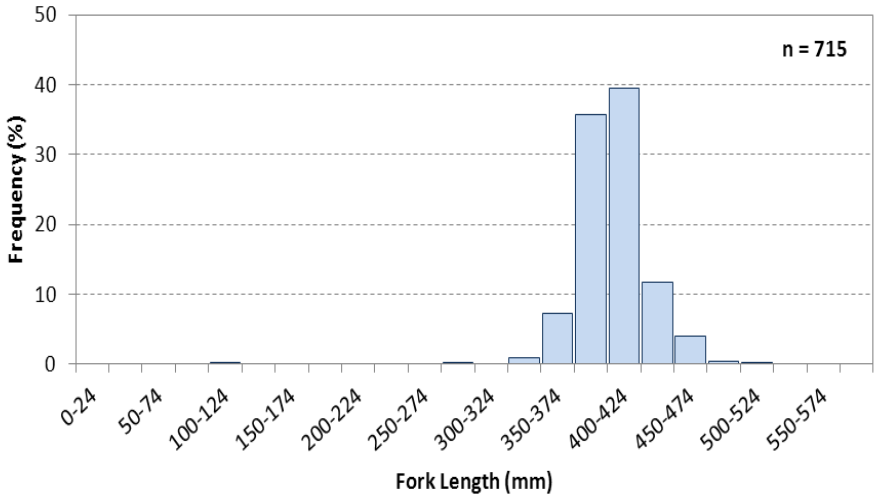


Figure 7-14. Length-frequency distribution for Lake Whitefish captured during boat electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

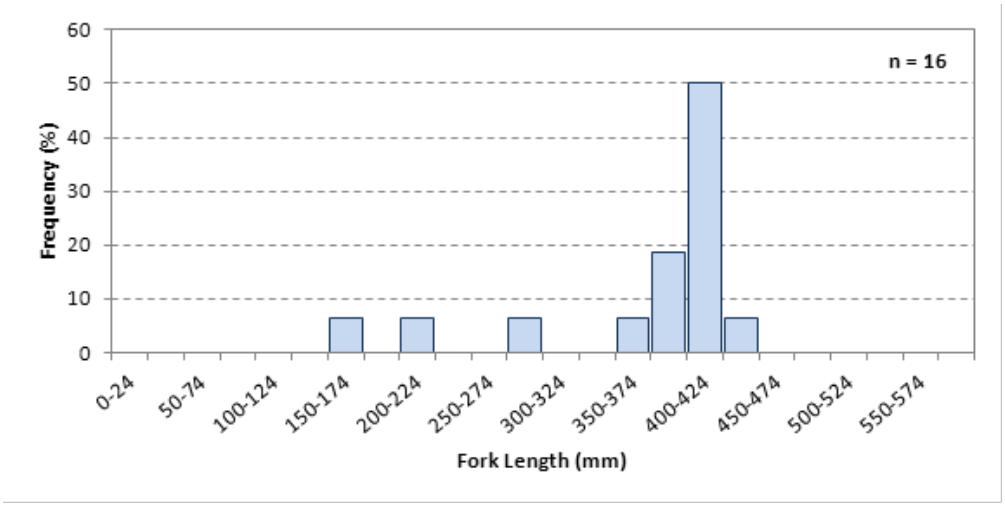


Figure 7-15. Length-frequency distribution for White Sucker captured during boat electrofishing surveys conducted in the Dauphin River, Sturgeon Bay, and Buffalo Creek during fall, 2011.

7.2.3 Spawning Activity

Twenty egg mats were deployed in the mouth of Buffalo Creek and in the Dauphin River (Table 7-11). Twelve mats were set October 29 - November 4 and eight mats November 5-15, 2011.

Ten egg mats were retrieved during the egg mat survey, nine of which captured 5,961 Lake Whitefish eggs. The remaining ten mats were not recovered (i.e. lost due to high flows). Eggs were detected in all sampling areas including 900 m downstream from Buffalo Creek and in and near the mouth of Buffalo Creek. Most eggs (n = 4,651) were captured at three sites in the Dauphin River just upstream from Buffalo Creek. One of these sites captured 3,729 eggs.

Females on the verge of spawning were first captured in abundance (53% of captured females) in the vicinity of Buffalo Creek on 05 November when almost all the captured males were also ripe and ready to spawn. Lake Whitefish eggs were captured on mats retrieved on 04 November, confirming that spawning had commenced in late October-early November in the vicinity of Buffalo Creek. Furthermore, egg abundance was much higher on mats retrieved on 15 November than on those retrieved earlier, suggesting that the bulk of spawning in the areas likely occurred during the first two weeks of November.

The much higher CPUE and more widely distributed aggregations of Lake Whitefish in pre-spawn condition during mid-October compared with results from early November when spawning was just beginning in the vicinity of Buffalo Creek may indicate that at least a portion of the captured Lake Whitefish were staging in the area before moving further upstream in the Dauphin River and into Lake St. Martin to spawn at other locations.

Table 7-12. Number of Lake Whitefish eggs captured on egg mats set in the Dauphin River and in the mouth of Buffalo Creek during fall, 2011.

Site ID	Location	Location [1]		Set Date	Pull Date	No. LKWH Eggs [2]
		Easting	Northing			
EM-1	Dauphin River	562983	5755318	29-Oct-11	04-Nov-11	30
EM-2	Dauphin River	562978	5755298	29-Oct-11	04-Nov-11	-
EM-3	Dauphin River	562988	5755345	29-Oct-11	04-Nov-11	-
EM-4	Dauphin River	562965	5755296	29-Oct-11	04-Nov-11	-
EM-5	Mouth of Buffalo Creek	562251	5754726	29-Oct-11	04-Nov-11	-
EM-6	Mouth of Buffalo Creek	562313	5754789	29-Oct-11	04-Nov-11	28
EM-7	Mouth of Buffalo Creek	562249	5754729	29-Oct-11	04-Nov-11	-
EM-8	Mouth of Buffalo Creek	562314	5754788	29-Oct-11	04-Nov-11	-
EM-9	Mouth of Buffalo Creek	562295	5754838	29-Oct-11	04-Nov-11	-
EM-10	Mouth of Buffalo Creek	562330	5754900	29-Oct-11	04-Nov-11	230
EM-11	Mouth of Buffalo Creek	562302	5754847	29-Oct-11	04-Nov-11	-
EM-12	Mouth of Buffalo Creek	562306	5754883	29-Oct-11	04-Nov-11	-
EM-13	Dauphin River	562299	5754904	05-Nov-11	15-Nov-11	740
EM-14	Upstream of Buffalo Creek	562107	5754835	05-Nov-11	15-Nov-11	62
EM-15	Upstream of Buffalo Creek	562128	5754778	05-Nov-11	15-Nov-11	860
EM-16	Upstream of Buffalo Creek	562204	5754763	05-Nov-11	15-Nov-11	3729
EM-17	Mouth of Buffalo Creek	562312	5754819	05-Nov-11	15-Nov-11	-
EM-18	Dauphin River	562224	5754922	05-Nov-11	15-Nov-11	242
EM-19	Downstream of Buffalo Creek	562424	5754849	05-Nov-11	15-Nov-11	0
EM-20	Downstream of Buffalo Creek	562716	5754879	05-Nov-11	15-Nov-11	40

1 - UTM coordinates; Zone 14U

2 - "-" indicates that the egg mat was not recovered from that site

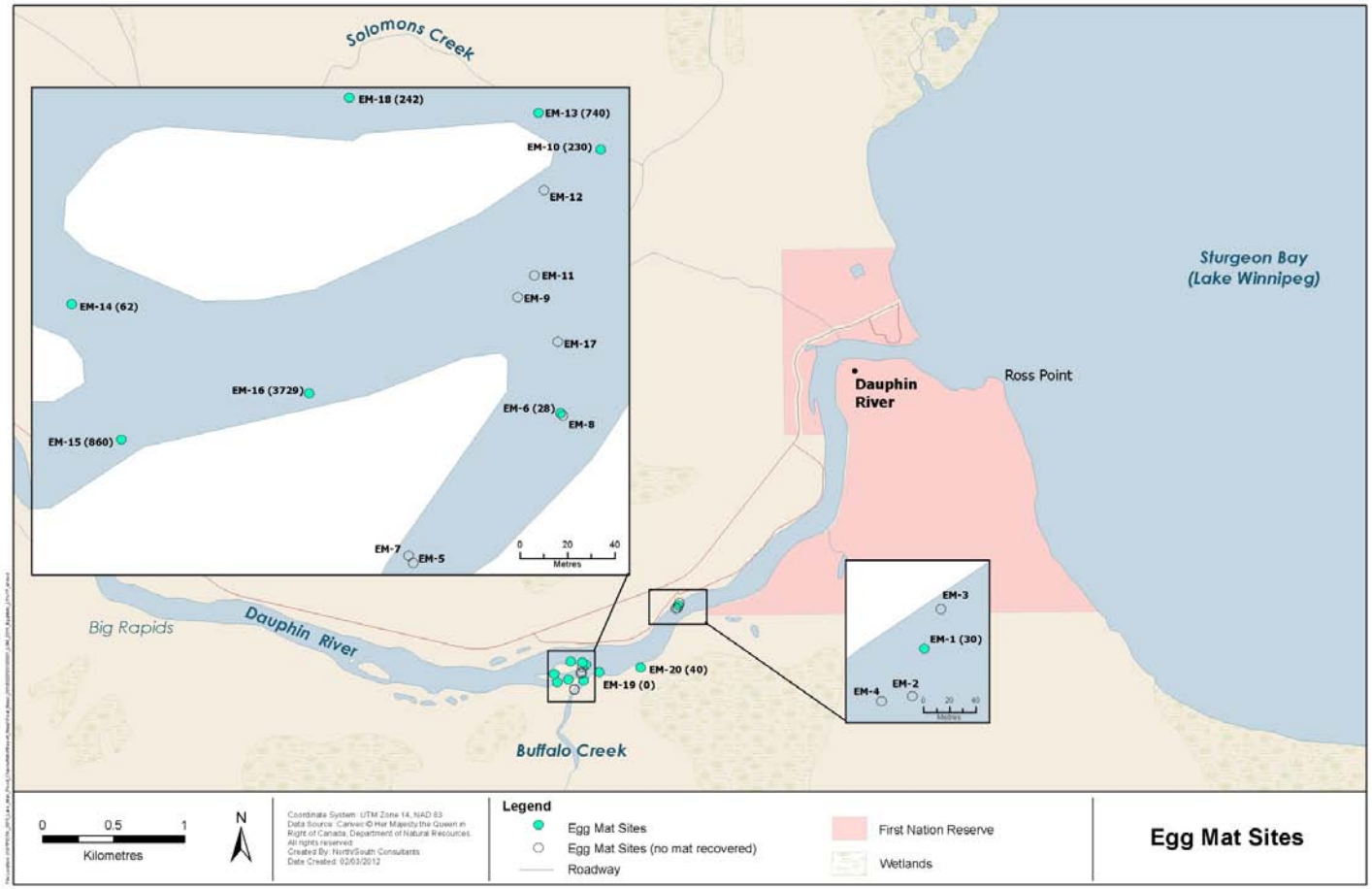


Figure 7-16. Location of egg mats set in the Dauphin River and Buffalo Creek during fall, 2011.

7.2.4 Debris Monitoring

Debris levels were obtained from four experimental gill nets set in Sturgeon Bay from 14 – 21 October, 2011 (Figure 7-5). Basic set information for the four gill nets is summarized in Table 7-3.

Three of the four experimental gill nets set in Sturgeon Bay in the fall of 2011 were long-duration (overnight) sets and one, the net set south of Willow Point, was short-duration. Of the three long-duration sets, two contained low levels of debris and one contained no debris (Table 7-13). Debris composition in the two nets consisted of 85% aquatic vegetation (weeds), followed by 10% terrestrial vegetation (grass) and 5% other (clam shells) (Table 7-13; Figure 7-17). The short-duration set contained a low level of debris that consisted of 50% grass and 50% weeds (Table 7-13).

Table 7-13. Net-specific debris level and composition in experimental gill nets set in Sturgeon Bay during fall, 2011.

Site	Set Duration (hrs)	Debris Level [1]	Debris Type (% of total debris per net)							Comments
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Aquatic Vegetation	Algae	Silt/Mud	Other	
GN-01	18.8	Low	-	-	-	90%	-	-	10%	clam shells
GN-02	23.3	Low	20%	-	-	80%	-	-	-	-
GN-03	18.1	None	-	-	-	-	-	-	-	-
GN-04	2.1	Low	50%	-	50%	-	-	-	-	-

1 - debris level categories defined in Section 7.1.4

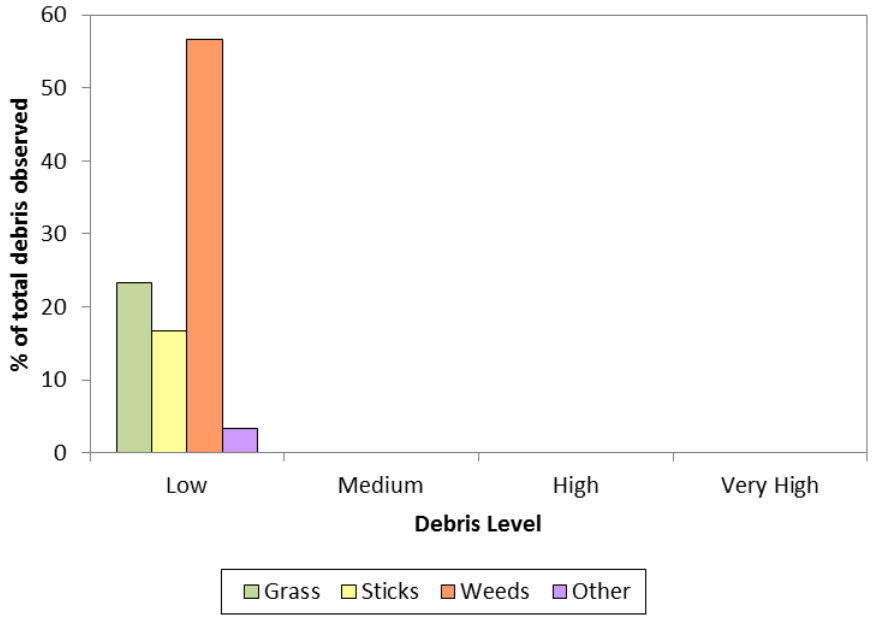


Figure 7-17. Relative composition of debris observed in three experimental gill nets set in Sturgeon Bay during fall, 2011. Note that one of four nets for which debris information was recorded had no debris in it.

7.3 SUMMARY

Water Temperature

Water temperature loggers were deployed on 19 October. Water temperature in the Dauphin River and Sturgeon Bay were between 6 and 7OC when the loggers were deployed and decreased to 0-1°C by mid-November.

Fish Utilization

Nine species of fish were captured, most of which occurred contiguously in the Dauphin River and Sturgeon Bay. Four standard experimental gillnet gangs in Sturgeon Bay captured 333 fish, comprising all nine species. Cisco, White Sucker, Northern Pike, and Lake Whitefish were the most abundant species. Species diversity and abundance were highest at two nets set near the mouth of the Dauphin River. Most Lake Whitefish captured were adult fish in a pre-spawn condition, including those fish captured near Willow Point.

Twenty-seven boat electrofishing runs were conducted in the Dauphin River, the lower-most reach of Buffalo Creek, and Sturgeon Bay in the vicinity of the Dauphin River during three sampling sessions during fall 2011. A total of 765 fish, comprising seven fish species, were captured during the electrofishing surveys with Lake Whitefish accounting for almost 94% of the catch. Most Lake Whitefish were captured in the Dauphin River in velocity refugia, including the downstream lee of shoals, small islands and at the confluence with Buffalo Creek. Male and female Lake Whitefish in early pre-spawn condition were captured at the onset of sampling in mid-October and, by November 5, most were in late pre-spawn condition.

Spawning Activity

Twenty egg mats were deployed in the mouth of Buffalo Creek and in the Dauphin River during fall 2011. Ten of these mats were successfully retrieved and sampled, producing a catch of 5,961 Lake Whitefish eggs. Most eggs were captured at three sites in the Dauphin River immediately upstream of the confluence with Buffalo Creek. The eggs were first captured on mats sampled on 04 November when large numbers of ripe females were observed during electrofishing surveys of the same area and egg abundance peaked on mats sampled on 15 November. The bulk of Lake Whitefish spawning in this reach of the Dauphin River during fall 2011 is thought to have occurred during the first two weeks of November.

Debris Monitoring

Debris levels were obtained from four experimental gill nets set in Sturgeon Bay from 14 – 21 October. Three nets contained low levels of debris and the fourth contained none. Debris consisted primarily of aquatic and terrestrial vegetation.

8.0 MERCURY CONCENTRATION IN FISH TISSUE

Operation of Reach 1 and consequent flooding of watercourses along the diversion route may result in increased loading of mercury and organic carbon (i.e., a food source for mercury methylating bacteria) to the aquatic environment and subsequent increased bioaccumulation of methylmercury in aquatic biota. The objectives of the mercury study were to:

- Document baseline mercury concentrations in commercially important fish species in Sturgeon Bay, prior to operation of Reach 1; and
- Monitor mercury concentrations in fish tissue during project operation and evaluate potential increases relative to baseline conditions.

To obtain baseline mercury concentrations in fish from Sturgeon Bay, muscle tissue samples were collected from Lake Whitefish, Northern Pike, and Walleye. These species are commonly selected in mercury monitoring programs because of their importance to commercial and domestic fisheries in Manitoba, because Pike and Walleye have relatively high mercury levels due to their position as top predators in the aquatic food chain, and because mercury concentrations for these species have historically been (Jansen and Strange 2007a) and currently are (CAMPP 2013) monitored in Manitoba ().

8.1 METHODS

8.1.1 Sample Selection and Processing

Fish for mercury analysis were collected during fish community sampling. An effort was made to collect 50 fish each of Lake Whitefish, Northern Pike, and Walleye. The individuals chosen for mercury analysis of these three species were to represent a broad size range and, as much as possible, provide an equal representation of size classes. Nets were set for various durations ranging from approximately 2-23 hours. Upon capture, large-bodied fish were measured for fork length (±1 mm) and total weight. Weight was recorded to ±50 g on an AccuWeight SM 410 (Yamato Scale Co., Ltd.) electronic pan balance. Fish were also examined internally to determine sex and maturity, and bony structures were removed for age analysis: otoliths were dissected from Lake Whitefish, dorsal spines were taken from Walleye, and cleithra were collected from Northern Pike. A portion of axial muscle weighing approximately 10-50 g was removed from each fish anterior to the caudal (tail) fin for mercury analysis. The muscle with skin attached was covered with cling-wrap, placed in a mercury-free Whirl-Pac bag with internal and external labeling, and stored on ice until it could be frozen.

8.1.2 Laboratory Analysis

Frozen muscle samples were shipped to ALS Laboratories (Winnipeg, MB) and analyzed for total mercury using an adaptation of US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues". Skin-off muscle samples were homogenized in a blender and sub-sampled (if necessary) prior to hot-block digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Mercury quantification was by atomic fluorescence spectrophotometry, using a PS Analytical (Deerfield Beach,

Florida) "Millenium Merlin" analyzer. The analytical detection limit (DL) of this method was 0.01 ppm for a sample weight of ≥ 2 g. Samples of three different standard (certified) reference materials (SRMs) were analyzed with each sample run:

- apple leaves (National Institute of Standards & Technology, NIST; https://www-s.nist.gov/srmors/view_cert.cfm?srm=1515; last accessed 10 June, 2011);
- lobster hepatopancreas (Tort-2; National Research Council Canada, NRC; http://www.nrc-cnrc.gc.ca/obj/inms-ienm/doc/crm-mrc/eng/TORT-2_e.pdf, last accessed 10 June, 2011; and,
- fish protein (DORM-3, NRC; http://www.nrc-cnrc.gc.ca/obj/inms-ienm/doc/crm-mrc/eng/DORM-3_e.pdf, last accessed 10 June, 2011.

In addition, several duplicate analyses of the same sample were run for quality control purposes.

Dried ageing structures of fish were prepared and analyzed using a variety of techniques (Mackay et al. 1990). Fin rays or spines were coated in epoxy and sectioned with a Struers microtome saw. Sections were then fixed on glass slides with Cytoseal 280 and fish ages were determined by examining the slides with a Wild M3 dissecting microscope. Otoliths were slightly polished on a whetstone, immersed in synthetic wintergreen oil, and viewed with a dissecting microscope. Cleithra were cleaned and examined under reflected light.

It should be noted that more than 90% of the total mercury in large-bodied boreal freshwater fish is in the form of methylmercury (Lockhart et al. 1972; Bloom 1992; Johnston et al. 2001). Total mercury was measured in the laboratory but is considered to be indicative of methylmercury because of the high proportion of total mercury that methylmercury comprises.

8.1.3 Data Analysis

Because fish accumulate mercury over their life time, so that older and, normally, larger individuals have higher levels than younger, smaller fish, mean mercury concentrations have been standardized to facilitate comparisons between samples of fish from the same location or between samples of fish from different waterbodies over time (Jansen and Strange 2007a). The standard lengths for Lake Whitefish, Northern Pike, and Walleye are 350, 550, and 400 mm, respectively.

In addition to arithmetic means, standardized mean mercury concentrations were calculated from unique regression equations for each species based on the analysis of logarithmic transformations of muscle mercury concentration and fork lengths using the following relationship:

$$\text{Log10}[Hg] = a + b\ (\text{Log10}L)$$

Where: [Hg] = muscle mercury concentration (µg/g);

L = fork length (mm);

a = Y-intercept (constant); and,

b = slope of the regression line (coefficient).

To present data in more familiar units, all standardized means and their confidence limits were retransformed to arithmetic values.

8.2 RESULTS

8.2.1 Mean Size and Age

A total of 33 Lake Whitefish, 45 Northern Pike, and 18 Walleye captured during fall gillnetting surveys were analysed for age. Northern Pike sampled for mercury had a mean length almost identical to the standard length of 550 mm, whereas Lake Whitefish were on average larger and Walleye were on average smaller than the standard length for those species (Table 8-1). Pike, Walleye, and Whitefish for which mercury analyses were conducted had mean ages of 5.4, 3.9 years, and 7.6, respectively (Table 8-1). Age-specific mean size and condition factor for each species are provided in Tables 8-2 to 8-4.

Size and condition factor at age for each species are presented in Tables 8-2 to 8-4, Appendix 8-1 includes biological variables for individual fish.

8.2.2 Mercury

The sample target size of 50 fish was nearly obtained for Northern Pike; Lake Whitefish and, particularly Walleye, had sample sizes that were considerably lower than the desired target.

Quality Control/Quality Assurance

Standard/certified reference materials (SRM) analyzed by ALS Laboratories during each fish muscle sample run had mean mercury concentrations that differed from the mean certified value by 3.8% on average (range 0-11%). The mean difference in mercury concentrations between duplicate analyses of the same sample was 5.7% with a range of 0.6 to 16.0% (see Appendix 8-1).

Mercury Concentration

Mean arithmetic and length standardized mercury concentrations of all three fish species were similar, reflecting the fact that mean lengths were close to the standard length for the species and/or that the length distribution of sampled fish within a species was reasonably balanced (i.e., similar numbers of smaller and larger fish were sampled). Only standardized means will be discussed further.

Mercury concentrations in fish from Sturgeon Bay were generally low. Pike and Walleye had mean concentrations of 0.17 ppm and 0.20 ppm (Table 8-5), respectively. Both were substantially below the Health Canada standard for commercial marketing of freshwater fish in Canada (Health Canada 2007) and were below the 0.2 ppm guideline originally instituted as a “safe consumption limit” for people eating “large quantities of fish” (Wheatley 1979). Although no longer officially recognized, the 0.2 ppm guideline is still considered for domestic consumption by Health Canada today (Ross Wilson, Wilson Scientific Consulting, Vancouver, Canada, pers. comm., January 2012). Even the largest (770-820 mm Pike; 440-480 mm Walleye) and oldest (7-8 year Pike; 5-6 year Walleye) fish had muscle concentrations of less than 0.4 ppm mercury. The mean mercury concentration in sampled Lake Whitefish was 0.04

ppm (Table 8-5), substantially lower than than Walleye and Northern Pike. Only one of the largest (456 mm) and oldest (15 years) Lake Whitefish sampled exceeded a mercury concentration of 0.10 ppm.

Mercury concentrations in all three species from the Sturgeon Bay area of Lake Winnipeg are generally similar to those recently documented for other areas of the lake. Results from the Province of Manitoba/Manitoba Hydro's Coordinated Aquatic Monitoring Pilot Program (CAMP) for 2010 show standardized mean mercury concentrations of Lake Whitefish (0.01 ppm), Walleye (0.11 ppm), and Northern Pike (0.22 ppm, arithmetic mean) from Mossy Bay to be the lowest or among the lowest of the 24 Manitoba waterbodies surveyed that year (CAMP 2013). Although the concentrations obtained for Walleye and Whitefish from Sturgeon Bay are significantly higher than those of their conspecifics from Mossy Bay, they are still in the lower third of concentrations of the representative samples of Manitoba lakes and rivers analyzed for fish mercury under CAMP.

Mean weights and condition factors of all three species (Tables 8-1 to 8-3) were similar to those for fish sampled for mercury analysis from other waterbodies in Manitoba (CAMPP 2013).

Table 8- 1. Mean (± standard error, SE) fork length, round weight, condition (K), and age of Northern Pike, Walleye, and Lake Whitefish sampled for mercury from Lake Winnipeg, Sturgeon Bay in 2011.

Species	n	Length (mm)	Weight (g)	K	Age (years)
Northern Pike	45[1]	550.8 ± 19.2	1573.5 ± 139.0	0.77 ± 0.01	5.4 ± 0.3
Walleye	18[2]	359.6 ± 27.8	822.6 ± 137.9	1.22 ± 0.04	3.9 ± 0.4
Lake Whitefish	33[3]	391.6 ± 9.8	953.9 ± 41.0	1.48 ± 0.03	7.6 ± 0.6

1 - n = 43 for weight and K
2 - n = 16 for weight and K
3 - n = 32 for weight and K

Table 8-2. Fork length, weight and condition factor (K), by age class, for Lake Whitefish captured in experimental gill nets set in Sturgeon Bay, fall 2011.

Age	Fork Length (mm)				Weight (g)				K			
	n[1]	Mean	SD[2]	Range	n	Mean	SD	Range	n	Mean	SD	Range
1	0	-	-	-	0	-	-	-	0	-	-	-
2	1	141	-	-	0	-	-	-	0	-	-	-
3	0	-	-	-	0	-	-	-	0	-	-	-
4	1	396	-	-	1	1000	-	-	1	1.61	-	-
5	1	375	-	-	1	900	-	-	1	1.71	-	-
6	13	381	37	280-421	13	813	209	400-1100	13	1.45	0.17	1.22-1.82
7	10	402	16	370-429	10	955	164	700-1200	10	1.46	0.12	1.33-1.68
8	0	-	-	-	0	-	-	-	0	-	-	-
9	1	408	-	-	1	1150	-	-	1	1.69	-	-
10	0	-	-	-	0	-	-	-	0	-	-	-
11	1	438	-	-	1	1100	-	-	1	1.31	-	-
12	0	-	-	-	0	-	-	-	0	-	-	-
13	1	440	-	-	1	1100	-	-	1	1.29	-	-
14	0	-	-	-	0	-	-	-	0	-	-	-
15	4	438	34	386-456	4	1288	193	1100-1500	4	1.56	0.34	1.16-2.00
Total	33	392	56	141-456	32	954	232	400-1500	32	1.48	0.18	1.16-2.00

1 - n = number of fish sampled; may not equal total number captured

2 - SD = standard deviation

Table 8-3. Fork length, weight and condition factor (K), by age class, for Northern Pike captured in experimental gill nets set in Sturgeon Bay, fall 2011.

Age	Fork Length (mm)				Weight (g)				K			
	n[1]	Mean	SD[2]	Range	n	Mean	SD	Range	n	Mean	SD	Range
1	2	221	15	210-231	0	-	-	-	0	-	-	-
2	1	235	-	-	1	75	-	-	1	0.58	-	-
3	1	340	-	-	1	150	-	-	1	0.38	-	-
4	10	494	51	423-568	10	960	278	600-1400	10	0.78	0.06	0.69-0.90
5	11	538	36	476-610	11	1205	251	900-1700	11	0.77	0.05	0.67-0.83
6	9	598	43	524-640	9	1706	385	1100-2200	9	0.79	0.07	0.66-0.87
7	7	651	62	572-771	7	2275	802	1475-3950	7	0.80	0.03	0.77-0.86
8	2	808	14	798-818	2	4175	389	3900-4450	2	0.79	0.03	0.77-0.81
9	0	-	-	-	0	-	-	-	0	-	-	-
10	1	634	-	-	1	2250	-	-	1	0.88	-	-
11	0	-	-	-	0	-	-	-	0	-	-	-
12	1	720	-	-	1	2700	-	-	1	0.72	-	-
13	0	-	-	-	0	-	-	-	0	-	-	-
14	0	-	-	-	0	-	-	-	0	-	-	-
15	0	-	-	-	0	-	-	-	0	-	-	-
Total	45	551	129	210-818	43	1573	912	75-4450	43	0.77	0.09	0.38-0.90

1 - n = number of fish sampled; may not equal total number captured

2 - SD = standard deviation

Table 8-4. Fork length, weight and condition factor (K), by age class, for Walleye captured in experimental gill nets set in Sturgeon Bay, fall 2011.

Age	Fork Length (mm)				Weight (g)				K			
	n[1]	Mean	SD[2]	Range	n	Mean	SD	Range	n	Mean	SD	Range
1	0	-	-	-	0	-	-	-	0	-	-	-
2	5	220	64	164-328	4	200	204	50-500	4	1.27	0.19	1.08-1.45
3	4	296	31	251-322	3	300	50	250-350	3	1.01	0.24	0.75-1.22
4	1	438	-	-	1	1000	-	-	1	1.19	-	-
5	4	467	14	455-486	4	1300	147	1150-1500	4	1.27	0.04	1.22-1.31
6	4	471	9	458-479	4	1313	193	1200-1600	4	1.26	0.15	1.12-1.46
7	0	-	-	-	0	-	-	-	0	-	-	-
8	0	-	-	-	0	-	-	-	0	-	-	-
9	0	-	-	-	0	-	-	-	0	-	-	-
10	0	-	-	-	0	-	-	-	0	-	-	-
11	0	-	-	-	0	-	-	-	0	-	-	-
12	0	-	-	-	0	-	-	-	0	-	-	-
13	0	-	-	-	0	-	-	-	0	-	-	-
14	0	-	-	-	0	-	-	-	0	-	-	-
15	0	-	-	-	0	-	-	-	0	-	-	-
Total	18	460	137	164-486	16	822	553	50-1600	16	1.21	0.17	0.75-1.46

1 - n = number of fish sampled; may not equal total number captured

2 - SD = standard deviation

Table 8-5. Mean arithmetic (± standard error, SE) and standardized (95% confidence limits, C.L.) mercury concentrations (ppm) for Northern Pike, Walleye, and Lake Whitefish from Lake Winnipeg, Sturgeon Bay in 2011.

Species	n	Arithmetic	SE	Standard	95% C.L.
Northern Pike	45	0.170	0.011	0.170	0.146 - 0.196
Walleye	18	0.200	0.016	0.188	0.130 - 0.273
Lake Whitefish	33	0.039	0.003	0.039	0.029 - 0.053

.

Table 8-5. Mean (± standard error, SE) fork length, round weight, condition (K), and age of Northern Pike, Walleye, and Lake Whitefish sampled for mercury from Lake Winnipeg, Sturgeon Bay in 2011.

Species	n	Length (mm)	Weight (g)	K	Age (years)
Northern Pike	45[1]	550.8 ± 19.2	1573.5 ± 139.0	0.77 ± 0.01	5.4 ± 0.3
Walleye	18[2]	359.6 ± 27.8	822.6 ± 137.9	1.22 ± 0.04	3.9 ± 0.4
Lake Whitefish	33[3]	391.6 ± 9.8	953.9 ± 41.0	1.48 ± 0.03	7.6 ± 0.6

1 - n=43 for weight and K
2 - n=16 for weight and K
3 - n=32 for weight and K

8.3 SUMMARY

The bioaccumulation of mercury in fish tissue was studied in Sturgeon Bay during fall 2011 due to the potential for flooding of watercourses as a result of Reach 1 operation increasing the loading of mercury and organic carbon into project waterbodies.

A total of 33 Lake Whitefish, 45 Northern Pike, and 18 Walleye captured during fall gillnetting surveys were analysed for age. Northern Pike sampled for mercury had a mean length almost identical to the standard length of 550 mm, whereas Lake Whitefish were on average larger and Walleye were on average smaller than the standard length for those species. Pike, Walleye, and Whitefish for which mercury analyses were conducted had mean ages of 5.4, 3.9 years, and 7.6, respectively.

Mercury concentrations in fish from Sturgeon Bay were generally low and similar to those recently documented for other areas of Lake Winnipeg. Concentrations, even in the largest fish, were typically lower than the Health Canada standard for commercial marketing of freshwater fish in Canada and most were lower than the now unofficial “safe consumption limit” for people eating “large quantities of fish”.

9.0 LOCAL KNOWLEDGE

At the onset of the Project, it was recognized that knowledge collected from local people (commercial fishers and First Nations) could considerable information about the existing aquatic environment, and would be of value in assessing and possibly mitigating project-related impacts.

9.1 METHODS

Information relating to biology and harvesting activities was collected from a series of meetings held as part of the community consultation process undertaken by Manitoba Infrastructure and Transportation, Aboriginal Affairs and Northern Development Canada, and Manitoba Aboriginal and Northern Affairs. While emphasis of the meetings was to present the Project, Project updates, and pre-Project assessments of possible Project-related environmental effects on local waterbodies to the communities, some discussion regarding fish and fishing activities did occur.

Meetings included the following:

- The Project description (including construction plans), a preliminary assessment of potential effects due to operation of Reach 1, the aquatic studies workplan, and an update on ongoing aquatic study results were presented to commercial fishermen (meeting at Gypsumville; 06 October 2011);

- The Project description (including construction update and plans), a preliminary assessment of potential effects due to operation of Reach 1, the aquatic studies workplan, and an update on ongoing aquatic study results were presented to Pinaymootang First Nation council (meeting at Fairford; 11 October 2011);

- The Project description (including construction update and plans), a preliminary assessment of potential effects due to operation of Reach 1, the aquatic studies workplan, and an update on ongoing aquatic study results were presented to Pinaymootang First Nation community members (meeting at Fairford; 03 November, 2011);

- The Project description (including construction update and plans), a preliminary assessment of potential effects due to operation of Reach 1, the aquatic studies workplan, and an update on ongoing aquatic study results were presented to Dauphin River First Nation community members (meeting at Winnipeg; 12 December, 2011); and,

- The Project description (including construction update and plans), a preliminary assessment of potential effects due to operation of Reach 1, the aquatic studies workplan, and an update on ongoing aquatic study results were presented to Dauphin River First Nation community members (meeting at Dauphin River; 11 January, 2012).

Local knowledge was generally collected on an opportunistic basis; formal questionnaires were not developed. Instead, information was often obtained during discussions regarding some aspect of the Project. The intent was to conduct a mapping session following each meeting, where participants would be encouraged to record known areas of importance or interest. Emphasis was placed on identifying important areas as they related to fish biology or fish harvest (domestic or commercial fishing), but other information was collected as well.

9.2 RESULTS

Most local knowledge was collected during the meeting held in Gypsumville on 06 October. This was the only meeting where there was an opportunity to sit down following the meeting to discuss areas of interest with meeting participants. At meetings other than on 06 October, most attendees left immediately afterwards.

Information pertaining to fish biology and fish harvest activities is illustrated in Figures 9-1 and 9-2. Other biological information collected at the 06 October meeting is presented in the meeting notes, contained in Appendix 9-1.

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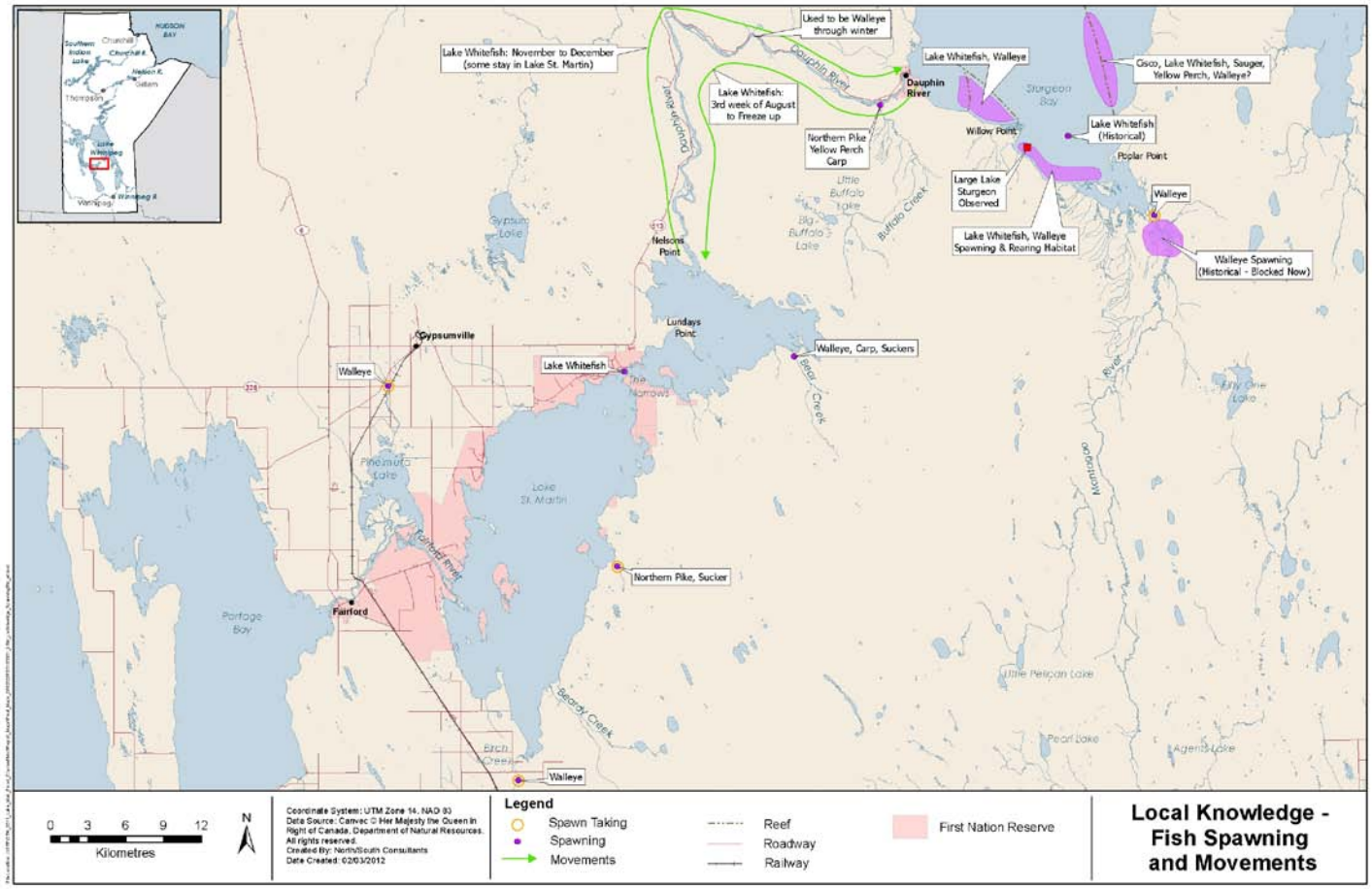


Figure 9- 1. Biological information collected during a community consultation meeting in Gypsumville, 06 October, 2011.

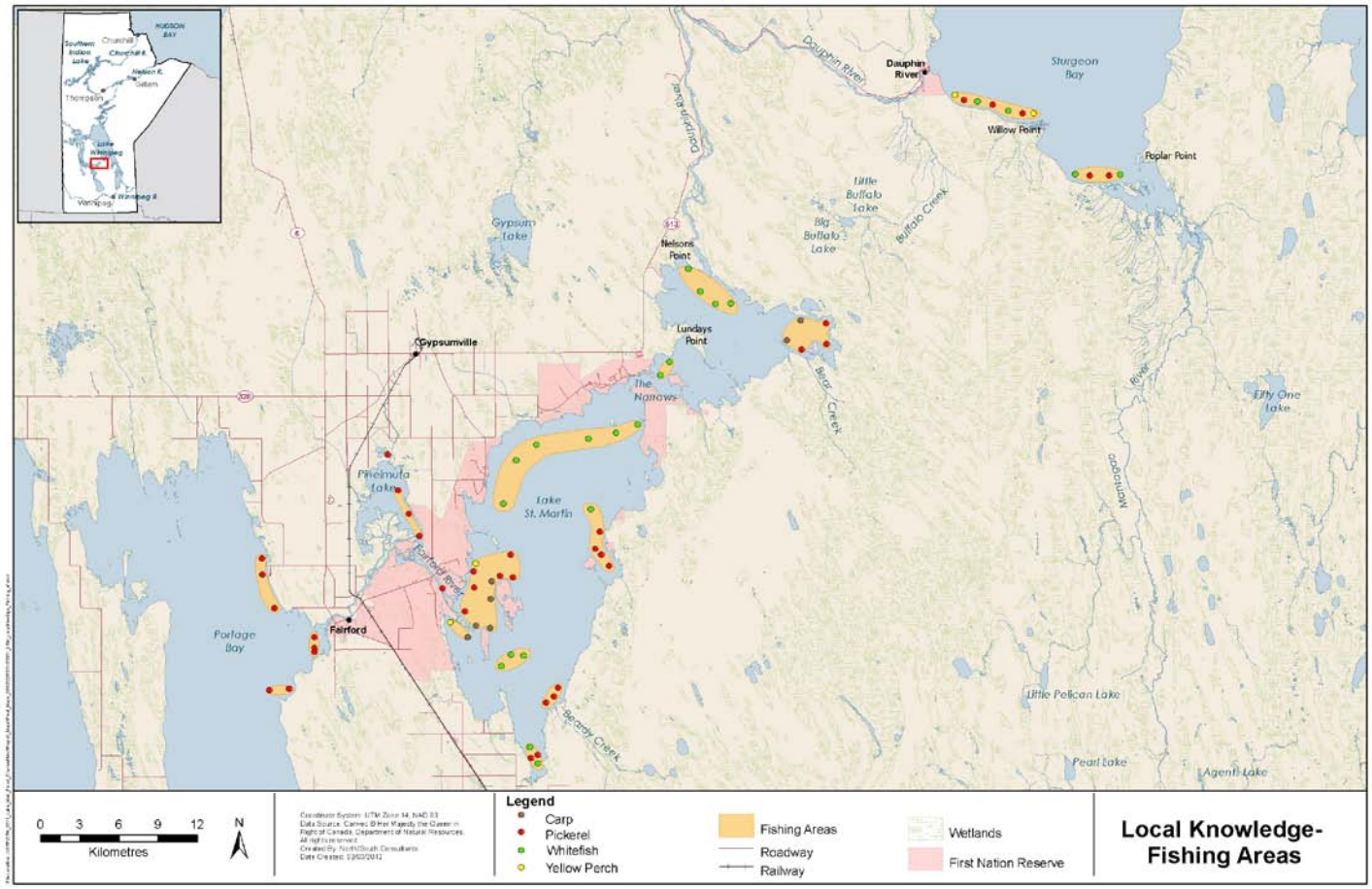


Figure 9- 2. Fish harvest locations collected during a community consultation meeting in Gypsumville, 06 October, 2011.

10.0 REFERENCES

AECOM. 2012. Lake St. Martin Emergency Outlet Channel Environmental Monitoring Final Report. A memorandum from AECOM to Manitoba Infrastructure and Transportation. February 12, 2012.

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low stream flow. Pages 62-73 in N. B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. American Fisheries Society, Western Division, Bethesda, Maryland.

Bloom, N. S. 1992. On the chemical form of mercury in edible fish and marine invertebrate tissue. Can. J. Fish. Aquat. Sci. 49:1010-1017.

British Columbia Ministry of Environment, Lands, and Parks (BCMELP). 1998. Guidelines for interpreting water quality data. Version 1, May 1998. Prepared for the Land Use Task Force Resource Inventory Committee.

CAMPP (Coordinated Aquatic Monitoring Pilot Program). 2013. Three Year Summary Report. Report prepared for the Manitoba/Manitoba Hydro CAMP MOU Working Group by North/South Consultants.

Canadian Council of Ministers of the Environment (CCME). 1999 (Updated to 2012). Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Graveline, P.G., and B.D. Horne. 1998. Norway House Commercial Fishery Debris Monitoring Program – Five Year Summary Report. 1993-1997. A report prepared for Manitoba Hydro, The Province of Manitoba, and the Norway House Commercial Fishermen's Cooperative by North/South Consultants Inc. ix + 48 p.

Health Canada. 2007. Human health risk assessment of mercury in fish and health benefits of fish consumption. Health Canada: Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Ottawa, Ont., 69 pp.

Jansen, W. and N.E. Strange. 2007a. Mercury in fish in northern Manitoba reservoirs: results from 2005 sampling and a summary of monitoring data from 1975-2005. Report by North/South Consultants Inc., Winnipeg, MB for Manitoba Hydro, 102 pp.

Jansen, W. and N.E. Strange. 2007b. Mercury concentrations in fish from the Keeyask project study area for 1999-2005. Report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, 152 pp.

Johnston, T.A., R.A. Bodaly, M.A. Latif, R.J.P. Fudge, and N.E. Strange. 2001. Intra- and interpopulation variability in maternal transfer of mercury to eggs of walleye (*Stizostedion vitreum*). Aquatic Toxicology 52: 73-85

KGS and AECOM. 2011. Analysis of options for emergency reduction of Lake Manitoba and Lake St. Martin levels. Manitoba Infrastructure and Transportation. 15 p.

La Haye, Michel, S. Desloges, C. Cote, J. Deer, S. Philips Jr., B. Giroux, S. Clermont, and P. Dumont. 2003. Location of lake sturgeon (Acipenser fulvescens) spawning grounds in the upper part of the Lachine rapids (St. Lawrence River). Study carried out on behalf of the Societe de la faune et des parcs du Quebec, Dirrection d l'amenagement de la faune de Montreal, de Laval et de la Monteregie, Longuieuil. Technical Report 16-15E. ix + 43 p.

Lockhart, W. L., J. F. Uthe, A. R. Kenney, and P. M. Mehrle. 1972. Methylmercury in northern pike (*Esox lucius*): distribution, elimination, and some biochemical characteristics of contaminated fish. J. Fish. Res. Board. Can. 29:1519 1523.

Manny, B.A., G.W. Kennedy, J.D. Allen, and J.R.P. French III. 2007. First evidence of egg deposition by walleye in the Detroit River. Journal of Great Lakes Research **33**: 512-513.

Mackay, W.C., G.R. Ash, and H.J. Norris (eds.). 1990. Fish ageing methods for Alberta. R.L. & L. Environmental Services Ltd., Edmonton, AB. 113 p.

McDougall, C. A. and D.S. MacDonell. 2009. Results of Lake Sturgeon Studies in the Slave Falls Reservoir and Pointe du Bois Forebay - 2008. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, Manitoba. 255 pp. #5811.08-04.

Manitoba Water Stewardship (MWS). 2010. Fairford Dam Operation. http://www.gov.mb.ca/waterstewardship/floodinfo/forecast_centre/reservoirs_dams/general_dam_inform_operation_targets/fairford_dam.pdf. Accessed August 10, 2011.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. July 4, 2011. 68 pp.

North/South Consultants Inc. 2011a. Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels – Existing Aquatic Environment, Potential Impacts, and Work Plan. A draft report prepared for Manitoba Infrastructure and Transportation by North/South Consultants Inc. (23 September 2011). xiv + 87 p.

North/South Consultants Inc. 2011b. Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels - Baseline Data Collection and Monitoring Plan for DFO. A draft monitoring plan prepared for Manitoba Infrastructure and Transportation by North/South Consultants Inc. (23 September 2011). iv + 20 p.

North/South Consultants Inc. 2012. Manitoba/Manitoba Hydro Coordinated Aquatic Monitoring Pilot Program (CAMPP): Three Year (2008-2010) Review. A draft report prepared for Manitoba and Manitoba Hydro by North/South Consultants Inc. xiii + 2425 p.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Can. Bull. Fish. Aquat. Sci. 191. 382 p.

Schetagne R. and R. Verdon. 1999. Mercury in fish of natural lakes of Québec. In: "Mercury in the Biochemical Cycle", Lucotte, M., Schetagne, R., Thérien, N., Langlois, C., and Trembley, A., eds., Springer, Berlin, p. 115-130.

Thompson, A.L. 2009. Walleye habitat use, spawning behavior, and egg deposition in Sandusky Bay, Lake Erie. Master's thesis. Ohio State University, Columbus.

Wheatley, B. 1979. Methylmercury in Canada; exposure of Indian and Inuit residents to methylmercury in the Canadian environment. Health and Welfare Canada, Medical Service Branch, Ottawa, ON. 200 pp.

Lake St. Martin Emergency Outlet Channel
Assessment of Effects and Development of Offsetting

Physical Environment Supporting Volume (PESV)

May 2015

A report prepared for
Manitoba Infrastructure and Transportation
by
North/South Consultants Inc. and KGS Group

PREFACE

The following document was prepared to provide the information required under Schedule 1 of the *Applications for Authorization under Paragraph 35(2) (b) of the Fisheries Act Regulations.* As requested by Fisheries and Oceans Canada (DFO), key information from all relevant materials provided during the environmental review of the Lake St. Martin Emergency Relief Channel Project has been summarized in this document, following the subsections identified in Schedule 1 to the extent possible.

It should be noted that, because of the emergency requirement to complete this Project, it was exempted from a review under Canada's *Canadian Environmental Assessment Act (CEAA)* and *The Environment Act (Manitoba)*. In the absence of a formal screening, DFO issued *Fisheries Act* authorizations for the Project (Authorization # DA-11-1585-01; Authorization # DA-11-1585-A1; and Authorization # 14-HCAA-00582). The requirement for documentation and possible offsetting for any residual serious harm to fish that have arisen due to the Project was identified within the authorizations.

The following document is one of a series of reports listed below to address reporting requirements stipulated in the *Fisheries Act* authorizations. The report series is comprised of an assessment of Project-related effects determined from ongoing project monitoring, an offsetting plan in which the needs for offsetting measures are discussed, and a series of support volumes that summarize Project monitoring data collections and results by major ecosystem component (i.e., Physical Environment, Water Quality, Aquatic Habitat, and Fish). Reports and supporting volumes include the following:

- Assessment of Effects to Aquatic Habitat and Fish (AEHF)
- Offsetting Plan
- Physical Environment Supporting Volume (PESV; this volume)
- Water Quality Supporting Volume (WQSV)
- Aquatic Habitat Supporting Volume (AHSV)
- Fish Supporting Volume (FSV)

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4.0 PHYSICAL ENVIRONMENT

Sections within this supporting volume are numbered to match the corresponding section within the "Effects to Aquatic Habitat and Fish " document.

4.1 INTRODUCTION

4.1.1 Project Background

Widespread record flooding throughout southern Manitoba during 2011 led to water levels in Lake Manitoba and Lake St. Martin that were several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin. As part of emergency relief measures, the Province of Manitoba, through Manitoba Infrastructure and Transportation (MIT), constructed the Lake St. Martin Emergency Outlet Channel System, which is comprised of two emergency channels (Figure .1-1).

The Reach 1 Emergency Outlet Channel (Reach 1) begins at the northeast shore of the north basin of Lake St. Martin and extends approximately 6 km to the bog area surrounding Big Buffalo Lake. Water from Reach 1 inundates the bog area and then follows the natural Buffalo Creek drainage until flowing into the lower Dauphin River and ultimately into Sturgeon Bay (Figure 4.1-1). Water began to flow through Reach 1 on 01 November 2011 and the channel was operated until 21 November 2012.

Computer models of potential water levels at the mouth of the Dauphin River indicated that there was a significant risk of major flooding of the Dauphin River communities in spring 2012. Consequently, a second channel (Reach 3 Emergency Channel; Reach 3) was constructed during winter 2011/2012. Reach 3 was designed to divert excess flow from Reach 1 and Buffalo Creek and away from the lower Dauphin River. Due to extremely mild winter conditions in 2011/2012, ice effects on both Reach 1 and the Dauphin River were much less severe than forecasted. Consequently, the proposed operation of Reach 3 was no longer required.

Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, prompting MIT to re-open Reach 1 at the beginning of July 2014. The channel was re-opened in two stages. The first occurred during in July 2014 when approximately 35 m of the berm closing Reach 1 was removed. The second stage occurred in November 2014, when an additional 10 m of the closure berm were removed to allow additional flow into the channel. Reach 1 currently remains in operation, and will remain so until at least 15 June 2015.

Collectively, construction and operation of Reach 1, as well as construction of Reach 3, are referred to hereafter as "the Project". Phases of the Project are defined as: Pre-Operation (up to 31 October 2011 and includes Historical and 2011 Flood periods), 2011/2012 Operation (01 November 2011 to 21 November 2012); 2011/2012 Closure (22 November 2012 to 04 July 2014); and 2014/2015 Operation (began 04 July 2014, and is ongoing).

Concurrent with construction of Reach 1 in summer 2011, MIT initiated studies and monitoring to help describe and assess environmental effects arising from the Project. These included studies to document changes to the physical environment (e.g., measurement of water flow through Reach 1 and the Dauphin River; sedimentation and erosion studies) and possible subsequent effects to the biological environment (e.g., possible change to fish community in Buffalo Creek). Environmental studies began in August 2011 and remain ongoing.

4.1.2 Study Area

The emphasis of aquatic monitoring is to determine what effects construction and operation of Reach 1 may have had on waterways downstream of the channel. These include the Buffalo Creek watershed (comprised of Big Buffalo Lake and the surrounding bog complex, and Buffalo Creek), the lower reach of the Dauphin River, and the southwest portion of Sturgeon Bay. However, these waterways are also affected by conditions occurring upstream of Reach 1 and, in some instances, fish move between areas upstream and downstream of Reach 1 (especially important is the movement of Lake Whitefish from Sturgeon Bay to spawning areas in Lake St. Martin). Consequently, some components of the aquatic monitoring program include waterways upstream of Reach 1.

Data analyses for the physical environment were divided spatially by Project area as follows:

- Lake St. Martin;
- Reach 1 and the Buffalo Creek watershed. For the purposes of sediment transport modeling, this area was sub-divided into three areas, including:
    - Reach 1;
    - The Bog Complex surrounding Big Buffalo Lake; and,
    - Buffalo Creek.
- The Dauphin River, which was subdivided into the upper Dauphin River (defined as the Dauphin River upstream of its confluence with Buffalo Creek) and the lower Dauphin River (defined as the Dauphin River downstream of Buffalo Creek to Sturgeon Bay; and,
- Sturgeon Bay.

4.1.3 Purpose of the Document

Hydrometric data, ice processes, water quality, vegetation cover, erosion, and sedimentation were characterized and compared between project phases to identify the potential impacts related to the construction and operation of Reach 1.

This volume is intended to compliment the “Lake St. Martin Emergency Outlet Channel - Assessment of Effects and Development of Offsetting: Assessment of Effects to Aquatic Habitat and Fish” document.

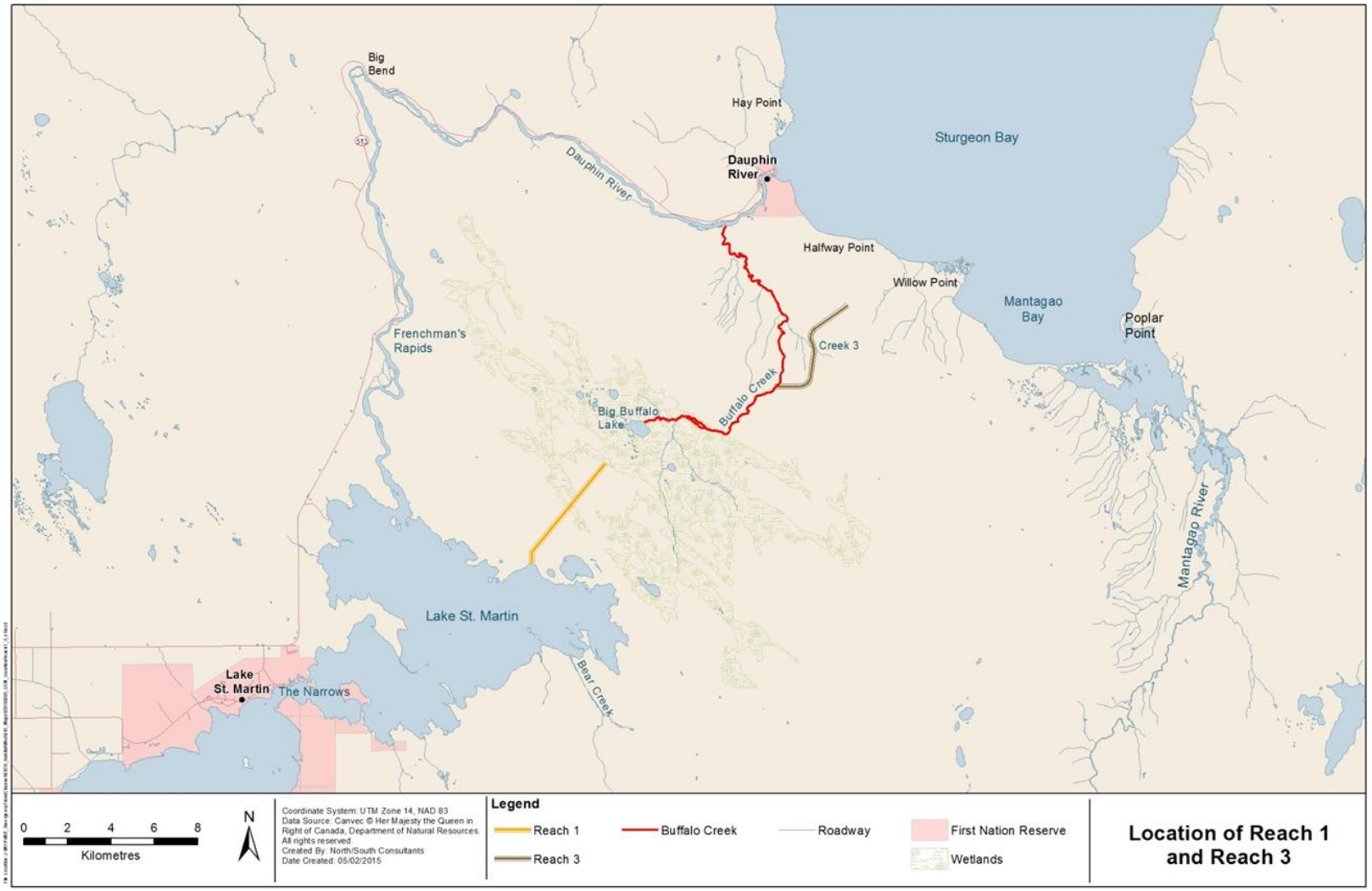


Figure 4.1-1. Location of the Reach 1 Emergency Outlet Channel, the Reach 3 Emergency Channel, and the Buffalo Creek watershed in relation to Lake St. Martin, the Dauphin River and Sturgeon Bay.

4.2 ASSESSMENT APPROACH

The characterization of the physical environment during each phase of the project is based on studies and monitoring programs initiated to document changes to the physical environment. A brief overview of the physical processes assessed within this volume is listed below. The details of each component, including a summary of the data collected, methods, analysis, and results are discussed individually for each reach of the system in Sections 4.3 to 4.6 of this report.

4.2.1 Data Sources

Hydrometric data, ice processes, water quality, vegetation cover, erosion, and sedimentation were characterized and compared between project phases to identify the potential impacts related to the construction and operation of Reach 1. A brief overview of these data sources is listed below.

Hydrometric Data – Water level data were collected during discrete periods on Reach 1, Big Buffalo Lake and Buffalo Creek starting in the fall of 2012 and continued through the 2014/2015 Operation. Periodic flow metering events were conducted on Reach 1 during the 2011/2012 and 2014/2015 Operation, and at a station in the lower reach of Buffalo Creek (BCTM) during the closure period. The hydrometric data were used to compute daily flows and was incorporated into the analyses and the numerical modeling.

Ice Processes – Ice reconnaissance surveys were also conducted along the Reach 1 System emphasizing on the upper Dauphin River. The purpose of the survey was to assess the ice conditions in the Dauphin River and to confirm the location and type of ice cover that caused restrictions in flows on the Dauphin River at the outlet of Lake St. Martin. Information on the ice conditions is necessary to determine winter discharges in the Dauphin River. Two surveys were conducted for this study; on December 20, 2012 and December 12, 2013. The surveys were conducted by helicopter and documented with photos while flying over the Reach 1 System.

TSS/Turbidity Data – Water samples were collected along the length of the Reach 1 System (includes Big Buffalo Lake, Buffalo Creek and the Lower Dauphin River), and regionally in water bodies and watercourses within the drainage basin from the beginning of Reach 1 construction, during the 2011/2012 Operation, and continued post closure through 2013 until freshet 2014 and again during the 2014/2015 Operation. Water samples were analyzed for general water quality parameters to determine potential impacts of the Project on the aquatic ecosystem. Turbidity and Total Suspended Solids (TSS) data were incorporated into the analyses and modeling of the physical environment.

Buffalo Creek Vegetation Cover Survey – A vegetation cover survey was conducted prior to the 2011/2012 Operation and in the summer of 2013 to assess the effects to the vegetation cover and riparian community as well as erosion along Buffalo Creek following operation of Reach 1. Results were compared between the pre- and post-operation surveys. A follow-up survey was conducted in June 2014 to estimate the vegetation cover regrowth along Buffalo Creek after a full growing season. Additionally, the 2014 survey examined areas of large woody debris and stands of potentially dead trees along Buffalo Creek to assist MIT in determining the extent of trees and woody debris that could fall into the stream and be washed downstream during potential future operation of Reach 1.

Buffalo Creek Cross Section Survey – Cross section surveys were conducted in 2011 and 2013 at 30 established transect locations along Buffalo Creek to compare pre- and post- operation conditions. These data were used to identify and measure areas of erosion and deposition along Buffalo Creek resulting from the 2011/2012 Operation. Results of the survey were also compared to the modeling results.

Dauphin River Bathymetric Survey – Bathymetric surveys of the Dauphin River were conducted prior to, during, and after the 2011/2012 Operation of Reach 1. Surveys aimed to assess impacts of the Project on the Dauphin River, in particular identifying potential areas of erosion and deposition and associated effects on fish habitat in the lower Dauphin River. Surveys emphasized the area extending from slightly upstream of the confluence with Buffalo Creek and downstream into Sturgeon Bay. Results of the survey were also compared to the modeling results.

Hydraulic and Sediment Transport Modeling – Numerical modeling was conducted to analyze flow patterns and trends in sediment transport, as well as to identify areas with a potential for sediment erosion and deposition along the Reach 1 System, including Reach 1, Buffalo Creek and Dauphin River, prior to, during and after the 2011/2012 Operation and during the 2014/2015 Operation of Reach 1. Three different models were used for the analysis, including a spreadsheet calculation model ("empirical" model) of the Reach 1 System, a 1-Dimensional (1D) HEC RAS Sediment Transport model of Buffalo Creek, and a 2-Dimensional (2D) hydraulic and sediment transport model of the Lower Dauphin River. Together, the models were used to identify areas of potential deposition and/or scour and estimate sediment load along the Reach 1 System to determine potential impacts as well as identify sediment transport trends.

Sedimentation Rate – Sediment traps were used to measure sedimentation rates in Sturgeon Bay throughout a variety of seasons during 2011/2012 Operation, 2011/2012 Closure, and 2014/2015 Operation.

4.2.2 Data Collection and Analysis

4.2.2.1 Hydrometric Data and Ice Processes

Hydrometric data were collected along the Reach 1 System to support the sediment transport models discussed in this report. Hydrometric data that were collected prior to November 2012 during operation of Reach 1 was obtained from the Analysis & Monitoring of Discharges & Ice Processes Report (KGS Group, 2014) of the Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels Project. This includes:

- Flow metering events on Reach 1 during operation;
- Water level measurements along the Reach 1 System during winter of 2011/2012; and,
- Ice reconnaissance survey of the Dauphin River during the winter of 2011/2012.

As part of the Project, a hydrometric monitoring program was conducted to obtain water level and discharge data along the Reach 1 System. This program included the following components:

- Installation of an array of pressure loggers in Reach 1, Buffalo Lake and Buffalo Creek to obtain a continuous recording of water levels and document changes in water level during the 2011/2012 Operation, 2011/2012 Closure and 2014/2015 Operation;
- Flow metering events on Reach 1 and Buffalo Creek to use in conjunction with the water level records to develop a flow record along the Reach 1 System during the 2011/2012 Operation, 2011/2012 Closure and 2014/2015 Operation; and,
- Ice reconnaissance survey of the Dauphin River in December 2012 and in December 2013.

A temporary hydrometric station on Buffalo Creek was set-up on May 14, 2013 at sample station BC-TM (Figure 4.2-1). The location of BC-TM was selected to be a sufficient distance upstream of the Dauphin River where the backwater effects were determined to be negligible. At the sample station, HOBO pressure loggers (Model U20-001-01, Onset Corporation) were installed to obtain a continuous recording of water levels at a 15 min interval. Data recorded by the water level loggers were then processed and adjusted with data from barometric loggers installed on the shore.

Flow meterings were conducted on Reach 1 between November 2011 and November 2014. Flows were recorded using a Teledyne RDI RiverRay – 600 kHZ Acoustic Doppler Current Profiler (ADCP). The ADCP was either connected to a boat or to the cableway system that was installed approximately 2 km downstream from the inlet of Reach 1. Flow readings at Reach 1 occurred on the following dates:

- November 18, 2011 following the opening of Reach 1 (2011/2012 Operation);
- March 21, April 17, and August 9, 2012 during operation of Reach 1 (2011/2012 Operation);
- November 15, 2012, immediately prior to closure Reach 1 (2011/2012 Operation);
- September 6, 2014 (2014/2015 Operation); and,
- November 18, 2014 (2014/2015 Operation).

The data listed above were supplemented with flow metering data conducted by MIT during the 2014/2015 Operation.

Flow metering was also carried out on Buffalo Creek at the BC-TM sample station using a Sontek Flow Tracker Acoustic Doppler Velocimeter (ADV) or the ADCP equipment on the following dates:

- May 14, 2013, during the spring freshet (2011/2012 Closure);
- August 14, 2013 (2011/2012 Closure);
- October 16, 2013 (2011/2012 Closure);
- May 15, 2014 (2011/2012 Closure); and,
- June 17, 2014, prior to the re-opening of Reach 1 (2011/2012 Closure).

Collection and processing of the flow metering data followed the widely accepted Water Survey of Canada (WSC) (Water Survey of Canada 1999; 2004) and United States Geological Survey (USGS; 2006; 2009) Guidelines for hydrometric surveys. On two occasions at the BC-TM station, the ADV was selected over the ADCP due to the shallower depth and lower flows that were present in the creek during the survey. In October 2013, a flow metering was also conducted using ADCP equipment to compare with the results of the ADV Flow Tracker.

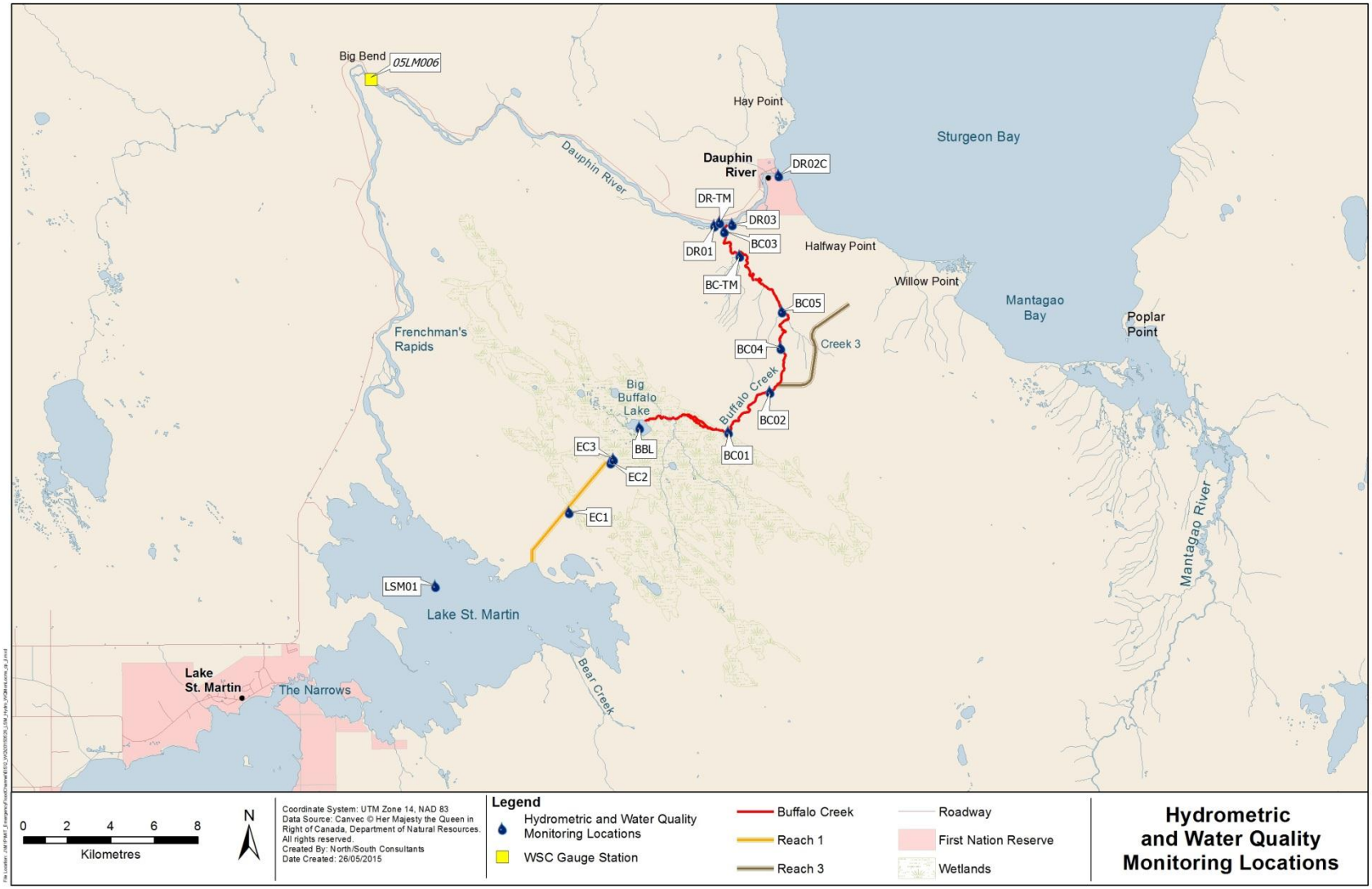


Figure 4.2-1. Hydrometric monitoring locations.

On Dauphin River, hydrometric daily flow records are available from WSC at the hydrometric station No. 05LM006 (Dauphin River near Dauphin River). A field program to collect hydrometric data on the Dauphin River was therefore not necessary for this study. The location of the WSC gauge on Dauphin River is shown on Figure 4.2-1.

4.2.2.2 TSS/Turbidity Data

Water quality monitoring of the Reach 1 System has been ongoing since early construction of Reach 1. Monitoring sites were established in Lake St. Martin, Reach 1, Big Buffalo Lake, Buffalo Creek and the Lower Dauphin River beginning upstream of the confluence with Buffalo Creek and the mouth of the river at Sturgeon Bay (Lake Winnipeg). Methods and data for water quality monitoring are provided in the Water Quality Supporting Volume. Analytical TSS data and *in situ* turbidity data collected as part of this monitoring were used to aide in determining the extent of suspended solids moving through the system and ultimately contributing to sediment inputs in the lower Dauphin River and downstream into Sturgeon Bay. In 2012, turbidity was added to the analytical data so that it could be correlated with *in situ* turbidity data measured in the field, and to potentially provide an alternate estimation of impacts from suspended solids.

The locations of the water quality monitoring sites are shown on Figure 4.2-1. Figure 4.2-1 has a greater number of monitoring sites than was presented in the Water Quality Supporting Volume. This is because additional sample stations were used, particularly along Buffalo Creek, which were not essential to describe changes in general water quality parameters (aside from TSS/turbidity) throughout the system.

Turbidity meters were installed within Buffalo Creek for a short period between October 26 and November 13, 2012 and within Buffalo Creek and the lower Dauphin River in 2013 and 2014 to collect long-term *in situ* data between the discrete water quality monitoring sampling events. Water quality data were also collected and analyzed at each turbidity meter location to verify the long-term *in situ* data and compare the turbidity readings to analytical data for TSS in support of the sediment transport analysis data. The 2013 Buffalo Creek Turbidity Meter (BC-TM) location was selected, as it was determined to be a sufficient distance upstream of the Dauphin River to avoid backwater effects during monitoring (monitoring station BC-TM in 2013 was approximately 700 m downstream of the 2012 location). The Dauphin River Turbidity Meter (DR-TM) location was selected upstream of the confluence with Buffalo Creek to provide background conditions. An initial visual survey of site conditions was completed to select suitable locations to install the turbidity meters including stable banks and channel bottoms as well as sufficient depth and flow.

Daily TSS records were computed for each phase of the project from the discrete TSS data and continuous data collected by the turbidity loggers, and converted to TSS with a relationship established between turbidity and TSS. To assess the potential relationships between turbidity and TSS, the long-term *in situ* turbidity data were imported into an excel spreadsheet for processing and data analysis. It was assumed that the laboratory analyzed turbidity would be more accurate than the turbidity meter data and, therefore, a relationship was developed to adjust the long-term *in situ* turbidity data. The adjustment factor was calculated using the average difference between the laboratory analyzed turbidity value and the measured value from the turbidity meter at the nearest time.

Separate correlations were developed between the TSS and turbidity data from each one of the turbidity loggers to compute continuous series of TSS data, based on the continuous records of turbidity. The continuous series of TSS were then used as input for the various sediment transport models described in Section 4.2.1.6.

4.2.2.3 Buffalo Creek Vegetation Cover Survey

Vegetation cover was examined along Buffalo Creek before and after the 2011/2012 Operation of Reach 1. Initially the vegetation survey was conducted to provide information that was incorporated into models to estimate flow and sediment along the creek once Reach 1 was opened in 2011. A survey was conducted in 2013 (post-operation) to estimate changes to riparian vegetation and erosion/deposition along the banks of the creek. A second post-operation/follow-up survey was conducted in 2014 primarily to document potential improvements after a full growing season. This was done to complement the data previously collected in 2013, which occurred in early July after a late spring (ice cover on the creek in May) following the closure of Reach 1 in November 2012. The 2014 survey also served as a pre-operation phase baseline for 2014/2015 Operation of Reach 1.

Thirty-one (31) vegetation survey transects were completed between stations 13+000 and 28+000 (see Figure 1 in Appendix 4.A). Transects were situated every 500 m along the length of the creek and spanned 100 m on each side of the creek. The following was recorded at each transect: transect orientation, start and end points, general description of cover types (e.g. bare, grass, shrub, trees), start and end distance of each cover type within the transect, and depth of soil organic layer. Methods and detailed results are discussed within Field Inspection Forms, and photographs are included that compare changes observed between surveys (Appendix 4.A). A brief description of change observed between the three surveys is provided below.

4.2.2.4 Buffalo Creek Cross Section Survey

A geodetic topographic survey of 30 cross-sections on Buffalo Creek was conducted prior to and after the 2011/2012 Operation of Reach 1. The 2013 survey was completed between July 3 and 7 and was conducted at the same location as the 30 cross sections that were initially surveyed in October 2011 prior to operation of Reach 1. The purpose of these surveys was to compare pre- and post-operating conditions in Buffalo Creek. Plans showing the location of the cross sections are provided on Figure 4.2-2. Comparisons of the 2013 cross sections (post 2011/2012 Operation) to the 2011 cross sections (Pre-2011/2012 Operation) are discussed in Section 4.4. GAIM imagery collected in 2011 and in 2013 was also used to support the cross section survey comparison. The comparison of the 2011 and 2013 GAIM imagery is also discussed in Section 4.4.

The thirty transects were surveyed at approximately 500 m intervals along Buffalo Creek. Each transect extended a minimum of 100 m from the centerline of the creek. The upstream limit (Sta. 13+000) had been previously established based on accessibility as this station is near the edge of the bog area surrounding Big Buffalo Lake. The downstream limit of the survey investigation (Sta. 27+500) is approximately 150 m upstream of the confluence with the Dauphin River.

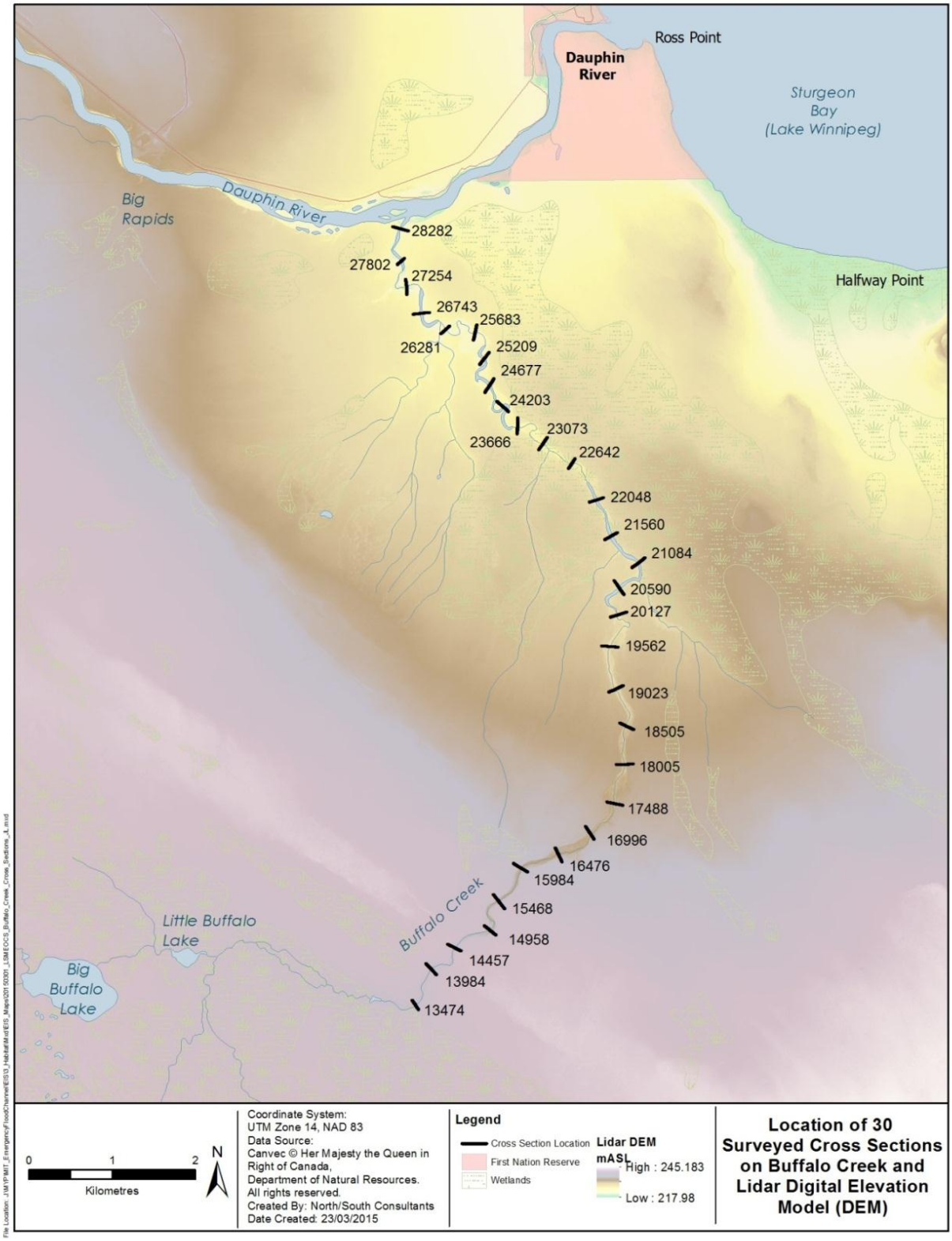


Figure 4.2-2. Location of HEC-RAS model cross sections.

The survey information was completed in Universal Transverse Mercator (UTM) NAD83 CSRS and NAD 83 Zone 14 projection and using the CGVD28 Datum for the determination of all orthometric heights for elevation datum. The survey was captured using Global Positioning System (GPS) Real Time Kinematic (RTK) style surveying and a total station. Geodetic project control benchmarks were established using a GNSS L1/L2 GPS receiver to collect the static data and static occupations on control networks were performed by L1/L2 dual constellation (GPS and GLONASS) receivers using post-processing procedures and confirmed using data from the Canadian Active Control System (CACS) available online. The absolute accuracy of the control networks are +/- 2.0 cm (horizontal) and +/- 2.0 cm (vertical) and the relative precision of each section is 0.01 m.

At section 21+560 and section 24+203, field conditions were such that the surveyed cross sections in 2013 could not follow the exact alignment of the 2011 survey. At those locations, new survey pins were installed, and the section alignment was re-established.

It should be noted that during both the 2011 and 2013 surveys, a layer of peat was present at the bottom of Buffalo Creek at many locations on either side of the riparian channel. Normal changes in the peat between survey events can result in slight differences when comparing cross sections.

The results of the cross section comparison are discussed in Section 4.4.4.

4.2.2.5 Dauphin River Bathymetry Survey

To help determine the effects of the Project on fish habitat or on navigation in the lower Dauphin River bathymetric surveys were conducted from slightly upstream of the confluence with Buffalo Creek to downstream into Sturgeon Bay. Bathymetric surveys of the entire Dauphin River were conducted in July 2011 (pre-operation), as well as of the lower Dauphin River in June 2012 (during operation), June/July 2013 and June 2014 (post closure of 2011/2012 operation).

Bathymetric surveys were conducted using a sonar device mounted on the rear of a boat. A Lowrance HDS-8 chartplotter computer was used to power and log sonar data from a dual transducer configuration using a survey grade narrow cone multi-beam sonar and a high frequency side scanner. The sonar point locations were referenced by linking the sonar unit to a survey grade Topcon Global Positioning System (GPS) RTK receiver. All controls established were set by completing a static GPS network for the entire project area and were referenced to known GPS 3D monuments set along PTH 6 from Lundar to Fairford and along PR 513. Survey data were typically collected along each river bank, the river centerline, and a crisscross pattern along the length of the Dauphin River where site conditions allowed.

2011 Survey Program

The 2011 survey program was undertaken along the Dauphin River during high flows occurring in the summer of the 2011 flood (July 1-4, 2011), prior to the operation of the Lake St. Martin Emergency Outlet Channel (Reach 1). The water condition along the Dauphin River was at bank full, the water surface elevation of Lake St. Martin at the Dauphin River inlet was at El. 245.1 m (804.1 ft) and the water

surface elevation of Lake Winnipeg at the mouth of Dauphin River was at El. 218.5 m (716.9 ft). The Dauphin River flow at the time of the survey was approximately 570 m³/s (20,100 cfs).

The 2011 bathymetry was completed from the inlet of the Dauphin River at Lake St. Martin to the mouth of the river at Lake Winnipeg, adjacent to the Dauphin River First Nation community. All rapids and natural water drops were fully submerged at the time of the bathymetric survey and a continuous survey was able to be conducted along the complete reach length. Access along the banks of the river was limited during the survey. Most of the banks could not be captured as unknown flow conditions were occurring at the river's edge, as well as the presence of trees and submerged vegetation.

2012 Survey Program

The 2012 survey program was undertaken along the Dauphin River from upstream of Buffalo Creek at Station 46+200 to the mouth of the river at Lake Winnipeg and including Sturgeon Bay. The survey occurred on June 18-20, 2012 during operation of Reach 1. The Dauphin River flow downstream of Buffalo Creek at the time of the survey was approximately 330 m³/s (11,700 cfs). The water surface elevation of Lake Winnipeg at the mouth of the Dauphin River at the time of the bathymetric survey was at El. 217.7 m (714.2 ft). The focus of the survey was to capture the river bottom to develop river bottom contours, profile and river cross-sections where possible.

2013 Survey Program

The 2013 survey program was undertaken along the Dauphin River from upstream of Buffalo Creek near Big Bend at Station 25+200 to the mouth of the river at Lake Winnipeg including Sturgeon Bay. The reach located upstream of the Buffalo Creek confluence was surveyed on June 5-7, while the reach downstream from the Buffalo Creek confluence to the Lake was surveyed on July 22-23. The purpose of this survey was to measure and record river bottom contours after the closure of Reach 1, which occurred in November of 2012. The water surface elevation of Lake Winnipeg at the mouth of the Dauphin River at the time of the bathymetric survey was at El. 217.9 m (714.9 ft). The Dauphin River flow downstream of Buffalo Creek at the time of the July 22-23 survey was approximately 300 m^3/s (10,700 cfs).

2014 Survey Program

The 2014 survey program was undertaken along the Dauphin River from upstream of Buffalo Creek at Station 46+200 to the mouth of the river at Lake Winnipeg and including Sturgeon Bay. The survey occurred on June 17-21, 2014 during operation of Reach 1. The Dauphin River flow at the time of the survey was approximately 330 m³/s (11,700 cfs). The water surface elevation of Lake Winnipeg at the mouth of the Dauphin River at the time of the bathymetric survey was at El. 218.0 m (715.2 ft).

4.2.2.6 Hydraulic and Sediment Transport Modeling

Numerical hydraulic and sediment transport models were developed to assess the conditions prior to, during and post-operation of Reach 1 System, as well as to evaluate the potential effects of the operations (2011/2012 and 2014/2015) on the erosion and sediment deposition processes in the study

area, including Reach 1, Buffalo Lake, Buffalo Creek, Dauphin River, and Lake Winnipeg. To complete this analysis, the following three models were developed:

- An **Empirical Model** was developed based on field measurements of TSS and turbidity and computed flows. The model included all reaches of the system.
- A one-dimensional (1D) **HEC-RAS Hydraulic and Sediment Transport Model** of Buffalo Creek was developed using surveyed cross sections of the creek. The results were compared to the empirical model results as well as the Buffalo Creek Vegetation and Cross Section surveys.
- A Two-Dimensional (2D) **Hydraulic and Sediment Transport Model of the Dauphin River**, using DHI's MIKE 21 Hydrodynamic Model (HD) and the Mike 21 Mud Transport Module (MTM), was developed to analyze flow patterns on the Dauphin River, and to identify areas of potential deposition and/or scour along the river downstream of Buffalo Creek and in Sturgeon Bay. The Dauphin River flow pattern and sediment transport analysis is documented in Section 4.5. The results of the 2D model were compared to the Dauphin River bathymetric surveys discussed in Section 4.5 as well as the results from the empirical and Buffalo Creek sediment transport models.

Empirical Model

To help quantify erosion through Reach 1, Buffalo Creek and the lower Dauphin River reaches of the Reach 1 System, an Empirical Model was developed as an Excel spreadsheet program. The model estimates cumulative volumes of suspended sediment being carried out of each reach (sediment inflow), and is indicative of the extent of erosion and sediment deposition of the smaller particles that occurred within each reach.

The empirical model combines measured TSS concentrations, computed average daily TSS concentrations from turbidity logger data, and estimated discharges to calculate a daily volume of suspended sediment at a given location. Sediment concentrations were based on actual TSS measurements taken at various locations in the Reach 1 System prior to, during and post 2011/2012 Operation and during 2014/2015 Operation, and computed average daily TSS using the turbidity data collected by the long-term *in situ* turbidity meters. Discharges along the system were estimated based on a combination of observations, measurements, flow records and computations.

The empirical model assumed an average soil density value of 1400 kg/m^3. The *in situ* or pre-excavation unit weight of the soil material within the channel is estimated to range between 2000 kg/m^3 and 2200 kg/m^3 based on observations and engineering judgment. The post-construction surface within the limits of the channel was disturbed from the excavation process, resulting in a loose and more exposed material that would be more vulnerable to riverine erosion than the *in situ* intact material. It is difficult to estimate a representative *in situ* density that would account for this disturbance; however, the unit weight that could be representative of this disturbed material is anticipated to be variable and in the range of 1100 to 1800 kg/m^3, based on previous experience and judgment. A sensitivity analysis was carried out to evaluate the potential impacts from this variability, and the selected value of 1400 kg/m^3 is believed to be conservative.

Two monitoring locations were selected for the analysis along each reach. One location was selected near or at the upstream end to capture "baseline" conditions prior to entering the reach. The second location was selected near the downstream end to capture "exit" conditions prior to exiting the reach. The net suspended sediment volume balance within a reach was assumed to be the difference in suspended sediment volume between exit conditions and baseline conditions. Figure 4.2-1 shows the location of these monitoring locations.

To estimate the actual effects of the operation of Reach 1, cumulative suspended volumes were also calculated using the daily flows computed for the Dauphin River and Buffalo Creek, if Reach 1 had not been operated. The flows in Dauphin River would have been greater than during the operation, therefore transporting a greater volume of suspended sediment originating from Lake St. Martin. The comparison of the cumulative volume with and without operation of Reach 1 is anticipated to provide the best estimate of the actual effects of the system at the exit of Buffalo Creek.

Reach 1

Baseline conditions in Reach 1 were based on TSS concentrations measured in Lake St. Martin (LSM1). During both operations of Reach 1 (2011/2012 and 2014/2015), it was assumed in the model that the TSS concentrations measured in the lake were representative of baseline conditions at the entrance of Reach 1. However, under normal conditions, the TSS concentrations measured in a standing body of water (i.e. Lake St. Martin) are generally lower than those in a moving body of water (i.e. Reach 1) and; therefore, this assumption was deemed conservative for this analysis.

Prior to January 17, 2012, TSS concentrations in Reach 1 were based on measurements taken at monitoring location EC1 that is situated near the midpoint between the Reach 1 inlet and Buffalo Lake bog. Data were not collected at the end of Reach 1 at monitoring location EC2 and EC3 until this date and, therefore, could not be used in the model. As a result, the net suspended sediment volume balance calculated in the model up to this point may not be completely indicative of what occurred throughout Reach 1 in 2011/2012. However, since Buffalo Creek is located downstream of Reach 1, any potential erosion or deposition occurring between monitoring location EC1 and EC2 would contribute to the baseline measurements on Buffalo Creek and is captured elsewhere in the model.

After January 17, 2012, exit conditions in Reach 1 were based on measurements taken at monitoring location EC2 that is situated at the end of Reach 1. Measured and estimated daily concentrations and the estimated balance of suspended sediment volumes after this date are therefore indicative of actual conditions in Reach 1.

Buffalo Creek

Prior to January 17, 2012, conditions near the upstream end of Buffalo Creek were based on measurements taken at monitoring location BC2, which is situated approximately 2 km downstream of the Buffalo Creek Inlet. Data were not continuously collected at monitoring location BC1 until this date and, therefore, could not be used to model conditions at the upstream end of Buffalo Creek. As a result, the net suspended sediment volume balance calculated in the model up to this point may not be

completely indicative of what occurred throughout Buffalo Creek. However, observation made after January 17, 2012 showed that conditions at BC2 were similar to those at BC1. As such, it was likely that conditions observed at BC2 were representative of baseline conditions in Buffalo Creek.

After January 17, 2012, conditions at the upstream end of Buffalo Creek were based on measurements taken at monitoring location BC1. Measured and estimated daily concentrations and estimated daily volumes after this date are indicative of actual conditions in the entire creek.

Exit conditions in Buffalo Creek were based on measurements taken at monitoring location BC3 and BC-TM. BC3 is situated on Buffalo Creek immediately upstream of the confluence with the Dauphin River, while BC-TM is situated an additional 2 km upstream of BC3 (to avoid the backwater effects of the Dauphin River for hydrometric data collection). BC-TM was used, once the turbidity meter was installed on May 14, 2013, because it provides a daily average value of TSS (based on Turbidity) rather than discrete sampling events and is representative of the exit of Buffalo Creek.

Dauphin River

Baseline conditions in the Dauphin River during and post operation of Reach 1 were based on measurements taken at monitoring location DR1 and DR-TM. DR1 was situated in the nearest accessible open water location on the south shore of the Dauphin River, approximately 500 m upstream of the confluence of Buffalo Creek and the Dauphin River (Figure 4.2-1). DR-TM is located on the north shore of the Dauphin River, approximately 200 m upstream of the confluence of Buffalo Creek and the Dauphin River. DR-TM was used, once the turbidity meter was installed on May 14, 2013, because it provides a daily average value of TSS (based on Turbidity) rather than discrete sampling events and is representative of the baseline conditions on the Dauphin River.

Exit conditions in the Dauphin River were based on measurements taken at monitoring location DR2, which was situated on the Dauphin River downstream of the confluence of Buffalo Creek and the Dauphin River.

HEC-RAS Sediment Transport Model of Buffalo Creek

A HEC-RAS V.4.1.0 from the US Army Corps of Engineers backwater model was developed to simulate the hydraulic conditions on the reach of river between Big Buffalo Lake and Dauphin River. Hydraulic parameters resulting from the HEC-RAS model were used in a theoretical analysis of the potential for erosion and sediment deposition along Buffalo Creek. A numerical Sediment Transport model of Buffalo Creek was also developed using the sediment transport subroutine in the program HEC-RAS.

Model Description

The geometry of the HEC-RAS model utilized cross sections obtained from a combination of LiDAR and surveyed cross sections prior to the 2011/2012 Operation of the channel. The surveyed cross sections were located approximately 500 m apart, as shown on Figure 4.2-2. Additional cross sections were interpolated at approximately 75 m intervals to improve the numerical stability of the model. Additional

cross sections were also added on the upstream end of the model to reach steady conditions outside of the study area.

A daily flow hydrograph of Buffalo Creek was used as upstream boundary condition for the HEC-RAS backwater model. A normal water depth of flow, based on a slope of 0.001, was applied as downstream boundary condition. A one day time-step was selected to optimize model stability and computational time.

Hydraulic Model Calibration

A Manning's 'n' value of 0.03 for the main channel and 0.08 for the overbank sections was selected based on knowledge of the channel characteristics and engineering judgment. Figure 4.2-3 shows the simulated water surface profile along with the 2014 surveyed water levels associated with a river flow of approximately 113 m³/s (4000 cfs). The comparison of the water surface profiles shows that there is good agreement between simulated and surveyed water levels, and that the selected channel roughness values are suitable for this application.

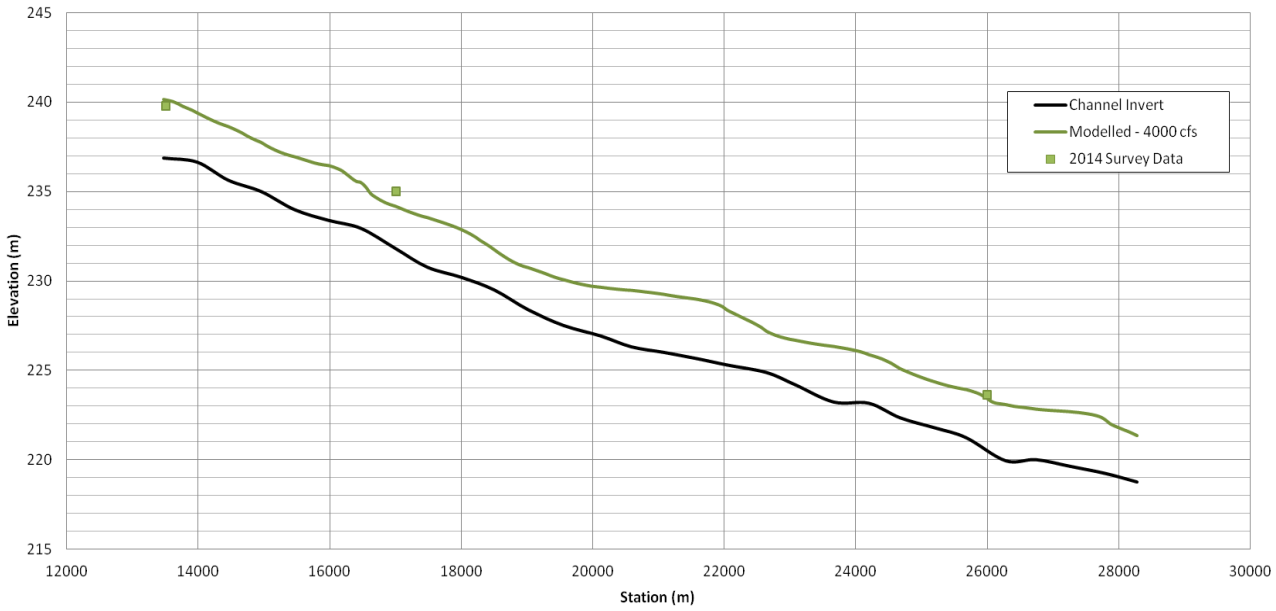


Figure 4.2-3. Simulated water surface profile for Buffalo Creek in 2014.

An analysis was completed to test the model's sensitivity to changes in channel roughness. The model was simulated for a range of channel and overbank roughness values smaller and greater than the selected values previously identified. The analysis indicated that although changes in channel roughness result in a notable change in water levels, resultant changes to velocities and shear stress were not sufficient to impact the results of the sediment transport analysis discussed in the subsequent sections of this report. Since the purpose of the model is to conduct a sediment transport analysis and define the

potential for erosion in Buffalo Creek, and not on defining water levels, further refinements to the model calibration was not necessary.

Theoretical Analysis of erosion and sediment deposition processes

The initiation of particle movement occurs when the shear stress in the channel exceeds the critical shear stress of the particle in place. The U.S. Geological Survey (USGS) has published theoretical critical shear values for a range of sediment grain sizes (USGS, 2008). The values used for this analysis are shown in Table 4.2-1.

Table 4.2-1. Critical shear stress for erosion.

Class	Diameter (mm)	Minimum Critical Shear Stress for Erosion (N/m^2)
Clay	0.002 - 0.005	-
Silt	0.005 - 0.075	0.03
Sand	0.075 - 4.75	0.11
Gravel	4.75 - 75	3.3
Cobble	75 - 250	64

Shear stress is a function of the river bed roughness, water depth and flow velocity. Therefore, potential for sediment erosion and deposition can also be determined by comparing flow velocities in the channel to critical velocities for erosion and deposition of particles, such as defined by Hjulstrom and provided on Figure 4.2-4. The Hjulstrom curve takes into account the cohesive properties of clay and silt particles, resulting in increasing critical erosion velocities with decreasing grain sizes for very small materials. However, as discussed previously, the clays and silts in Buffalo Creek are mostly non-cohesive in nature and will likely start eroding before sand and gravel particles. Therefore, Hjulstrom's critical erosion velocities for silts and clays were excluded from the analysis. Values from the Hjulstrom curve corresponding to the grain classes used for this analysis are shown in Table 4.2-2.

Minimum, median and maximum flows during the project phases were simulated with the HEC-RAS model with steady state conditions. Average shear stress and velocities obtain from the model results were compared to the critical values for deposition and erosion for each class of material. Results in the overbanks of the creek were analyzed separately from results in the main channel due to the wide range of expected values within a cross section. Results of the theoretical analysis of the potential for erosion and sediment deposition based on the Buffalo Creek HEC-RAS model are discussed in Section 4.4.

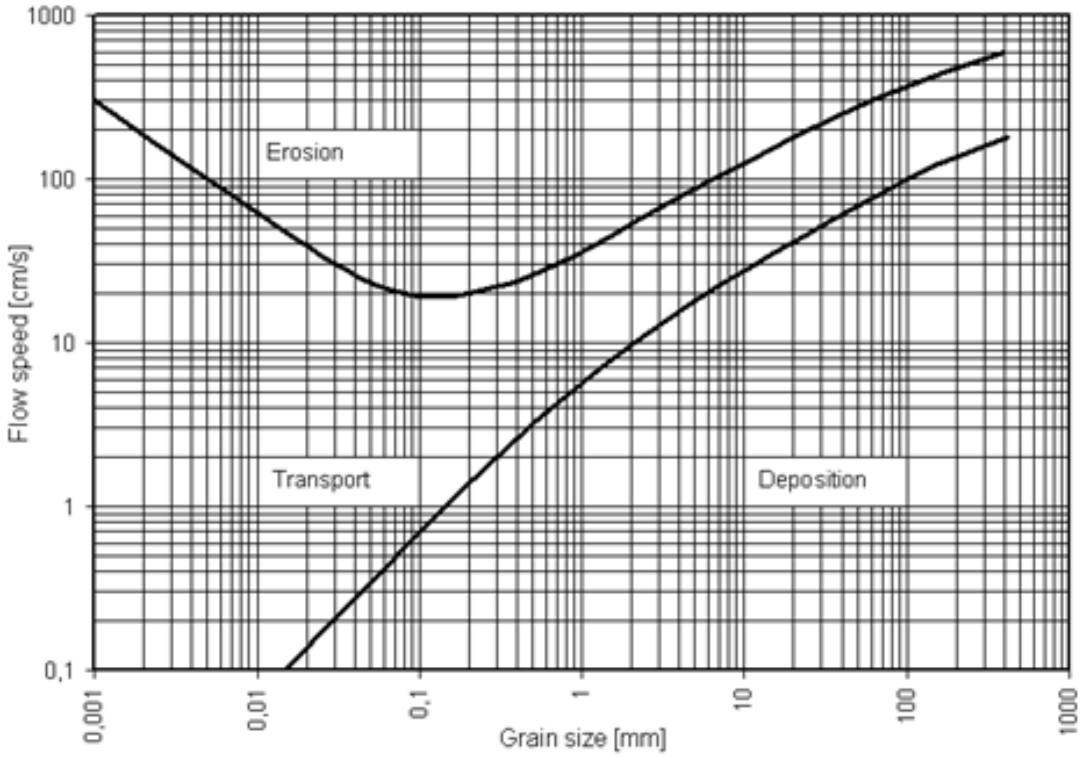


Figure 4.2-4. Hjulstrom curve.

Table 4.2-2. Critical velocity for deposition and erosion.

Class	Diameter (mm)	Maximum Critical Velocity for Deposition (m/s)	Minimum Critical Velocity for Erosion(m/s)
Clay	0.002 - 0.005	<0.001	-
Silt	0.005 - 0.075	0.005	-
Sand	0.075 - 4.75	0.18	0.2
Gravel	4.75 - 75	0.85	0.85
Cobble	75 - 250	1.5	3.2

2D Hydrodynamic Model

To study the changes to the physical environment and the possible subsequent effects to the biological environment in the Lower Dauphin River and Sturgeon Bay, a 2D hydrodynamic model was developed to numerically investigate the flow patterns in the Lower Dauphin River and identify areas with a potential for erosion and sediment deposition.

Model Description

The MIKE 21 software with Flexible Mesh (MIKE 21), developed by DHI Group in Denmark, is a two dimensional model simulating free surface flows. The model solves the depth-averaged 2D Navier-Stokes equations using a cell-centered finite volume solution technique to simulate flows in rivers, lakes, estuaries, bays, coastal areas, and overland flooding. MIKE 21 FM is a commercial software widely used in the industry in North America with many possible applications in river engineering.

The MIKE 21 model encompasses a reach of the Lower Dauphin River located between Station 47+800 (Upstream of Buffalo Creek) to Station 53+200 (in Sturgeon Bay) as shown in Figure 4.2-5. The digital elevation model (DEM) was built with data obtained from different sources. The bathymetry data in the Dauphin River and Lake Winnipeg were derived from the sonar survey data collected in 2011 and 2012. The topographic data outside of the river and the lake were obtained from the LiDAR data completed in June/July 2011. The integrated DEM for 2011 includes the river bathymetry data based on a sonar survey in 2011 and the LIDAR data completed in 2011. The DEM for 2012 was built based on the river bathymetry sonar survey in 2012 and the LIDAR data completed in 2011.



Figure 4.2-5. Extents of MIKE 21 model.

The computational mesh was diligently designed with a combination of quadrangular and triangular elements. The quadrangular mesh was only used in Buffalo Creek to adequately represent the narrow river channel, while the triangular mesh was applied to the rest of the study area. A refined mesh was used on Buffalo Creek, the Dauphin River and Sturgeon Bay. A coarser mesh was used in Lake Winnipeg away from shore.

Once the appropriate mesh sizing was established, the digital elevation data exported from the digital elevation model (DEM) were imported into the MIKE 21 model for mesh interpolation. Mesh interpolation is the process of draping the computational mesh onto the topographic and bathymetric data to assign the elevation data to the mesh. The mesh development incorporated the features captured in the DEM to facilitate the interpolation of the DEM to the mesh. The model geometry for the 2011 and 2012 MIKE 21 models were developed based on the DEM of the corresponding year. Figure 4.2-6 shows the mesh development and the location of model boundaries in the study area.

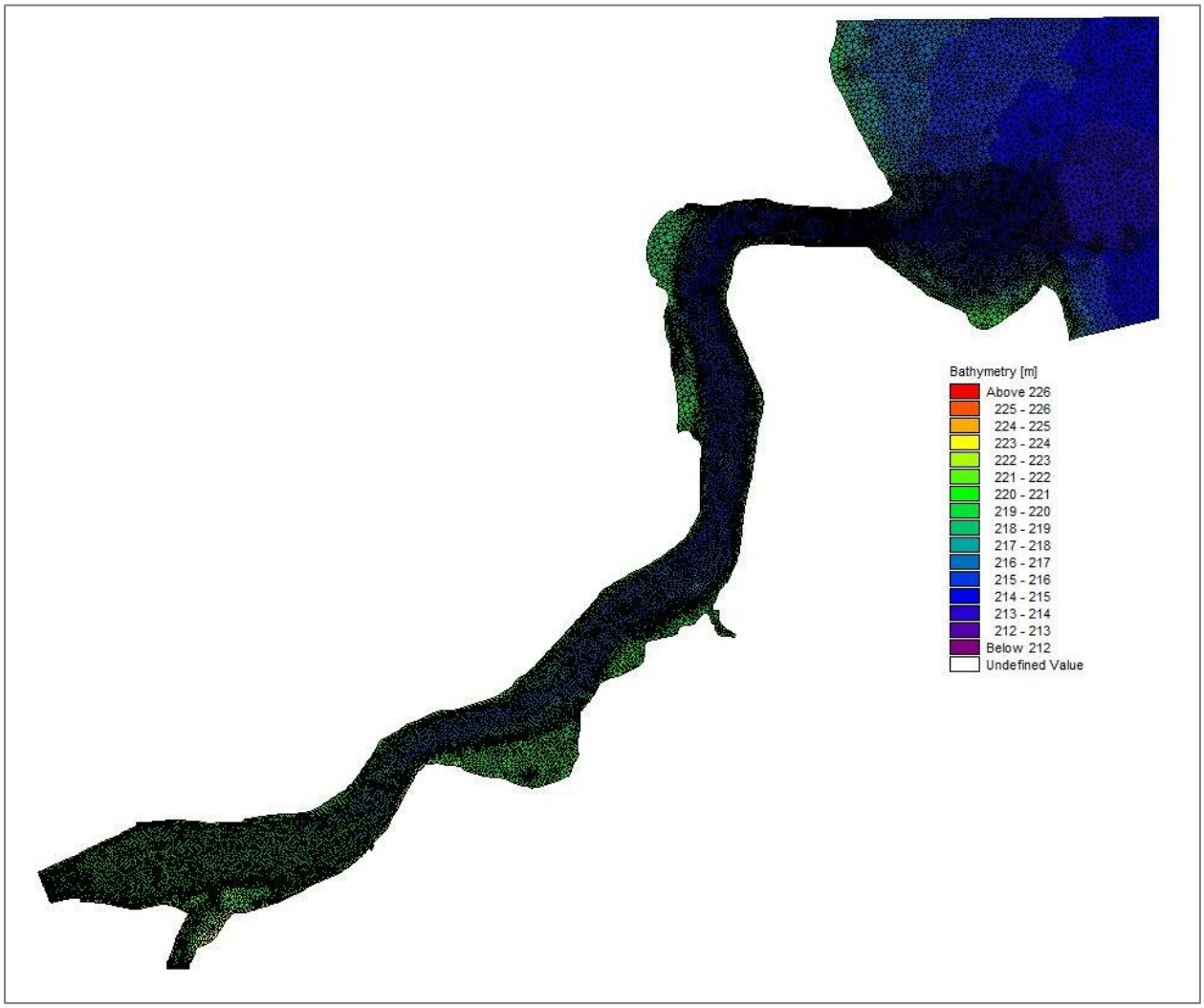


Figure 4.2-6. Computational mesh and boundary conditions of MIKE 21 model.

The upstream boundary conditions of the MIKE 21 model consisted of inflow hydrographs at the on Dauphin River and Buffalo Creek. A water level was applied at the downstream boundary of the model on Lake Winnipeg.

Model Calibration

The MIKE 21 model was calibrated to the hydraulic conditions observed during the summer of 2011 and 2012. The riverbed roughness coefficient (Manning's n) distribution in the model was adjusted in the study area to represent the July 2, 2011 and June 20, 2012 conditions, defined as follows:

July 2, 2011

- Dauphin River inflow of 568 m^3/s, as recorded at the WSC hydrometric Station 05LM006;
- Buffalo Creek inflow of 2 m^3/s, assumed in the absence of available data; and,
- Lake Winnipeg Water Level at El. 218.17 m (surveyed data).

June 20, 2012

- Dauphin River inflow of 215 m^3/s, as recorded at the WSC hydrometric Station 05LM006;
- Buffalo Creek inflow of 122 m^3/s, as computed with the routing model of Reach 1 System; and,
- Lake Winnipeg Water Level at El. 217.74 m (surveyed data).

Surveyed water levels on these dates were compared with the simulated water surface profiles from the MIKE 21 model with various roughness coefficients ranging from 0.016 to 0.020, as shown on Figures 4.2-7 and 4.2-8. The simulated water levels using a Manning's number of 0.018 were determined to give the best representation of the surveyed conditions in July 2011 and June 2012.

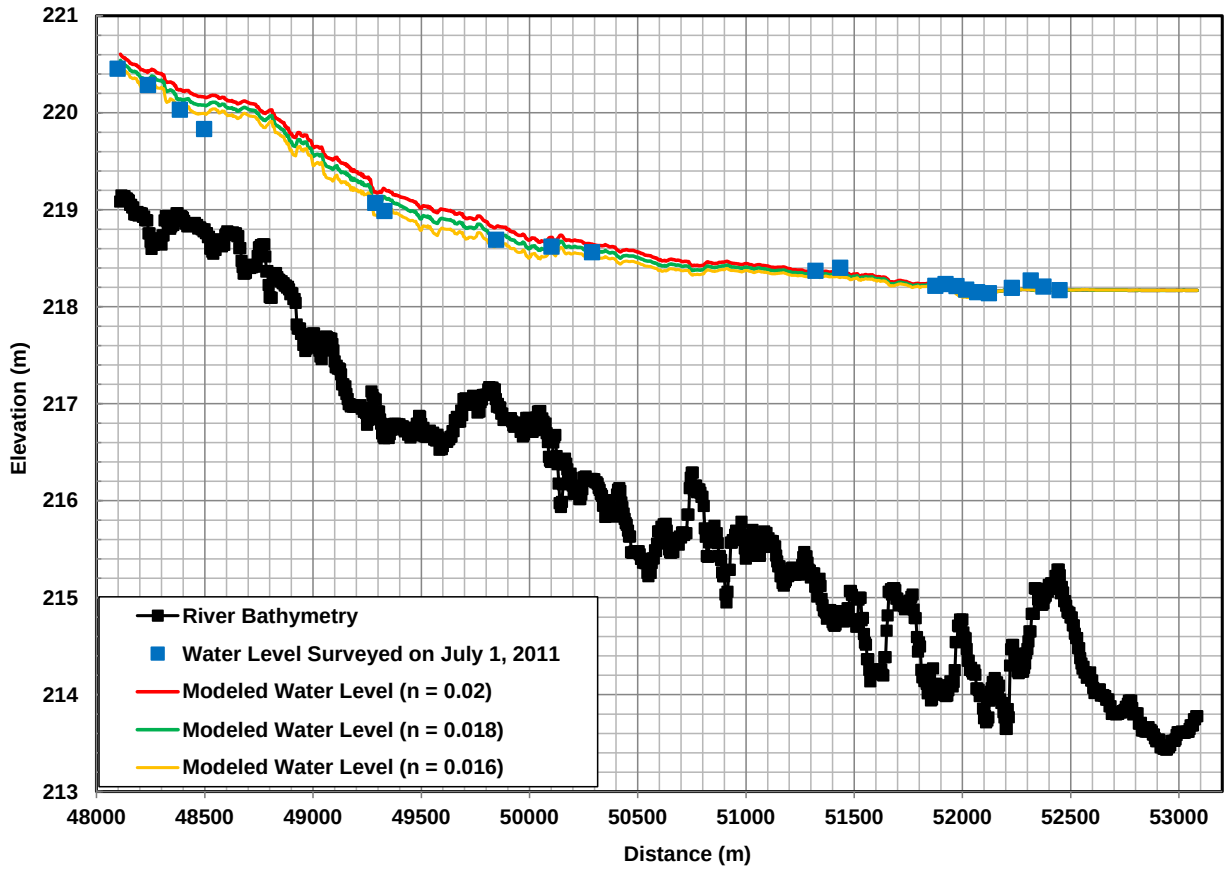


Figure 4.2-7. Computational mesh and boundary conditions of MIKE 21 model.

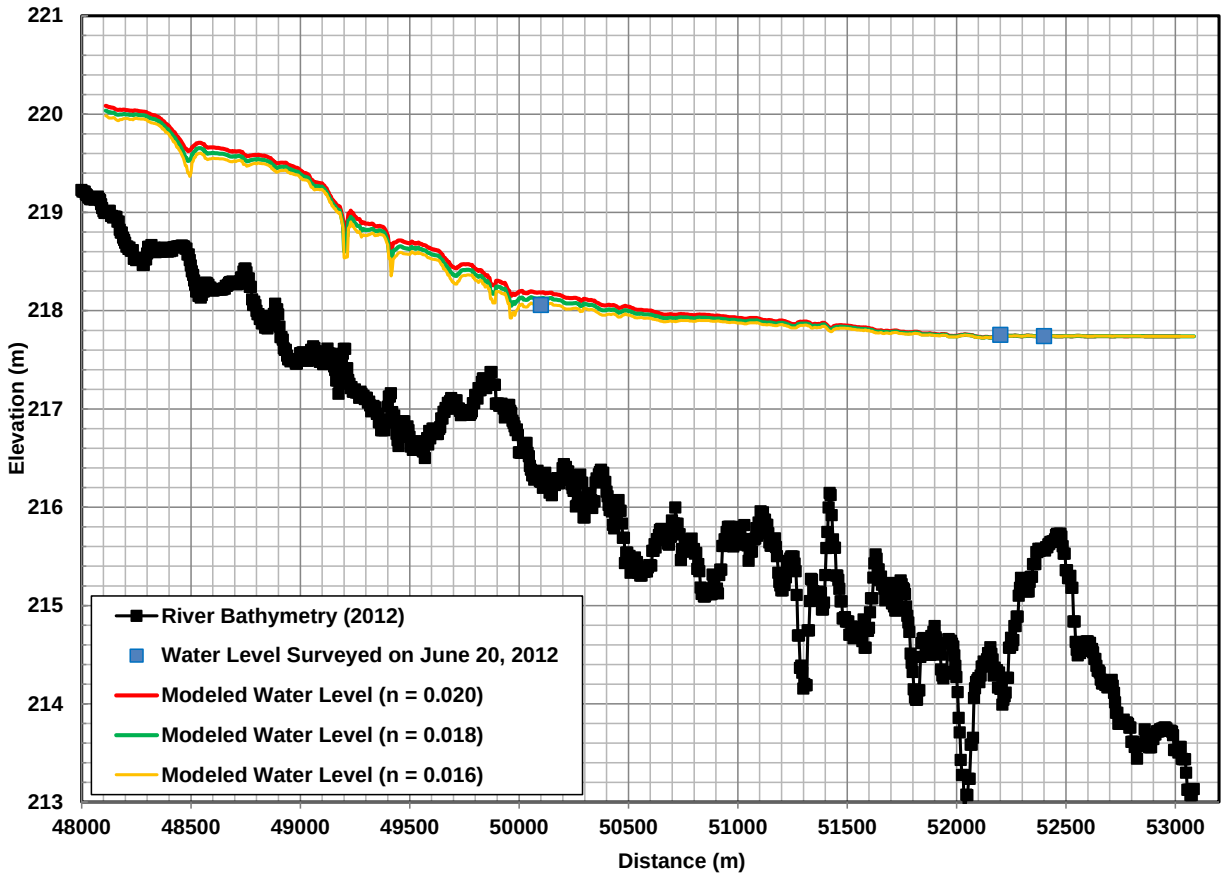


Figure 4.2-8. Computational mesh and boundary conditions of MIKE 21 model.

Ice covered conditions were also simulated with the MIKE 21 model. The calibration of the MIKE 21 model with presence of an ice cover was completed by adjusting the roughness coefficient of the ice-cover. The value of the ice-cover roughness coefficient can be defined as a variable dependant on its thickness.

The ice processes on the Dauphin River are fairly complex. The steep river slope existing on the Lower Dauphin River is prone to the formation of frazil ice pans which generally accumulate to form an ice dam. Upstream velocities are then reduced due to the backwater effect resulting from the presence of the ice dam, which helps the formation of a stable ice cover. When the ice dam reaches a certain height, the accumulated ice is pushed further downstream as a result of the difference in head across the ice dam, resulting in a decrease of the water level on its upstream side. In the middle of the winter, an ice cover is formed and the water levels in the river tend to stabilize.

Water levels were surveyed between November 20 and December 17, 2011 as well as January 6, 2012. The surveyed water levels reached a maximum on December 10, 2011 due to the accumulation of frazil ice, and then the river adjusted itself to relative stable water levels after December 15, 2011.

Calibration of the 2D model was done using a variable ice-cover roughness distribution computed from an independent 1D numerical ice model based on observed conditions as well as a uniform ice-cover with a constant thickness. The simulated water surface profiles obtained with both methods were compared with the water levels surveyed on December 7 and 16, 2011 with a Dauphin River flow of 446 m^3/s. A uniform ice cover of 0.65 m with a roughness of 0.038 was determined to achieve both numerical stability of the model and a good representation of the average ice conditions in winter on the Lower Dauphin River. A comparison of the simulated and surveyed water levels is shown in Figure 4.2-9.

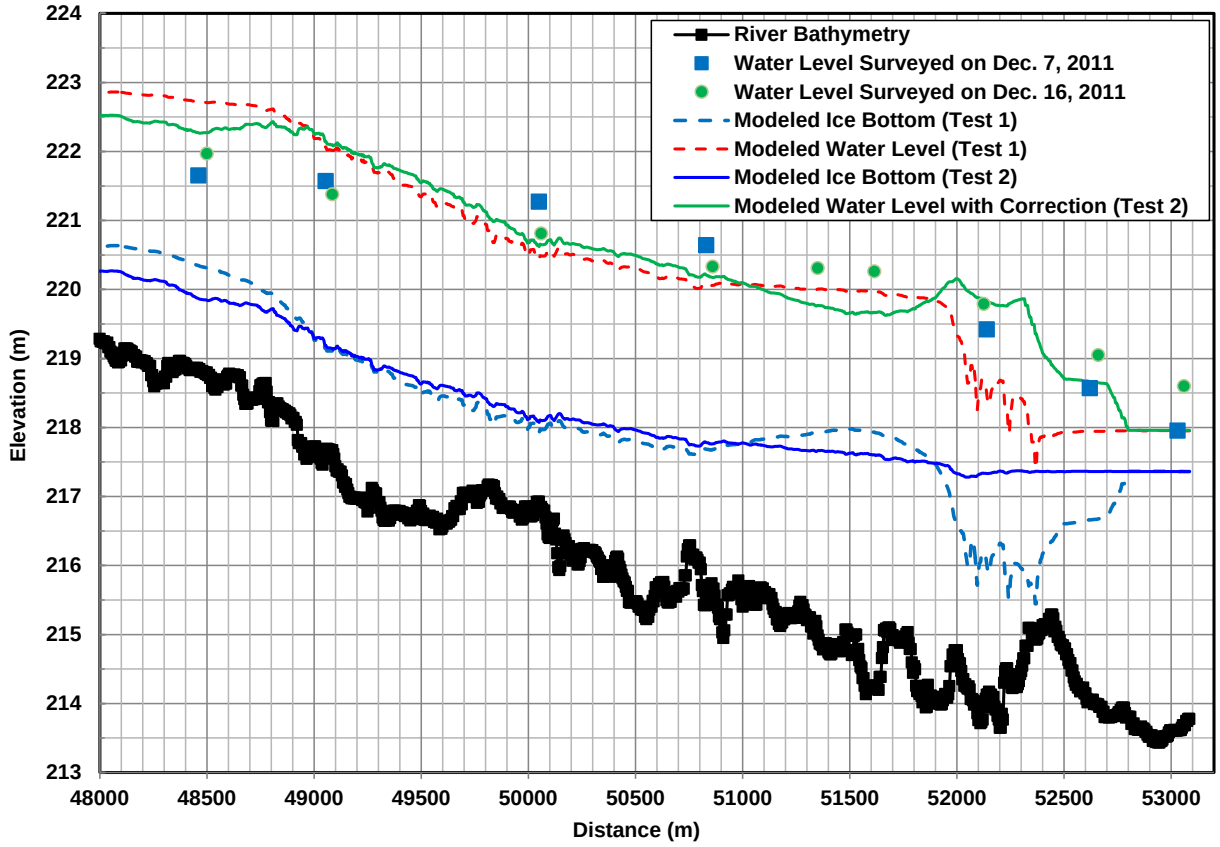


Figure 4.2-9. MIKE 21 model calibration for ice-covered conditions

Sediment Transport Analysis

A theoretical sediment transport analysis was carried out by comparison of the simulated velocities and critical velocities for erosion or sediment deposition for the different class of material present in the system.

Preliminary substrate surveys conducted by North/South Consultants in 2011 and 2013 indicate that the riverbed material downstream of Station 50+500 was comprised of areas of gravel and sand (called

sandy gravel hereafter). From Station 51+200 to Lake Winnipeg and into Sturgeon Bay, a high percentage of the substrate was gravel and sand. Upstream from Station 50+500 however, riverbed materials were comprised of more compact materials and contained cobble/gravel (called gravelly cobble hereafter), and boulder/cobble. After reviewing the background information (including the sample photos) and the USCS, the suggested gradation for "sandy gravel" is as follows:

- Gravel (64 – 2 mm): 45% - 60%
- Sand (2 – 0.063 mm): 30% - 25%
- Silt and Clay (less than 0.063 mm): 10% - 20%

The suggested gradation for "gravelly cobble" is as follows:

- Cobble (256 – 64 mm): 10% - 15%
- Gravel (64 – 2 mm): 40% - 50%
- Sand (2 – 0.063 mm): 15% - 20%
- Silt and Clay (less than 0.063 mm): 5% - 20%

Table 4.2-3 was developed based on the Hjulstrom curve (Figure 4.2-4) to assess the potential for erosion, transport or sediment deposition based on the critical velocity and grain size of the sediment.

Table 4.2-3. Critical velocity for deposition and erosion.

Class	Upper Limit of Grain Size (mm)	Maximum Critical Velocity for Deposition (m/s)	Minimum Critical Velocity for Erosion(m/s)
Silt/Clay	0.063	<0.005	0.2
Sand	2	0.1	0.5
Gravel	64	0.8	3.0
Cobble	256	1.5	5.1

The critical velocities were compared to the velocities simulated with the MIKE 21 model for flow a range of conditions representative of each project phase (5, 50 and 95 flow percentiles).

4.2.2.7 Sedimentation Rate

Sampling Periods

Sedimentation rates over eight different sampling periods (some of which overlapped) were measured in Sturgeon Bay, as follows:

- October 2011-August 2012 (open water to ice cover then back to open water);
- February-March 2012 (ice cover);
- March 2012-August 2012 (ice cover to open water);
- August-October 2012 (open water);

- October 2012-June 2013 (open water to ice cover then back to open water);
- January-April 2014 (ice cover);
- April-June 2014 (open water); and,
- June-October 2014 (open water).

The traps were set in transects that ran perpendicular to the southwest shore, beginning about 1.5 km from the shoreline and extending out as far as 10 km into the bay. Transects began in the vicinity of Hay Point and continued south to the mouth of Manatagao Bay.

Data Collection

Sediment traps consisted of three 0.5 m long plastic pipes with a 5.0 cm outer diameter (inner diameter of 4.68 cm), clamped together with cable ties. The bottom of each pipe was sealed. Foam was attached along the length of the trap to maintain the pipes upright in the water column. To anchor the trap, the bottom of the pipes was connected by a short rope to a cinder block. Effort was made to ensure that when the cinder block was lying flat, the length of rope attaching the block to the trap was such that bottom of the trap was suspended 30 cm above the lake bottom. Further buoyancy was provided by attaching a float to the top of the trap; this float also served to help in trap retrieval.

Configuration of the sediment trap assembly varied depending upon when the taps were to be emptied. Traps set in open water for subsequent retrieval during the same open water period were configured such that the float attached to the top of the trap was well below the water surface. A secondary anchor was attached to the trap anchor by a line at least 6 m long and a surface float was attached to the secondary anchor (see Figure 4.2-10). The trap was deployed by lowering the trap anchor and trap assembly (sediment trap and top float) to the bottom using the line connecting the secondary anchor to the trap anchor. The secondary anchor was then lower to the bottom using the surface float line. Effort was made to keep the line attaching the secondary and trap anchors taut so that the two anchors were as far apart as the line would allow. This was done to prevent the surface float line from tangling with the trap assembly during deployment.

Traps set in open water for deployment through the winter, or traps set through the ice for retrieval during open-water, were set similarly, except that a secondary anchor system was not used, there was no surface float, and the top float was at least 2 m below the water/ice surface. This was to prevent the trap from being moved around by ice during spring break up. Traps set and retrieved through the ice during winter were constructed in the same manner, except that a line attached to the top float was tied off to a pole on the surface of the ice.

At the time of deployment, the following information was recorded at each trap location:

- deployment date and time;
- location (UTM coordinates; recorded with a hand held GPS receiver);
- water depth (m); and,
- ice thickness (m; only for traps deployed in winter time).

Sediment traps were retrieved by one of three methods, as follows:

- Traps deployed in open water and retrieved during the same open water period were lifted to the water surface using the surface float;
- Traps deployed and retrieved during winter were lifted to the water surface using the attachment line connecting the trap to a pole frozen into the ice; and,
- Traps left in place during periods of ice cover (i.e., traps with a submerged top float) but retrieved in open water were first located with side scan sonar and then retrieved by divers.

During each method of retrieval, care was taken to avoid disturbing the sediments within the trap.

Upon retrieval, contents of the three plastic pipes comprising the trap were poured into a 4 L plastic container. The trap pipes were rinsed with water, which was also poured into the sample container. This process was repeated until the trap pipes were clean of sediment. Samples were labeled, the collection date and time were noted, and samples were kept refrigerated or frozen until delivery to the analytical laboratory. Samples were submitted to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. [CALA] accredited laboratory) for analysis of particle size, moisture content, dry weight, and organic content.

Data Analysis

Values that were less than the analytical detection limit (DL) were treated as equal to one half the DL for use in equations and calculation of means (e.g., < 1.0 g = 0.5 g). Dry weight and organic carbon content were used to calculate the inorganic dry weight for each sample using the following equation:

Inorganic Dry Weight (g) = Total Dry Weight (g) x (100 – Organic Carbon Content (%)/100)

For each trap, sedimentation rate was calculated using the following equation:

Sedimentation Rate (mg/cm^2/day) = Total Dry Weight (mg) / Area of Trap Opening (cm^2) / Length of Deployment (days)

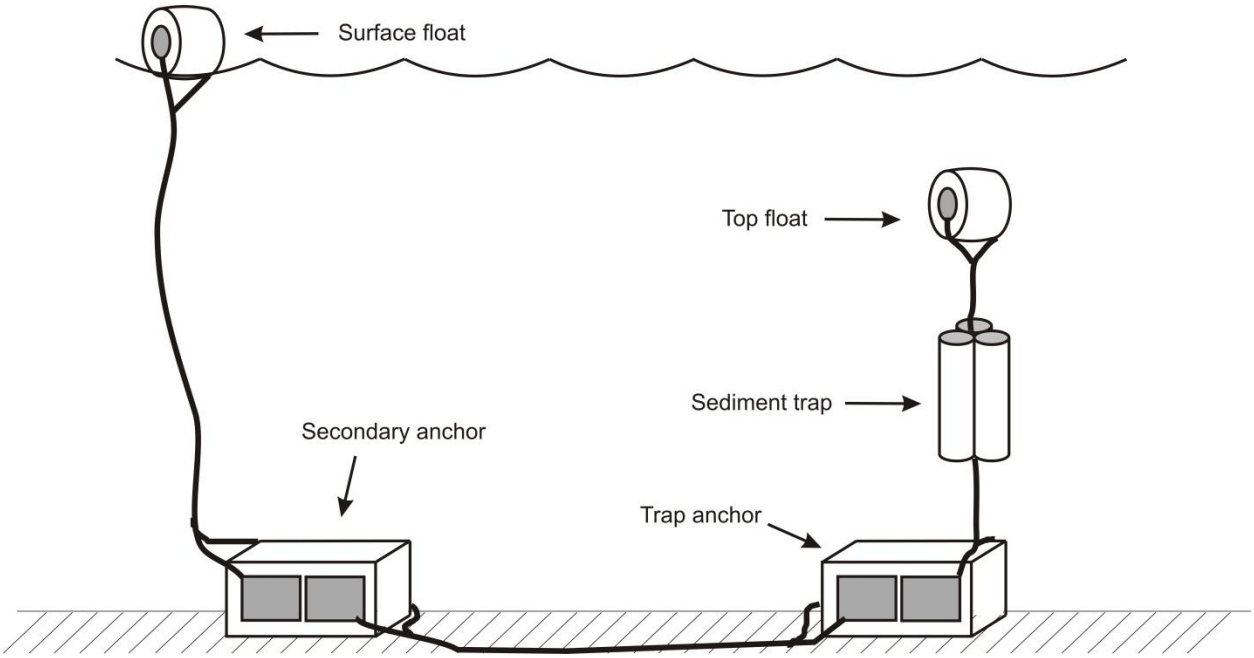


Figure 4.2-10. Sediment trap assembly.

4.3 LAKE ST. MARTIN MONITORING RESULTS

4.3.1 Lake St. Martin Water Levels

Historic water levels for the period of record from 1966 to 2010 on Lake St. Martin, that precede the 2011 flood conditions, are shown on Figure 4.3-1. The water levels are based on WSC data at gauge No. 05LM005 (Lake St. Martin near Hilbre). The 5th, 50th, and 95th percentile water levels of 242.7 m (796.4 ft), 243.3 m (798.4 ft), and 244.3 m (801.4 ft) respectively, for the period of 1966 to the fall of 2010, are shown on the graph. For comparison, the desirable range on Lake St. Martin is 242.9 m to 243.8 m (797 ft to 800 ft) and the flood stage was defined as 244.4 m (801.7 ft) in 2011.

As shown on Figure 4.3-1, the levels can vary by almost two meters within a given year. Inflows to Lake St. Martin are governed by the Fairford River Water Control Structure (FRWCS), which was first put into operation in 1961 and is located approximately 14km upstream of Lake St. Martin at the outlet of Lake Manitoba. Outflow from Lake St. Martin is naturally controlled by the Dauphin River. In the winter, ice conditions in the river restrict outflows on Lake St. Martin which generally causes an increase in water levels on the lake. For this reason, the FRWCS has historically been operated to limit inflows into Lake St. Martin during winter, and at the same time control water levels on the lake.

With the operation Reach 1, the FRWCS remained fully open during the winter of 2011/2012. Recorded water levels prior to, during, and following closure of Reach 1 are shown on Figure 4.3-2. The figure also illustrates the estimated water levels that would have occurred on Lake St. Martin without operation of Reach 1, assuming that the FRWCS would have remained fully opened throughout the period.

As shown on Figure 4.3-2, operation of Reach 1 was successful in lowering the water levels on Lake St. Martin by on average 0.6 m, and as much as 1m at the peak of the winter ice conditions during the winter of 2011/2012. With the Reach 1 in operation, water levels on the lake returned below the 95th percentile value as well as the flood stage value of 244.4m (801.7ft) about 6 months sooner than what is predicted to have occurred in the absence of Reach 1 operation.

4.3.2 Ice Processes

A solid ice cover typically forms on Lake St. Martin in the month of November and remains until the following spring break-up in April/May. Operation of Reach 1 does not change the ice processes in Lake St. Martin, with exception of at the inlet of Reach 1. During the 2011/2012 Operation, open water remained at the inlet of Reach 1 throughout the winter and extended approximately 400 m upstream of the inlet. Similar conditions were observed during the 2014/2015 Operation. During the 2011/2012 closure period, the inlet area remained ice covered, which is consistent with historic conditions at this location.

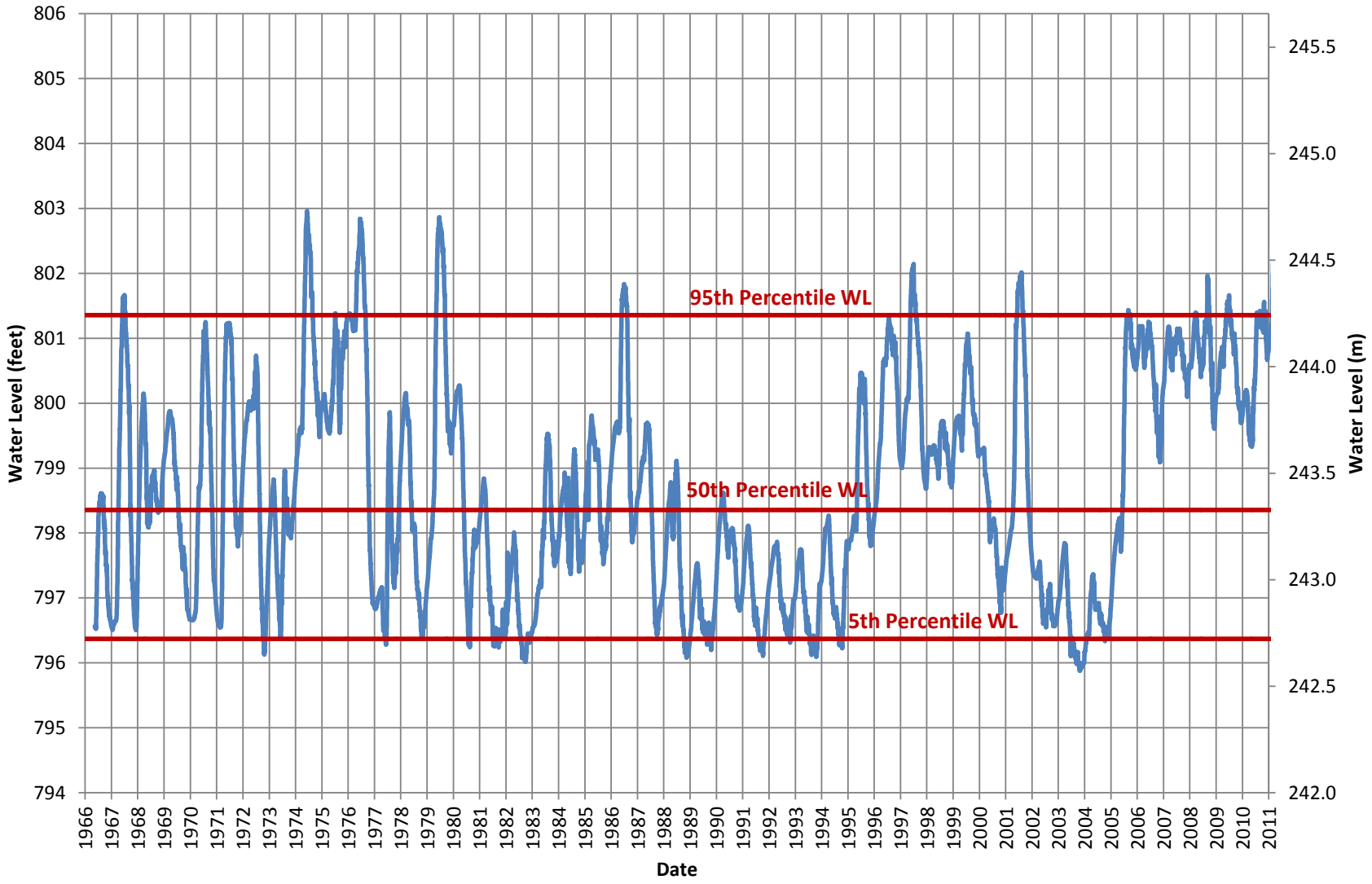


Figure 4.3-1. Historic Lake St. Martin Water Levels – 1966 to 2010.

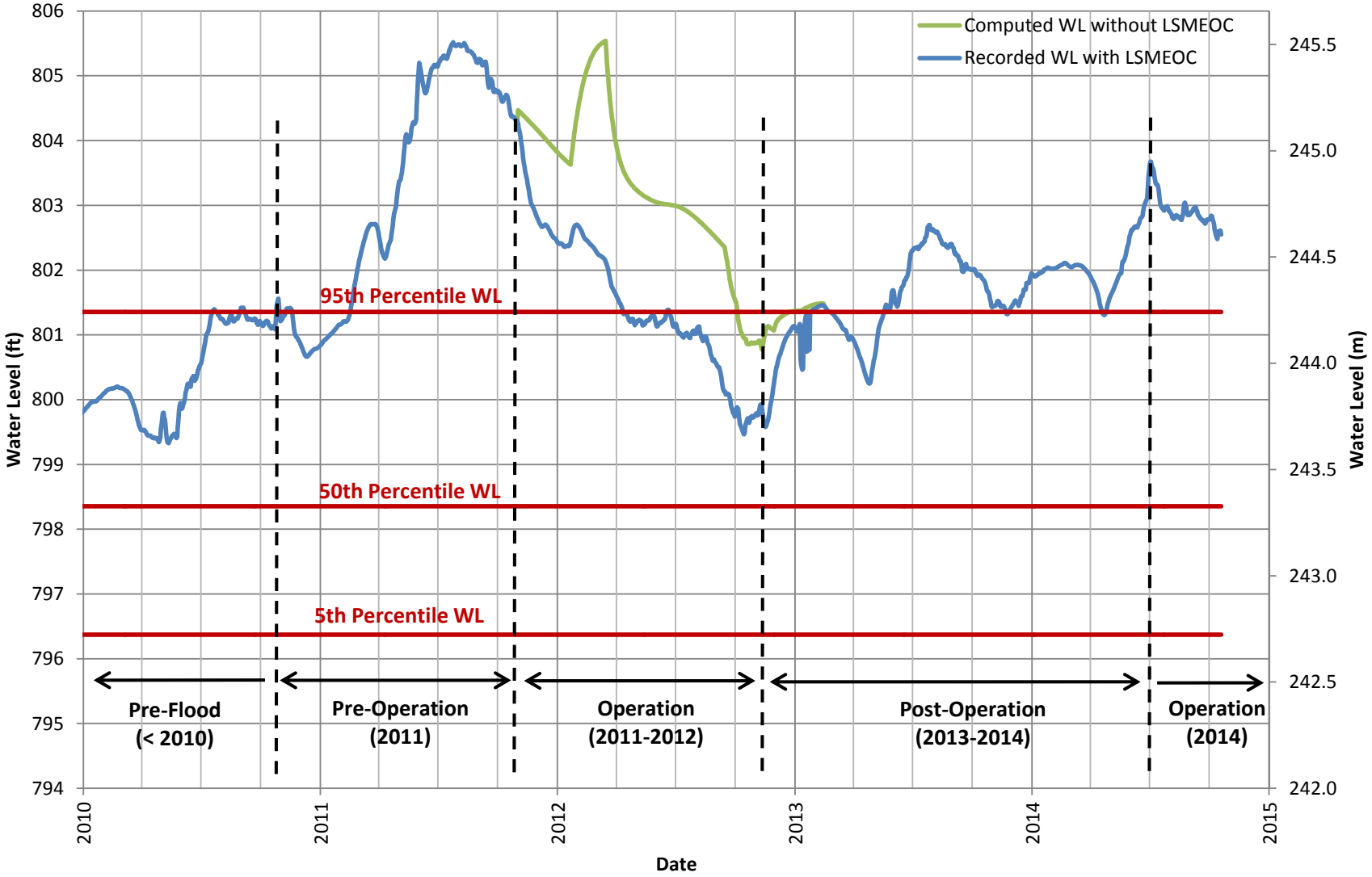


Figure 4.3-2. Lake St. Martin Water Levels with and without Reach 1.

4.4 REACH 1 AND BUFFALO CREEK WATERSHED MONITORING RESULTS

4.4.1 Flow

The water level records and hydrometric surveys carried out on Reach 1 and Buffalo Creek were compiled to compute hydrographs for the entire period of record. Rating curves were developed at each site from the surveyed water level and flow metering data, to convert the series of instantaneous water levels into a flow record. Figure 4.4-1 shows the computed flows at the EC1 monitoring station on Reach 1, along with the discharge measurements collected since 2011. The flows measured at Reach 1 during operation or at the BC-TM monitoring station on Buffalo Creek are considered representative of the entire Reach 1 and Buffalo Creek Watershed (Figure 4.4-2). The storage effect from Buffalo Lake and the local component of the inflow were not considered in this analysis, therefore, the computed flows for Buffalo Creek and Reach 1 are assumed to be identical.

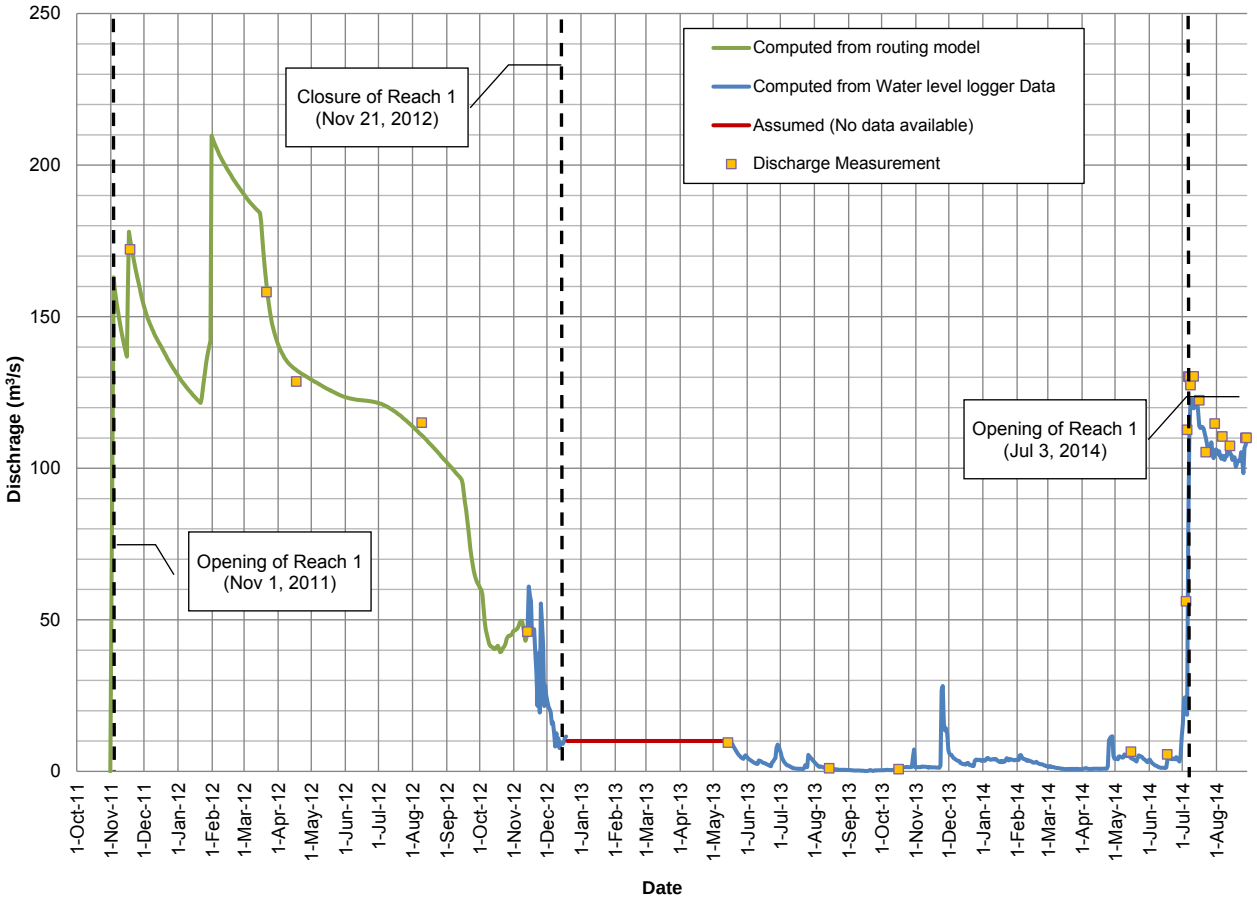


Figure 4.4-1. Buffalo Creek Discharge.

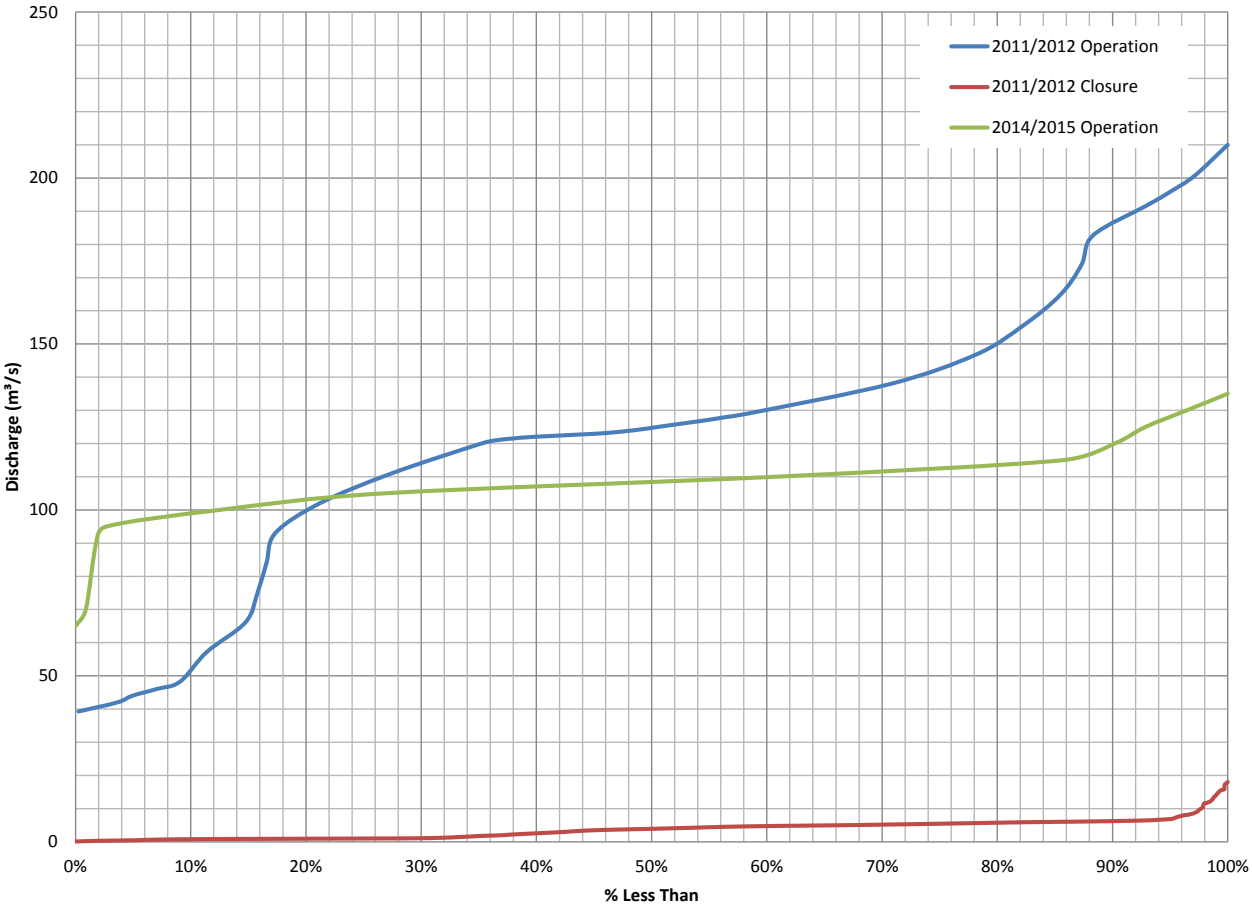


Figure 4.4-2. Duration curves of daily flows for the Reach 1 and Buffalo Creek watershed.

The standard 5, 50 and 95 percentiles flows utilized in the habitat assessment were derived from the duration curves of daily flows computed from the flow records at both sites. Table 4.4-1 summarizes these flow conditions for each project phase. It should be noted that the duration curve for the 2014/2015 operation period was computed based on a shorter time period since the channel was still in operation at the time of the analysis, and is based on the flows measured between July 3, 2014 to October 22, 2014.

Table 4.4-1. Modelled discharge (as 5th, 50th, and 95th percentiles) for Reach 1 and Buffalo Creek during each project phase.

Flow Percentile (%)	2011/2012 Operation (m³/s)	2011/2012 Closure (m³/s)	2014/2015 Operation (m³/s)
5	44	0.5	97
50	125	3.9	109
95	196	6.9	128

4.4.2 TSS/Turbidity Data

Time series of TSS were computed for Reach 1 and Buffalo Creek from the turbidity records and the TSS data collected between 2011 and 2014. These computed concentrations used in conjunction with the computed flows for the corresponding period in the empirical model. Figures 4.4-3 and 4.4-4 show the times series of computed TSS on Reach 1 and Buffalo Creek, respectively.

During the 2011/2012 period, the TSS at the upstream end of Reach 1 (baseline in Lake St Martin) ranged from less than 5 mg/L up to almost 75 mg/L in September of 2012. During this period, the TSS at the exit of Reach 1 was always slightly greater than the baseline, except between March and May 2012, when it was almost double the baseline as it exceeded 25 mg/L. The maximum TSS concentration at the exit of Reach 1 was calculated at 95 mg/L. The difference that existed between the baseline and the exit of the channel suggested that sediment particles entered the system due to riverine erosion or due to sediment inflow from local run-off, and were transported in suspension to the outlet of Reach 1.

After closure of Reach 1 on November 21, 2012, the TSS at the exit of Reach 1 remained greater than the baseline until October 2013, possibly due to rainfall and erosion along the side slopes of the channel. In the absence of instantaneous data from turbidity loggers, the daily TSS concentration was interpolated between discrete TSS samples. While this method is adequate for a cumulative calculation of the total volume of suspended sediment, this may not have captured instantaneous peaks in TSS resulting from meteorological events.

A peak of TSS was observed following the opening of Reach 1 on July 3, 2014, where the TSS exceeded 175 mg/L. The increase in TSS was very brief and likely associated with the re-operation of Reach 1 and the flushing of smaller particles of sediment that would have settled in the standing water in Reach 1 during the closure period.

In Buffalo Creek, the TSS computed at the exit of the creek is always greater than the baseline, suggesting that erosion occurs in this reach. During the closure period in the summer of 2013, the TSS concentrations at the exit of the creek reached a maximum of 210 mg/L. These brief and local increases appear to be resulting from rainfall events and the run-off contribution from the local watershed. Additionally, erosion of the material displaced during the 2011/2012 Operation could have also contributed to the high TSS concentrations.

As for Reach 1, a peak of TSS was also observed following the initial operation on July 3, 2014, where the TSS exceeded 200 mg/L. The increase in TSS was very brief and likely associated with flushing of smaller sediment particles that would have settled in the standing water in Reach 1 during the closure period, and the loose till material along the side slopes of the channel that had eroded over time since closure of the 2011/2012 Operation.

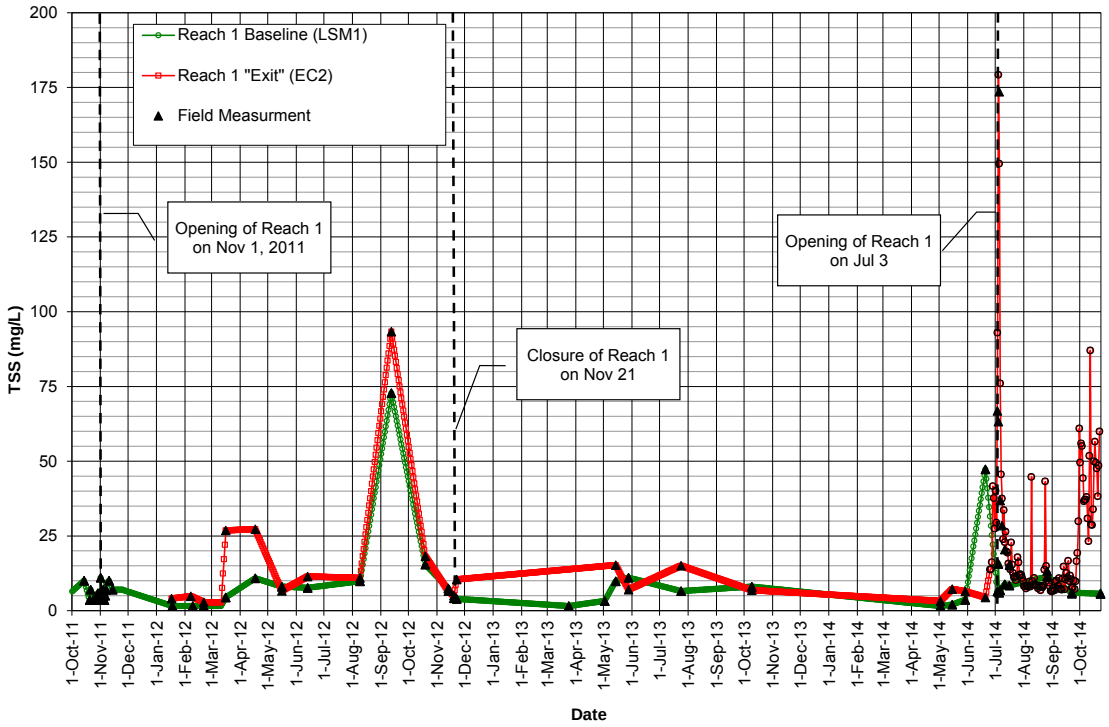


Figure 4.4-3. Times series of computed total suspended solids in Reach 1.

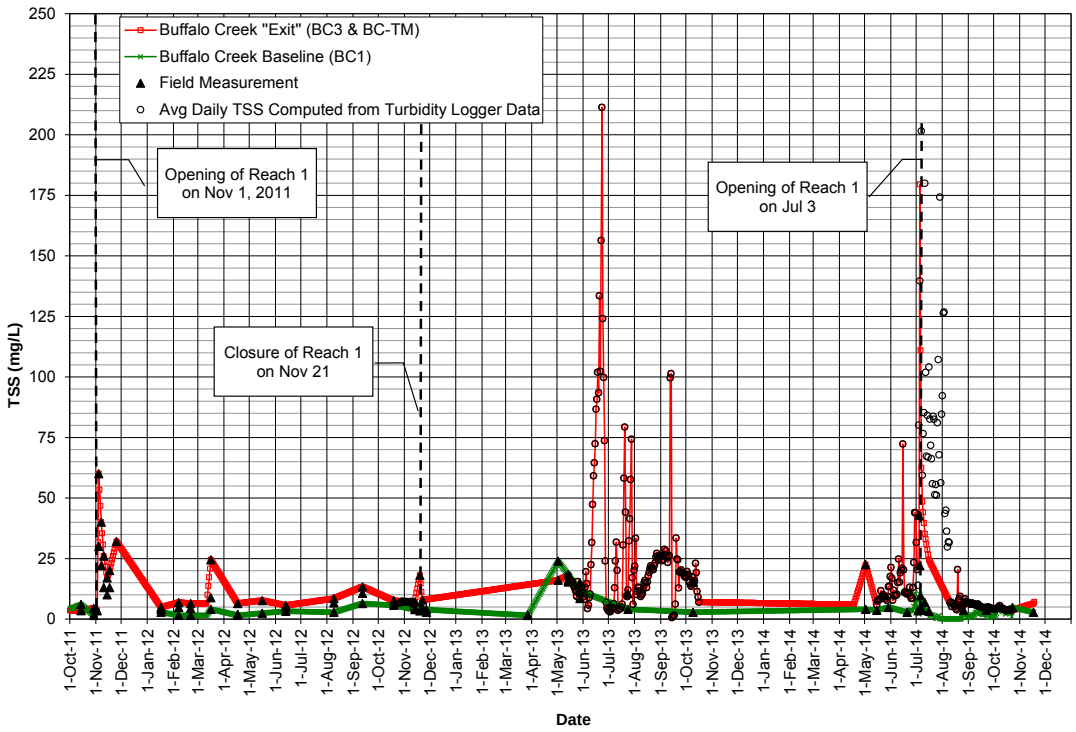


Figure 4.4-4. Times series of computed total suspended solids in Buffalo Creek.

4.4.3 Buffalo Creek Vegetation Cover Survey

In general, the 2011 survey showed full and dense vegetation coverage within the study area. Transects were composed of thick grasses adjacent to the creek which transitioned to dense shrubs followed by trees further from the creek. Few bare patches and no signs of erosion were noted. Numerous beaver dams were present along the length of the creek resulting in inundation of several transects. Following 2011-2012 Operation of Reach 1, the July 2013 survey showed extensive bare areas along the entire length of the creek. At the upstream reaches (stations13+000 to 19+500) most of the bare soil was organic in nature. Many shrubs were also dead. Larger trees were generally located further from the creek bank and appeared relatively healthy. The impact area from the high water levels appears to be narrowest between stations 13+500 and 16+000. Further downstream (stations 19+500 to 28+000), trees were often closer to the creek. High water reached deep into the trees resulting in large areas of dead mature trees. This is particularly evident when 2011 GAIM imagery is compared against 2013 GAIM imagery (see Figure 2 in Appendix 4.A). The vegetation impact zone represents areas where dead vegetation is present along the length of the creek. The understory beneath these trees was largely bare. Concentrations of debris (branches, trees) had accumulated at several locations (e.g. 19+500). Some trees near the creek had fallen over. Numerous areas of erosion and deposition were present, with much of the organic soil covered with variable depths of inorganic soils (silt, sand, gravel, cobble). Bank failures resulting in steep banks and slumping organic and inorganic soils, were also observed at several transects in 2013. There were no beaver dams along the creek in 2013. During the June 2014 survey, thick grass had begun to re-establish at the majority of bare areas. Few of the shrubs and trees that appeared dead in 2013 recovered. Conversely, large stands of trees that, in 2013, appeared were to have survived inundation, were visually dead or extremely stressed when observed during the follow-up survey in 2014; specifically along transects at stations 20+500 to 22+500. In 2014, areas with deposition of sand, gravel and cobble remained largely free of vegetation, while areas with deposited silt had much more vegetation. Beaver activity including several beaver dams were observed in 2014.

4.4.4 Cross Section Surveys

As indicated in Section 4.3.1.3, 30 cross sections were surveyed along Buffalo Creek in 2011 and 2013. The purpose of these surveys was to compare pre and post operating conditions in Buffalo Creek. Comparisons of the 2013 cross sections (post 2011/2012 Reach 1 Operation) to the 2011 cross sections (Pre 2011/2012 Reach 1 Operation) are provided in Appendix 4.B.

The results of the comparison show that erosion has occurred in Buffalo Creek almost along the entire reach. Typically, the erosion occurred within the main channel, generally making it 5 to 10 meters wider and 0.3m deeper on average. There were a few localized areas that showed deposition of material. These were generally located in the overbanks, immediately adjacent to the main channel, and field observations indicated that the material deposited usually consisted of gravels and cobbles.

Based on the 2011 and 2013 survey comparison, the total in-situ volume of material that was eroded from the channel was estimated to be approximately 86,500 m^3. This volume represents the amount of material displaced within the reach, between the outlet of Buffalo Lake and the confluence with Dauphin River. From the cross section comparison and vegetation survey, it is apparent that some of this

material has deposited within the Buffalo Creek reach, and only a portion of this total volume is assumed to leave Buffalo Creek and enter the Dauphin River. This quantity is considered to be very approximate since interpolation is necessary between the cross sections which were approximately 500m apart, and it was assumed that each cross section is representative of conditions in the channel upstream and downstream. In reality, observations of conditions in the channel show that the magnitude of erosion changes more frequently than at the 500m intervals between sections. As such, the 86,500 m^3 should be used for comparison purposes only, and in conjunction with other results and modeling presented in this report.

4.4.5 Ice processes

In Buffalo Creek, the ice conditions prior to the 2011/2012 Operation of Reach 1 were not documented. However, based on the observations made during the 2011/2012 closure, it is anticipated that a solid ice cover would naturally form on the creek. Depending on the severity of the winter, some residual latent heat present in the water (mostly originating from the Buffalo Bog Lake) may not allow the formation of a complete and solid ice cover.

During the 2011/2012 Operation, the velocities in Reach 1 were on average 1.0 m/s. Some border ice was present, but no solid ice cover formed during the winter. Production of frazil ice was observed in the channel. The Buffalo Bog Lake was mostly covered, with some open water in the main flow paths. The flow velocities in Buffalo Creek were approaching 2.0 m/s for the 95th percentile flow and were greater than 1.5 m/s on average. Some border ice was present but the creek was mostly open, with the exception of a small reach where an ice jam formed after large pieces of border ice were dislodged from the shore. Production of frazil ice was also observed in Buffalo Creek.

During the 2011/2012 closure, Reach 1 and the Buffalo Bog Lake were covered. Some open water areas remained in the bog, but to a lesser extent than during operation. Buffalo Creek was mostly ice covered.

Limited data are available for the 2014/2015 Operation period. The flows are similar in magnitude to the 2011/2012 Operation, suggesting that Reach 1 and Buffalo Creek would remain open. Some border ice was observed along Reach 1, with presence of frazil ice. An ice cover has also been observed at the Buffalo Creek outlet into Dauphin River, which is contrary to what occurred in 2011/2012.

4.4.6 Hydraulic and Sediment Transport Modeling

4.4.6.1 Empirical Model Results

To help quantify erosion through the Reach 1 System to the confluence between Buffalo Creek and Dauphin River, an Empirical Model was developed as an Excel spreadsheet program. The model estimates cumulative volumes of suspended sediment being carried out of each reach (sediment inflow), and is indicative of the extent of erosion and sediment deposition of the smaller particles that occurred within each reach.

Properties of the Buffalo Creek bed material defined in the model were based on substrate surveys conducted in September 2011 along the channel overbanks. The grain size distribution of the material

that was used for the analysis is shown on Table 4.4-2. The class and diameter size of the material shown in the table were defined by the laboratory where the substrate material was tested, and were adopted for the Buffalo Creek analysis.

Table 4.4-2. Grain size distribution of Buffalo Creek substrate.

Class	Diameter (mm)	% Finer
Clay	0.002 - 0.005	49.1
Silt	0.005 - 0.075	69.9
Sand	0.075 - 4.75	93.3
Gravel	4.75 - 75	99.3
Cobble	75 - 250	100

The sediment load inflow referenced in Figure 4.4-4 was combined with a grain size distribution based on laboratory results of suspended solids from two water samples collected on January 17, 2012 on Buffalo Creek and on Dauphin River. The grain size distribution of the suspended solids is summarized in Table 4.4-3.

Table 4.4-3. Grain size distribution of suspended solids.

Class	Diameter (mm)	% Finer
Clay	0.002 - 0.005	16
Silt	0.005 - 0.075	93
Sand	0.075 - 4.75	100
Gravel	4.75 - 75	100
Cobble	75 - 250	100

2011/2012 Operation

Tables 4.4-4 to 4.4-7 present the suspended sediment volume balance computed with the empirical model for the 2011/2012 Operation for each one of the reaches between Lake St. Martin and the Exit of Buffalo Creek. The general trend is for sediment originating from Lake St. Martin and the sediment eroded along Reach 1 to deposit in Buffalo Lake Bog. Erosion and sediment transport resume along Buffalo Creek with higher velocities resulting from the operation of Reach 1. The total cumulative volume of suspended sediment released at the exit of Buffalo Creek is estimated at approximately 34,400 m^3. The total volume of sediment calculated at the inlet of Reach 1 is estimated at approximately 30,900 m^3, which constitutes a net balance of 3,500 m^3 at the outlet of Buffalo Creek.

As described in Section 4.5, the combined cumulative volume of suspended sediment downstream of the confluence with the Dauphin River during operation is estimated at 82,200 m³. Without operation of Reach 1, this volume is estimated at 73,300 m³ of suspended sediment, which represents an increase of 8,900 m³ that could be attributed to the operation of Reach 1.

Table 4.4-4. Suspended sediment volume balance in Reach 1 during the 2011/2012 Operation (Nov. 1, 2011 to Nov 21, 2012).

Description	Cumulative Sediment Volume (m³)
Baseline	30,900
Channel or "Exit"	58,000
Net Total	27,100

Table 4.4-5. Suspended sediment volume balance in the Buffalo Lake Bog during the 2011/2012 Operation (Nov. 1, 2011 to Nov 21, 2012).

Description	Cumulative Sediment Volume (m³)
Reach 1 Channel or "Exit"	58,000
Buffalo Creek baseline or near Entrance	17,000
Net Total	-41,100

Table 4.4-6. Suspended sediment volume balance in Buffalo Creek during the 2011/2012 Operation (Nov. 1, 2011 to Nov 21, 2012).

Description	Cumulative Sediment Volume (m³)
Baseline or near Entrance	17,000
Exit	34,400
Net Total	17,400

Table 4.4-7. Suspended sediment volume balance in the Reach 1 System from Entrance of Reach 1 to Exit of Buffalo Creek during the 2011/2012 Operation (Nov. 1, 2011 to Nov 21, 2012).

Description	Cumulative Sediment Volume (m³)
Reach 1 Baseline	30,900
Buffalo Creek Exit	34,400
Net Total	3,500

2011/2012 Closure

Following closure of Reach 1 in November 2012, the only sources of inflow to the system was local inflow to the Buffalo Creek watershed downstream of Reach 1 combined with the natural drainage of the Buffalo Lake. According to the empirical model results, sediment transport still occurred after closure of Reach 1 (Table 4.4-8). The additional suspended sediment eroded from the system could result from bank slumping and local erosion following recession of the flows and water levels in Buffalo Creek, combined with natural sediment transport processes occurring along Buffalo Creek and unrelated to the past operation of Reach 1. The total cumulative volume of suspended sediment released at the exit of Buffalo Creek is estimated at approximately 2,600 m^3. The total volume of sediment calculated at the inlet of Reach 1 is estimated at approximately 1,100 m^3, which constitutes a net balance of 1,500 m^3.

As discussed in Section 4.5, the combined cumulative volume of suspended sediment downstream of the confluence with the Dauphin River during operation is estimated at 74,800 m^3. Without operation of Reach 1, this volume is estimated at 72,600 m^3 of suspended sediment, which represents an increase of 2,200 m^3 that could be attributed to the operation.

The total combined volume of suspended sediment related to the operation of Reach 1 is then estimated at approximately 11,100 m^3 (8,900 m^3 during operation and 2,200 m^3 after closure).

Table 4.4-8. Suspended sediment volume balance in Buffalo Creek during the 2011/2012 Closure (Nov. 21, 2012 to July 3, 2014).

Description	Cumulative Sediment Volume (m^3)
Baseline	1,100
Channel or “Exit”	2,600
Net Total	1,500

2014/2015 Operation

Tables 4.4-9 to 4.4-12 present the suspended sediment volume balance computed with the empirical model for the 2014/2015 Operation for each one of the reaches between Lake St. Martin and the Exit of Buffalo Creek. The period of record is shorter than for the 2011/2012. Over this period, an overall lower volume of sediment transported was observed than during the 2011/2012 period. The general trend is similar to the 2012/2012 Operation. As demonstrated by the increase in volume of suspended sediment at the exit of Reach 1, the trend is for erosion to occur along Reach 1. According to the empirical model results and the change in TSS concentrations, a large portion of the suspended sediment settles and deposits in Buffalo Lake. As during the 2011/2012 Operation, erosion generally resumes along Buffalo Creek, which results in an increase in the volume of suspended sediment at the exit of Buffalo Creek. The effects of operation of Reach 1 on the volume of suspended sediment released from the system in Dauphin River are discussed in Section 4.5.

Table 4.4-9. Suspended sediment volume balance in Reach 1 during the 2014/2015 Operation (Jul. 3, 2014 to Oct. 22, 2014).

Description	Cumulative Sediment Volume (m^3)
Baseline	6,200
Channel or "Exit"	17,200
Net Total	11,000

Table 4.4-10. Suspended sediment volume balance in the Buffalo Lake Bog during the 2014/2015 Operation (Jul. 3, 2014 to Oct. 22, 2014).

Description	Cumulative Sediment Volume (m^3)
Reach 1 Channel or "Exit"	17,200
Buffalo Creek baseline or near Entrance	1,400
Net Total	-15,800

Table 4.4-11. Suspended sediment volume balance in Buffalo Creek during the 2014/2015 Operation (Jul. 3, 2014 to Oct. 22, 2014).

Description	Cumulative Sediment Volume (m^3)
Baseline or near Entrance	1,400
Exit	10,600
Net Total	9,200

Table 4.4-12. Suspended sediment volume balance in Reach 1 System from Entrance of Reach 1 to Exit of Buffalo Creek during the 2014/2015 Operation (Jul. 3, 2014 to Oct. 22, 2014).

Description	Cumulative Sediment Volume (m^3)
Reach 1 Baseline	6,200
Buffalo Creek Exit	10,600
Net Total	4,400

4.4.6.2 HEC-RAS model results

2011-2012 Operation

A steady state hydraulic model was simulated for the 5%, 50% and 95% flows of 44 m^3/s (1550 cfs), 125 m^3/s (4415 cfs) and 196 m^3/s (6920 cfs) for the 2011/2012 Operation, respectively, as previously discussed in Section 4.2.

The computed average shear stresses in the main channel and in the overbanks are shown in Figures 4.4-5 and 4.4-6 respectively, and are compared to the critical shear stress for erosion of the different grain classes. The computed average velocities in the main channel and in the overbanks are shown on Figures 4.4-7 and 4.4-8, and are compared to the minimum critical velocity for erosion of the different grain classes. Figures 4.4-9 and 4.4-10 show the resulting average velocities in the main channel and in the overbanks compared to the maximum critical velocity for deposition of the different grain classes.

As shown in Figures 4.4-5 to 4.4-8, the velocities and shear stresses that were present in the main channel and in the overbanks of Buffalo Creek during the 2011/2012 Operation of Reach 1, even for the minimum flow, were large enough to induce the movement of gravel size materials or smaller. In the main channel, the results also indicate that cobble size material could be subject to erosion in some areas. These results are consistent with cross section comparisons of pre and post operating conditions in Buffalo Creek, as discussed in Section 4.4.4. The cross section comparisons showed that erosion had occurred in Buffalo Creek, and that the erosion was concentrated in the main channel.

Once in movement, Figure 4.4-9 shows that for flows occurring during operation of Reach 1, there is a low potential for gravel size sediments or smaller to deposit in the main channel. When flows exceed median conditions, cobble size material also has a low potential for deposition. However, at the minimum flow, there are many locations where cobbles have a high potential for deposition.

In the overbanks, Figure 4.4-10 shows that gravel size sediment has a high potential for deposition during operation of Reach 1. The figure also shows that there are many areas where sand size sediment has the potential to deposit at the minimum flow.

These results on potential for deposition are also consistent with the pre and post cross section comparisons. As discussed in Section 4.4.4, the comparisons showed that deposition generally occurred in the overbanks, immediately adjacent to the main channel, and that the material deposited usually consisted of cobbles and gravels. The results are also consistent with the vegetation cover survey, discussed in Section 4.4.3, which showed that a layer of fine sediments could be found in the overbanks of the channel.

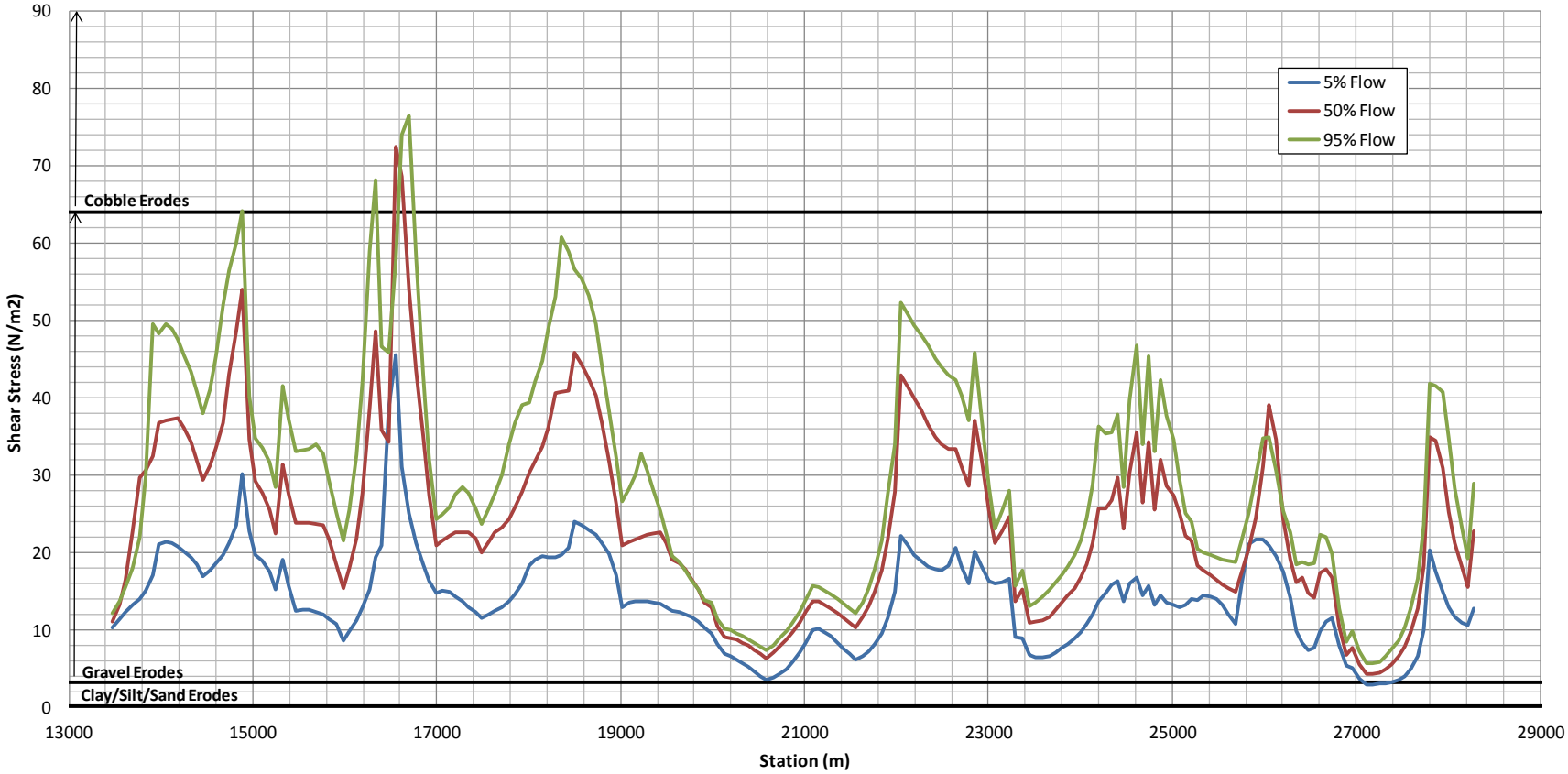


Figure 4.4-5. Comparison of computed Shear Stress profiles in the main channel with critical shear stresses for erosion.

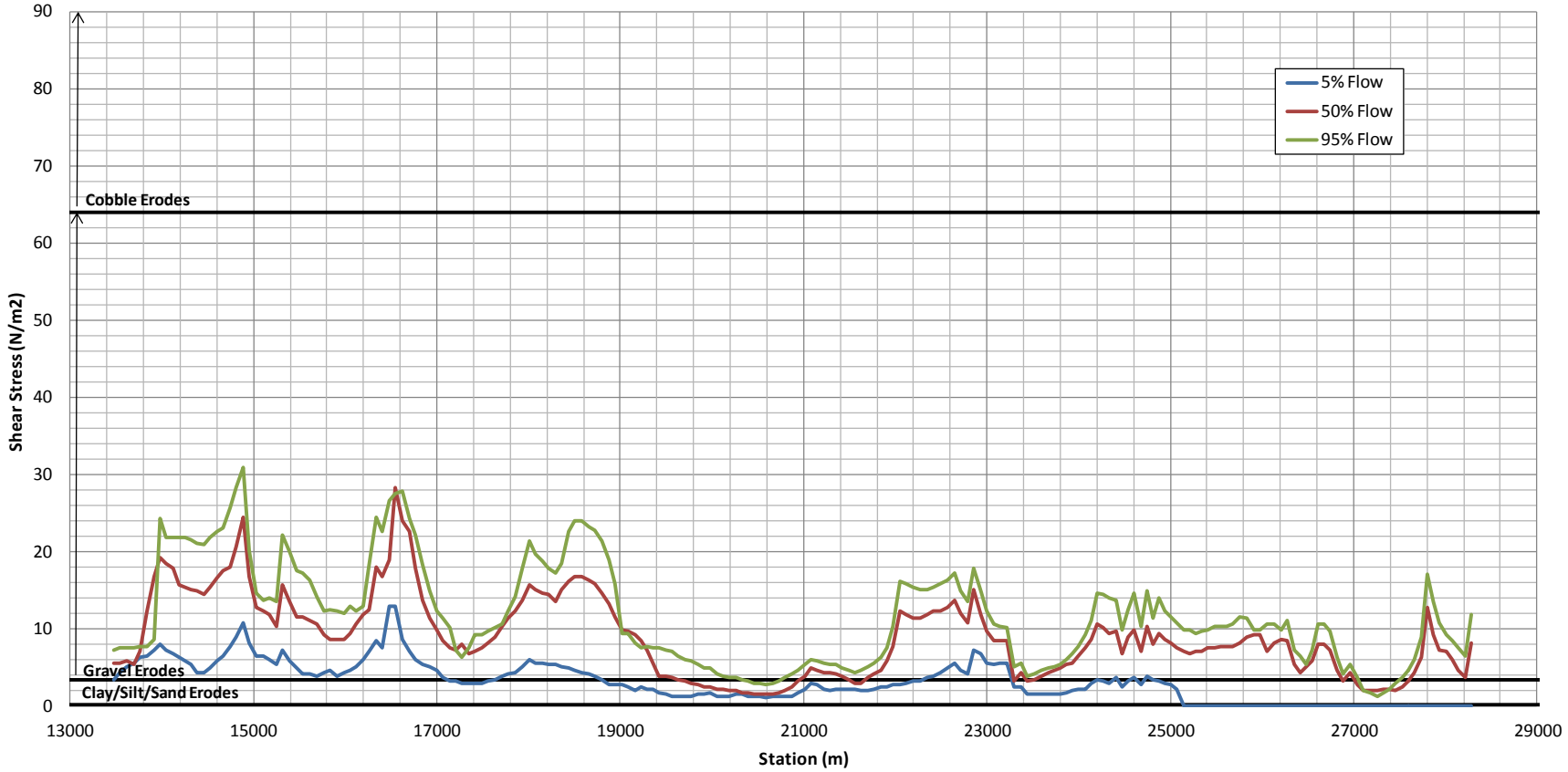


Figure 4.4-6. Comparison of computed Shear Stress profiles in the overbanks with critical shear stresses for erosion.

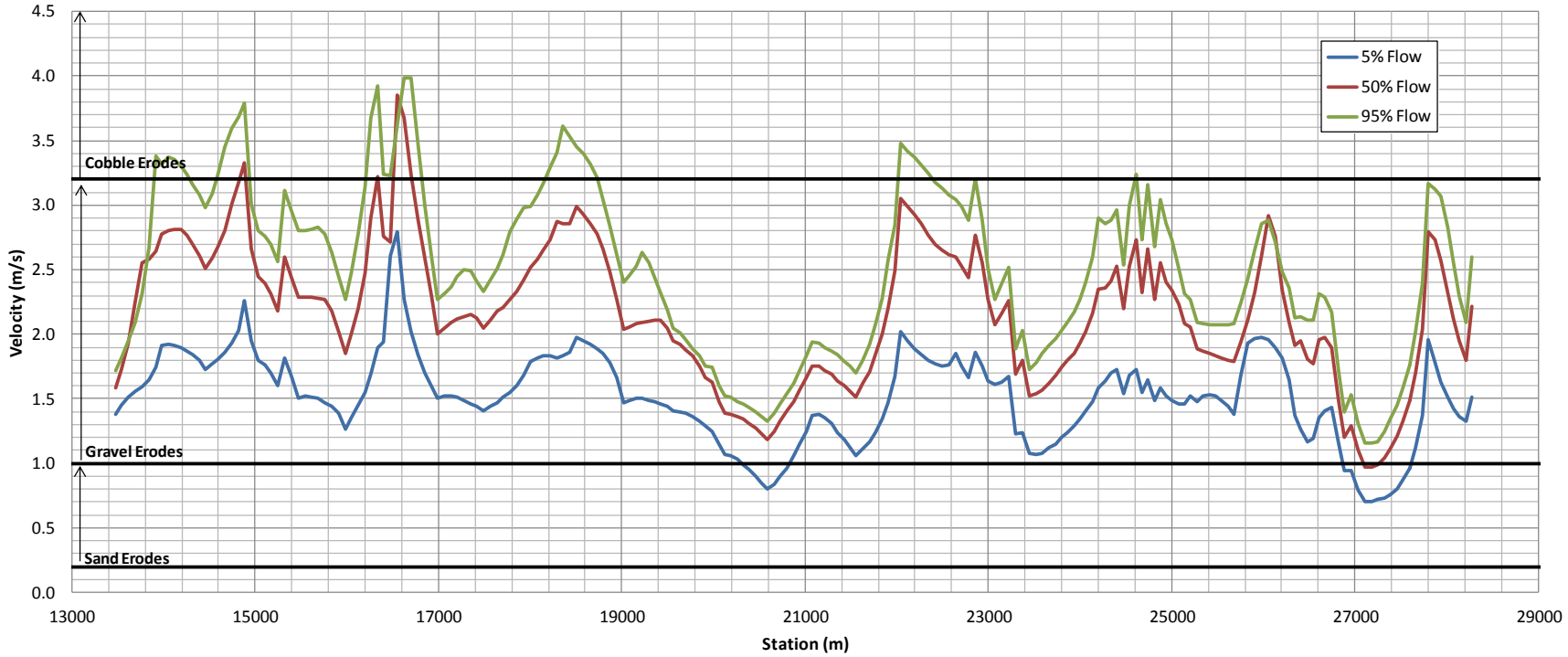


Figure 4.4-7. Comparison of computed velocity profiles in the main channel with minimum velocity for erosion.

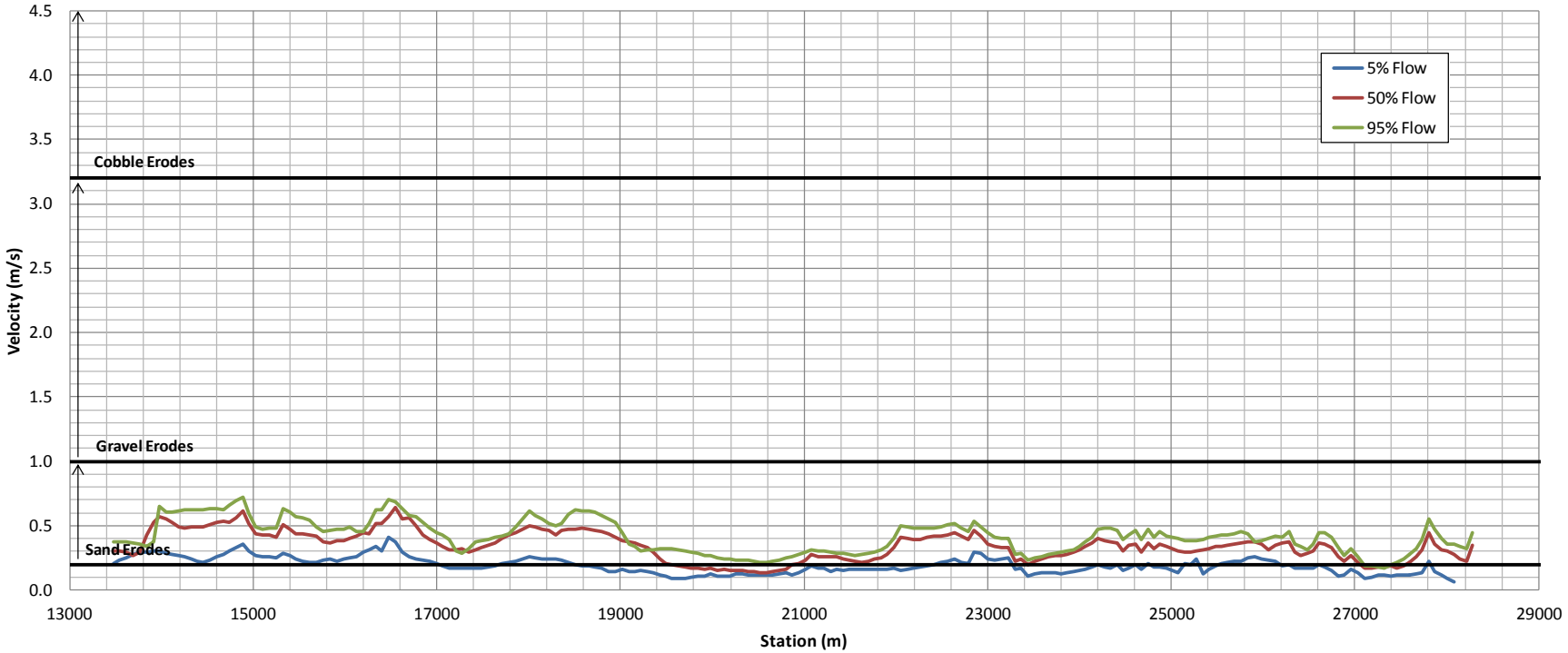


Figure 4.4-8. Comparison of computed velocity profiles in the overbanks with minimum velocity for erosion.

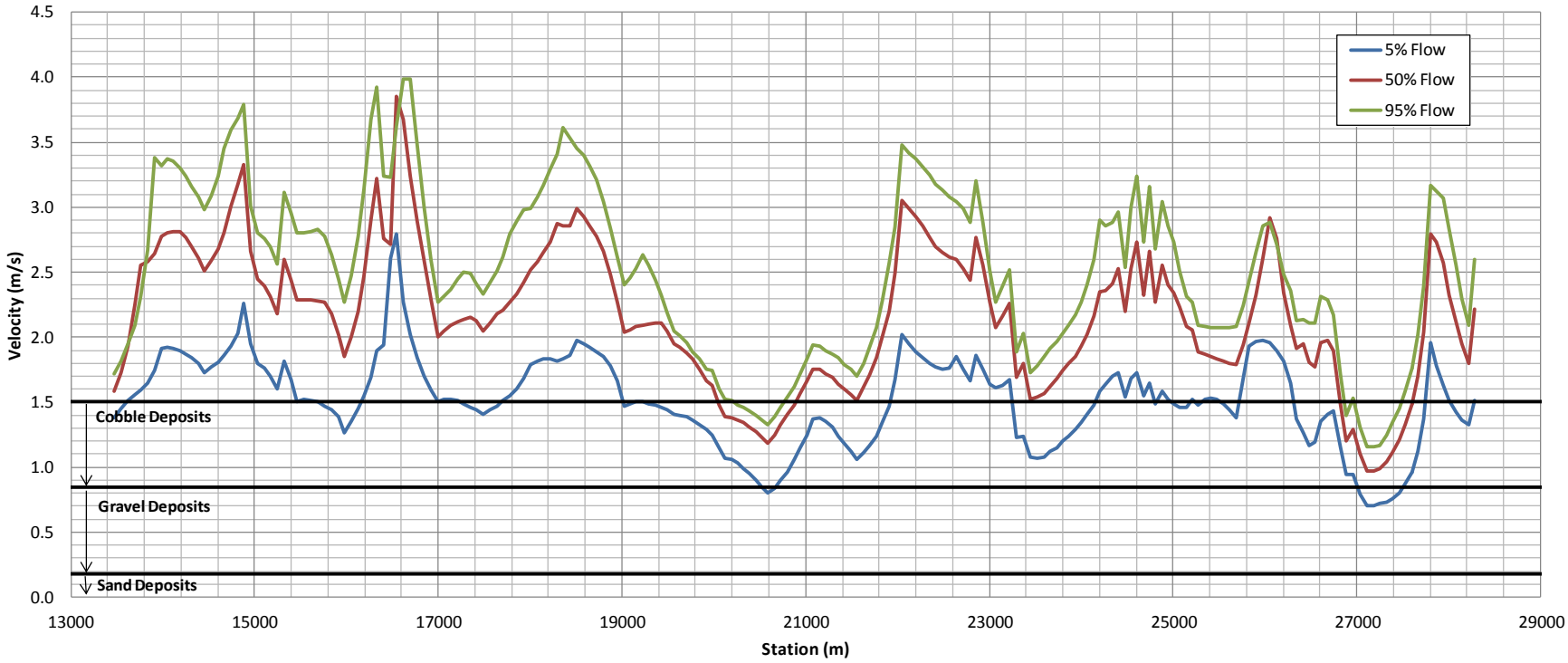


Figure 4.4-9. Comparison of computed velocity profiles in the main channel with maximum velocity for deposition.

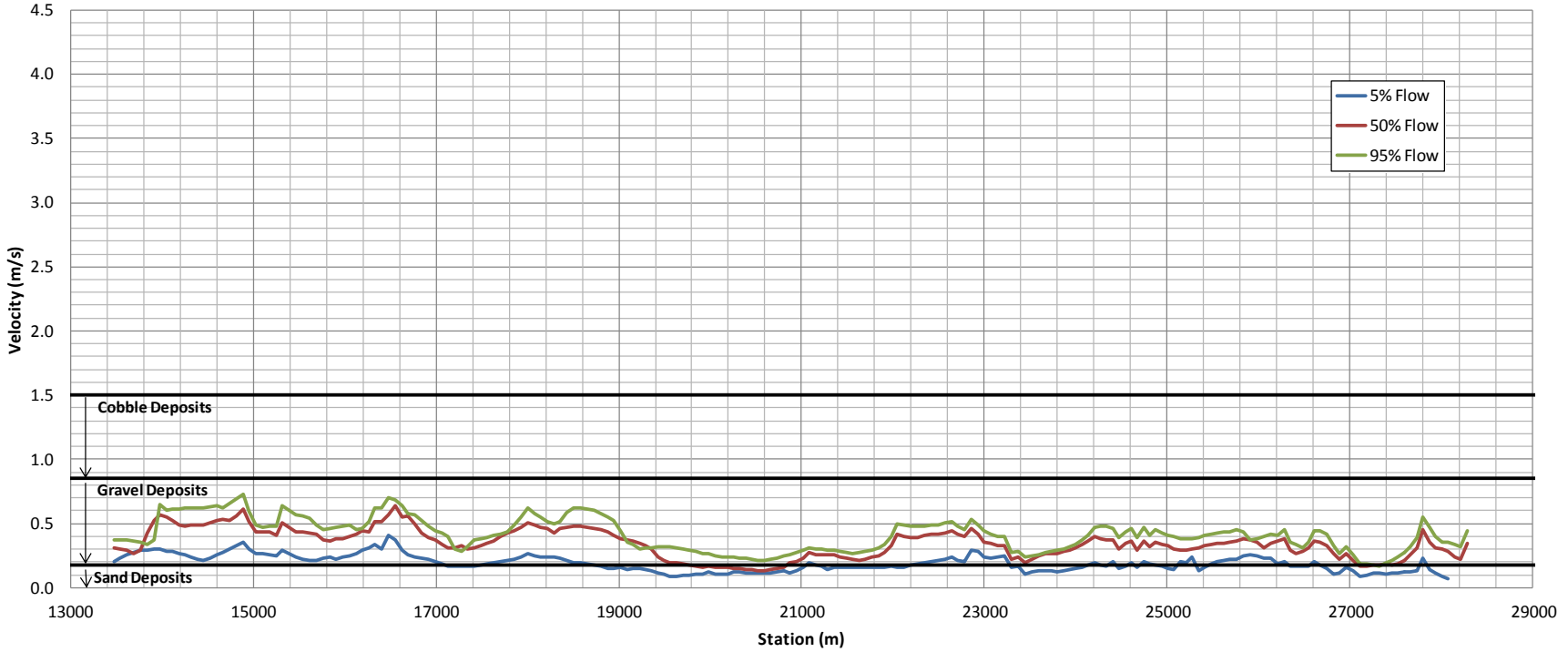


Figure 4.4-10. Comparison of computed velocity profiles in the overbanks with minimum velocity for deposition.

2011-2012 Closure

A steady state hydraulic model using the cross sections surveyed in 2013 was simulated for the 5%, 50% and 95% flows of 0.5 m^3/s (20 cfs), 3.9 m^3/s (140 cfs) and 6.9 m^3/s (245 cfs) for the 2011/2012 closure, respectively, as previously discussed in Section 4.2.

The computed average shear stresses in the main channel during the 2011/2012 closure are shown in Figure 4.4-11, and are compared to the critical shear stress for erosion of the different grain classes. The computed average velocities in the main channel are shown on Figure 4.4-12, and are compared to the minimum critical velocity for erosion of the different grain classes. Figures 4.4-13 show the resulting average velocities in the main channel compared to the maximum critical velocity for deposition of the different grain classes.

As shown on Figure 4.4-11 and 4.4-12, the computed average shear stresses and velocities in the Buffalo Creek channel are large enough to induce the movement of sands. Smaller gravel could also be mobilized and transported in some areas. Even for lower flows, gravels could be transported by bedload and erosion could occur in areas with higher flow velocities.

Once in movement, Figure 4.4-13 shows that there is a low potential for sands and smaller particles to deposit in the channel for median and high flows. At high flows, even gravels may not deposit in certain areas of the channel. However at low flows, the results of the analysis show that there are locations where the velocities are becoming small enough for potential deposition.

Contrary to the 2011-2012 Operation period, water levels in Buffalo Creek during the 2011-2012 closure period remained generally within the main channel and rarely exceeded the overbanks. On this basis, the potential for erosion and deposition was negligible for this period. In the rare locations where water levels exceeded the overbanks for brief periods of time, velocities would have remained low and there would have been a potential for deposition.

When compared to the 2011-2012 Operation period, the results of the 2011-2012 closure period indicate that the larger size materials such as gravels and cobbles had a greater potential for erosion in the main channel during the 2011-2012 Operation period. There was also a potential for erosion and deposition in the overbanks during the 2011-2012 Operation period. However since water levels generally did not exceed overbanks during the 2011-2012 Closure period, the potential for erosion and deposition was negligible in the overbanks during this period. The potential for deposition was greater during the 2011-2012 Closure period for smaller size material such as gravel and sands.

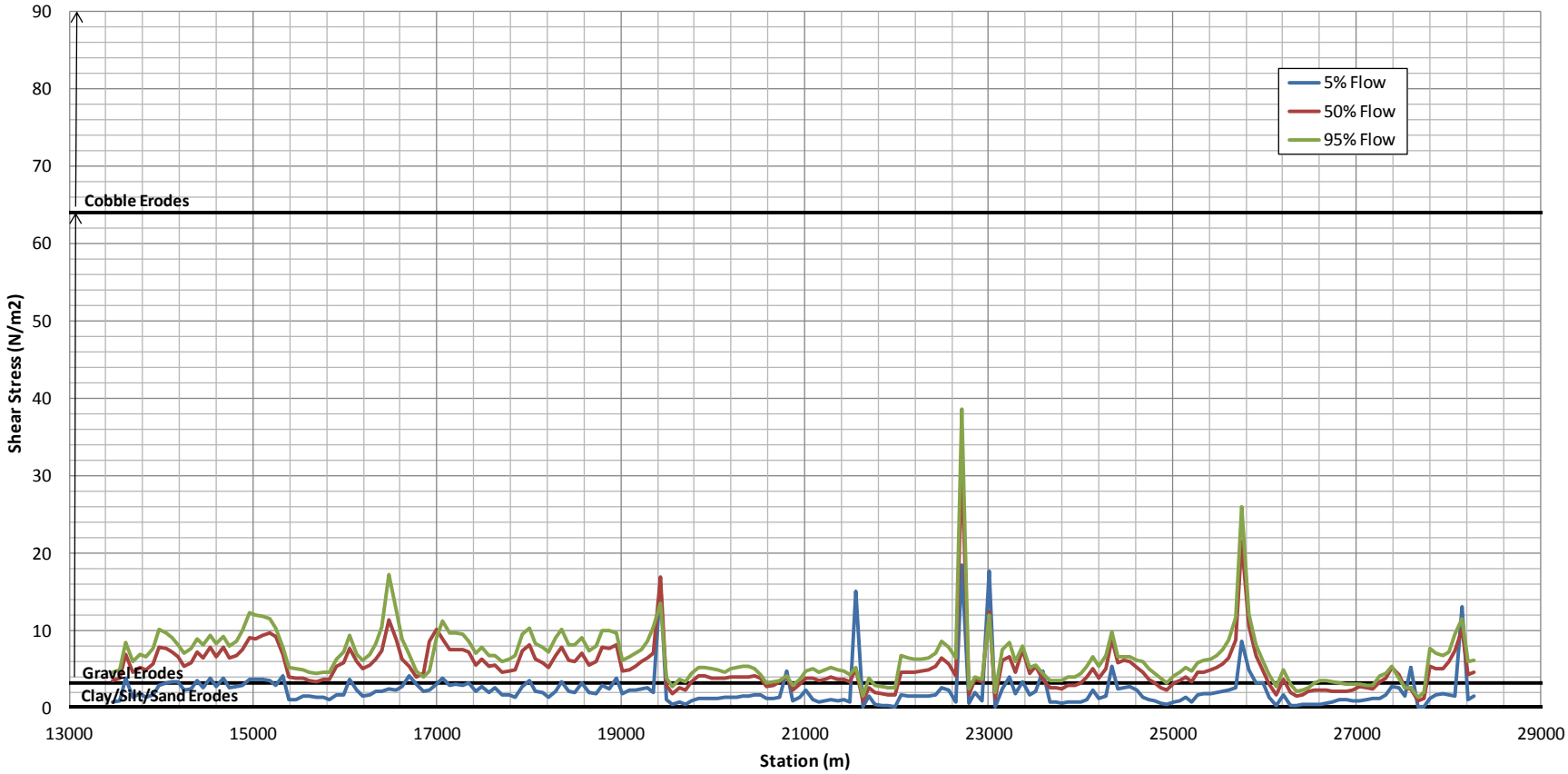


Figure 4.4-11. Comparison of computed Shear Stress profiles in the main channel with critical shear stresses for erosion.

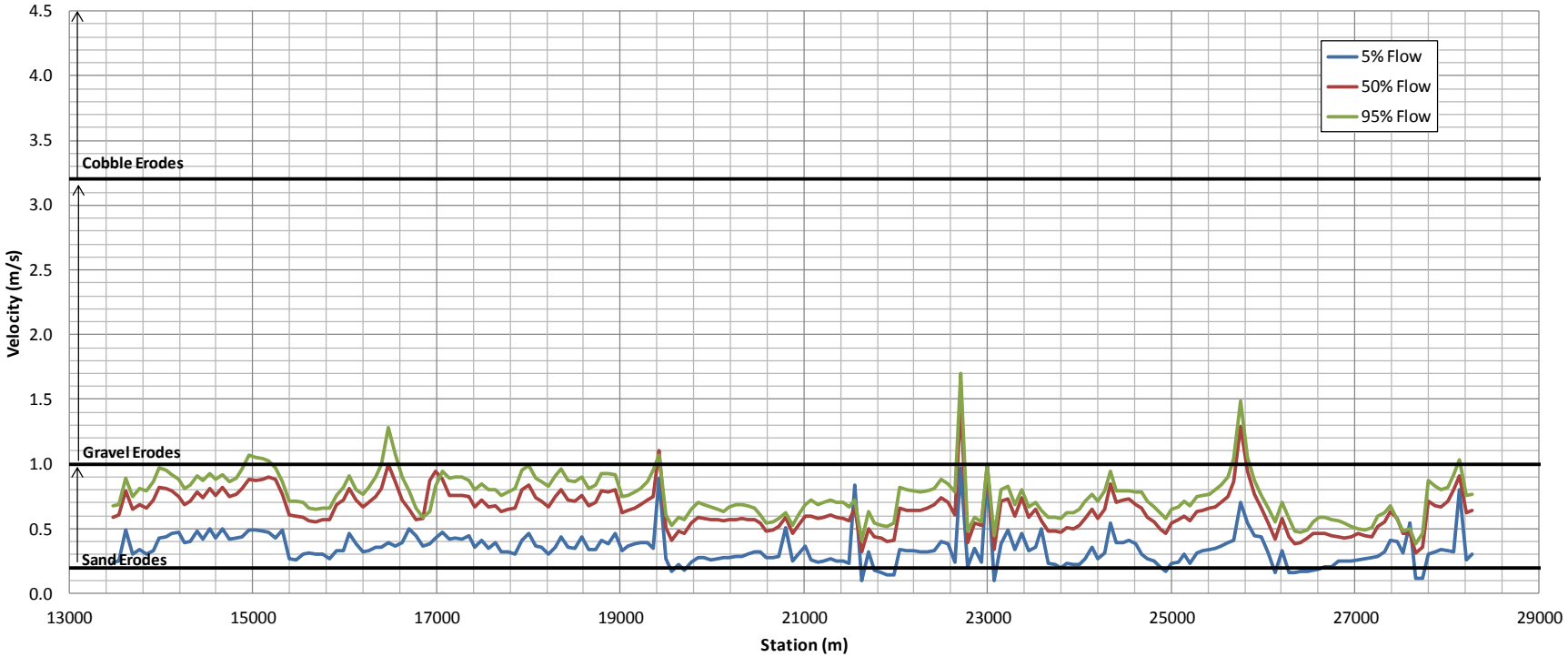


Figure 4.4-12. Comparison of computed velocity profiles in the main channel with minimum velocity for erosion.

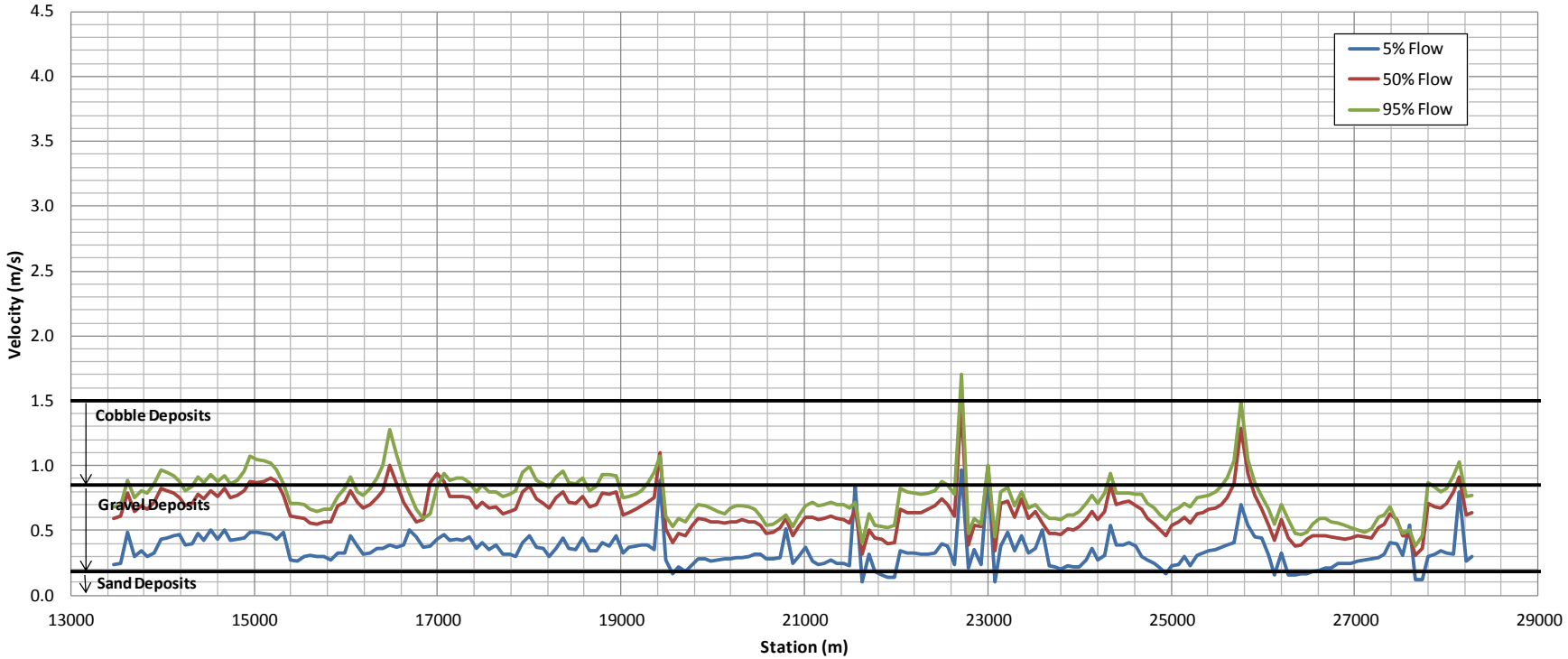


Figure 4.4-13. Comparison of computed velocity profiles in the main channel with maximum velocity for deposition.

2014-2015 Operation

A steady state hydraulic model using the cross sections surveyed in 2013 was simulated for the 5%, 50% and 95% flows of 97 m³/s (3420 cfs), 109 m³/s (3845 cfs) and 128 m³/s (4534 cfs) for the 2011/2012 closure, respectively, as previously discussed in Section 4.2.

The computed average shear stresses in the main channel and in the overbanks are shown in Figures 4.4-14 and 4.4-15 respectively, and are compared to the critical shear stress for erosion of the different grain classes. The computed average velocities in the main channel and in the overbanks are shown on Figures 4.4-16 and 4.4-17, and are compared to the minimum critical velocity for erosion of the different grain classes. Figures 4.4-18 and 4.4-19 show the resulting average velocities in the main channel and in the overbanks compared to the maximum critical velocity for deposition of the different grain classes.

As shown in Figures 4.4-14 to 4.4-17, the range of computed velocities and shear stresses for the 2014/2015 closure is similar to the 2011/2012 Operation, despite the wider cross sections due to the past riverbank erosion that occurred during the 2011/2012 Operation. In the main channel, velocities and shear stresses are large enough to induce the movement of gravel size materials or smaller, and potential erosion of cobbles, locally.

Once in movement, Figure 4.4-18 shows that for flows occurring during the 2014/2014 Operation of Reach 1, there is a low potential for gravel size sediments or smaller to deposit in the main channel. When flows exceed median conditions, cobble size material also has a low potential for deposition.

In the overbanks, Figure 4.4-19 shows that gravel and sand size sediment has a potential for deposition during operation of Reach 1.

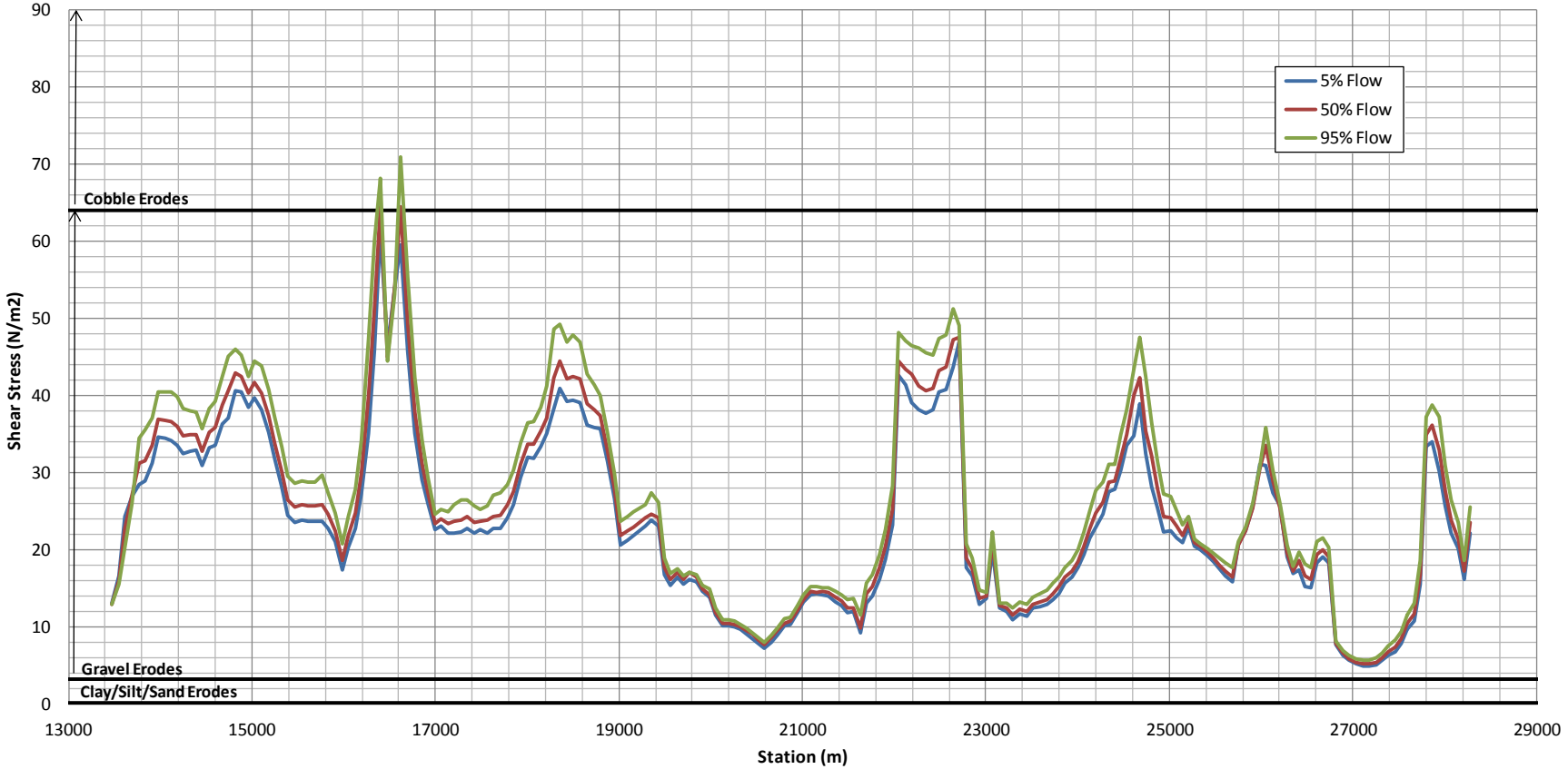


Figure 4.4-14. Comparison of computed Shear Stress profiles in the main channel with critical shear stresses for erosion.

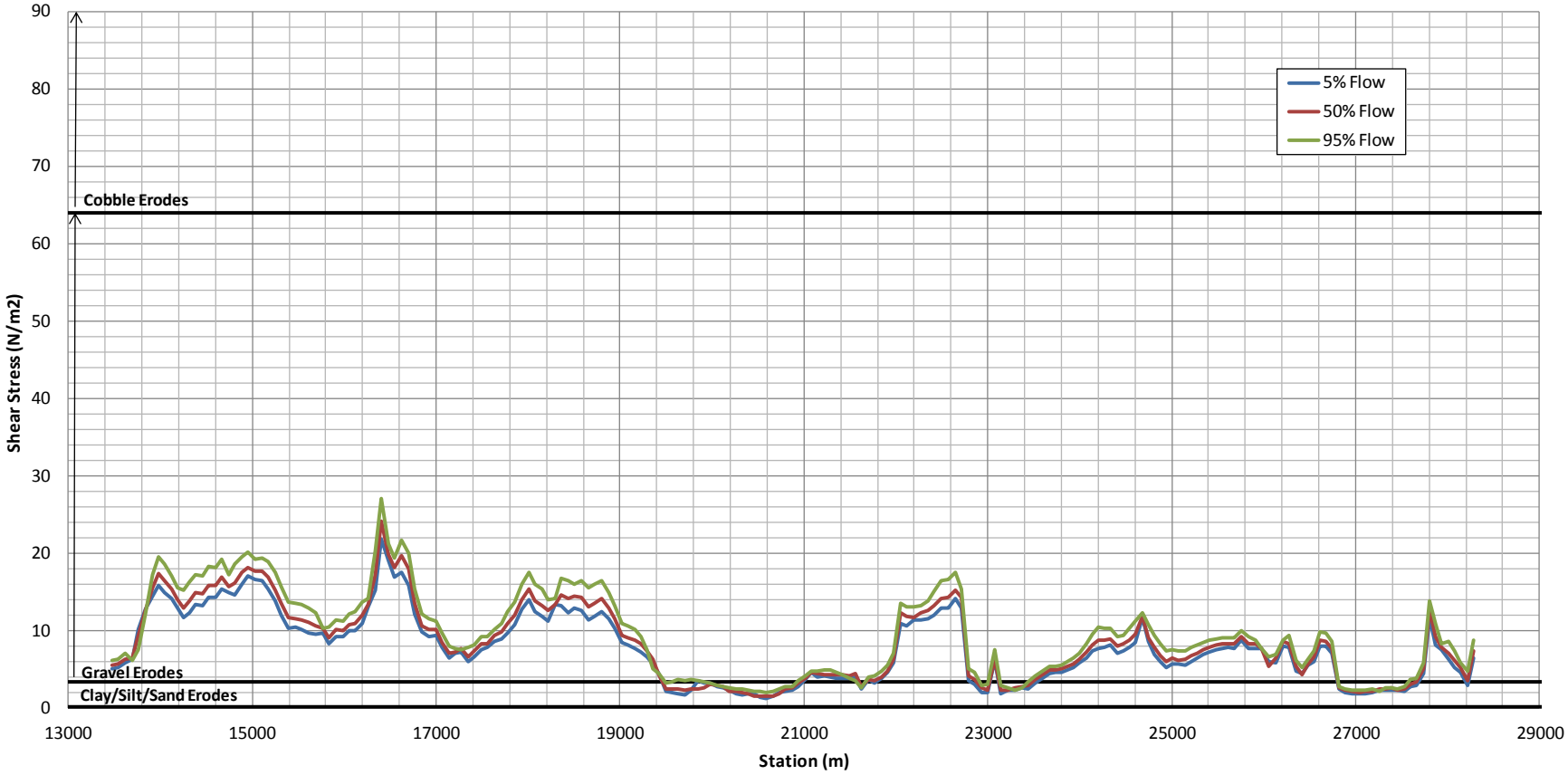


Figure 4.4-15. Comparison of computed Shear Stress profiles in the overbanks with critical shear stresses for erosion.

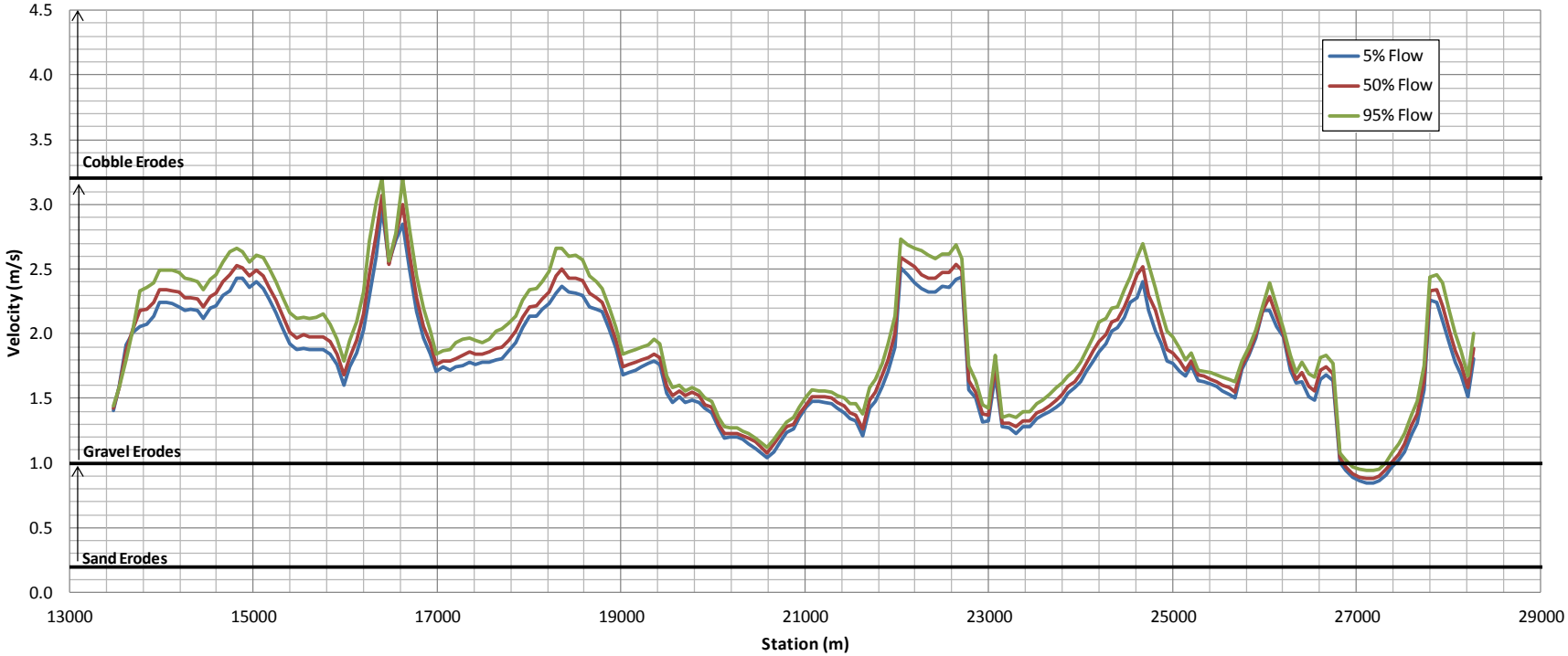


Figure 4.4-16. Comparison of computed velocity profiles in the main channel with minimum velocity for erosion.

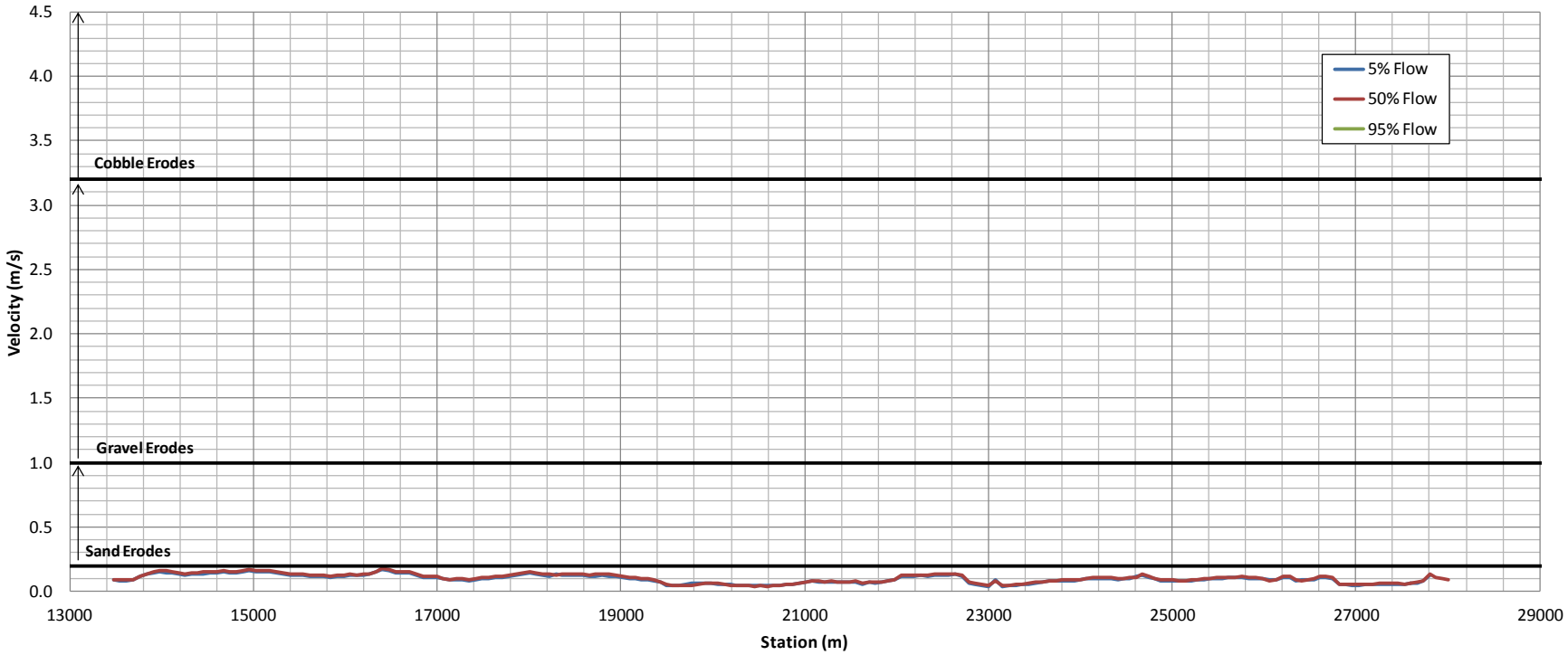


Figure 4.4-17. Comparison of computed velocity profiles in the overbanks with minimum velocity for erosion.

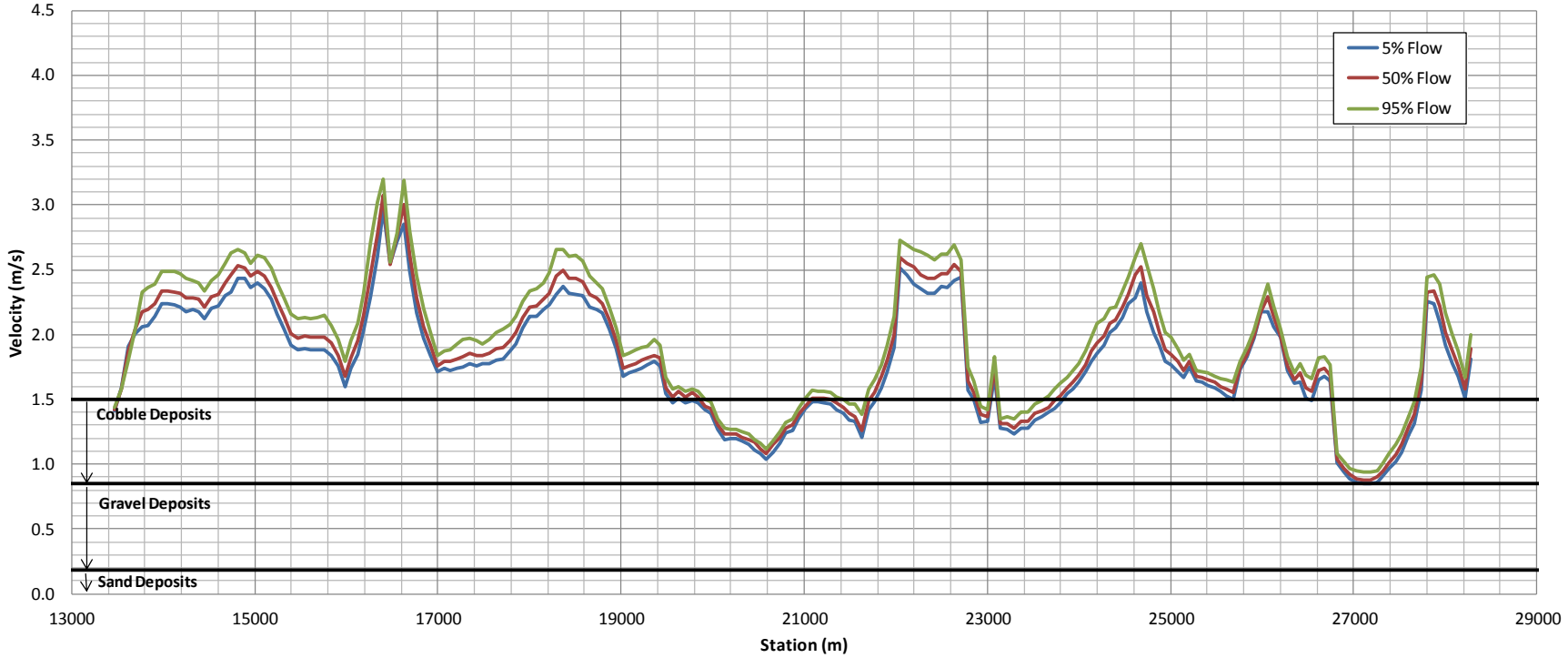


Figure 4.4-18. Comparison of computed velocity profiles in the main channel with maximum velocity for deposition.

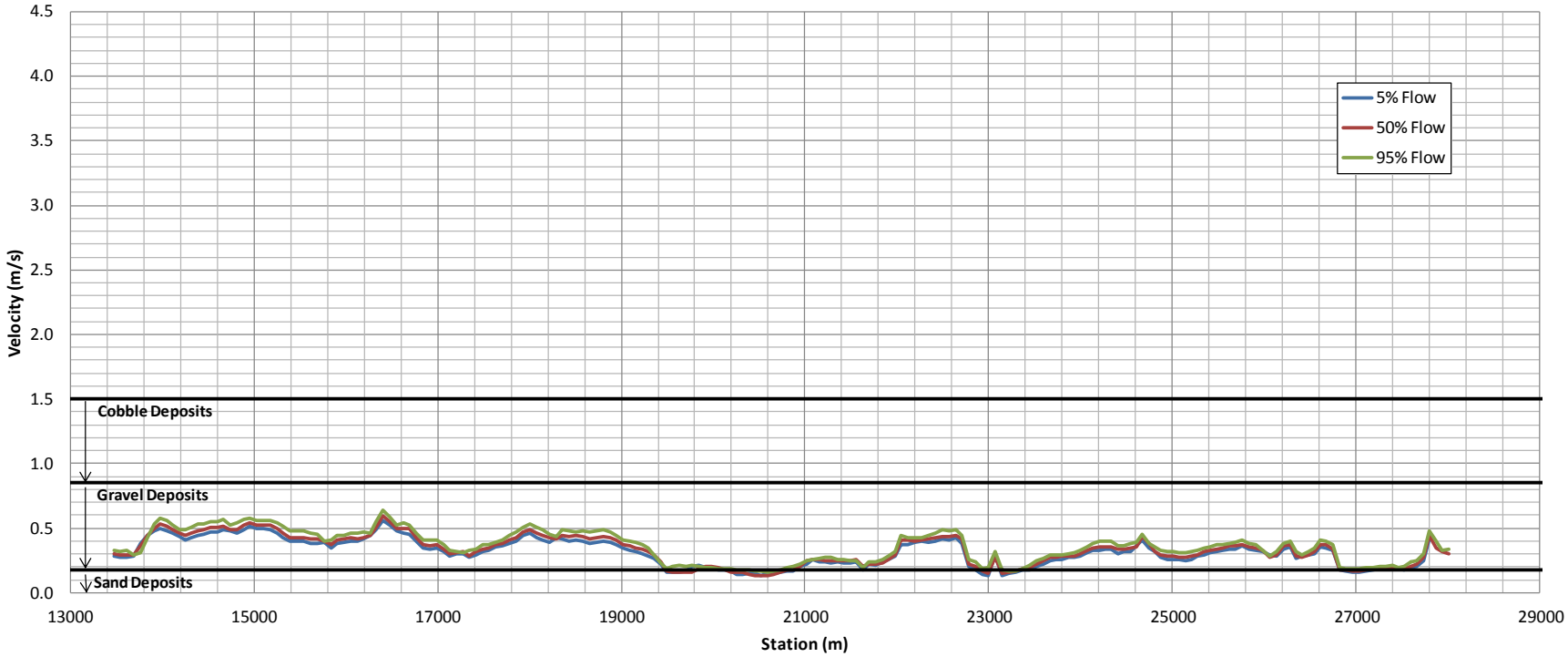


Figure 4.4-19. Comparison of computed velocity profiles in the overbanks with minimum velocity for deposition.

4.5 DAUPHIN RIVER MONITORING RESULTS

4.5.1 Flow

On Dauphin River, hydrometric data are available from the WSC hydrometric station No. 05LM006 (Dauphin River near Dauphin River). The flows recorded at the WSC station are shown on Figure 4.5-1. The Dauphin River flows were also computed without Reach 1 with a routing model of Lake St. Martin, to assess the effects of the operation of the emergency channel on the Upper and Lower Dauphin River flows, also shown on Figure 4.5-1.

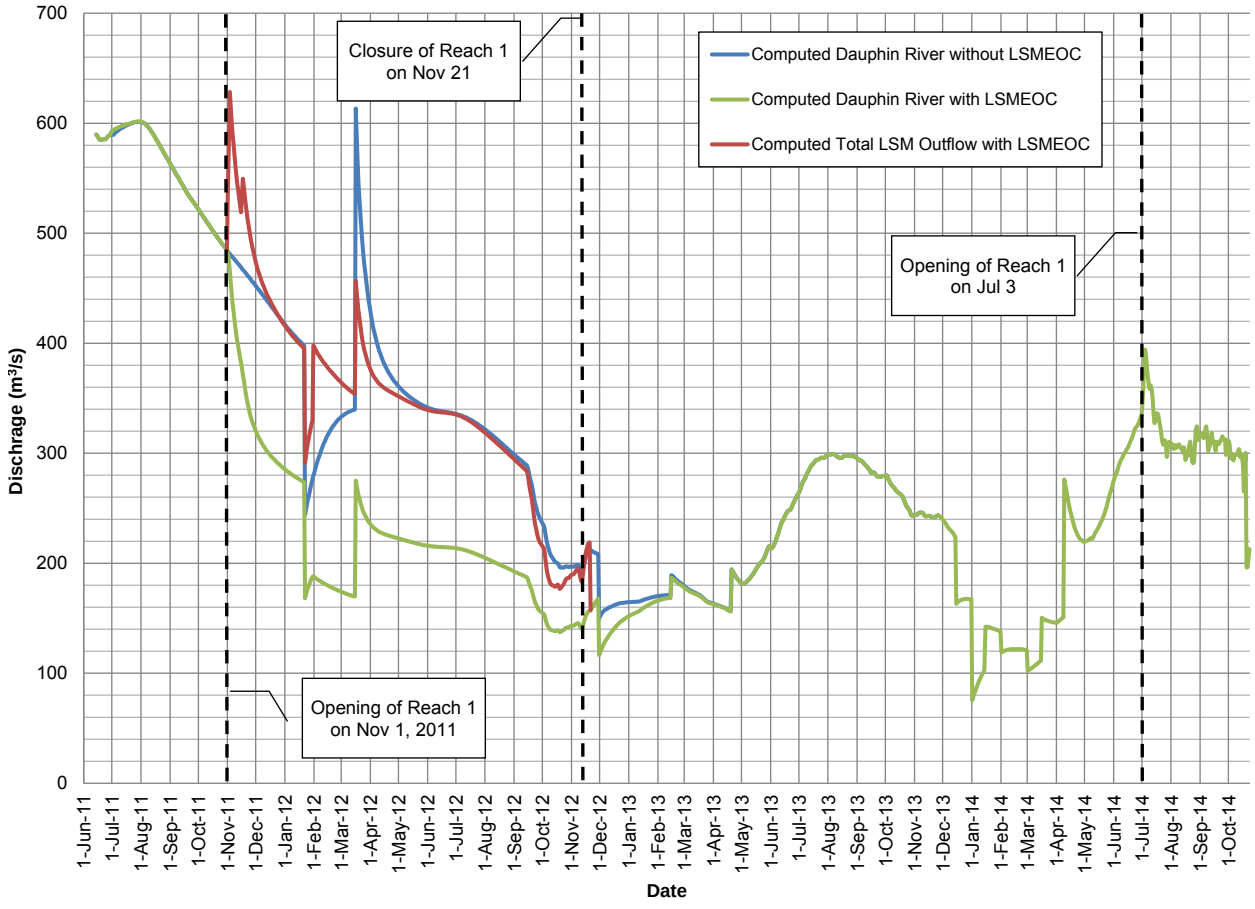


Figure 4.5-1. Computed Dauphin River flows with and without operation of Reach 1.

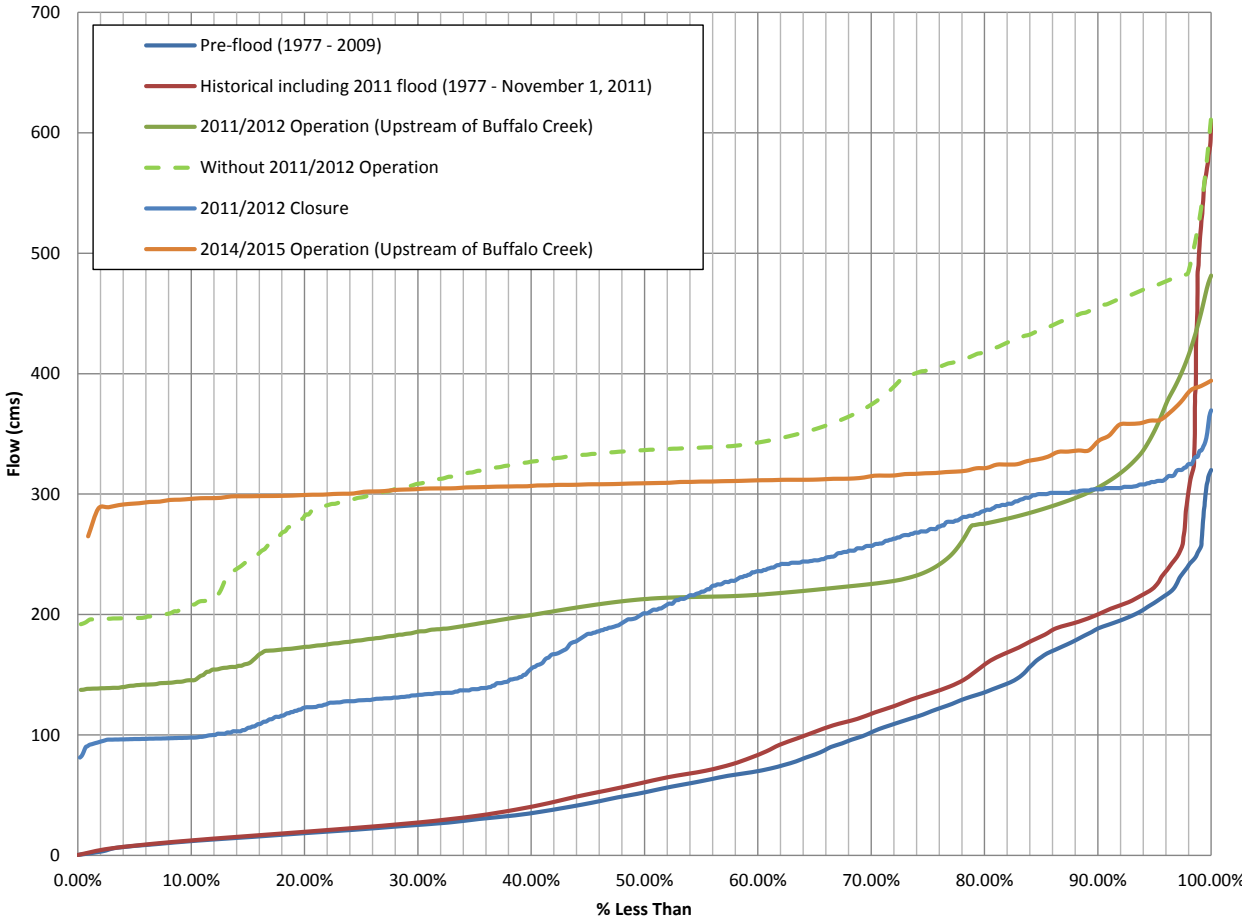


Figure 4.5-2. Duration Curves of Upper Dauphin River Flows.

The 5, 50 and 95 percentile flows utilized in the habitat assessment were derived from the duration curves of daily flows computed from the recorded or computed flows upstream of the confluence with Buffalo Creek, and presented in Figure 4.5-2. Table 4.5-1 summarizes these flow conditions for each project phase. It should be noted that the duration curve for the 2014/2015 Operation period was computed based on a shorter time period since the channel was still in operation at the time of the analysis, and is based on the flows measured between July 3, 2014 to October 22, 2014.

As indicated in Table 4.5-1, the Dauphin River flows upstream of Buffalo Creek were reduced by the 2011/2012 Operation of Reach 1. This reduction results from the additional outflow provided by Reach 1 during operation, which in turn also reduced the water levels on Lake St. Martin compared to the natural conditions without the operation of the emergency channel.

Table 4.5-1. Modeled discharge (as 5th, 50th, and 95th percentiles) for the Dauphin River (upstream of confluence with Buffalo Creek) during each project phase.

Flow Percentile (%)	Pre-flood (m^3/s)	2011 Flood (m^3/s)	2011/2012 Operation (m^3/s)	2011/2012 Without Operation (m^3/s)	2011/2012 Closure (m^3/s)	2014/2015 Operation (m^3/s)
5	8	-	141	197	97	292
50	58	368	213	337	201	309
95	212	603 (peak)	353	473	310	361

4.5.2 TSS/Turbidity Data

Time series of TSS were computed for Dauphin River from the turbidity records and the TSS data collected between 2011 and 2014. These computed concentrations were used in conjunction with the computed flows for the corresponding period in the empirical model.

As shown on Figure 4.5-3, During the 2011/2012 Operation, the TSS at the exit of Dauphin River exceeded the baseline (representative of the conditions existing upstream of the confluence with Buffalo Creek) following the initial operation of Reach 1. After March 2012, the difference in TSS concentration between the baseline and the exit of the Dauphin River appeared to be insignificant. The TSS concentration during the 2011/2012 Operation ranged from 0 to 30 mg/L.

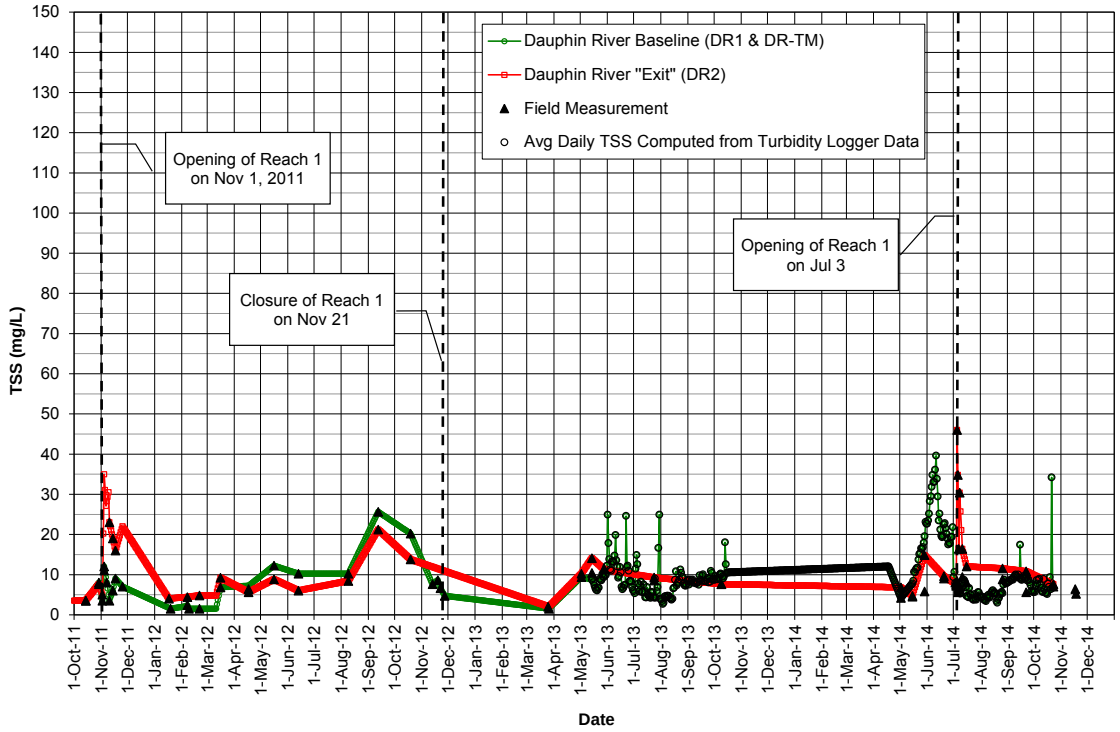


Figure 4.5-3. Times series of computed daily total suspended solids for the Dauphin River.

After closure of Reach 1 on November 21, 2012, the TSS concentrations were variable and never exceeded 40 mg/L at the exit of the Dauphin River. The differences in TSS between the baseline and Sturgeon Bay varied between 5 and 20 mg/L, but no significant difference could be noted.

A peak of TSS was also observed following the opening of Reach 1 on July 3, 2014, where the TSS reached a maximum of 50 mg/L. The increase in TSS was very brief and likely associated with the re-operation of the Reach 1 system and the flushing of smaller particles of sediment that would have settled in Reach 1 and Buffalo Creek.

4.5.3 Bathymetric Survey

The bathymetric surveys of the Lower Dauphin River carried out in June 2011, June 2013 and June 2014 were processed and compared to identify areas with notable changes in riverbed elevations (Appendix 4.C).

The comparison between the 2011 and 2013 surveys shows the potential changes in bathymetry that have occurred during the operation of Reach 1. The accuracy of the survey methods, considering the site conditions and the equipment used, was considered to be valid at a +/- 0.5 m. The initial purpose of the 2011 survey was to collect bathymetry data for the development of the hydraulic model. Therefore, the density of the SONAR data is coarser than what would typically be targeted for an analysis by comparison of riverbed elevations. The interpolation method between survey points required to develop a continuous surface could lead to local variations in elevation greater than -0.5 m / +0.5 m and may not necessarily be attributed to an actual change in bathymetry.

Between 2011 and 2013, the variations in bathymetry on the Dauphin River upstream of Buffalo Creek mainly ranged from - 0.5 m to + 0.5 m. Locally, some areas were lower in elevation in 2013 than in 2011 by 0.5 to 1.0m. Other areas, mostly located along the shoreline, were higher in elevation by 0.5 to 1.0m. These changes are considered representative of the natural conditions on the Dauphin River since they are also present upstream of the confluence with Buffalo Creek. As discussed in Section 4.5.1, the flow velocities at the centreline of this reach of the river have reached a magnitude greater than 1.5 m/s. Such velocity is capable of eroding gravel size material and of transporting cobbles up to 0.2 m in diameter. The natural conditions on the river, as observed upstream of the confluence with Buffalo Creek, appear to be variable, with local changes in elevation greater than -0.5 and +0.5 m.

Downstream of the confluence with Buffalo Creek, the differences in elevation are generally similar to those observed upstream of the confluence. Most of the variations in this reach are comprised between -0.5m and +0.5m. Locally, some areas exceed this range, however, no significant changes in bathymetry can be identified between the confluence and Station 51,500.

Downstream of Station 51,500, the variations are fairly similar to the rest of the reach, except in one area across the river showing a decrease in the riverbed elevation by 1.0 to 1.5m. This area appeared to be the location where some erosion occurred, and could be associated with the formation of the ice cover during the winter. The review of the ice processes identified this area as being prone to the formation of an ice dam, which would force more flow under the ice cover and generate higher

velocities with a higher potential for erosion. This phenomenon has been known to naturally occur at this location prior to the operation of Reach 1. Finally, the variations in bathymetry in Sturgeon Bay are generally comprised between -0.5m and +0.5m. Some areas present a difference in elevation marginally greater than 0.5m.

The comparison between the 2013 and 2014 survey shows the potential changes in riverbed elevations that have occurred during the 2011/2012 Closure, and prior to the 2014/2015 Operation. Most of the changes observed in the Lower Dauphin River ranged between -0.5m and +0.5m. Some areas were actually lower in 2014 by up to 1.0m, and even 1.5m, locally. There are signs of sediment deposition as far downstream as Sturgeon Bay. Areas already identified as potentially subject to sediment deposition during the 2011/2012 Operation, shows that some erosion could have occurred during the 2011/2012 Closure.

In conclusion, the changes in riverbed elevations identified with the comparison of the 2011 and 2013 data, and again in 2013 and 2014, appear to be fairly uniform along the Lower Dauphin River. The variations in elevations generally range between -0.5 to 0.5m, with some areas showing signs of erosion principally along the centreline of the river and others some deposition, along the shoreline. One location at Station 52,050 presents signs of erosion that could have been attributed to the formation of an ice dam during the 2011/2012 winter. Changes of such magnitude are also present upstream of the confluence with Buffalo Creek, and appear to take part in the dynamic sediment transport processes that naturally occur in the Lower Dauphin River. On this basis, it cannot be confirmed if the changes in riverbed elevations observed on the Lower Dauphin River can directly be attributed to the operation of Reach 1. The sediment transport processes are further discussed in Section 4.5.5.

4.5.4 Ice processes

Natural Conditions

The Dauphin River is the only natural outlet from Lake St. Martin. It traverses over a distance of about 50 km from Lake St. Martin to its outlet into Lake Winnipeg and the water typically changes from approximately 242.9 to 243.8 m (797 to 800 ft) at Lake St. Martin to 216.7 to 217.9 m (711 to 715 ft) at Lake Winnipeg. Over the first 25 km, the river gradient is relatively flat and the flow has a low velocity. The discharge capacity at the outlet from Lake St. Martin is dominated by the frictional effects of the flow in the upper Dauphin River. Winter conditions can cause formation of an ice cover and significantly affect the discharge capacity. Typically, it has been observed that the greater is the outflow, the larger the potential reduction due to ice can be.

The lower 30 km of the river is steeply inclined, with a gradient of about 25 m over the relatively short length of the lower river. Velocities are relatively high. The formation of a smooth ice cover is rarely possible. In most years the ice cover forms as result of an accumulation of frazil ice pans formed in the fast flowing lower river. Rises in water level in the freeze-up period have, prior to 2011, been observed to be in the range of 1 to 2 m. The higher the flow, the higher the river water level must rise to create a stable ice cover. Conditions in the lower Dauphin River do not affect Lake St. Martin water levels or outflow.

In spring, the sudden increase in flow due to resumption of open water conditions at the outlet of Lake St. Martin could trigger ice jams in the lower river.

The Dauphin River slopes relatively gently over the first 40 km from its source at Lake St. Martin, with a gradient of about 0.3 m per 1000 m. This is comparable to many slowly moving streams in the flat topography of central Manitoba. However, it then steepens significantly over the next 10 km to a gradient that averages about 1 m per 1000 m of length, and in short portions of that reach, approaches 1 m per 700 m of length. Even in the last few kilometers where the river enters Lake Winnipeg the river slope remains steep. Flow velocities typically range between 0.5 to 1.5 m/s over the first 40 km and increase to approximately 2 m/s over the next 10 km.

This wide variation in slope of the river results in widely varying ice conditions. In the upper river, the sluggish flow can develop an ice cover due to border ice advancement, skim ice formation, and bridging of moving slush ice between border ice edges, even before the ice cover advances from downstream.

In the steep lower part of the river where the velocities are high, the river surface typically cools to freezing in early November. At that point, frazil ice begins to generate and coalesce into slush ice pans that travel down into Lake Winnipeg. The surface of Lake Winnipeg typically ices over in the area of the Dauphin River mouth by early November. At that point, the slush ice being delivered by the Dauphin River begins to amass at the river mouth and back up the water levels. This is the classic formation of a hanging ice dam, and would be expected to occur at this location when river flows are greater than about 70 m^3/s (2,470 cfs).

In the late fall of 2010, the river flow was in the order of 200 m^3/s (7,060 cfs). The ice cover advanced from Lake Winnipeg, being supplied continuously by a steady inflow of slush ice. Water levels were estimated to have risen over 2 m as the ice cover formed and stabilized. These photos showed recognizable landmarks such as roads, and the water levels that were occurring at that time could be estimated. It was reported that the road near Cranberry Creek was overtopped in 2010 by November 21, and provided more evidence of the rising stage of the river with the ice cover advancement.

In spite of the high flow in the Dauphin River, the water and ice levels did not exceed the bankfull stage in the Dauphin River communities and no serious damages occurred in 2010. Upstream, water did exceed bankfull stage and flooded part of PR 513 and an access road west of the Dauphin River community, but only at a few minor locations.

MIT reported that the river developed a full ice cover that extended from Lake Winnipeg to Lake St. Martin by mid-December in 2010. Short reaches of open water remained by that time.

This mode of ice formation and advancement, or variations of it, occurs every year, and affects the discharge capacity from Lake St. Martin. MWS has estimated that in previous years with normal river flow conditions, the stage-discharge relationship at the outlet of Lake St. Martin rises approximately 60 cm due to the formation of the ice cover.

Observations during the 2011/2012 Operation

The winter of 2011-2012 was exceptionally warm. The total degree days of freezing for the 2011-2012 winter were the lowest of the previous thirty years on record. The ice development during the winter was significantly affected by this, not only on the timing of occurrence of the ice cover, but also the maximum staging during the formation process.

In general, the mild temperature conditions allowed the ice cover to form and stabilize at lower water levels than predicted under normal conditions. Nevertheless, water level staging of 3 to 4 m was measured at some locations. Also since the frequency of the measurements were not continuous, it is possible that the peak water was not measured at other locations. The peak water level may have occurred either between two measurements or possibly later in the winter. The monitoring program ended on January 6, 2012. At that time the ice front was located just upstream of Buffalo Creek, therefore it was possible that additional staging still occurred.

4.5.5 Hydraulic and Sediment Transport Modeling

4.5.5.1 Empirical Model Results

2011/2012 Operation

Table 4.5-2 present the suspended sediment volume balance computed with the empirical model for the Dauphin River during the 2011/2012 Operation of Reach 1. The general trend is for sediment to leave the Upper Dauphin River into Sturgeon Bay. According to the empirical model results, the combined cumulative volume of suspended sediment at the confluence between Buffalo Creek and the Dauphin River is estimated at 82,200 m³. The Upper Dauphin River contributes to almost 60% of this volume, while the Reach 1 and the Buffalo Creek watershed is the source of the remaining 40%. The total volume of suspended sediment available for transport or deposition in the Lower Dauphin River should be analyzed in conjunction with the flow velocities occurring along this reach to identify the potential for transport or deposition. This analysis was carried out based on the MIKE-21 results and is discussed in Section 4.5.5.2.

Table 4.5-2. Suspended sediment volume balance for Reach 1 System from Exit of Buffalo Creek to Exit of Dauphin River (Nov. 1, 2011 to Nov 21, 2012).

Description	Cumulative Sediment Volume (m³)
Dauphin River Baseline	47,800
Buffalo Creek Exit	34,400
Combined Dauphin River Baseline & Buffalo Creek Exit	82,200

As indicated in Table 4.5-2, the combined volume of suspended sediment downstream of the confluence with Buffalo Creek during the 2011/2012 Operation is estimated at 82,200 m³. To assess the effects of the operation of Reach 1 on the volume of suspended sediment in the Dauphin River downstream of Buffalo Creek, the same volume was computed with the empirical model with Dauphin River flows

obtained from the routing model if Reach 1 had not been operated. The total volume of suspended sediment at this location during the 2011/2012 Operation period, but if Reach 1 had not been operated, is estimated at 73,300 m³. Since the Upper Dauphin River flows would have been significantly greater without operation of the emergency channel, the cumulative volume of suspended sediment upstream of Buffalo Creek would also exceed the volumes actually observed at that location during operation. According to the empirical model results, the operation of Reach 1 contributed to an additional 8,900 m³ of suspended sediment in the Dauphin River downstream of the confluence with Buffalo Creek during operation. This amount represents approximately 12% of the total volume of sediment that would have naturally been transported in the Dauphin River without operation of Reach 1.

2011/2012 Closure

Table 4.5-3 presents the suspended sediment volume balance computed with the empirical model for the Dauphin River during the 2011/2012 Closure. The general trend is for sediment to leave the Upper Dauphin River, to a lesser degree than during the operation period. According to the empirical model results, the combined cumulative volume of suspended sediment at the confluence between Buffalo Creek and the Dauphin River is estimated at 74,800 m³. The Upper Dauphin River contributes to almost 97% of this volume, while Buffalo Creek is the source of the remaining 3%. The total volume of suspended sediment available for transport or deposition in the Lower Dauphin River should be analyzed in conjunction with the flow velocities occurring along this reach to identify the potential for transport or deposition. This analysis was carried out based on the MIKE-21 results and is discussed in Section 4.5.5.2.

Table 4.5-3. Suspended sediment volume balance for Reach 1 System from Exit of Buffalo Creek to Exit of Dauphin River (Nov. 21, 2012 to July 3, 2014).

Description	Cumulative Sediment Volume (m³)
Dauphin River Baseline	72,200
Buffalo Creek Exit	2,600
Combined Dauphin River Baseline & Buffalo Creek Exit	74,800

The total cumulative volume of suspended sediment in the Dauphin River downstream of the Buffalo Creek confluence during the 2011/2012 closure period was also estimated if Reach 1 had not been operated. Based on the empirical model results, this would amount to 72,600 m³. Conservatively assuming that without operation of Reach 1, flows in Buffalo Creek during the closure period would have been negligible, the residual effects of the operation of Reach 1 after closure of Reach 1 contributed to an additional 2,200 m³ of suspended sediment in the Dauphin River downstream of the confluence with Buffalo Creek. This amount represents only 3% of the total volume of sediment that would have naturally been transported in the Dauphin River without operation. The additional volume of suspended sediment can be explained by the combined effects of the drawdown on Buffalo Lake,

riverbank instabilities following the recession of the water levels and the transport of finer sediment mobilized during the operation of the channel.

2014/2015 Operation

Table 4.5-4 presents the suspended sediment volume balance computed with the empirical model for the Dauphin River during the 2014/2015 Closure. Since these volumes were computed over a shorter period of time, the magnitude is smaller than that reported for the 2011/2012 period, however the same general trend can be observed. According to the empirical model results, the combined cumulative volume of suspended sediment at the confluence between Buffalo Creek and the Dauphin River during this shorter period is estimated at 25,400 m³. The Upper Dauphin River contributes to almost 58% of this volume, while Buffalo Creek is the source of the remaining 42%. Based on the shorter period of record, the contribution of each reach in suspended sediment appears to be similar in proportion as during the 2011/2012 Operation.

Table 4.5-4. Suspended sediment volume balance for Reach 1 System from Exit of Buffalo Creek to Exit of Dauphin River (Jul. 3, 2014 to Oct. 22, 2014).

Description	Cumulative Sediment Volume (m³)
Dauphin River Baseline	14,800
Buffalo Creek Exit	10,600
Combined Dauphin River Baseline & Buffalo Creek Exit	25,400

4.5.5.2 MIKE 21 Model Results

The 5, 50 and 95 percentile flows for the Dauphin River during the 2011/2012 Operation were simulated with the MIKE 21 model. The depth-averaged velocities and water depths were exported from the 2D model and used in this analysis. The simulated velocities for each flow conditions were compared with the theoretical critical velocities for deposition and erosion of each class of material, as defined by the Hjulstrom relationship presented in Figure 4.2-4.

As computed with the MIKE 21 model, velocities in the Lower Dauphin River downstream of the confluence with Buffalo Creek range from 0.5 to 1.5 m/s for the 5th percentile flow. Some areas exceed 1.5 m/s, locally. For the 95th percentile, the computed velocities are greater than 1.5 m/s between the confluence with Buffalo Creek and the exit of the Dauphin River in Sturgeon Bay. According to the Hjulstrom relationship, velocities of 0.5 m/s and greater can erode sand size particles, and are able to transport gravel size material. As flow velocities reach 1.5 m/s, bed material of a gravel size can be eroded, and cobbles with a diameter up to 0.20 m can now be transported by bed load. The range of velocity that existed in the Lower Dauphin River during operation indicates that the general trend is for river bed material to be eroded and transported further downstream until the velocities and shear stresses reach the critical value for deposition of the material.

During the 2011 flood, the flows observed on the Lower Dauphin River have exceeded the 95th percentile calculated for the 2011/2012 Operation period. The range of velocities and therefore the sediment transport processes previously described naturally occurred prior to the operation of Reach 1.

The empirical model computed the total volume of suspended sediment resulting from the operation of Reach 1 and released at the downstream end of Buffalo Creek at 8,900 m^3.The suspended sediment was essentially constituted of clay, silts and sands. Suspended sediment of such sizes will deposit when velocities are lower than 0.01 m/s. Since the minimum velocities during the 2011/2012 Operation generally exceeded 0.5 m/s, it appears that the suspended sediment released from the Reach 1 System would be transported through the Lower Dauphin River into Sturgeon Bay. Some local deposition may occur in back eddies or near the shoreline, however the volume of sediment that will deposit is anticipated to be marginal. The sediment transport processes within Sturgeon Bay are further discussed in Section 4.6.

During the 2011/2012 Closure, the simulated velocities at the median flow remained greater than 0.5 m/s on average. The remaining volume of suspended sediment released from the Reach 1 System at the exit of Buffalo Creek is anticipated to continue to be transported in suspension to Lake Winnipeg.

The velocities in the Lower Dauphin River are such that the smaller particles up to the sand size would be transported in suspension into Sturgeon Bay. Larger particles of the cobble size diameter, could be transported by bed load, and gravel could be eroded. As shown with the bathymetric survey and the simulated flow patterns and velocities, the sediment transport processes in the Lower Dauphin River appear to be highly dynamic and to naturally occur on the Lower Dauphin River. The additional suspended sediment released from Buffalo Creek as the result of the operation of Reach 1 will continue to be transported in suspension into Sturgeon Bay.

4.6 STURGEON BAY MONITORING RESULTS

4.6.1 Water Level

Historical daily water levels for the period of record from 1957 to 2014 on Lake Winnipeg are shown on Figure 4.6-1. The water levels are based on the WSC data at gauge No. 05SD002 (Lake Winnipeg at Matheson Island Landing), which is located approximately 80km South-East of Dauphin River. The 5th, 50th, and 95th percentile water levels of 217.0m (711.9 ft), 217.6m (713.9 ft), and 218.3m (716.14 ft) respectively, for the period of 1957 to the fall of 2014, are shown on the figure.

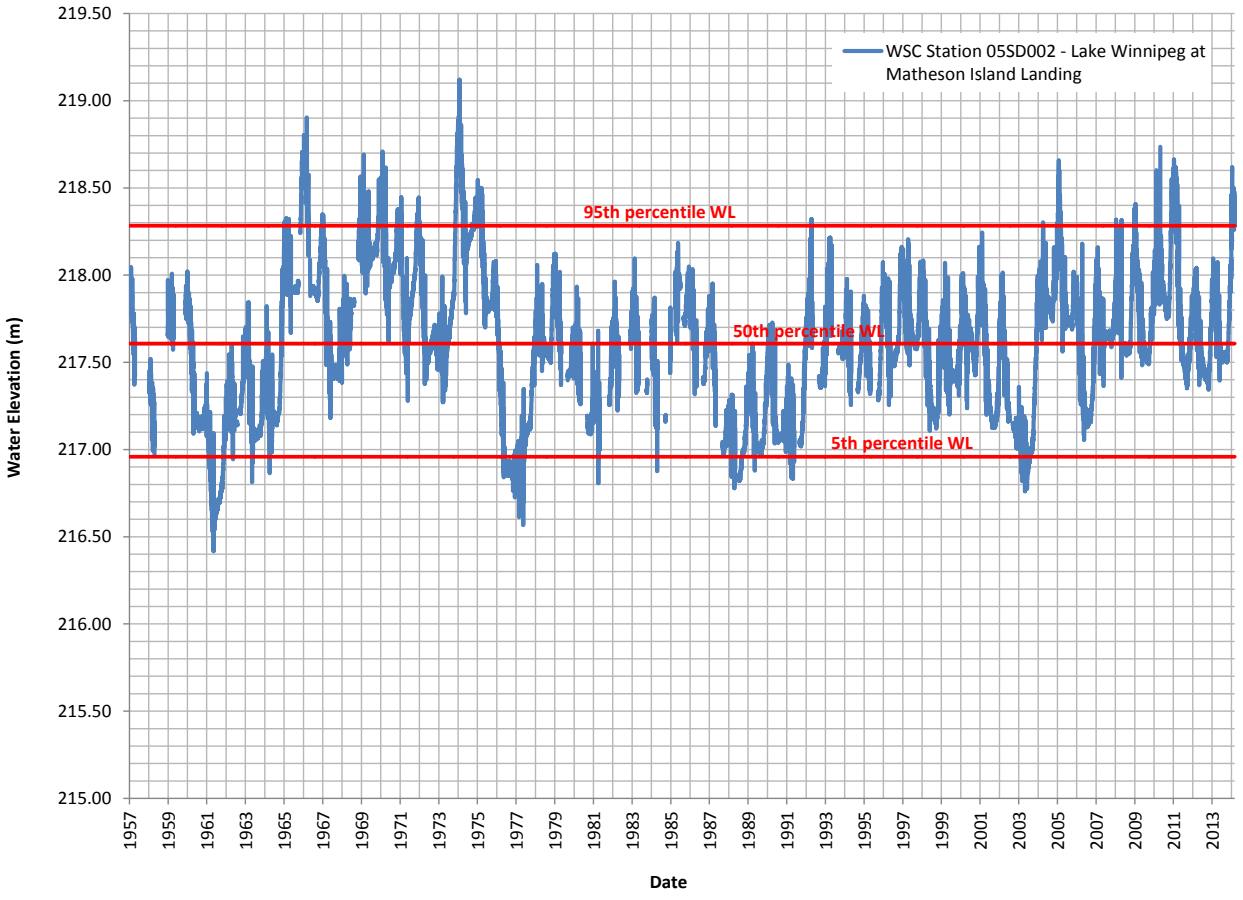


Figure 4.6-1. Recorded water level on Lake Winnipeg.

In 2011, Manitoba Hydro estimated that, at most, Reach 1 running at full capacity would contribute less than 2.5 cm (one inch) to the level of Lake Winnipeg (KGS and AECOM 2011). On this basis, and since the channel evaluated by Manitoba Hydro was larger than the one that was actually constructed, it has been determined that the impacts of the Reach 1 System on Lake Winnipeg water levels are negligible.

4.6.2 Sedimentation Rates

The modeled sediment input indicates that the majority of the suspended sediment entered Sturgeon Bay during the 2011/2012 Operation of Reach 1 during the first month of operation.

The results of sediment trap sampling are shown in Table 4.6-1. Sampling conducted under ice cover indicated that sediment deposition was uniform and occurred at low levels during the winter months, when external factors such as wind-driven current and waves are not a factor. During the open water season, sediment deposition was still uniform throughout the area sampled, but as a result of wind and current driven re-suspension of sediments, it was much higher, as shown on Figures 4.6-2 to 4.6-9. Results from the sediment traps agree with the seasonal variation presented in the State of the Lake Winnipeg (EC and MWS 2011), with sedimentation rates higher in the fall than spring and summer, as shown on Figures 4.6-5 and 4.6-9. It appears that no evident relationship can be established between sedimentation rate and trap distances from the mouth of the Dauphin River.

According to the 1999-2007 State of the Lake report for Lake Winnipeg, while inputs from rivers that discharge into the lake do affect sediment dynamics in the lake, it has been shown that “antecedent winds were the most significant contributor to suspended sediment dynamics” (EC and MWS 2011). While the north basin of Lake Winnipeg is deeper than the south (mean depth of 13.3m and 9m, respectively), the whole lake is quite shallow compared to other lakes than cover a similar amount of area, and it has been shown that “wind driven mixing can reach the bottom, even of the north basin, at least occasionally during most open water season”. The maximum water depths in Sturgeon Bay were measured at 12m, which is less than the average for the north basin. In addition, analyses of satellite imagery by McCullough et al. (2001) indicate that TSS are generally higher in Sturgeon Bay than the rest of the north basin of the Lake.

4.6.3 Hydraulic and Sediment Transport Modeling

The results of the empirical model and the MIKE 21 model showed that the suspended sediment inflow from Reach 1 would remain in suspension in the Lower Dauphin River and would enter Sturgeon Bay. For all flow conditions simulated with the MIKE 21 model during operation and closure, the main flow path is located in front of the exit of Buffalo Creek, at the south end of the model. This main flow path presents velocities exceeding 0.5 m/s further than 500m away from the exit of the river into the bay. Eventually, past this point, velocities become nil.

In theory, the velocities outside of the main flow path where the flows from the Dauphin River enter Sturgeon Bay are such that sediment particles of the sand size category and smaller could deposit. However, as demonstrated in the previous section, the processes affecting the suspension of sediment in Sturgeon Bay are mostly induced by wind effects. Depending on the wind conditions, material originating from Dauphin River could deposit in Sturgeon Bay, and be re-suspended under the effects of wind generated waves and currents.

Table 4.6-1. Summary of sedimentation rates during winter, summer and fall in Sturgeon Bay from October 2011 to October 2014.

Site ID	October 2011 to August 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	-	-	-	-	-	-	-
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	-	-	-	-	-	-	-
ST-7	-	-	-	-	-	-	-
ST-8	-	-	-	-	-	-	-
ST-9	-	-	-	-	-	-	-
ST-10	-	-	-	-	-	-	-
ST-11	-	-	-	-	-	-	-
ST-12	-	-	-	-	-	-	-
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	-	-	-	-	-	-	-
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	-	-	-	-	-	-	-
ST-20	-	-	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	-	-	-	-	-	-	-
ST-23	-	-	-	-	-	-	-
ST-24	-	-	-	-	-	-	-
ST-25	-	-	-	-	-	-	-
ST-26	-	-	-	-	-	-	-
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	-	-	-	-	-	-	-
ST-33	-	-	-	-	-	-	-
ST-34	-	-	-	-	-	-	-
ST-35	296	129.9	8.50	1.17	88.8	10	Silt
ST-36	296	79.2	5.19	0.32	90.8	8.89	Silt
ST-37	296	71.9	4.71	0.17	86.4	13.4	Silt loam
ST-38	296	69.8	4.57	0.35	88.1	11.5	Silt
ST-39	-	-	-	-	-	-	-
ST-40	296	354.0	23.18	67.2	26.7	6.14	Sandy loam
ST-41	297	146.6	9.57	3.46	87.9	8.6	Silt
ST-42	296	86.1	5.64	0.44	86.5	13.1	Silt loam
ST-43	297	67.0	4.37	3.33	83	13.7	Silt loam
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	295	233.0	15.31	17	74.6	8.38	Silt loam
ST-47	297	144.6	9.44	1.22	87.2	11.6	Silt
ST-48	296	75.9	4.97	0.21	90.1	9.67	Silt

Table 4.6-1. Continued.

Site ID	October 2011 to August 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	295	178.1	11.70	12.9	75.3	11.8	Silt loam
ST-49B	-	-	-	-	-	-	-
ST-50	297	134.4	8.77	4.96	88.4	6.66	Silt
ST-51	295	108.1	7.10	1.51	88.2	10.3	Silt
ST-51B	-	-	-	-	-	-	-
ST-52	295	88.7	5.83	0.68	81.4	18	Silt loam
ST-53	295	158.1	10.39	11.1	80.9	7.99	Silt
ST-53B	-	-	-	-	-	-	-
ST-54	295	99.5	6.54	0.59	92.5	6.89	Silt
ST-55	-	-	-	-	-	-	-
ST-55B	-	-	-	-	-	-	-
ST-56	296	67.6	4.43	0.65	85.7	13.7	Silt loam
ST-56B	-	-	-	-	-	-	-
ST-57	297	73.4	4.79	6.49	82.5	11	Silt
ST-58	296	97.5	6.38	2.58	86.3	11.1	Silt
ST-58B	-	-	-	-	-	-	-
ST-59	296	94.8	6.21	1.41	89.6	8.94	Silt
ST-60	296	96.0	6.29	0.83	92.2	6.93	Silt
ST-61	297	88.2	5.76	0.7	80.8	18.5	Silt loam
ST-61B	-	-	-	-	-	-	-
ST-62	-	-	-	-	-	-	-
ST-63	-	-	-	-	-	-	-
Average	**-**	**119.2**	**7.8**	**6.1**	**83.2**	**10.7**	**-**
SD	**-**	**65.9**	**4.3**	**14.1**	**13.2**	**3.3**	**-**

Table 4.6-1. Continued.

Site ID	February to March 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	40	<1	-	-	-	-	-
ST-2	40	<1	-	-	-	-	-
ST-3	40	<1	-	-	-	-	-
ST-4	38	<1	-	-	-	-	-
ST-5	38	7.3	-	-	-	-	-
ST-6	40	<1	-	-	-	-	-
ST-7	40	<1	-	-	-	-	-
ST-8	40	<1	-	-	-	-	-
ST-9	40	<1	-	-	-	-	-
ST-10	38	<1	-	-	-	-	-
ST-11	39	<1	-	-	-	-	-
ST-12	39	<1	-	-	-	-	-
ST-13	38	<1	-	-	-	-	-
ST-14	38	<1	-	-	-	-	-
ST-15	38	<1	-	-	-	-	-
ST-16	36	<1	-	-	-	-	-
ST-17	36	<1	-	-	-	-	-
ST-18	36	<1	-	-	-	-	-
ST-19	36	<1	-	-	-	-	-
ST-20	38	<1	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	36	<1	-	-	-	-	-
ST-23	38	<1	-	-	-	-	-
ST-24	38	<1	-	-	-	-	-
ST-25	37	<1	-	-	-	-	-
ST-26	39	<1	-	-	-	-	-
ST-27	38	<1	-	-	-	-	-
ST-28	39	<1	-	-	-	-	-
ST-29	39	<1	-	-	-	-	-
ST-30	39	<1	-	-	-	-	-
ST-31	39	<1	-	-	-	-	-
ST-32	39	<1	-	-	-	-	-
ST-33	39	<1	-	-	-	-	-
ST-34	39	<1	-	-	-	-	-
ST-35	-	-	-	-	-	-	-
ST-36	-	-	-	-	-	-	-
ST-37	-	-	-	-	-	-	-
ST-38	-	-	-	-	-	-	-
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	-	-	-	-	-	-	-
ST-42	-	-	-	-	-	-	-
ST-43	-	-	-	-	-	-	-
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	-	-	-	-	-	-	-
ST-48	-	-	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	February to March 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	-	-	-	-	-	-	-
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	-	-	-	-	-	-	-
ST-51B	-	-	-	-	-	-	-
ST-52	-	-	-	-	-	-	-
ST-53	-	-	-	-	-	-	-
ST-53B	-	-	-	-	-	-	-
ST-54	-	-	-	-	-	-	-
ST-55	-	-	-	-	-	-	-
ST-55B	-	-	-	-	-	-	-
ST-56	-	-	-	-	-	-	-
ST-56B	-	-	-	-	-	-	-
ST-57	-	-	-	-	-	-	-
ST-58	-	-	-	-	-	-	-
ST-58B	-	-	-	-	-	-	-
ST-59	-	-	-	-	-	-	-
ST-60	-	-	-	-	-	-	-
ST-61	-	-	-	-	-	-	-
ST-61B	-	-	-	-	-	-	-
ST-62	-	-	-	-	-	-	-
ST-63	-	-	-	-	-	-	-
Average	**-**	**<1**	-	-	-	-	-
SD	**-**	**-**	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	March to August 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	-	-	-	-	-	-	-
ST-3	141	42.1	5.79	0.63	87.7	11.6	Silt
ST-4	-	-	-	-	-	-	-
ST-5	141	49.7	6.83	3.36	78.7	18	Silt loam
ST-6	-	-	-	-	-	-	-
ST-7	-	-	-	-	-	-	-
ST-8	140	52.0	7.20	0.62	90.8	8.54	Silt
ST-9	-	-	-	-	-	-	-
ST-10	-	-	-	-	-	-	-
ST-11	-	-	-	-	-	-	-
ST-12	141	71.4	9.81	0.7	82.8	16.5	Silt loam
ST-13	143	97.4	13.20	6.12	87.8	6.1	Silt
ST-14	119	13.0	2.12	0.63	83.1	16.3	Silt loam
ST-15	-	-	-	-	-	-	-
ST-16	-	-	-	-	-	-	-
ST-17	143	98.7	13.38	3.86	86	10.2	Silt
ST-18	141	81.4	11.19	0.36	92.3	7.33	Silt
ST-19	141	57.8	7.94	1.17	80.4	18.4	Silt loam
ST-20	139	59.5	8.30	0.69	85.7	13.7	Silt loam
ST-21	-	-	-	-	-	-	-
ST-22	141	103.8	14.27	3.45	90.2	6.36	Silt
ST-23	139	60.1	8.38	0.57	85.1	14.4	Silt loam
ST-24	-	-	-	-	-	-	-
ST-25	141	128.3	17.63	16.6	76	7.39	Silt loam
ST-26	139	131.4	18.32	14.7	79	6.3	Silt loam/silt
ST-27	141	60.5	8.32	0.47	72.7	26.9	Silt loam
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	140	75.6	10.47	0.49	94.4	5.08	Silt
ST-31	141	66.9	9.20	0.62	68.5	30.9	Silty clay loam
ST-32	141	85.2	11.71	8.51	82.9	8.59	Silt
ST-33	140	112.3	15.55	7.92	82.7	9.4	Silt
ST-34	140	102.0	14.12	6.05	88.5	5.42	Silt
ST-35	-	-	-	-	-	-	-
ST-36	-	-	-	-	-	-	-
ST-37	-	-	-	-	-	-	-
ST-38	-	-	-	-	-	-	-
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	-	-	-	-	-	-	-
ST-42	-	-	-	-	-	-	-
ST-43	-	-	-	-	-	-	-
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	-	-	-	-	-	-	-
ST-48	-	-	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	March to August 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	-	-	-	-	-	-	-
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	-	-	-	-	-	-	-
ST-51B	-	-	-	-	-	-	-
ST-52	-	-	-	-	-	-	-
ST-53	-	-	-	-	-	-	-
ST-53B	-	-	-	-	-	-	-
ST-54	-	-	-	-	-	-	-
ST-55	-	-	-	-	-	-	-
ST-55B	-	-	-	-	-	-	-
ST-56	-	-	-	-	-	-	-
ST-56B	-	-	-	-	-	-	-
ST-57	-	-	-	-	-	-	-
ST-58	-	-	-	-	-	-	-
ST-58B	-	-	-	-	-	-	-
ST-59	-	-	-	-	-	-	-
ST-60	-	-	-	-	-	-	-
ST-61	-	-	-	-	-	-	-
ST-61B	-	-	-	-	-	-	-
ST-62	-	-	-	-	-	-	-
ST-63	-	-	-	-	-	-	-
Average	**-**	**77.5**	**10.7**	**3.9**	**83.8**	**12.4**	**-**
SD	**-**	**30.1**	**4.1**	**4.8**	**6.6**	**7.1**	**-**

Table 4.6-1. Continued.

Site ID	August to October 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	-	-	-	-	-	-	-
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	-	-	-	-	-	-	-
ST-7	-	-	-	-	-	-	-
ST-8	-	-	-	-	-	-	-
ST-9	-	-	-	-	-	-	-
ST-10	-	-	-	-	-	-	-
ST-11	-	-	-	-	-	-	-
ST-12	-	-	-	-	-	-	-
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	-	-	-	-	-	-	-
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	68	94.6	26.96	0	64.6	35.4	Silty clay loam
ST-20	68	88.2	25.14	0	74.2	25.8	Silt loam
ST-21	-	-	-	-	-	-	-
ST-22	68	127.4	36.31	1.02	71.6	27.4	Silt loam / Silty clay loam
ST-23	68	98.6	28.10	0.13	59.1	40.7	Silt Clay loam / Silty clay
ST-24	-	-	-	-	-	-	-
ST-25	68	116.9	33.32	39.3	35.8	24.9	Loam
ST-26	68	133.2	37.96	18	55	27	Silt loam
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	-	-	-	-	-	-	-
ST-33	67	167.0	48.30	8.35	70.1	21.6	Silt loam
ST-34	67	191.3	55.33	6.06	72.1	21.8	Silt loam
ST-35	-	-	-	-	-	-	-
ST-36	-	-	-	-	-	-	-
ST-37	-	-	-	-	-	-	-
ST-38	-	-	-	-	-	-	-
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	-	-	-	-	-	-	-
ST-42	-	-	-	-	-	-	-
ST-43	-	-	-	-	-	-	-
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	-	-	-	-	-	-	-
ST-48	-	-	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	August to October 2012						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	-	-	-	-	-	-	-
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	-	-	-	-	-	-	-
ST-51B	-	-	-	-	-	-	-
ST-52	-	-	-	-	-	-	-
ST-53	-	-	-	-	-	-	-
ST-53B	-	-	-	-	-	-	-
ST-54	-	-	-	-	-	-	-
ST-55	-	-	-	-	-	-	-
ST-55B	-	-	-	-	-	-	-
ST-56	-	-	-	-	-	-	-
ST-56B	-	-	-	-	-	-	-
ST-57	-	-	-	-	-	-	-
ST-58	-	-	-	-	-	-	-
ST-58B	-	-	-	-	-	-	-
ST-59	-	-	-	-	-	-	-
ST-60	-	-	-	-	-	-	-
ST-61	-	-	-	-	-	-	-
ST-61B	-	-	-	-	-	-	-
ST-62	-	-	-	-	-	-	-
ST-63	-	-	-	-	-	-	-
Average	**-**	**127.2**	**36.4**	**9.1**	**62.8**	**28.1**	**-**
SD	**-**	**36.3**	**10.7**	**13.7**	**12.8**	**6.7**	**-**

Table 4.6-1. Continued.

Site ID	October 2012 to June 2013						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	-	-	-	-	-	-	-
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	-	-	-	-	-	-	-
ST-7	-	-	-	-	-	-	-
ST-8	-	-	-	-	-	-	-
ST-9	-	-	-	-	-	-	-
ST-10	-	-	-	-	-	-	-
ST-11	-	-	-	-	-	-	-
ST-12	-	-	-	-	-	-	-
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	-	-	-	-	-	-	-
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	-	-	-	-	-	-	-
ST-20	-	-	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	-	-	-	-	-	-	-
ST-23	-	-	-	-	-	-	-
ST-24	-	-	-	-	-	-	-
ST-25	-	-	-	-	-	-	-
ST-26	-	-	-	-	-	-	-
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	-	-	-	-	-	-	-
ST-33	-	-	-	-	-	-	-
ST-34	-	-	-	-	-	-	-
ST-35	253	53.5	4.10	2.85	78.2	18.9	Silt loam
ST-36	253	33.5	2.57	0.51	73.4	26.1	Silt loam
ST-37	253	28.3	2.17	1.47	76	22.6	Silt loam
ST-38	253	20.6	1.58	1.44	75.1	23.5	Silt loam
ST-39	-	-	-	-	-	-	-
ST-40	253	48.8	3.74	28.4	59.8	11.8	Silt loam
ST-41	253	40.6	3.11	1.47	74.1	24.4	Silt loam
ST-42	253	22.7	1.74	0.14	77.1	22.8	Silt loam
ST-43	243	10.2	0.81	1.16	65.4	33.4	Silty clay loam
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	253	47.8	3.66	12.7	69.3	18.1	Silt loam
ST-47	-	-	-	-	-	-	-
ST-48	253	30.4	2.33	2.6	69.3	28.1	Silty clay loam

Table 4.6-1. Continued.

Site ID	October 2012 to June 2013						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	-	-	-	-	-	-	-
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	242	24.6	1.97	2.1	79.9	18	Silt loam
ST-51B							
ST-52	242	15.5	1.24	0.25	73.1	26.7	Silt loam
ST-53	-	-	-	-	-	-	-
ST-53B	-	-	-	-	-	-	-
ST-54	242	27	2.16	1.32	75.5	23.2	Silt loam
ST-55	242	22.7	1.82	0.2	78.2	21.6	Silt loam
ST-55B	-	-	-	-	-	-	-
ST-56	242	16.6	1.33	0.15	83	16.9	Silt loam
ST-56B	-	-	-	-	-	-	-
ST-57	243	11.2	0.89	1.12	71.4	27.5	Silt loam / Silty clay loam
ST-58	-	-	-	-	-	-	-
ST-58B	-	-	-	-	-	-	-
ST-59	242	27.9	2.23	2.06	73.1	24.8	Silt loam
ST-60	-	-	-	-	-	-	-
ST-61	-	-	-	-	-	-	-
ST-61B	-	-	-	-	-	-	-
ST-62	-	-	-	-	-	-	-
ST-63	-	-	-	-	-	-	-
Average	**-**	**28.3**	**2.2**	**3.5**	**73.6**	**22.8**	**-**
SD	**-**	**12.9**	**1.0**	**7.0**	**5.6**	**5.1**	**-**

Table 4.6-1. Continued.

Site ID	January to April 2014						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	75	< 1.0	-	-	-	-	-
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	75	< 1.0	-	-	-	-	-
ST-7			-	-	-	-	-
ST-8	74	< 1.0	-	-	-	-	-
ST-9	74	< 1.0	-	-	-	-	-
ST-10	71	< 1.0	-	-	-	-	-
ST-11	70	< 1.0	-	-	-	-	-
ST-12	70	< 1.0	-	-	-	-	-
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	74	< 1.0	-	-	-	-	-
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	-	-	-	-	-	-	-
ST-20	-	-	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	-	-	-	-	-	-	-
ST-23	-	-	-	-	-	-	-
ST-24	-	-	-	-	-	-	-
ST-25	-	-	-	-	-	-	-
ST-26	-	-	-	-	-	-	-
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	70	< 1.0	-	-	-	-	-
ST-33	-	-	-	-	-	-	-
ST-34	-	-	-	-	-	-	-
ST-35	75	< 1.0	-	-	-	-	-
ST-36	-	-	-	-	-	-	-
ST-37	75	< 1.0	-	-	-	-	-
ST-38	75	< 1.0	-	-	-	-	-
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	74	< 1.0	-	-	-	-	-
ST-42	74	< 1.0	-	-	-	-	-
ST-43	75	< 1.0	-	-	-	-	-
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	74	< 1.0	-	-	-	-	-
ST-48	74	< 1.0	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	January to April 2014						
	Number of Days	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	73	< 1.0	-	-	-	-	-
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	72	< 1.0	-	-	-	-	-
ST-51B			-	-	-	-	-
ST-52	73	< 1.0	-	-	-	-	-
ST-53	70	< 1.0	-	-	-	-	-
ST-53B	-	-	-	-	-	-	-
ST-54	-	-	-	-	-	-	-
ST-55	70	< 1.0	-	-	-	-	-
ST-55B	-	-	-	-	-	-	-
ST-56	70	< 1.0	-	-	-	-	-
ST-56B	-	-	-	-	-	-	-
ST-57	70	< 1.0	-	-	-	-	-
ST-58	70	< 1.0	-	-	-	-	-
ST-58B	-	-	-	-	-	-	-
ST-59	-	-	-	-	-	-	-
ST-60	70	< 1.0	-	-	-	-	-
ST-61	70	< 1.0	-	-	-	-	-
ST-61B	-	-	-	-	-	-	-
ST-62	70	< 1.0	-	-	-	-	-
ST-63	75	< 1.0	-	-	-	-	-
Average	**-**	**<1**	-	-	-	-	-
SD	**-**	**-**	-	-	-	-	-

Table 4.6-1. Continued.

Site ID	April to June 2014						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	75	14.1	3.64	0.49	68.7	30.8	Silty clay loam
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	75	7	1.81	1.34	59.4	39.2	Silty clay loam
ST-7	-	-	-	-	-	-	-
ST-8	77	216.3	54.44	0.25	48.3	51.5	Silty clay
ST-9	77	248.6	62.57	0.27	45	54.7	Silty clay
ST-10	77	3.6	0.91	0.71	58.1	41.2	Silty clay
ST-11	78	4.7	1.17	0.79	56.2	43	Silty clay
ST-12	77	5.8	1.46	0.52	58.7	40.8	Silt Clay loam / Silty clay
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	77	4.7	1.18	3.94	55.2	40.8	Silt Clay loam / Silty clay
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	-	-	-	-	-	-	-
ST-20	-	-	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	-	-	-	-	-	-	-
ST-23	-	-	-	-	-	-	-
ST-24	-	-	-	-	-	-	-
ST-25	-	-	-	-	-	-	-
ST-26	-	-	-	-	-	-	-
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	77	8.8	2.21	4.66	58.2	37.1	Silty clay loam
ST-33	-	-	-	-	-	-	-
ST-34	-	-	-	-	-	-	-
ST-35	76	4	1.02	1.11	57.4	41.5	Silty clay
ST-36	-	-	-	-	-	-	-
ST-37	75	5.2	1.34	0.16	58.7	41.2	Silty clay
ST-38	75	3.8	0.98	1.22	58.4	40.4	Silt Clay loam / Silty clay
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	77	9.5	2.39	0.82	67.1	32.1	Silty clay loam
ST-42	77	5.8	1.46	2.24	58.2	39.5	Silty clay loam
ST-43	75	3.4	0.88	0.91	51.4	47.6	Silty clay
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	77	10.5	2.64	0.59	71.6	27.8	Silt loam / Silty clay loam
ST-48	77	5.7	1.43	3.63	59.4	37	Silty clay loam

Table 4.6-1. Continued.

Site ID	April to June 2014						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	77	115.6	29.09	17	64.5	18.5	Silt loam
ST-49B	-	-	-	-	-	-	-
ST-50	-	-	-	-	-	-	-
ST-51	78	77.5	19.26	0.61	69	30.4	Silty clay loam
ST-51B	-	-	-	-	-	-	-
ST-52	77	4.7	1.18	1.77	62.9	35.3	Silty clay loam
ST-53	77	14.5	3.65	4.4	59.3	36.3	Silty clay loam
ST-53B	-	-	-	-	-	-	-
ST-54	-	-	-	-	-	-	-
ST-55	78	5.3	1.32	0.82	59.7	39.5	Silty clay loam
ST-55B	-	-	-	-	-	-	-
ST-56	78	3.9	0.97	1.67	57.5	40.8	Silt Clay loam / Silty clay
ST-56B	-	-	-	-	-	-	-
ST-57	77	5.9	1.48	0.64	56.8	42.6	Silty clay
ST-58	77	7.8	1.96	0.78	62.5	36.7	Silty clay loam
ST-58B	-	-	-	-	-	-	-
ST-59	-	-	-	-	-	-	-
ST-60	77	6.7	1.69	0.85	65.6	33.6	Silty clay loam
ST-61	77	5.9	1.48	5.33	56.5	38.2	Silty clay loam
ST-61B	-	-	-	-	-	-	-
ST-62	77	9.6	2.42	9.04	63.7	27.3	Silt loam / Silty clay loam
ST-63	75	3.1	0.80	0.89	57.7	41.4	Silty clay
Average	**-**	**30.0**	**7.5**	**2.1**	**59.4**	**38.4**	**-**
SD	**-**	**63.5**	**16.0**	**3.3**	**6.0**	**7.1**	**-**

Table 4.6-1. Continued.

Site ID	June to October 2014						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate ($mg/cm^2/day$)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-1	-	-	-	-	-	-	-
ST-2	109	107.1	19.04	0.24	46.9	52.8	Silty clay
ST-3	-	-	-	-	-	-	-
ST-4	-	-	-	-	-	-	-
ST-5	-	-	-	-	-	-	-
ST-6	109	90.7	16.13	0.27	49.3	50.4	Silty clay
ST-7	-	-	-	-	-	-	-
ST-8	108	98.3	17.64	0.14	45.9	54	Silty clay
ST-9	109	66.1	11.75	<0.10	43.1	56.9	Silty clay
ST-10	109	68.9	12.25	<0.10	46	54	Silty clay
ST-11	109	84.7	15.06	<0.10	46.1	53.8	Silty clay
ST-12	110	107.8	18.99	0.68	49.5	49.8	Silty clay
ST-13	-	-	-	-	-	-	-
ST-14	-	-	-	-	-	-	-
ST-15	108	82	14.71	0.2	46.7	53.1	Silty clay
ST-16	-	-	-	-	-	-	-
ST-17	-	-	-	-	-	-	-
ST-18	-	-	-	-	-	-	-
ST-19	-	-	-	-	-	-	-
ST-20	-	-	-	-	-	-	-
ST-21	-	-	-	-	-	-	-
ST-22	-	-	-	-	-	-	-
ST-23	-	-	-	-	-	-	-
ST-24	-	-	-	-	-	-	-
ST-25	-	-	-	-	-	-	-
ST-26	-	-	-	-	-	-	-
ST-27	-	-	-	-	-	-	-
ST-28	-	-	-	-	-	-	-
ST-29	-	-	-	-	-	-	-
ST-30	-	-	-	-	-	-	-
ST-31	-	-	-	-	-	-	-
ST-32	110	129	22.73	2.66	57.2	40.1	Silt Clay loam / Silty clay
ST-33	-	-	-	-	-	-	-
ST-34	-	-	-	-	-	-	-
ST-35	108	118.1	21.19	0.99	64.1	34.9	Silty clay loam
ST-36	-	-	-	-	-	-	-
ST-37	109	91	16.18	<0.10	47.5	52.5	Silty clay
ST-38	109	92.3	16.41	<0.10	49.2	50.7	Silty clay
ST-39	-	-	-	-	-	-	-
ST-40	-	-	-	-	-	-	-
ST-41	108	78.9	14.16	0.38	61.7	37.9	Silty clay loam
ST-42	108	93.9	16.85	<0.10	48.8	51.2	Silty clay
ST-43	110	76.6	13.50	0.18	45.6	54.3	Silty clay
ST-44	-	-	-	-	-	-	-
ST-45	-	-	-	-	-	-	-
ST-46	-	-	-	-	-	-	-
ST-47	108	104.8	18.81	0.71	69.1	30.2	Silty clay loam
ST-48	108	85.7	15.38	<0.10	50.7	49.2	Silty clay

Table 4.6-1. Continued.

Site ID	June to October 2014						
	Number of Days Deployed	Total Dry Weight (g)	Sedimentation Rate (mg/cm^2/day)	Sand (%)	Silt (%)	Clay (%)	Texture
ST-49	108	115.3	20.69	23.8	57	19.3	Silt loam
ST-49B	115	122.8	20.69	28.7	52.9	18.4	Silt loam
ST-50	-	-	-	-	-	-	-
ST-51	108	112.1	20.12	<0.10	70.9	29.1	Silty clay loam
ST-51B	115	121.8	20.53	0.16	70.5	29.3	Silty clay loam
ST-52	108	92.4	16.58	<0.10	49.9	50	Silty clay
ST-53	-	-	-	-	-	-	-
ST-53B	116	122.8	20.52	19.4	52.3	28.3	Silty clay loam
ST-54	-	-	-	-	-	-	-
ST-55	109	44	7.82	0.2	57	42.8	Silty clay
ST-55B	116	148.7	24.84	0.12	63.2	36.7	Silty clay loam
ST-56	109	129.4	23.01	0.12	53.7	46.1	Silty clay
ST-56B	116	89.8	15.00	0.14	51.4	48.5	Silty clay
ST-57	110	112.1	19.75	0.37	55.7	43.9	Silty clay
ST-58	110	102	17.97	2.97	62.1	34.9	Silty clay loam
ST-58B	116	91.6	15.30	2.25	63	34.8	Silty clay loam
ST-59	-	-	-	-	-	-	-
ST-60	110	102.7	18.09	1.11	58.4	40.5	Silt Clay loam / Silty clay
ST-61	110	102.5	18.06	0.6	56	43.4	Silty clay
ST-61B	116	102.7	17.16	0.6	56.4	43	Silty clay
ST-62	110	161.8	28.51	2.45	70.9	26.6	Silt loam
ST-63	109	93.1	16.55	0.35	47.5	52.1	Silty clay
Average	**-**	**99.6**	**17.5**	**3.8**	**54.4**	**42.9**	**-**
SD	**-**	**21.3**	**3.6**	**8.2**	**7.8**	**10.7**	**-**

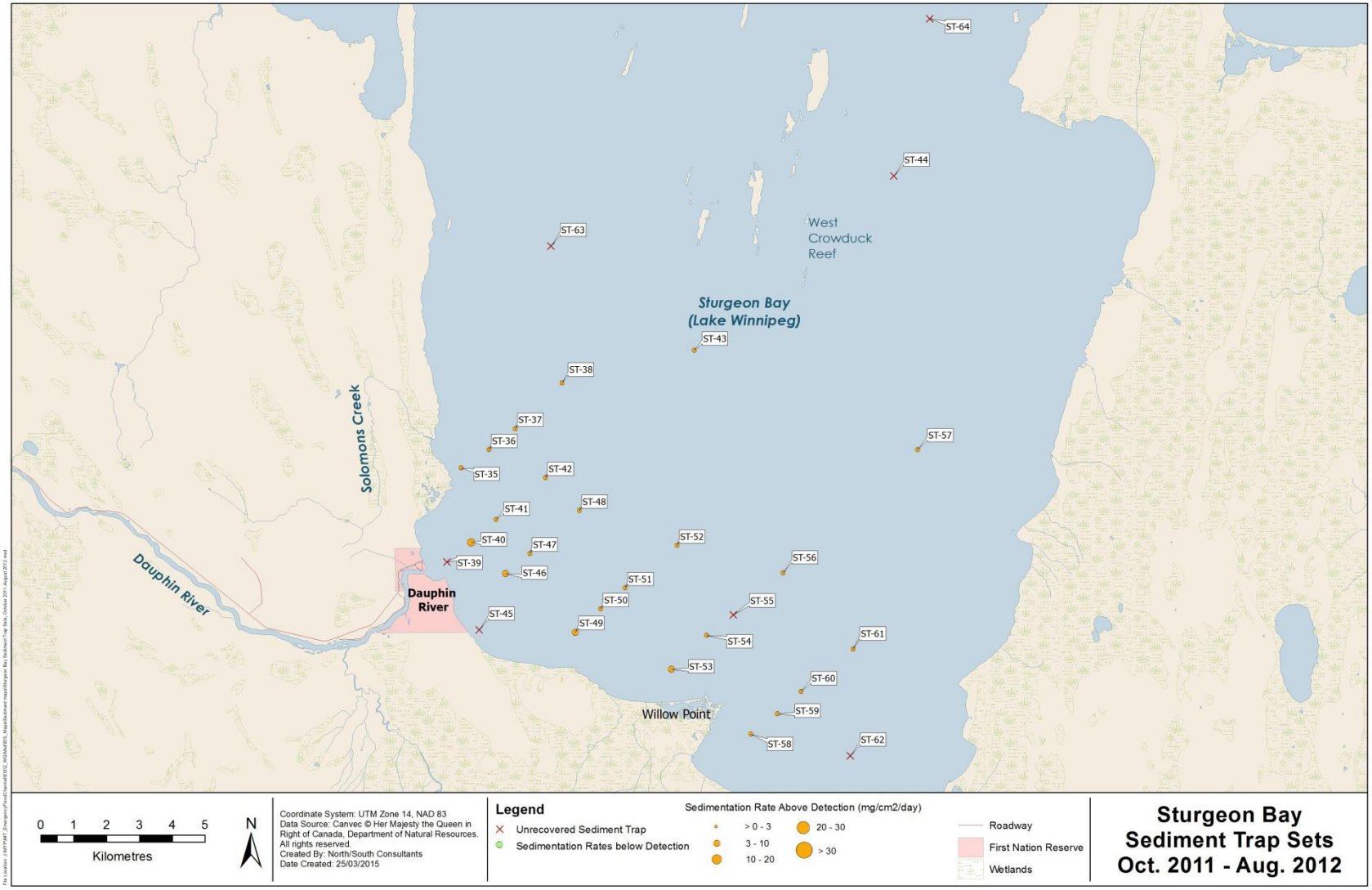


Figure 4.6-2. Sedimentation rates in Sturgeon Bay, October 2011 to August 2012.

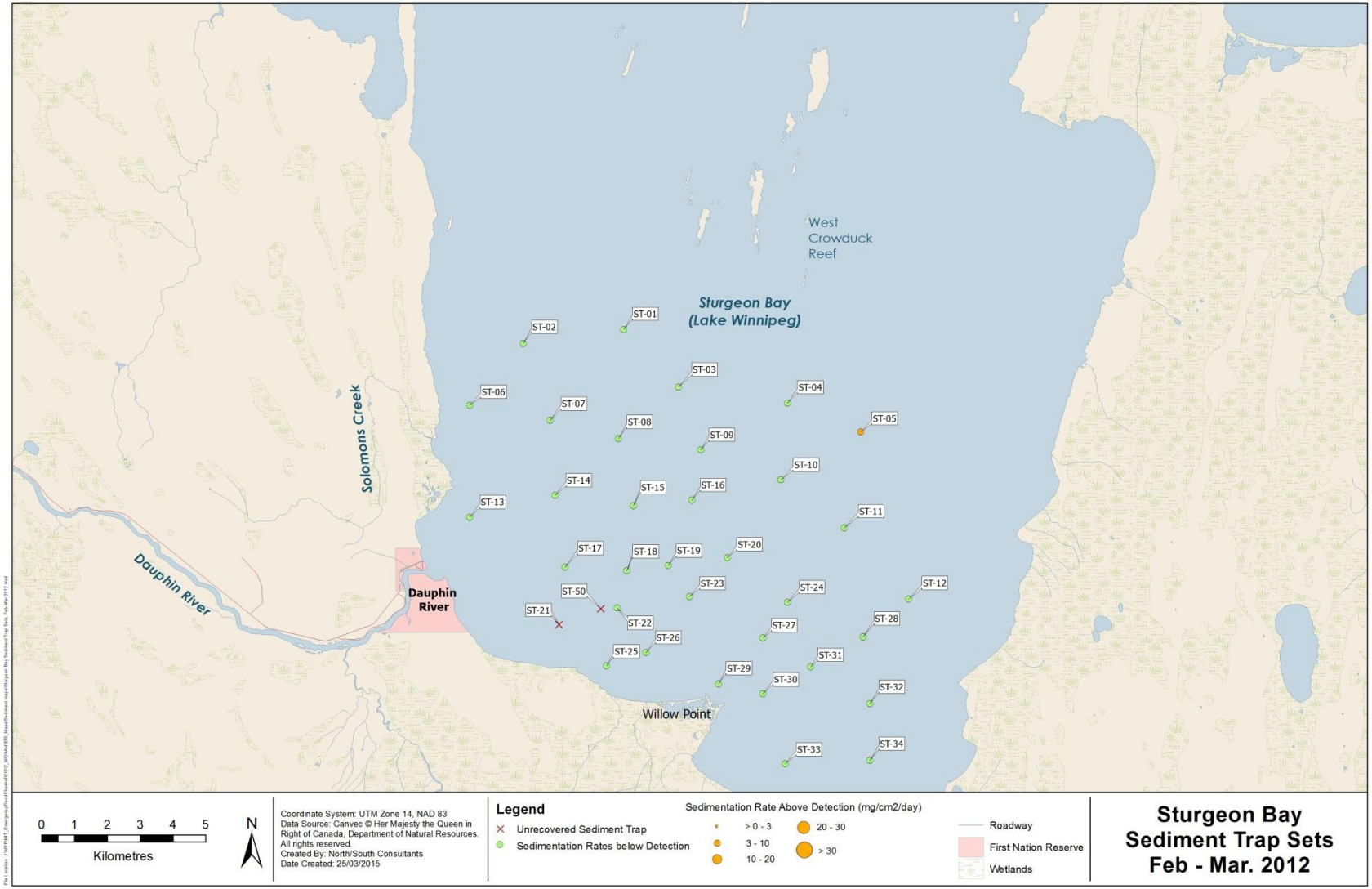


Figure 4.6-3. Sedimentation rates in Sturgeon Bay, February to March 2012.

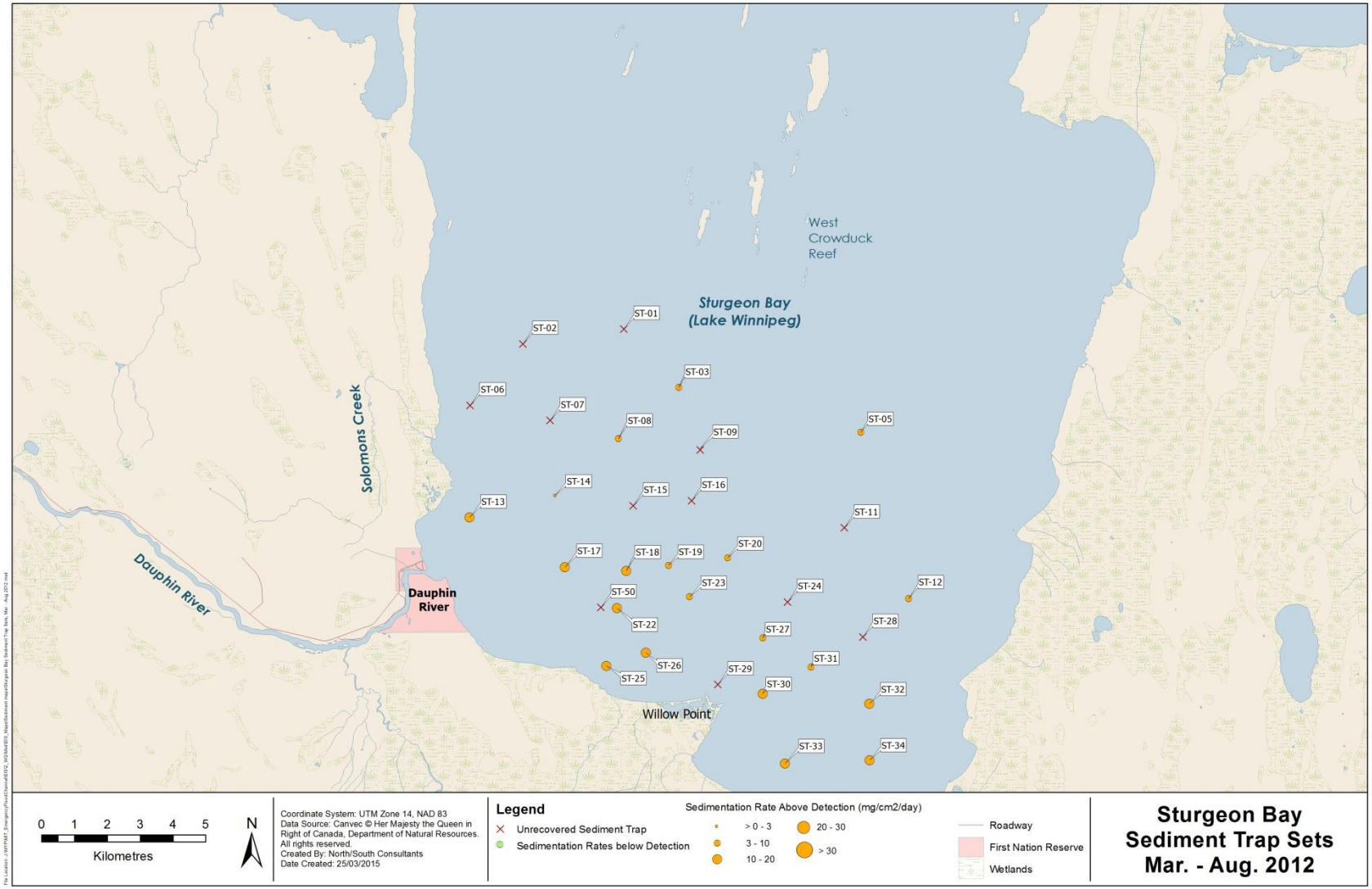


Figure 4.6-4. Sedimentation rates in Sturgeon Bay, March to August 2012.

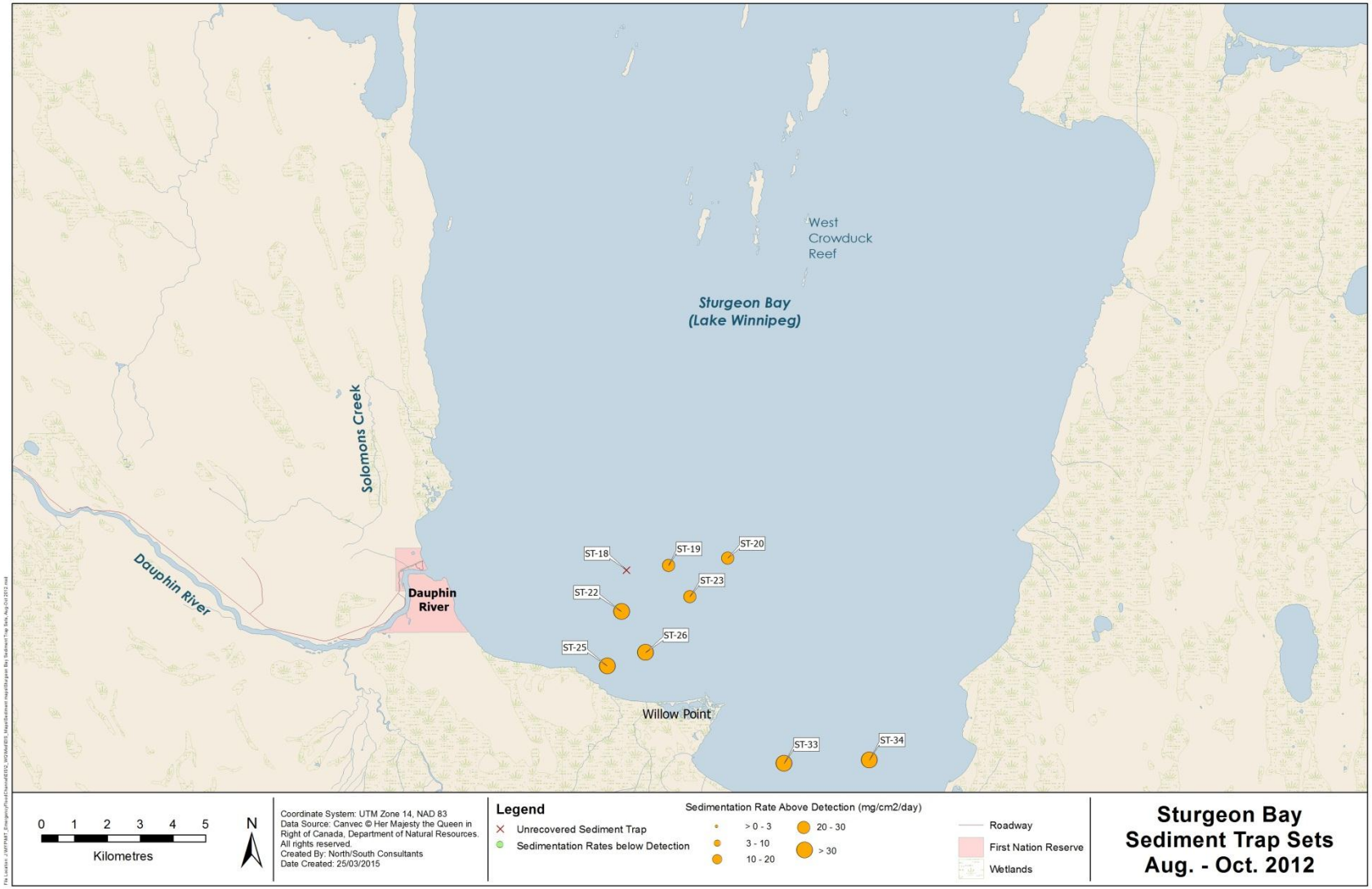


Figure 4.6-5. Sedimentation rates in Sturgeon Bay, August to October 2012.

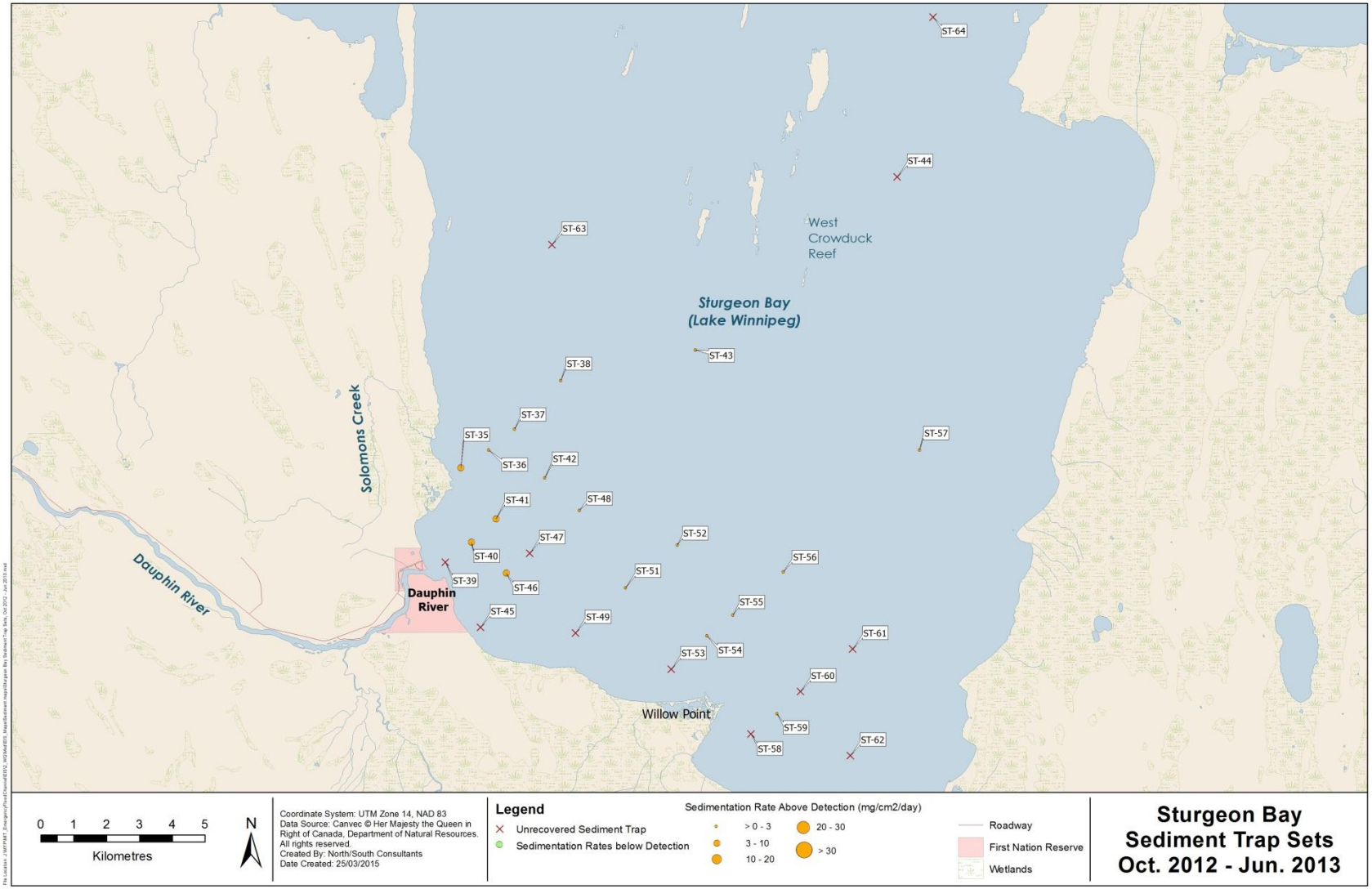


Figure 4.6-6. Sedimentation rates in Sturgeon Bay, October 2012 to June 2013.

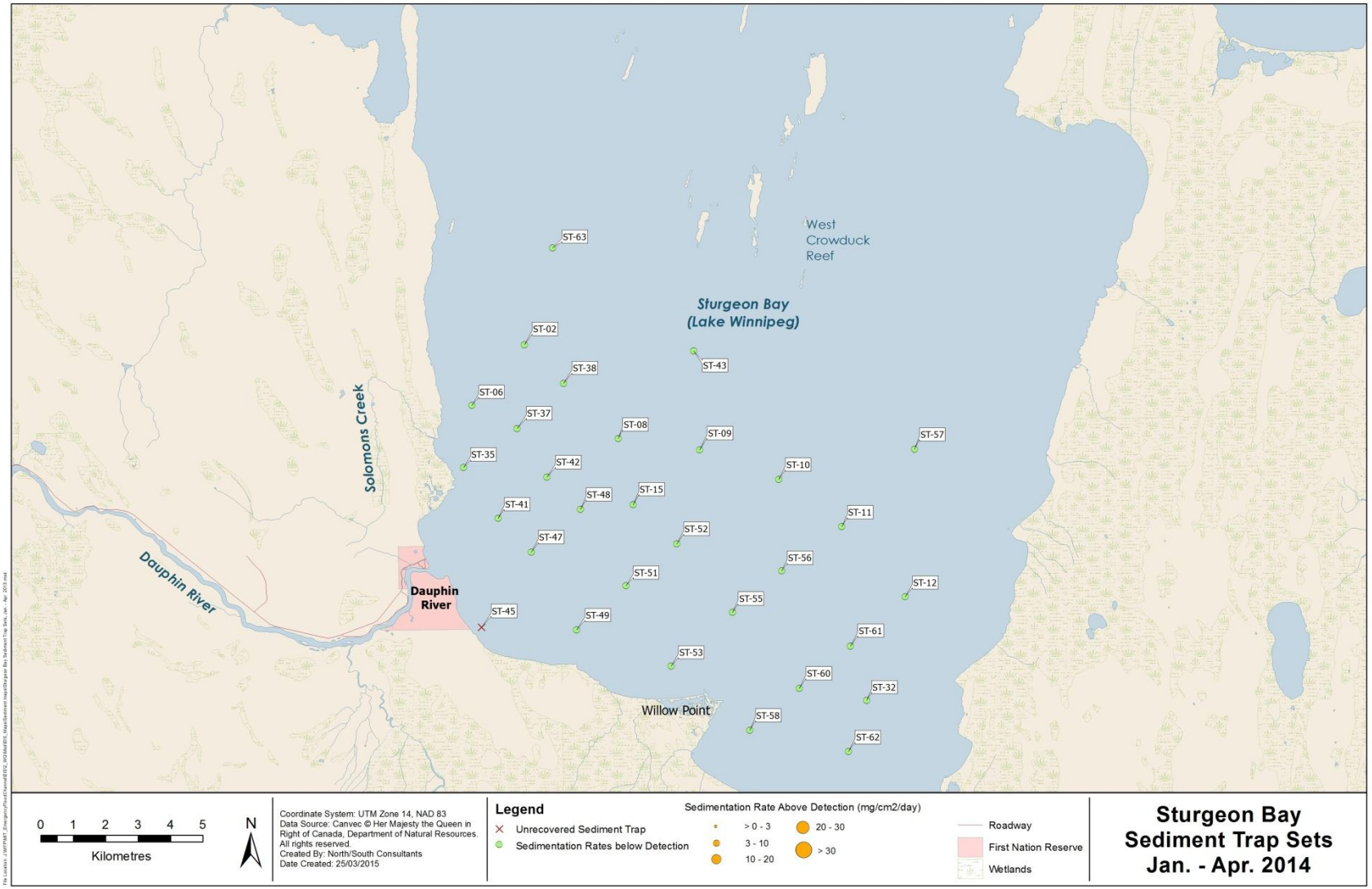


Figure 4.6-7. Sedimentation rates in Sturgeon Bay, January to April 2014.

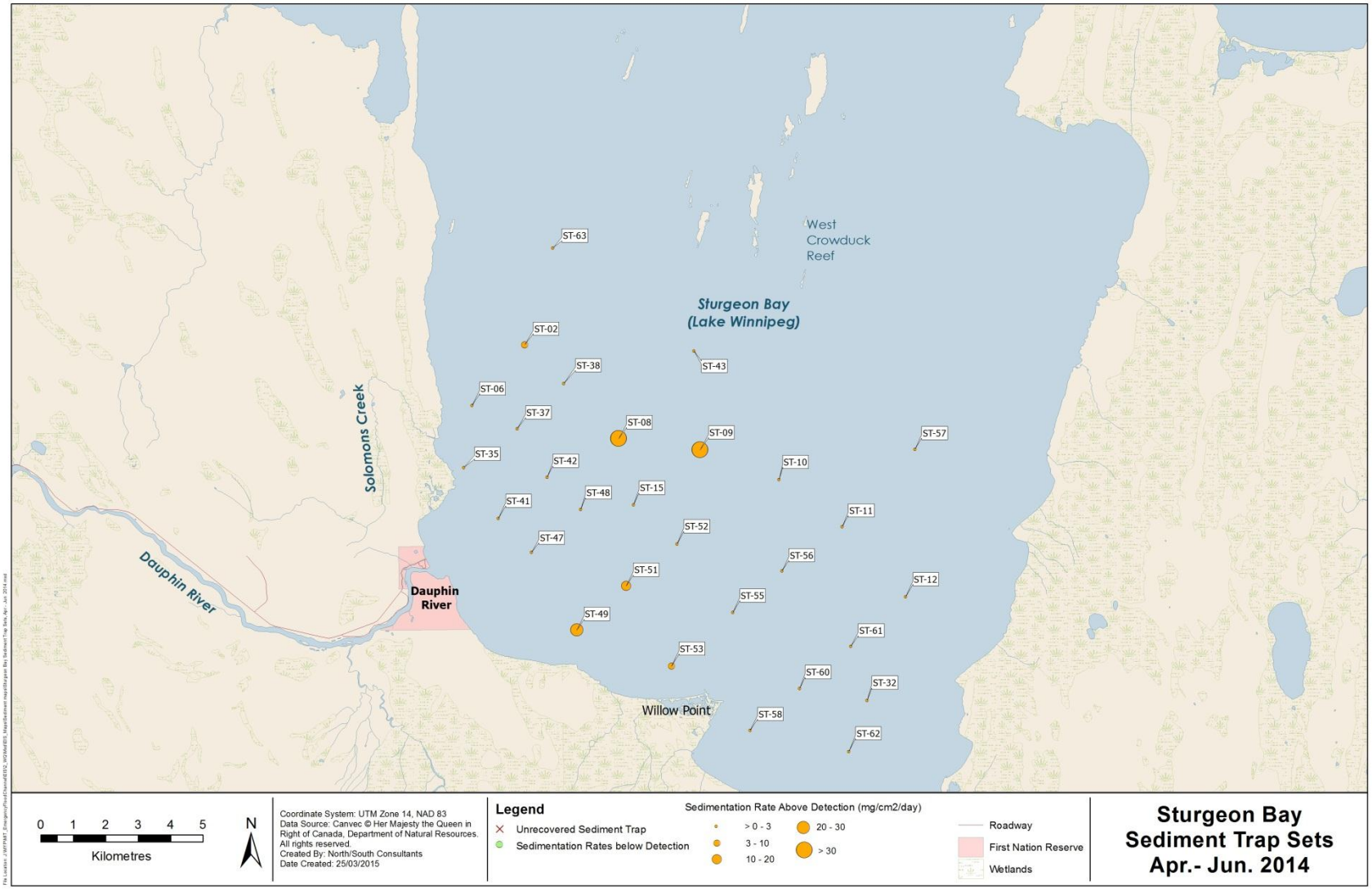


Figure 4.6-8. Sedimentation rates in Sturgeon Bay, January to April 2014.

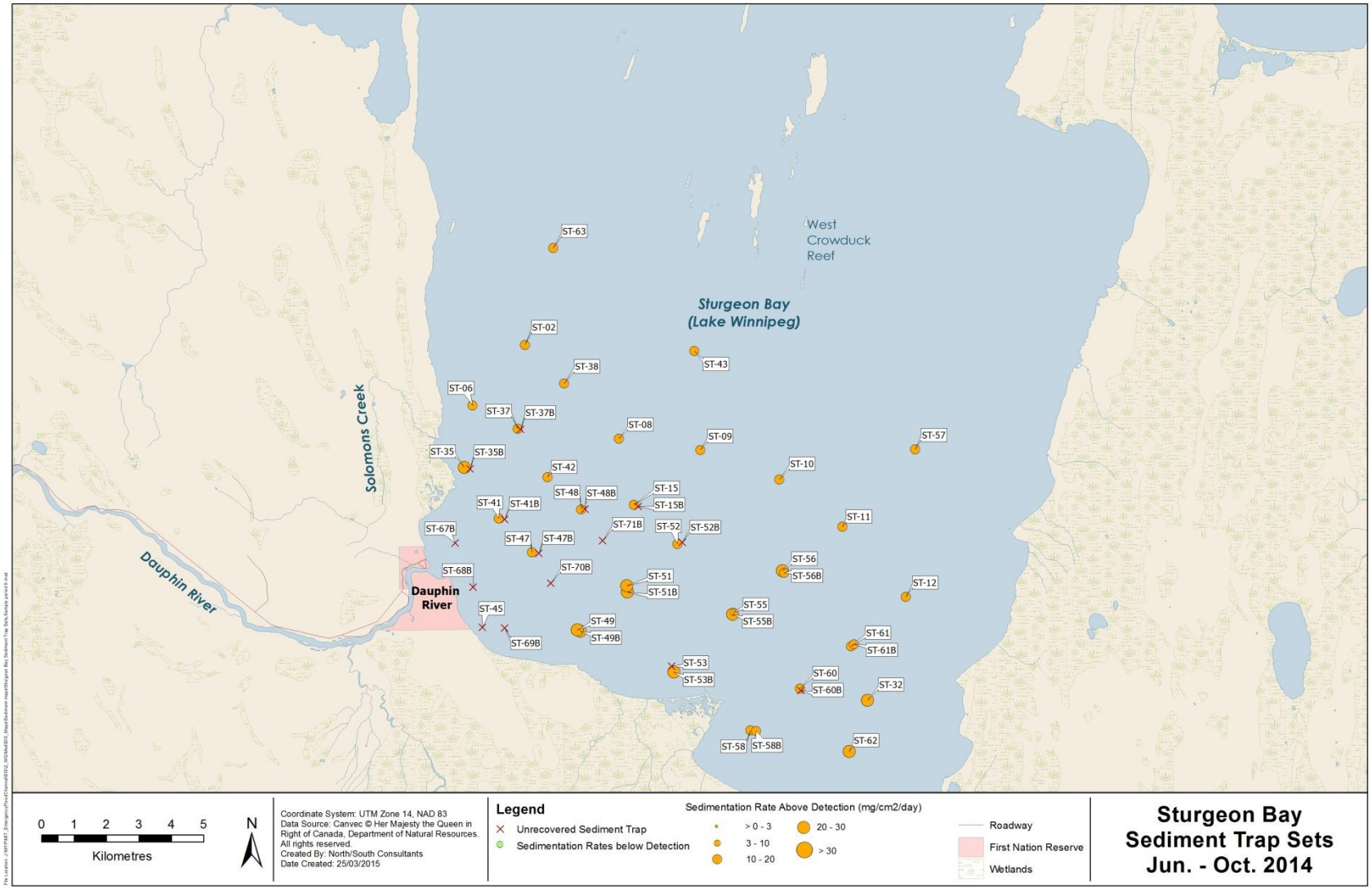


Figure 4.6-9. Sedimentation rates in Sturgeon Bay, June to October 2014.

4.7 SUMMARY

Flows, water quality, erosion, sedimentation, vegetation cover, and ice processes were characterized and compared between project phases to identify the potential impacts related to the construction and operation of the Reach 1 System. Hydrometric data, total suspended solid concentrations, topographic and bathymetric surveys were used in conjunction with numerical hydraulic models to identify the potential effects of the operation of Reach 1 on the erosion and sediment deposition processes in the watershed.

The Reach 1 was successful in lowering the water levels on Lake St. Martin by on average 0.6m (2ft), and as much as 1m (3ft) at the peak of the winter ice conditions. With the operation of Reach 1, the median flows in Buffalo Creek during the operation were more than 30 times the median normal flow recorded during the 2011/2012 Closure.

The operation of Reach 1 had limited effects on the ice processes. Some open water was present in the area of the Reach 1 inlet, with formation of frazil ice in the channel itself. Buffalo Creek was fully open with presence of border ice during operation. Observations during the closure period showed that a solid ice cover would form on the creek under natural conditions. Despite the large area of open water on Buffalo Creek during operation, the production of frazil ice along this reach of river is reduced by the latent heat of the water originating from the Buffalo Lake.

The high flows in Buffalo Creek were accompanied with high velocities, which generated some erosion of the main channel and of the riverbanks, as demonstrated with a comparison of river cross sections prior to and after operation. The TSS measurements and the empirical model results indicated that some erosion also occurred in Reach 1 during its operation. As the flows from Reach 1 reached Buffalo Lake, the bulk of the suspended sediment deposited in the bog. The sediment that was then eroded in Buffalo Creek was transported in suspension into the lower Dauphin River.

The volume of suspended sediment released from Buffalo Creek as a result of the operation of Reach 1 was computed with the empirical model with and without operation of Reach 1. It was estimated that the operation resulted in an additional total volume of 8,900 m^3 of suspended sediment at the confluence between the lower Dauphin River and Buffalo Creek during operation and another 2,200 m^3 during the closure period. This amount represents approximately 12% of the total volume of sediment that would have naturally been transported in the Dauphin River without operation. Analyses of the grain size distribution of the suspended solids showed that the material was essentially constituted of clays and silts.

As simulated with the MIKE 21 model, the velocities in Dauphin River are such that the suspended material would be transported several hundred meters into Sturgeon Bay, with very limited local deposition occurring along the Dauphin River shoreline or in back eddies.

The cross section comparison in Buffalo Creek computed a total volume of displaced material of 85,000 m^3. This represents the total volume of material that was eroded and displaced within Buffalo Creek, and also includes some material that went in suspension. Simulated velocities and shear stresses

showed that larger material could be transported by bed load. Some of this material may have left the system, however, a review of the simulated velocities and shear stresses showed that most of the coarser material has deposited in the overbank areas or in reaches with lower velocities, as also confirmed by direct observations.

According to the hydraulic modeling, the suspended sediment originating from the operation of Reach 1 and released at the exit of Buffalo Creek remains in suspension in the Dauphin River and eventually reaches Sturgeon Bay. Sediment traps installed in Sturgeon Bay demonstrated that no evident relationship can be established between sedimentation rate and trap distances from the mouth of the Dauphin River. This appears to be in agreement with the 1999-2007 State of the Lake report for Lake Winnipeg, while inputs from rivers that discharge into the lake do affect sediment dynamics in the lake, it has been shown that “antecedent winds were the most significant contributor to suspended sediment dynamics”.

4.8 REFERENCES

Environment Canada and Manitoba Water Stewardship (EC and MWS). 2011c. State of Lake Winnipeg 1999 to 2007. Environment Canada Report. 222 p.

KGS Group. 2014. Analysis & Monitoring of Discharges & Ice Processes. A report prepared for Manitoba Infrastructure and Transportation by KGS Group.

KGS and AECOM. 2011. Analysis of options for emergency reduction of Lake Manitoba and Lake St. Martin levels. A report for Manitoba Infrastructure and Transportation. 15 p.

McCullough, G.K., K. Hocheim, and P.M. Cooley. 2001. Retrospective study of suspended sediment patterns on Lake Winnipeg using NOAA AVHRR Satellite Imagery. Report to the Department of Fisheries and Oceans, Winnipeg, Canada. v+72 pp.+4 appendices.

USGS. 2006. Application of the Loop Method for Correcting Acoustic Doppler Current Profiler Discharge Measurements Biased by Sediment Transport.

USGS. 2008. Simulation of Flow, Sediment Transport and Sediment Mobility of the Lower Coeur D'Alene River, Idaho, Scientific Investigations Report 2008-5093.

USGS. 2009. Measuring Discharge with Acoustic Doppler Current Profilers from a Moving Boat, Chapter 22 of Book 3, Section A.

Water Survey of Canada. 1999. Hydrometric Technician, Career Development Program, Water Survey of Canada, Environment Canada.

Water Survey of Canada. 2004. Procedures for the Review and Approval of ADCP Discharge Measurements, Water Survey of Canada, Environment Canada.

Appendix 4A. Buffalo Creek Vegetation Cover Survey

Provided Within: Buffalo Creek vegetation cover survey results from 2013 and 2014.

KGS GROUP CONSULTING ENGINEERS

Field Inspection Form

PROJECT: **Lake St. Martin Channel Monitoring - 2015**

CLIENT: **North/South Consultants Inc.**

CONTRACTOR:

FILE NO.: **13-0431-001 Task 16 (161 Additional Work)**

REPORT DATE: March 9, 2015

BY: Dan Leitch

POSITION TITLE: Environmental Scientist

Buffalo Creek Vegetation Cover Survey Results
June 17-19, 2014

1.0 Introduction

During a Steering committee meeting held on April 16, 2014, MIT expressed interest in conducting a follow-up vegetation cover survey along the banks of Buffalo Creek. This task was categorized as additional work under Task 16 (ESH-4) Buffalo Creek Watershed – Post-Project Evaluation. The intent of the 2014 survey was to discern the extent of natural regrowth of vegetation that had occurred after one full growing season following the 2011/2012 operation of the LSMEOC system. A survey had been conducted in July 2013; however, the LSMEOC System was closed in November 2012 during freeze-up and, with the late spring in 2014, ice was still melting off the lakes and creeks at the beginning of May. As such, during the 2013 survey, the water was still in the process of receding and there was not sufficient time for any natural regrowth of vegetation. Conversely, large stands of trees, that appeared to have survived inundation in 2011/2012, may have yet to show signs of distress. This led to additional concern of whether large woody debris that remains in Buffalo Creek could likely be washed into Sturgeon bay if the LSMEOC System was ever to be operated in the future. Prior to conducting the survey, figures produced for MIT using the 2011 and 2013 GAIM data to show the extent of trees that

were likely killed and could likely fall into the creek potentially be washed downstream should the LSMEOC be operated again in the future.

In June 2015, it was determined that the LSMEOC would be operated again in late June/early July 2015. As such the proposed vegetation survey was pushed forward and was conducted between June 17 and June 19, 2014, in order to be complete prior to the 2014/2015 operation of the LSMEOC system. Using a helicopter for daily access/egress, and a canoe to navigate downstream, KGS Group completed vegetation surveys along 31 transects between Station 13+000 m and 28+000 m along Buffalo Creek.

The purpose of the vegetation survey along the Buffalo Creek was to assist in monitoring and assessing the impacts and recovery from operation of the emergency channel, specifically the changes to the riparian vegetation community and erosion along the river. The vegetation survey program involved walking perpendicular 100 m transects on both sides of the creek, and documenting the cover types along the transects. Vegetation cover types were used to estimate the amount of protection from erosion afforded to the soil via plant cover. Representative sample photos were taken. The soil composition was also recorded, particularly within the previously flooded area from past operation of the LSMEOC.

In addition to the vegetation cover survey, observations of areas with deadfall and larger amount of erosion were documented with photographs and waypoints. In the event of future operation, it is possible that deadfall near the creek could be carried away with higher water levels and moved downstream resulting in various issues including log jams and interference with fishing nets in the lower Dauphin River and Sturgeon Bay (Lake Winnipeg). Observations of areas of erosion will help identify when the erosion occurred (e.g. during 2011-2012 operation or during 2014-2015 operation).

2.0 Methodology

Sampling locations were set every 500 m along the length of the Buffalo Creek beginning at Station 13+000 m and continuing to just upstream of the confluence with the Dauphin River at Station 28+000 (Figure 1). The vegetation survey transects were run perpendicular to the creek when possible, starting from centreline and continuing for a distance of 100 m on each bank. Transect orientation was modified

for those locations where the meander of the creek resulted in overlap of a transect from another location.

The bank on both sides of the creek was recorded to determine the centreline. Transect orientation (cardinal direction), start and end point, general description of cover types, start and end distance of each cover type within the transect, and soil composition and depth were also recorded. Cover types were placed in four broad categories:

- Bare: exposed mineral soil with no vegetation or soil organic layer;
- Grass: vegetation cover consists of grass, sedge, or rush families;
- Shrub: vegetation cover consists of woody species that do not form distinct trunks or canopies of leaves, especially those which do not normally exceed 10m in height; At times, a distinction was made between short herbaceous shrubs and taller woodier shrubs.
- Treed: vegetation cover consists of woody species which form distinct trunks and leaf canopies, and which normally can or do exceed 10m in height.

Photos 1 to 4 show the four representative cover types. A photo log was compiled with several photos taken along each transect. Some of these photos are provided in the results section below.



Photo 1. “Bare” substrate observed at 18+000.


Photo 2. “Grass” vegetation observed at 13+500.


Photo 3. “Shrub” vegetation observed at 26+000.


Photo 4. “Treed” vegetation observed at 25+000.

Composites or matrices of these four types were possible, and their corresponding ground cover was provided e.g. 50% area covered by grass 50% area covered by shrubs. Due to plant morphology and habit, total percentages greater than 100% were possible.

Soil composition including organic soil depths were measured from representative areas within each change in cover along a transect, where feasible (i.e. if substrate changes from grass to trees, a soil measurement was taken in each section). Soil was removed using a garden trowel and measured using a tape measure. When the organic soil depth was greater than could be measured within reason using the

garden trowel, soil depth was recorded as 'greater than' the depth that was excavated (i.e. > x cm).

The survey was conducted over a 3 day period coinciding with other project activities (fisheries work, hydraulics work, brush cutters, and a GAIM flight). Personnel were: Day 1: Dan Leitch and Steve Offman; Day 2: Dan Leitch and John Burns; Day 3: Dan Leitch and Garrett Wellwood.

3.0 Results

The following subsections detail the results found for each transect, including orientation, description of terrain, cover types, and organic layer depths in soil. Unique features related to the investigation are also mentioned where appropriate. Where possible, observations were compared against conditions described during the 2013 and 2014 surveys. Due to the accuracy of the GPS and movement of creek banks due to varying water levels, detailed comparisons are not feasible. Photos contrasting several locations in 2013 and 2014 are included. Full records for each transect are found in Table 1 with the transect data broken into subsection A (left bank, when facing downstream) and subsection B (right bank, when facing downstream).

Soils along the length of Buffalo Creek were variable and showed signs of recent erosion along the riverbed. Soils further from the creek are outside of the flooded area and are generally dominated by sphagnum peat moss. Soil composition and depths are highly spatially variable so comparisons are difficult. At the upstream end of the creek (Stations 13+000 to 16+500), organic soils were predominant on the surface near the creek, with depths ranging from 1 to 20 cm. Beneath the organic soils was a mixture of inorganic soils including silt, clay, sand, gravel, and cobble. Beginning around Station 17+000, inorganic soils were more frequently seen above organic soils. These inorganic soils appeared to be recently deposited, and consisted predominantly of silt, but also sand, gravel, and cobble. At some locations, a thin layer of organic soil deposition was observed above the deposited inorganic soils, which was above the original organic soil. In 2013, many soils were also overlain with inorganic deposition, with observations of this beginning around 19+500 and continuing along much of the creek until Dauphin River. There was no note of inorganic soils observed in 2011.

Change at each transect from pre-operation (2011 survey) to post-operation (2013 survey) is described in the field inspection form for the 2013 survey (Appendix A). The focus of this field inspection form is primarily to document potential improvements after a full growing season following the 2011/2012 operation of the LSMEOC. The photos and descriptions provided herein are supplemented by imagery captured during GAIM flights that tended to correspond with the surveys, particularly in 2013 and 2014 (Appendix B). The 2013 survey was done in early July following a late spring, while the 2011 survey was conducted in late September. It is possible that some of the bare areas noted in 2013 were more related, in part, to the season. The 2014 survey was conducted in late June of 2014. While this is reasonably early in the growing season, it is one more year removed from operation of the LSMEOC and, therefore, vegetation had a full growing year since the previous survey. As noted earlier, due to the planned 2014/2015 operation of the LSMEOC, the survey had to be conducted earlier than initially planned. The survey in essence provided a baseline condition for the 2014/2015 operation of the LSMEOC.

An additional task included as part of the substrate cover survey of Buffalo Creek was the determination of the extent of potentially dead stands of trees and woody debris that could end up in the creek over time and/or if the LSMEOC channel was to be operated. Imagery captured during GAIM flights in 2011 and 2013 were used to create a figure highlighting the "Vegetation Impact Zone". Figure 2 (Sheets 1 to 8) shows areas adjacent to Buffalo Creek where vegetation died as a result of 2012-2013 operation of the LSMEOC. It shows narrower vegetation impact zones from 13+000 to 19+000, and generally broader impact zones from 19+000 downstream to the confluence with the Dauphin River.

In general, the large areas of dead trees observed in 2014 remained similar to what was observed in 2013. In some locations, dead trees have fallen over, possibly due to high wind events and the declining strength of the trunks and root structure. While many of the shrubs were still dead, regeneration from the roots had resulted in the resurgence of shrubs in numerous locations, particularly willows. The branches from the dead shrubs were still present above the surface, but are more frequently found along the ground with new green vegetation growing through and above it. In some cases (particularly between stations 20+500 and 22+500), trees that had appeared to be alive in 2013, appeared dead in 2014. Many areas were showing early successional stages of grass and herbaceous species during the 2013 survey. Many areas near the creek bank were relatively barren in 2013 however. Ground cover in 2014 near the creek bank

was much thicker, taller and greener than what was observer in 2013.

Below is a brief description of each transect surveyed. For more detail, see Table 1.

3.1 13+000

This transect runs in a northeast-southwest orientation. This section is within the vast open bog area surrounding Buffalo Lake that was widely flooded during operation of the emergency channel. During the 2013 survey, both sides had dead shrubs and approximately 50% bare and 50% grass. A dense patch of dead willows was present near end of the right transect. In 2014, some bare areas were present in the first 2 m adjacent to the creek, but otherwise the grass was much thicker (90%-100% coverage) and taller. Also, some of the shrubs which appeared dead in 2013 had begun regrowth, particularly on the right transect. Most shrubs did not recover however. Organic soil depths were similar during both surveys and were fairly deep (>12 cm). There was no sign of deposition.



13+000 – Left. Transect from creek bank in 2013 (left) and 2014 (right)



13+000 – Left. Looking across creek from left bank in 2013 (left) and 2014 (right)



13+000-Right: Willows at end of right transect in 2013 (left) and 2014 (right).

3.2 13+500

This transect runs in a northwest-southeast orientation and is situated at a left turn in the creek and is comprised of grass, shrubs and bare ground cover. On the right, the transect ended in a marshy area with stagnant water with sedges and aquatic vegetation, while on the left, the transect ended in thick bush. In 2013, the majority of shrubs on the transect were dead and the ground cover was largely bare, but with a high percentage of young grass species emerging (especially on the left side). In 2014, with the exception of a small area (1 m) along the right creek bank, grass coverage was thick (100%) for the entire transect except for the flooded portion along the right transect where cattails (*typha spp.*) were observed. treed areas, which typically may not have thick groundcover had thick vegetative cover, possibly as a result of the lack of leaves on dead shrubs and trees, subsequently allowed sunlight to penetrate to the ground. In 2014, 100% grass coverage was observed in the open areas along the creek. None of the dead trees or

shrubs appeared to have recovered. The flooded area on the right transect appeared to be larger and deeper in 2014 than in 2013, possibly as a result of recent beaver activity. Organic soils were present at the surface on both sides of the creek with depths of at least 2 cm. Beneath the organic soils, a mixture of till, silty clay and gravel were observed.



13+500-Right: Transect from creek in 2013 (left) and 2014 (right).



13+500-Left: Transect from creek in 2013 (left) and 2014 (right).

3.3 14+000

This transect runs in a northwest-southeast orientation. In 2013, greater than 50% of the area along the creek (up to the slope) was bare exposed soil, while the slopes were a mixture of grass, dead shrubs, and a dried up residue remnant from high water. In 2014, the same area along the creek was almost entirely grassed over with small bare areas (5%). None of the dead shrubs along the slope regenerated. High water from operation of the LSMEOC does not appear to have gone above the top of the slopes, and therefore the forested area in this section of the transect (on both sides) is similar between years. The left side transect runs into a flooded marsh area comprised of grasses, cattails and willows. This was observed in both 2013 and 2014. More and deeper open water was present in 2014, likely related to the obvious sign

of beaver presence at that location. Similar to 2013, organic soil was present at the surface in 2014 (1-4 cm). Beneath the organic soil was a mixture of silty and sandy clays. An area with gravel deposition was noted approximately 100 m upstream from 14+000 and an area with erosion on left and deposition on right was noted 75 m downstream from 14+000 (photos below).



14+000-Right. Transect from creek in 2013 (left) and 2014 (right).



14+000-Left: Wet area above high water mark on left side in 2013 (left) and 2014 (right).



14+000: Looking downstream from left bank in 2013 (left) and 2014 (right).



14+000: Deposition on left side of creek 100 m upstream from 14+000 (2014).



14+000: Erosion on left side and deposition on right approximately 75 m downstream from 14+000 (2014).

3.4 14+500

This transect runs in a northwest-southeast orientation. In 2013, the area nearest the channel was largely bare on both sides of the creek with exposed soil on the left side and exposed cobble on the right. Young grass species were starting to emerge. In 2014, much of this area was covered with grass and other herbaceous plants, but much of the exposed cobble on the right transect was still bare. Further away from the creek, there is a relatively thin strip of dead shrubs on both banks as the slope increases slightly. This was present both years, but grass was growing in the understory and through the dead shrubs in 2014. Beyond the slope and outside of the flooded area, both sides transitioned from largely shrubs to largely trees. Organic soils near the creek ranged from 0 (cobble) to 15 cm. Cobble appeared to be depositional. Some of the cobble was also overlain with depositional organic soils. Beneath the organic soils was silty clay and sand. At a creek bend upstream from 14+500, obvious signs of erosion and deposition were noted (photos below).



14+500: Bare area on right side of creek in 2013 (left) and 2014 (right).



14+500: Right transect from creek bank in 2013 (left) and 2014 (right).



14+500: Left transect from creek bank in 2013 (left) and 2014 (right).



14+500: On right side of creek, looking downstream in 2013 (left) and 2014 (right).



14+500: On left side of creek, looking downstream in 2013 (left) and 2014 (right).


14+500: Erosion on right side approximately 175 m upstream from 14+500 (2014).



14+500: Erosion on left side (left) and deposition on right side (right) approximately 250 m upstream from 14+500 (2014).

3.5 15+000

This transect runs in a northwest-southeast orientation at a left turn in the creek. Extensive erosion on the right side and deposition on the left side have occurred at this location. Exposed silt on the right side appears to be as a result of erosion, while cobble on the left side appears to be depositional. In 2013, large bare areas of inorganic materials were observed adjacent to the channel. On the right side was a steep bank of exposed till which appeared to be actively eroding, as evidenced by the exposed tree roots and clumps of vegetation slumping down the slope. On the left side (inside bend) was a gently sloping

expansive bare area of cobble deposition, and beyond that was a large area of dead shrubs with bare understory. In 2014, little appears to have changed. The right transect still had a steep unvegetated slope with exposed silt, while the left side of the creek still had large areas of exposed cobble. The area with dead shrubs further along the left transect had developed a thick layer of vegetation beneath it which has begun to grow through the dead shrubs. As the high water levels do not appear to have reached above the bank on the right, the vegetative composition appears to be the same between years. The slope on the left side is very gentle and the bank is much further away from the creek. Above the slope, the vegetative composition of short shrubs and young trees followed by larger trees remained the same. Organic soils were present further away from the creek up the slopes. Exposed cobble and silt covered the areas closer to the creek channel. Several areas of significant erosion and deposition were seen both upstream and downstream from transect 15+000 (photos below).



15+000: On right side of creek, looking downstream in 2013 (left) and 2014 (right).



15+000: On right side of creek, looking downstream in 2013 (left) and 2014 (right).




15+000: On left side of creek. Looking at transect from near creek bank in 2013 (left) and 2014 (right).




15+000: On left side of creek in 2013 (left) and 2014 (right).




15+000: On left side of creek above slope in 2013 (left) and 2014 (right).




15+000: Erosion approximately 150 m upstream from 15+000 (2014).



15+000: Erosion on right bank approximately 200 m downstream from 15+000 (2014).


15+000: Deposition on right bank approximately 300 m downstream from 15+000 (2014).


15+000: Erosion on left bank approximately 360 m downstream from 15+000 (2014).

3.6 15+500

The orientation of this transect followed a northwest-southeast direction. In 2013, bare areas (30-80%) with dead shrubs and young grass were found adjacent to the creek channel from the creek bank to the top of the slopes. In 2014, much of the bare areas were vegetated by grass and herbaceous species, but some bare areas remained, particularly on the left side slope. Several shrub species (willow, alder) were beginning to get established by 2014 on the top of the left slope however. Vegetation on the right side of the creek in 2014 was long and dense grass with a small amount of dead shrubs along the ground. Above

the slopes on each side was outside of the impact zone from the elevated water levels and little change was observed. A mixture of jack pine, black spruce, aspen and willow were observed. Organic soils from 3 to 18 cm deep were observed at the surface in both 2013 and 2014 at most locations on both sides of the creek with clayey silt and silty clay beneath. The slope on the left side had negligible organics and was primarily clayey silt. There doesn't appear to any significant erosion or deposition at this transect.



15+500: Looking downstream on left side of creek in 2013 (left) and 2014 (right).



15+500: Right transect from near creek bank in 2013 (left) and 2014 (right).

3.7 16+000

This transect is oriented in a northwest-southeast direction at a gentle right bend in the creek. In 2013, a relatively small bare eroded area (cobble, sand, silt) was noted on the left bank, while a larger bare area with deposition of sand, gravel and cobble was observed on the right side (inside bend). Both sides of the creek had dead shrubs with young grass species beginning to emerge in 2013. In 2014, the transect had largely been revegetated by grass and other herbaceous species although a thin strip of bare cobble, sand and silt remained along the creek bank on the left side while patches of deposited cobble, sand and silt were scattered for the first 20 m on the right side. Dead shrubs did not regenerate, but have largely fallen to the ground and are obscured by the thick layer of vegetation that has developed. Further from the

channel, a dense mixture of shrubs and trees which was above the high water level was unchanged between years. Both ends of the transect ended in sphagnum bog. Where bare inorganic soils were not present, 4-5 cm of organic soils overlaid a clayey soil within the flooded portion of the transect. The ends of the transect were in sphagnum and therefor had a thick organic layer which was unchanged between years. An extended area of erosion was present on the left side approximately 50 m downstream from the transect (photos below).



16+000: Left bank, looking downstream in 2013 (left) and 2014 (right).



16+000: Right transect from creek bank in 2013 (left) and 2014 (right).



16+000: Deposition on left side (left) and erosion on right side (right) approximately 150 m upstream from 16+000.



16+000: Erosion on left side approximately 50 m downstream from 16+000 (2014).

3.8 16+500

This transect runs in a north-northwest to south-southwest orientation. Directly adjacent to the creek channel, a short eroded area exposing bare cobbles and gravel was observed on the right side beneath an area of bank failure. This was little changed between 2013 and 2014, although some vegetation was beginning to grow on the top of the bank failure and some emergent vegetation had begun to grow near the creek bank in 2014. Above the relatively steep bank and beyond the high water mark, shrubs transition to trees, then to a mixture of shrubs and trees in a sphagnum bog, which was unchanged between 2013 and 2014. A thin strip of dead shrubs was observed at the top of the right slope which does not appear to be regenerating. The slope on the left side was more gradual, and shows a large area of thick dead shrubs and trees that have been knocked over. In 2013, 30% of this area was bare, with extensive areas being covered with dead shrubs, deadfall and debris accumulation. Approximately 60% of the ground was covered with young grass growth. In 2014, none of dead shrubs or trees regenerated, but a thick layer of grass covered 100% of the area including beneath the dead shrubs and trees. Past the dead trees and debris and up a slight bank there is a well-defined end to the impacts of the high water (see photo below). Above the bank, shrubs transition to trees, then to a mixture of shrubs and trees in a sphagnum bog in both 2013 and 2014. Organic soils were observed on the surface at most locations, with depths up to 15 cm. Beneath the organic soils was a mixture of clayey silt and silty clay. With the exception of near the creek, no obvious signs of erosion or deposition were noted. Near the creek on the right side was an area showing both deposition and erosion. Deposited clayey silt with gravel and sand (5 cm) was above organic soil (10 cm), with much of the bank showing signs of erosion (see photo below). Beneath the organic soils was cobble. An area of erosion was observed approximately 175 m downstream

from the transect (photo below).



16+500: On left side of creek, looking downstream in 2013 (left) and 2014 (right).



16+500: On left side of creek at end of dead vegetation zone, looking downstream in 2013 (left) and 2014 (right).



16+500: Looking downstream from right bank in 2013 (left) and from left bank 2014 (right).



16+500: Right bank looking upstream in 2013 (left) and from left bank 2014 (right).



16+500: Right bank: Deposition above eroding bank.



16+500: Erosion on right of creek 175 m downstream from transect (2014).

3.9 17+000

This transect runs in a northwest-southeast orientation and is situation immediately upstream of the beginning of Reach 3. In 2013, both sides of the creek showed a mix of bare cover, grass and dead shrubs extending 10 to 15 m from the creek banks. Bare areas were much reduced in 2014 compared to 2013 as most areas are now covered with a thick grass layer. Larger bare areas consisting of deposited cobbles and sand were still present on the right side of the creek. Dead shrubs observed in 2013 did not recover in 2014, but have become less obvious as they fall to the ground and the grass grows up and around it. Up the slope on the left side of the river is an area of herbaceous plants and very young poplar trees which transitions into a mixture of trees and shrubs comprised of poplar, willow and alder. This area is above the high water mark and did not change between years. A similar mixture of taller shrubs was observed on the right side of the river. The transect on the right side ended in wet peaty bush. Soils near the creek show signs of deposition of inorganic clayey silt, coarse sand, and gravel above the organic soils (1-5 cm). Above the creek banks, organic soils were observed at the surface at depths of 10 to >15 cm.



17+000: Right transect from near creek bank in 2013 (left) and 2014 (right).



17+000: Left side of creek looking downstream in 2013 (left) and 2014 (right).



17+000: Shrubs and young trees at clearing on top of left side bank in 2013 (left) and 2014 (right).

3.10 17+500

This transect runs west-northwest to east-southeast. In 2013, the area adjacent to the channel was largely bare ground with dead shrubs and grass. In 2014, much of this area has been vegetated by grass, but a large area of exposed deposited sand and gravel remained on the left side of the creek. Dead shrubs observed in 2013 did not recover, but are much less prominent in 2014 as many have fallen to the ground and grass grows above it. The right slope is slightly steeper and leads to small area of short shrubs and herbaceous vegetation and then on to taller shrubs with some young trees and a bog. High water does not

appear to have breached the bank, and the vegetative community noted above the bank did not change between years. The left side had a gentler slope as this was the inside bend of river. Beyond the large area with dead shrubs and inorganic deposition, was an area with live shrubs where it appears high water levels did not reach. Inorganic soils overlay organic soils at most locations sampled along this transect. Soils on the left side were mainly sand near the creek and silt further away from the creek. On the right side was a mixture of silts and clays. Areas with sand were 3 to 15 cm deep, while silty soils ranged from 1 to 5 cm deep. Peat was observed at the end of the right transect



17+500: Right bank seen from creek bank in 2013 (left) and 2014 (right).



17+500: On left side of creek in 2013 (left) and 2014 (right).



17+500: Inorganic deposition on left side of creek, looking downstream (2014).

3.11 18+000

This transect runs in a northeast-southwest direction at a relatively strait section of the creek. A large bare area (20 m) of cobble and gravel was observed on the left side of the creek in 2013. In 2014, this area looked very similar as only a small area was revegetated. Beyond the bare exposed area on the left side in 2013 was a band of dead shrubs (17 m) which was also bare beneath. When visited in 2014, much of this area was now covered by grass, but up to 40% of some areas remained bare. The dead shrubs and trees did not recover. Beyond this, as the slope increased, an area of short shrubs (herbaceous and young poplar) transitioned to taller shrubs (alder) and then to trees. This area appears to be outside of the impacts of high water and was unchanged between years. On the right side of the river, the first 18 m were largely bare soil with grass and some dead shrubs in 2013. In 2014, this area was entirely covered by grass, but dead shrubs still protruded above. Up the slope and beyond the impact area of high water, shrubs transitioned to trees with a largely sphagnum understory which was unchanged between years. Depositional inorganic soils were noted at most sites along this transect, but particularly on the left side. On the left side, large areas of sand, gravel and cobble were observed closer to the creek, while further from creek, organic soils are overlain with 0.5 to 5 cm of silt. On the right side of the creek, a thin layer of organic soil overlaid silt which was above the organic soil.



18+000: Right transect seen from creek bank in 2013 (left) and 2014 (right).



18+000: Right side, looking downstream in 2013 (left) and 2014 (right).



18+000: Bare area on left transect in 2013 (left) and 2014 (right).



18+000: Left transect looking upstream in 2013 (left) and looking downstream in 2014 (right).



18+000: Silt overlaying organic soils on left side of creek (2014).

3.12 18+500

This transect runs in a northwest-southeast orientation. In 2013, bare areas with dead shrubs and grass were observed on both sides of the river, however most extensively on the right side. In 2014, the bare areas were much smaller (5%) as most of the area was covered with thick grass. The dead shrubs and trees did not recover, but new vegetation was beginning to grow beneath and through the dead shrubs and trees. Above the slope on the left side, and beyond the high water impact zone, the understory was largely sphagnum beneath shrubs with a small percentage of trees in both 2013 and 2014. On the right side, beyond the dead shrub area, vegetation transitioned to shrubs, then largely trees before ending in a grassy marsh area with standing water. This area was unchanged between 2013 and 2014. In 2013, inorganic soils were observed at the surface adjacent to the creek on the right side, while elsewhere 2-7 cm of organic soils were measured at the surface. On the right side in 2014, sand was noted near the creek, and deposited silt was noted throughout the area where dead shrubs and trees were seen. On the left side in 2014, a small amount of silt deposition was present above the organic soils. Peat was present at both ends of the transects in both 2013 and 2014. During the 2011 survey, this area was inundated by a beaver dam which flooded areas near the channel. No beaver dam was observed in 2013 in 2014 whoever a beaver lodge was present.



18+500: Right transect seen from creek bank in 2013 (left) and 2014 (right).



18+500: Right transect, looking downstream in 2013 (left) and 2014 (right).




18+500: Left transect seen from creek bank in 2013 (left) and 2014 (right).




18+500: Left transect, looking upstream in 2013 (left) and 2014 (right).




18+500: Erosion on left bank approximately 50 m upstream from transect.



18+500: Beaver lodge on right side of river, looking downstream (2014).

3.13 19+000

This transect runs in a northeast-southeast orientation. In 2013, the left side of the creek consisted of bare areas, dead shrubs, and early stage grass regrowth near the creek. In 2014, this area was almost entirely grassed over, with a small amount (5%) of bare areas remaining. Dead shrubs did not recover. The left transect transitions to live short shrubs followed by tall shrubs with a high percentage of grass before becoming largely treed. This remained consistent between 2013 and 2014. Standing water was present at the end of the transect. The right side had a similar, although slightly larger, area consisting of dead shrubs, bare areas, and early stage grass regrowth in 2013. In 2014 this areas was entirely grassed over, although a dead trees and debris (logs, etc.) still covered a large area approximately half way down the transect. Beyond the dead shrubs a small area of short shrubs followed by a tree/shrub mixture was observed both years. At the end of the transect, the understory became sphagnum-dominated. Exposed inorganic soils were noted in 2013 immediately adjacent to the creek on the left side, however elsewhere organic soils were noted on the surface. In 2014, depositional soils were observed on both sides of the creek. On the left side, a mix of deposited sand, gravel, cobble and silt were observed above the organic soil. On the right side of the creek, a thin layer of silt was present above the organic soils along much of the transect. Deposited organic soils were also observed above the silt along the right transect at one location. An area of bank erosion was noted approximately 100 m upstream from the transect (photo below).



19+000: Left transect seen from near creek bank in 2013 (left) and 2014 (right).



19+000: Right transect seen from near creek bank in 2013 (left) and 2014 (right).


19+000: Erosion on left side of creek approximately 100 m upstream (2014).

3.14 19+500

This transect followed an east-west alignment. In 2013, the left side was bare along the creek, followed by a large area of mature dead trees which were largely bare beneath (80%). High water marks were visible on many of the tree trunks. Lots of trees and debris were on the ground, as it appeared the trees at this location acted as a catch/dam/strainer for dead vegetation floating down the creek. In 2014, this section appeared similar but a lush layer of grass was present throughout the majority of the area. There was no bare area along the creek edge in 2014. Dead trees did not recover. At the end of the transect, live trees with a sphagnum understory were encountered both years. The terrain on the right side of the creek was much flatter. In 2013, bare areas were observed near the creek channel, with a combination of dead shrubs and trees for the entire transect distance. Aquatic emergent vegetation was found at several locations on this side. In 2014, the same area was largely grassed over, but did still have some bare exposed sand areas. The dead shrubs and trees did not recover. Depositional inorganic soils (1-5 cm) were observed on both sides of the creek in 2013. In 2014, thick layers of fine to medium sand were measured on the right side near the creek (10-15 cm) while further from the creek, thinner layers of silty

sand (5 cm) were measured. On the left side in 2014, a mixture of deposited silty clay, silt and sandy silt was observed for the majority of the transect.



19+500: Right transect seen from near creek bank in 2013 (left) and 2014 (right).



19+500: Dead trees along right transect in 2013 (left) and 2014 (right).



19+500: Small channel on left transect in 2013 (left) and 2014 (right).




19+500: Dead trees along left transect in 2013 (left) and 2014 (right) (photos not from exactly same location).



19+500: High water mark on spruce trees on left transect in 2013.

3.15 20+000

This transect runs in a south-southwest to north-northeast direction and is just downstream from a sharp left turn in the creek. In 2013, the left side had a large bare area of cobble and gravel which extended for about half of the transect, followed by an area of dead shrub which was largely bare beneath. The entire area along the inside bend of the creek appears to have been inundated by high water, including the entire left transect. In 2014, most of the bare cobble areas were still exposed and all the dead shrubs remained dead. Grass was beginning to establish itself on the further half of the transect, however large bare areas remained near the creek in 2014. In 2013, the right side had a smaller bare area near the creek, followed by dead shrubs underlain by grass, then dead trees underlain by grass. In 2014, small bare areas remained near the creek, but grass had overtaken most of the transect including beneath the dead trees and shrubs. As the whole transect appears to have been inundated, deposited inorganic soils were observed on the surface throughout. In 2013, 1-5 cm of inorganics were measured above organic soils. In 2014, 3-13 cm of inorganics were measured above organic soils. On the left side in 2014, thick layers of sand, gravel and cobble were present near the creek, while mainly sand was present further along the transect. On the right side in 2014, silt overlaid organic soils for the length of the transect. An eroded bank was noted approximately 300 m upstream from the transect on the left side (outside bend of river).

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.



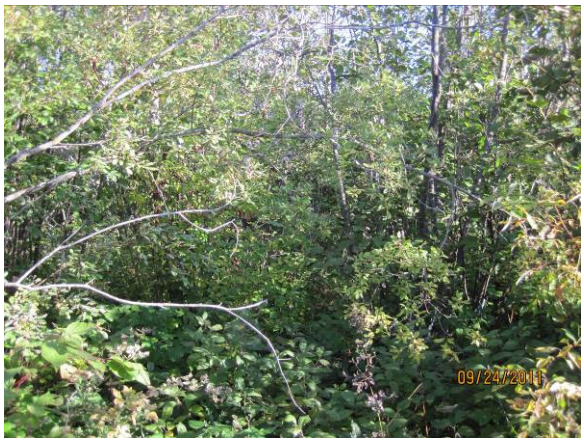


20+000: Grass on right transect in 2011 (left) and 2014 (right). (Photos not from exact same location)





20+000: Looking downstream from right side of creek in 2011 (left) and 2014 (right). (Photos not from exact same location)





20+000: Trees along right transect seen in 2011 (left0 and 2014 (right). (Photos not from exact same location)



20+000: Bare area on left side of creek as seen from right bank (2014).

3.16 20+500

This transect was oriented in an east-west orientation at a strait stretch of creek shortly after a right turn. In 2013, both sides had bare areas with dead shrubs and a small proportion of grass. On the left side, live trees were encountered approximately half way along the transect. On the right side in 2013, the dead shrubs transitioned to a mixture of dead trees and dead shrubs. The entire right transect appears to have been inundated as all shrubs and trees were dead. In 2014, the entire left transect was covered in grass including beneath dead shrubs and trees. It appears as though live trees that were observed in 2013 died between 2013 and 2014 as no live trees were noted along the transect in 2014. The right side in 2014 was fully grassed over near the creek, but several bare patches were still present between 50 m and 100 m. In 2013, deposited inorganic soils were present above the organic soils throughout both sides of the transect in thicknesses varying from 1 cm to 13 cm. In 2014, similar depths of silt (<1 cm to >15 cm) were measured above organic soils on both sides of the creek.

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.





20+500: Left transect from near creek bank in 20111 (left) and 2014 (right). (Photos not from exact same location)





20+500: Looking upstream from left bank in 2011 (left) and 2014 (right). (Photos not from exact same location)



20+500: Dead shrubs and grass along left transect (2014).


20+500: Dead trees and grass along left transect (2014).

3.17 21+000

This transect runs in an east-west direction at a gentle left turn in the creek. In 2013, the left side of the creek was comprised largely of dead shrubs, with bare areas near the creek channel and some dead trees near the end of the transect. In 2014, this area was covered by a thick layer of grass, while dead trees and shrubs did not recover. The high water mark can be seen on many of the mature dead spruce (see photo below). In 2013, the right side had a mixture of dead shrubs, grass, and bare patches for the first approximately 30 m. Beyond this was live shrubs and grass layer underlain by sphagnum which transitioned to trees approximately halfway along the transect at the end of a small clearing up the slope. In 2014, this transect had lots of grass near the creek, and then transitioned to an area of shrubs (1/2 dead) and then to an area of trees (1/2 dead). These trees appear to have died between 2013 and 2014 as these trees were live in 2013. In 2013, deposited inorganic soils above the organic soils were 6-13 cm thick on the left side and 4 cm thick on the right side near the creek. Peat was observed above the slope on the right side. In 2014, inorganic fine sand and silt was present along most of the transect including all of the left side and the first half of the right side. On the right side, organic soils (peat) was present starting at approximately 50 m. Thicknesses of inorganic soils above the organic soils in 2014 varied from 5 to 15 cm. An area of erosion and fallen trees was observed on left side of creek approximately 200 m upstream from the transect (photo below).

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.





21+000: Right side of creek looking downstream in 2011 (left) and 2014 (right).





21+000: Right transect from near creek bank in 2011 (left) and 2014 (right). (Photos not from exact same location)



21+000: High water mark seen on dead spruce on left side of creek in 2014.



21+000: Erosion and fallen trees on left side of creek approximately 200 m upstream from transect 21+000 (2014).

3.18 21+500

This transect runs in a southwest-northeast orientation at a strait stretch of the creek. In 2013, the left side of the creek was dominated by dead shrubs for the first 32 m, followed by dead trees up to 57 m, followed by live spruce trees. The understory was bare for the first half of the left transect in 2013. In 2014, the area near the creek was a mixture of grass and shrubs (2/3 live), and then transitioned to an area of dead trees with a thick herbaceous groundcover. Trees were dead all the way to the end of the transect. These trees appear to have died between 2013 and 2014. The right side of the creek in 2013 had dead shrubs until 25 m, followed by live spruce trees which developed a sphagnum understory beyond 36 m. In 2014, dead shrubs were again seen for the first 23 m, although there was also a thick layer of grass growing beneath it. Beyond the dead shrubs, dead mature spruce trees were observed for the duration of the transect. These trees appear to have died between 2013 and 2014. In 2013, organic soil depths varied from 3 to >17 cm, with much of the area overlain by inorganic soils of 3 to 7 cm. In 2014, >13 cm of silt was observed in the area with dead shrubs on the left side, while on the right side, >15 cm of fine sand was observed. Within the mature trees, 3-8 cm of deposited silt was observed above organic soils in 2014.

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.




21+500: Left side of creek looking upstream in 2011 (left) and 2014 (right).




21+500: Right side of creek in 2014 looking upstream (left) and downstream (right).



21+500: Right side of creek as seen from left side in 2014. Note high water mark on trees.



21+500: Dead spruce trees showing high water mark and a herbaceous understory on left transect in

2014.

3.19 22+000

This transect runs in a southwest-northeast direction at a relatively treed stretch of the creek. In 2013, the first approximately 13-18 m on both sides of the creek were dominated by dead shrubs, but also had bare areas and grass. Beyond the dead shrubs were live mature trees on the left and a mixture of dead and live mature trees on the right. Both sides end in a forested area with sphagnum understory. In 2014, dead shrubs were still present along the creek, but were less visible as many had fallen to the ground and thick layer of grass now existed. Within the trees, the first 26-43 m were dead, followed by live trees transitioning into bog. High water marks were visible on the mature spruce well away from the creek. A small proportion of shrubs were also present on the left side. In 2013, inorganic soils overlaid organic soils along most of the transect with the exception of the sphagnum areas near the end on each side. Depths ranged from >13 cm near the creek to 5-6 cm in the trees. In 2014, 3-5 cm of silt overlaid most of the transect with a thick layer of sand (>13 cm) also found on the left side near the creek (beneath silt). Peat was again observed at the surface at the end of the transects. An area of erosion and fallen trees on the right bank approximately 230 m downstream from the transect.

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.



22+000: Mature spruce trees and herbaceous understory in 2011 (left) and 2014 (right). Note high water mark in 2014. (Photos not from exact same location)



22+000: Right side of creek, looking downstream in 2014.



22+000: Dead trees on right side of creek, as seen from creek bank in 2014.



22+000: Erosion and fallen trees on the right bank approximately 230 m downstream from 22+000 (2014).

3.20 22+500

This transect runs in an east-west direction at a left bend in the creek just downstream from a small rapid. The creek is particularly wide at the transect location. In 2013, the left side had a large bare area of gravel and sand adjacent to the creek. Beyond this, dead trees with a mainly bare understory were observed until near the end of the transect. The last 27 m of the transect had live trees and a few shrubs. In 2014, the same bare area was observed along the creek, although this time it had a small (5%) amount of grass. Beyond the bare area, dead trees were observed until the end of the transect. The trees at the end of the

transect that were alive in 2013 appear to have died by 2014. The understory of this area was almost entirely grass. Large piles of debris (trees, sticks, etc.) were captured by trees on the left transect during high water (see photo below). The right side in 2013 had an area of dead trees with bare understory immediately adjacent to the creek for about 20 m, followed by live mature trees for the remainder of the transect. In 2014, a similar extent of dead trees was observed, although this time there was a 50% understory of herbaceous plants. The remainder of the transect was comprised of live trees. Organic soils in 2013 were beneath a 5-9 cm layer of inorganic soil deposition, with the exception of near the ends of transects. In 2014, 3-13 cm of silt was on the surface at most locations.

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.





22+500: Mature spruce trees and herbaceous understory in 2011 (left) and 2014 (right). Note high water mark in 2014. (Photos not from exact same location)



22+500: Bare area on left side, looking downstream in 2014.



22+500: Dead trees, accumulated debris and grass on left transect in 2014.



22+500: Debris on rock in creek, as seen from left bank in 2014 (flow going left).



22+500: Dead trees and grass on right side, as seen from near creek bank in 2014.

3.21 23+000

This transect runs in a southwest-northeast direction. In 2013, dead shrubs were observed on both sides of the creek, with dead trees also present beyond the dead shrubs on the right side. The dead zones were approximately 30 m on both sides and were largely underlain by deposited bare exposed soils. Beyond the dead zone, live trees covered approximately half of the transect on each side. In 2014, the areas closest to the creek on each side were covered with thick grass. Dead shrubs were still present amongst the grass. Beyond the dead shrubs, dead trees were observed. An area of trees on the left side that was alive in 2013

was dead in 2014. Live trees were still present at the end of the transect on both sides. In 2013, organic soils were beneath 5-9 cm of inorganic deposition at test holes near the creek, while peat was observed on the surface further along the transect on each side of the creek. In 2014, 3-5 cm of silt was measured above organic soils near the creek, while peat was again observed near the end of the transect on each side.

* Due to camera malfunction in 2013, photos below are from 2011 and 2014 only.





23+000: Mature spruce trees and herbaceous understory in 2011 (left) and 2014 (right). Note high water mark in 2014. (Photos not from exact same location)



23+000: Grass and dead trees, looking downstream from right bank in 2014.



23+000: Dead trees and grass on left transect as seen from near creek bank in 2014.



23+000: Silt deposition above organic soil on the left side of the creek in 2014.

3.22 23+500

This transect runs in a north-south orientation near a sharp left bend in the river. During emergency channel operation, it appears water immersed the inside bend of the river including the entire left transect. In 2013, all vegetation on the left side of the river was dead. Dead shrubs were present from the creek bank to 50 m, while dead trees were present from 50 m to 100 m. The understory was bare for the entire left side transect. On the right side in 2013, dead trees were observed adjacent to the creek bank for the first 21 m. The understory was bare close to the creek, while a herbaceous understory was present starting at 9 m for the remainder of the transect. The remainder of the right side transect consisted of live trees with a sphagnum understory. In 2014, all the shrubs and trees on the left transect were still dead. Thick grass was present close to the creek around the dead shrubs, while a herbaceous layer was present beneath the dead trees. On the right side in 2014, grass cover was present near the creek along with a small proportion of new young shrubs. The extent of dead trees was similar as was observed in 2013, and live mature trees were again present for the majority of the transect. In 2013, 6 to >20 cm of inorganic soil was measured above organic soils, with the thickest layer of deposition being along the left transect. Only a narrow area of deposition was noted on the left side with organic soils at the surface for the majority of

the transect. In 2014, 3 to >10 cm of silt was measured above organic soils near the creek, but silt was again observed along the full length of the left transect. An area of erosion and fallen trees on the left side of the creek and deposition on the right side of the creek was observed approximately 175 m upstream from the transect.

* Due to camera malfunctions in 2011 and 2013, photos below are from 2014 only.



23+500: Looking downstream from left bank (2014).



23+500: Grass and dead trees on left transect, as seen from shore (2014).



23+500: Dead trees on left transect, with herbaceous ground layer and accumulated debris on upstream side of trees. Note high water mark on tree trunks (2014).



23+500: Bog at end of right transect. Typical of what was seen at the end of many transects (2014).




23+500: Erosion and fallen trees on left (left) and deposition on right (right) approximately 175 m upstream from transect (2014).

3.23 24+000

This transect runs in an east-west orientation immediately upstream from a sharp S-turn in the creek. In 2013, the left bank was a steep eroded bank. At the top of the bank was a mixture of deciduous shrubs and trees for the duration of the transect. At 61 m, where the transect approached the river bank further down stream, the trees and shrubs were dead. On the right side of the river in 2013, the slope was much gentler, and the ground were largely wet and muddy. The creek appears to have flooded the full length of the right transect. Dead trees and shrubs dominated the first 68 m of the transect. The understory of that section was largely bare, but with increasing concentrations of grass as the transect progressed away from the creek. Live trees were present from 68 m to the end of the transect. In 2014, the steeply eroded bank on the left side appeared unchanged. A similar composition of shrubs and trees was recorded for the remainder of the transect although the bare areas noted in 2013 near the end of the transect were now covered with a herbaceous layer of vegetation. In 2014, the right transect was mainly grassed over. Some areas had stagnant water and emergent aquatic plants were growing (*typha* spp.) Trees remained dead, although it appears that some of the shrubs further from the creek had recovered. In 2013, deposited

inorganic sediments varied from 8 to 13 cm above the organic soils along the right transect and near the creek along the left transect. Organic soils were on the surface at the majority of the left transect. In 2014, a similar pattern was observed with relatively small amounts of deposited silt near the creek on the left side and a thicker layer of silt on the right transect. Many areas were too wet to assess soil content.

High water levels forged new creek channels immediately downstream from the transect, essentially short-cutting the previous meandering route. While water continues to pass though the previous channel, it appears the majority of water now goes through the new channels, particularly during low water conditions.



24+000: Looking across creek at left transect from right bank in 2013 (left) and 2014 (right).



24+000: Dead trees on right transect in 2013 (left) and 2014 (right) (photos not from exactly the same location).




24+000: Looking upstream from left bank in 2013 (left) and 2014 (right).




24+000: Looking downstream from left bank in 2013 (left) and 2014 (right). Original channel is to the right, while new channel is on left (2014 photo).




24+000: Erosion immediately downstream from transect where near channels were created (2104)

3.24 24+500

This transect is oriented in an east-west direction downstream from the S-turn in the creek where new channels were created during high water. In 2013, the left side of the river was composed of dense dead

shrubs with a bare understory until 34 m where a layer of live shrubs began. Beyond this, the vegetation became largely treed with a sphagnum understory. Effects from high water appear to end approximately 20 m from the creek bank. On the right side, bare areas with dead shrubs and trees span the entire transect in 2013. This side of the creek is lower and was clearly immersed by high water for its entire length. In 2014, the left side was unchanged other than the 90% grass cover near the creek where it was previously bare. The right side in 2014 showed a similar pattern. Dead shrubs and trees did not recover, but the understory was largely covered by grass near the creek and more herbaceous species within the dead trees further away from the creek. Soils in 2013 showed thick layers of inorganic deposition near the creek. 14-15 cm deep inorganics were measured above organics on the left side while >19 cm of inorganics were measure on the left side near the creek. Thinner inorganic layers were noted further from the creek on both sides. In 2014, 5 cm of silt was measured near the creek on both sides, while >15 cm of silt was present further along the right transect. Peat was observed at the end of the left transect which was unchanged between 2013 and 2014. An area of erosion and deadfall was observed approximately 190 m downstream from the transect (see photos below).




24+500: Left bank, looking downstream in 2013 (left) and 2014 (right).



24+500: Right transect seen from near creek bank in 2013 (left) and 2014 (right).



24+500: Along right transect, looking downstream in 2013 (left) and 2014 (right).



24+500: Erosion and deadfall on left (left) and right (right) of creek approximately 190 m downstream from transect.

3.25 25+000

This transect is oriented in a northwest-southeast direction. In 2013, the left side of the creek had a steep

bank which appears to have slumped (see photo below). At the top of the slope were shrubs which were followed by deciduous trees and then coniferous trees. The right side in 2013 was less steep and had dead shrubs and a bare understory until 36 m. Much of the area consisted of exposed cobbles, gravel and sand. Beyond this was a mixture of live trees and shrubs. In 2014, the slumped bank was still present and had minimally more vegetation on it. Above the slope, a similar composition of shrubs and trees was observed. The right side in 2014 still had a bare cobble area adjacent to the creek although patches of grass had grown in a few locations. Beyond the cobble, thick grass was growing within the dead shrubs until near the end of the transect where the transect leaves the dead zone and live trees and shrubs are encountered. A fair bit of debris (logs, branches) was deposited within the dead shrub area. In 2013, 1 to 4 cm of inorganic soil overlaid organic soils near the creek, except for the large areas of coble which were deeper. Organic soils were present on the surface further from the creek on both sides. In 2014, the bank slump on the left side was identified as being mainly silt. Above the bank, trace silt was present above organic soils. On the right side in 2014, 10 cm of silty organic soil was observed above silt within the grassy area with dead shrubs. Peat was present at the end of the right transect. An area with cobble and gravel deposition was observed approximately 200 m upstream from the transect at a sharp bend in the creek (photo below).



25+000: Bank slump on left side of creek, looking upstream in 2013 (left) and 2014 (right).




25+000: Cobble area on right side of creek in 2013 (left) and 2014 (right) (photos not from exact same location).




25+000: Dead trees along right transect in 2013 (left) and 2014 (right) (photos not from exact same location).



25+000: Areas with cobble and gravel deposition approximately 200 m upstream from transect (2014).

3.26 25+500

This transect was oriented in an east-west direction at a left turn in the creek. In 2013, the left side of the creek had a very gentle slope and consisted of dead shrubs and a largely bare understory for the entire left-side transect. The entire left transect had clearly been inundated during high water. The right side of the creek has a steeper bank. In 2013, it had a thin layer of dead shrubs with a bare understory, followed by a progression of live shrubs followed by trees with a sphagnum understory starting at 54 m. In 2014, the left side had been completed vegetated over with mainly grass, but also herbaceous species further from the creek. None of the dead shrubs recovered. On the right side in 2014, the thin strip with dead shrubs now had a thick layer of vegetation growing beneath it. Above the bank, a similar composition of shrubs, and trees was observed. Soils in 2013 had 1 to 4 cm of inorganics above organic soils near the creek and along the left transect. In 2014, 5 to 8 cm of silt was observed at the surface on the left side. At one location, beneath the silt was 3 cm of organic soil followed by further silt. On the right bank, 10 cm of organic soil was measured above a layer of silt. An area of erosion was observed at an outside bend in the creek approximately 175 m upstream from the transect (photo below).



25+500: Right side of creek, looking downstream in 2013 (left) and 2014 (right).




25+500: Left transect in 2013 (left) and 2014 (right).




25+500: Left transect in 2013 (left) and 2014 (right).



25+500: Area of erosion on left side of creek approximately 175 m upstream from transect (2014).

3.27 26+000

This transect runs in a east-northeast to west-southwest direction at an S-turn in the river. The left transect approximately paralleled the river and had very little topography. In 2013, the ground cover was entirely

comprised of dead shrubs and bare understory, with a small percentage of grass. The right side of the creek in 2013 had a similar area of dead shrub and bare understory adjacent to the creek until the transect went up the slope and a dense shrub coverage was encountered seemingly above the high water mark. Due to the winding nature of the creek at this point, this transect approaches the creek again near its end. In this area, dead shrubs and trees and a bare understory were again encountered. In 2014, there was a 3 m area adjacent to the creek on the left side which was still bare, but otherwise the remainder of the left transect was 100% covered by grass, None of the dead shrubs recovered. On the right side in 2014, areas near the creek both at the beginning and end of the transect (which were previously bare) were largely covered by grass. In 2013, a thin inorganic soil layer was observed above organic soils on the left side. On the right side, 4-13 cm of inorganic soils were present above the organic soils. In 2014, the small bare area adjacent to the creek was composed of 5 cm of silt above gravel. On the right bank in 2014 a silty organic soil was noted. An area of erosion on the left bank approximately 250 m upstream from transect was observed (photo below).



26+000: Right transect in 2013 (left) and 2014 (right).



26+000: Left transect in 2013 (left) and 2014 (right).


26+000: Bare area adjacent to creek on left side, looking upstream.


26+000: Area of erosion on left bank approximately 250 m upstream from transect.

3.28 26+500

This transect runs in a south-southeast to north-northwest direction and is situated between two bends in the creek. In 2013, the left side, which is fairly low and flat, was comprised entirely of dead shrubs and trees with a small amount of grass, but the understory was largely bare. The right side was also largely bare adjacent to the creek, but with a slightly higher coverage of grass. Dead shrubs were found until 59

m where the transect entered 100% live trees. In 2014, none of the dead shrubs or trees recovered. The first half of the left transect was fully grassed over while a more herbaceous layer was present further along the transect closer to the dead trees. The right side in 2014 was fully grass-covered near the creek with a more herbaceous groundcover seen within the dead shrubs. Some accumulated debris (branches) was also noted on the right side. Soils in 2013 had 2-5 cm of inorganic deposition above organic soils near the creek, and throughout the left transect. Organic soils were observed on the surface on the right side after the first 20 m. In 2014, 15 cm of sandy silt was measured above organic soils near the creek on the left side, while organic soil was noted on the right side of the creek. An area of erosion was noted on the on right side approximately 175 m downstream from transect (photo below).



26+500: Right transect from shore in 2013 (left) and 2014 (right).



26+500: Within dead shrubs on right transect in 2013 (left) and 2014 (right).



26+500: Accumulated debris on right transect (2014).




26+500: Left transect in 2013 (left) and 2014 (right).




26+500: Trees near end of left transect in 2013 (left) and 2014 (right).



26+500: Erosion on right side of creek approximately 175 m downstream from transect (2014).

3.29 27+000

This transect runs in an east-west direction at a left turn in the creek. The inside bend (left side) is low in elevation, while a distinct bank was present on the right side at approximately 20 m from the creek bank. In 2013, the left side of the river was composed of mainly dead shrubs with a smaller portion of grass and a largely bare understory. At 77 m the transect entered live mature trees. On the right side in 2013, a similar composition of dead shrubs, grass and bare understory was encountered adjacent to the creek. At 42 m (base of slope), the transect transitioned to shrubs and at 58 m, there was a mixture of shrubs and trees. In 2014, the lower lying areas which were largely bare were now covered with a thick layer of grass. Dead shrubs did not recover. Organic soils near the creek in 2013 were overlain with 2-3 cm of inorganic deposition at the low areas near the creek, while organic soils were observed on the surface up the bank on the right side. In 2014, 1 cm of silt was measured above >13 cm of fine gravel near the creek on the left side, while 1 cm of silt was measured above organic soils on the right side (near the creek). Erosion was noted at locations 100 m to 200 m downstream from the transect along the outside bend of the creek (photos below).




27+000: Right transect in 2013 (left) and 2014 (right).




27+000: Left transect in 2013 (left) and 2014 (right).




27+000: Near end of left transect in 2013 (left) and 2014 (right).



27+000: Eroded right bank approximately 100 m downstream (left) and 200 m downstream (right) from transect (2014 photos).

3.30 27+500

This transect runs in an east-west direction just downstream from a sharp right-hand bend in the creek. The inside bend of the river (right side) was lower in elevation, while there was a distinct bank on the left side near the creek. In 2013, the left side of the river had an area of dead shrubs with some grass but was largely bare until the slope increased at 34 m. Above the slope was a mixture of thick shrubs and trees until 59 m where 100% trees were encountered along with a sphagnum understory. The right side in 2013 had a larger flat area which was largely bare (cobble, sand) until 25 m. Beyond this, an area of dead shrubs with grass and bare understory transitions to an area of largely trees at 51 m, and then back to shrubs at 92 m. In 2014, the left side was covered with a thick layer of grass up to the slope. Dead shrubs did not recover. Up the slope appears to be outside of the high water impact zone and therefore appears that little changed between 2013 and 2014. On the right side in 2014, the cobble/sand area was largely still bare for about 6 m from the creek. Beyond that, grass covered the ground and grew through the dead shrubs. A similar composition of live shrubs and trees was observed beyond 50 m along the right transect. In 2013, a thin layer (1 cm) of inorganic soil was present above organic soil on the left side of the creek, while a thicker layer (3-5 cm) was present on the right side aside from the cobble area which was much thicker. In 2014, 6 cm of silt was measured above organic soil on the left side, while >15 cm of sand and gravel was measured near the creek on the right side and sandy silt was identified further from the creek.



27+500: Left transect in 2013 (left) and 2014 (right).



27+500: Left transect, looking downstream in 2013 (left) and 2014 (right).



27+500: Right transect in 2013 (left) and 2014 (right) (photo not from exactly same location).

3.31 28+000

This transect runs in an east-southeast to north-northwest direction at a right-hand bend in the creek. The

right side is a large open area with low elevation, while the left side is sloped near the creek bank. On the left side in 2013, a small bare/grass patch adjacent to the creek transitioned to shrubs and then to trees. On the right side of the creek, a large (60 m) bare area with some grass leads to a band of shrubs, followed by trees up a gentle slope. In 2014 on the left side, aside from some erosion immediately at the water's edge, the ground was covered with thick grass up the slope. Shrubs and trees above the slope were beyond the impacted area and are therefore not changed. The right side in 2014 had a 4 m area adjacent to the creek which was still mostly bare, but the remainder of the open area was covered with grass. A similar composition of shrubs and trees was noted beyond the open area. Soils in 2013 were organic at the surface on the left, and a mixture of gravel, sand and silt on the right side. In 2014, 1 cm of silt was observed above organic soil on the left, while gravel, sand and silt were again noted on the right side of the creek.



28+000: Right transect from near creek bank in 2013 (left) and 2014 (right).



28+000: Looking downstream from left bank in 2013 (left) and 2014 (right) (photos not from exact same location).



28+000: Erosion on left bank, looking downstream (2014).



28+000: Erosion on left bank, looking upstream (2014).

TABLE

TABLE 1
RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
13+000	A	Left	Northeast	River	0	16	-
				Grass 90%; Bare 10%; Shrub (dead) 5%	16	60	>12
				Grass 100%; Shrub (dead) 15%	60	100	>12
	B	Right	Southwest	River	0	16	-
				Grass 50%; Bare 50%	16	18	20
				Grass 100%; Shrub (dead) 5%	18	58	>12
				Grass 50%; Shrub (regrowth) 50%	58	78	-
				Shrubs (mainly dead) 90%; Grass 75%	78	87	>12
				Grass 100%; Shrub (dead, standing) 75%	87	100	-
13+500	A	Left	Northwest	River	0	20	-
				Grass 100%; Shrub (dead) 10%	20	39	20 (above till)
				Grass 100%; Shrub (dead) 50%	39	44	>20
				Grass 100%; Shrub (tall, 90% dead) 75%	44	58	>20
				Grass 100%; Shrub (tall, 50% dead) 50%; Trees (dead) 25%	58	84	-
				Grass 100%; Shrub (tall) 90%	84	100	2 (above silty clay)
	B	Right	Southeast	River	0	20	-
				Grass 50%; Bare 50%	20	21	4 (above clay with gravel)
				Grass 100%; Shrub (dead) 5%;	21	34	-
				Grass 100%; Shrub (dead) 25%; Tree (dead) 10%	34	49	-
				Grass 100%; Shrub (dead) 20%; Tree (dead) 5% (marshy)	49	92	-
				Grass (typha) 40%; Shrub (dead) 40% (deeper water)	92	100	-
14+000	A	Left	Northwest	River	0	13	-
				Grass 100%	13	23	1 (above fine silty clay)
				Grass 90%; Shrubs (mostly dead) 60%	23	27	-
				Grass 100%; Shrubs 40%; Trees (dead) 5%	27	37	1 (above clay with silt and fine sand)

				Grass (typha) 100%; Shrubs 70% (wet)	37	52	-
				Grass 50%; Open Water 50%; Shrubs 20%	52	82	-
				Shrubs 80% (wet)	82	100	-
	B	Right	Southeast	River	0	13	
				Grass 95%; Bare 5%; Shrubs (dead) 5%	13	20	3 (above sandy clay)
				Grass 95%; Bare 5%; Shrubs (dead) 25%	20	28	-
				Shrubs (short) 100%	28	33	4 (above clay with rocks)
				Trees 50%; Shrubs 50%	33	46	-
				Shrubs (short) 100%; Trees 80%	46	78	-
				Trees 80%; Shrubs (short) 75%	78	100	-
14+500	A	Left	Northwest	River	0	8	-
				Grass 95%; Bare 5%	8	15	15 (above fine silty clay)
				Grass 75%; Bare 25%; Shrubs (dead) 25%	15	17	5 (above clay)
				Shrubs (short) 100%; Trees 40%	17	30	-
				Trees 75%, Shrubs 25%	30	50	<1 (above silty clay with sand)
				Trees 100%; Shrubs (short) 100%	50	100	-
	B	Right	Southeast	River	0	8	-
				Grass 60%; Bare 40%	8	18	mix of cobble and 3 cm org soil (above sand)
				Grass 90%; Shrubs (dead) 50%	18	20	-
				Shrubs 95%; Trees 5%	20	28	-
				Shrubs (tall) 50%; Trees 5% (100% herbaceous understory)	28	46	8
				Trees 100% (100% herbaceous understory)	46	69	-
				Trees 70%; Shrubs 30% (100% herbaceous understory)	69	100	-
15+000	A	Left	Northwest	River	0	10	-
				Bare 100%	10	24	0
				Grass 100%; Shrubs (dead) 60%; Trees (dead) 5%	24	44	-
				Shrubs 100%	44	65	9 (above clayey silt)
				Trees 100%; Shrubs 25% (100% herbaceous understory)	65	100	-
	B	Right	Southeast	River	0	10	-
				Bare 100%	10	12	0

				Trees 50%; Shrubs 50% (75% short shrub understory, 25% deadfall)	12	18	-
				Shrubs (tall) 75%; Trees 25% (100% herbaceous understory)	18	41	-
				Trees 25%; Shrubs 25% (100% herbaceous understory with sphagnum)	41	100	-
15+500	A	Left	Northwest	River	0	7	-
				Grass 95%; Shrubs (dead) 25%; Bare 5%	7	17	8 (above clayey soil)
				Shrubs 75%; Bare 25%	17	21	exposed clayey silt with negligible organics
				Trees (jack pine) 100% (75% short shrub understory)	21	55	-
				Shrubs (tall) 75%; Trees 25% (100% short shrub understory)	55	100	-
	B	Right	Southeast	River	0	7	-
				Grass 100%; Shrubs (dead) 20%	7	24	18 (above clayey silt)
				Shrubs 50%; Trees (dead) 40% (80% short shrub understory)	24	26	3 (above silty clay)
				Trees 80%; Shrubs 20% (understory 100% short shrubs)	26	40	-
				Shrubs (tall) 90%; Trees (spruce) 10% (short shrub and sphagnum understory)	40	100	-
16+000	A	Left	Northwest	River	0	9	-
				Bare (inorganics) 100%	9	10	0
				Grass 100%; Shrubs (dead) 15%	10	26	4 (above clay with rocks)
				Trees 95% (jack pine); Shrubs 5% (100% short shrub understory)	26	44	-
				Shrubs (tall) 100% (100% short shrub understory)	44	81	-
				Trees 100% (mainly jack pine) (100% short shrub understory)	81	100	-
	B	Right	Southeast	River	0	9	-
				Grass 75%; Shrubs (dead) 40%; Bare 25%	9	29	0
				Shrubs 80%; Trees 10%	29	49	5 (above clay)
				Shrubs (tall) 95%; Trees 5% (100% short shrub understory)	49	100	-
16+500	A	Left	North-Northwest	River	0	10	-
				Grass 100%; Shrubs (dead) 75%	10	28	15 (above clayey silt)

				Grass 100%; Shrubs and trees (dead) 90%	28	80	2 (above silty clay)
				Shrubs (short) 100%	80	84	-
				Trees (jack pine) 60%; Shrubs (40%) (100% short shrub understory)	84	100	-
	B	Right	South-Southeast	River	0	10	-
				Bare (cobble) 100%	10	12	0
				Shrubs (dead) 100%; Grass 90%; Bare 10%	12	17	5 cm of clayey silt with gravel and sand above 10 cm of organic soil, then cobble
				Shrubs (short) 100%	17	19	-
				Shrubs (tall) 100% (10% short shrub understory)	19	45	-
				Trees 75%; Shrubs 20% (100% short shrub understory)	45	100	-
17+000	A	Left	Northwest	River	0	15	-
				Grass 100%; Shrubs (dead) 10%	15	21	3 (above sandy silt)
				Grass 50%; Shrubs (dead) 50%; Bare 25%	21	25	clay with silt soil
				Shrubs (short) 100%	25	44	-
				Shrubs (tall) 80%; Trees 20% (100% short shrub understory)	44	100	-
	B	Right	Southeast	River	0	15	-
				Grass 50%; Bare (cobble with sand) 50%; Shrubs (dead) 40%	15	29	trace org., 1 cm silt, then coarse sand and gravel
				Grass 100%; Shrubs (dead) 80%	29	39	5 silt with fine sand, then 15 organic, then cobble
				Shrub (tall) 95%; Trees 5% (100% herbaceous understory)	39	66	10 above silty clay
				Shrub (tall) 65%; Trees 35%	66	83	>15 (wet at 13)
				Trees 50%; Shrubs 50%	83	100	organic peat, wet at 3 cm
17+500	A	Left	West-Northwest	River	0	12	-
				Grass 90%; Bare 10%; Shrub (dead) 20%	12	19	3 cm coarse sand, then >13 cm org. peat
				Grass 60%; Bare 40%; Shrubs (dead) 20%	19	21	15 cm sand and gravel, then org. peat
				Bare 75%; Shrubs (dead) 40%; Grass 10%	21	34	15 cm sand and gravel, then org. peat

				Grass 100%; Shrubs (dead) 40%; Deadfall logs 10%	34	74	3 cm deposited silt, then 20 cm organics, then silt
				Trees 60%; (100% herbaceous understory)	74	100	1 cm silt, then 5 cm org. peat, then cobble and coarse sand
	B	Right	East-Southeast	River	0	12	-
				Grass 100%; Shrubs (dead) 25%	12	15	15 (peat), then clayey silt
				Bare 60%; Shrubs (dead) 40%, Grass 25%	15	19	5 cm silt, then 8 cm org. peat, then clayey silt
				Shrubs (short) 100%	19	20	1 cm silt, then 5 cm organics, then 9 cm clayey silt, then silty clay
				Shrubs 85%; Trees 15%	20	60	15 cm peat, then silty fine sand
				Trees 40%; Shrubs 40% (sphagnum understory)	60	100	-
18+000	A	Left	Northeast	River	0	9	-
				Bare (cobble) 95%; Shrubs (dead) 10%; Grass 5%	9	25	sand, gravel, cobble with areas showing trace organic deposition
				Grass 95%; Shrubs (dead) 20%; Bare 5%	25	37	3 cm peat, then silt
				Shrubs (dead) 60%; Bare 40%; Grass 25%	37	43	5 cm silt, then 8 cm org. peat, then clayey silt
				Shrubs 100% (100% herbaceous understory)	43	49	0.5 cm silt above 6 cm of peat, then clayey silt
				Shrubs (tall) 95%	49	74	trace silt above 5 cm of peat, then silt with trace clay
				Trees 95%; Shrubs (tall) 5%	74	100	15 cm organic soil above then silt with trace sand
	B	Right	Southwest	River	0	9	-
				Grass 100%; Shrubs (dead) 50%	9	19	0.5 cm peat, then 4 cm silt, then peat
				Shrubs 100%	19	27	13 cm peat above silt with fine sand
				Shrubs (tall) 80%; Trees 20%	27	41	>18 cm peat
				Trees 50%; Shrubs 40%	41	97	
				Trees 90%; Shrubs 10%	97	100	peat
18+500	A	Left	Northwest	River	0	11	-

				Grass 95%; Shrubs (dead) 25%; Bare 5%	11	18	1 cm silt deposition, then 13 cm peat, then clayey silt
				Shrubs 90%; Trees 10%	18	36	6 cm organic soil above silt with trace clay
				Shrubs (tall) 100%	36	100	18 cm peat
	B	Right	Southeast	River	0	11	-
				Grass 95%; Shrubs (dead) 40%; Bare 5%	11	70	13 cm sand, then peat (near creek); 8 cm silt, then peat approx. 30 m from creek
				Shrubs (dead) 90% (75% herbaceous understory)	70	75	1 cm silt, then >20 cm org. peat
				Shrubs 80%; Trees 20% (grassy understory)	75	89	3 cm peat above silt with trace clay and sand
				Grass 100%; Shrubs 75% (wet)	89	100	peat
19+000	A	Left	Southwest	River	0	6	-
				Grass 95%; Shrubs (dead) 25%; Bare 5%	6	23	3 cm of sand with trace gravel and cobble above org. peat
				Grass 100%; Shrubs (dead) 40%	23	37	-
				Grass 75%; Shrubs 25%	37	42	10 cm silt at surface, then 13 cm organics, then stones
				Shrubs (tall) 90%; Trees 10%	42	100	-
	B	Right	Northeast	River	0	6	-
				Grass 100%; Shrubs (dead) 40%	6	26	1 cm organics, then 2 cm silt, then peat
				Grass 100%; Shrubs (dead, standing) 40%; deadfall	26	58	1 cm silt above >15 cm peat
				Shrubs (short) 60%; Grass 40%; deadfall	58	63	-
				Trees 75%; Shrubs 25% (100% herbaceous understory)	63	87	-
				Shrubs 80%; Trees 20%	87	100	-
19+500	A	Left	East	River	0	10	-
				Grass 100%; Shrubs (dead) 5%	10	19	organic silty clay
				Grass 90%; Trees (dead) 80%; Shrubs (short) 10%	19	91	5 cm silt, 5 cm sandy silt, then peat
				Shrubs 85%; Trees 15% (sphagnum understory)	91	100	-
	B	Right	West	River	0	10	-

				Grass 95%; Shrubs (dead) 10%; Bare (sand) 5%	10	34	15 cm fine-medium sand above roots near creek, then 10 cm sand above organics further from creek
				Grass 90%; Trees (dead) 80%	34	100	5 cm silty sand, 3 cm of peat, then fine sand
20+000	A	Left	South-Southwest	River	0	10	-
				Bare 100%; Shrubs (dead) 5%	10	39	sand, gravel, cobble
				Grass 90%; Shrubs (dead) 25%; Bare 10%	39	100	13 cm of sand above organics
	B	Right	North-Northeast	River	0	10	-
				Grass 95%; Shrubs (dead) 20%; Bare 5%	10	28	3 cm silt with organics, 5 cm silt, then organics
				Grass 100%; Shrubs (tall, dead) 95%; Trees (dead) 5%	28	100	8 cm silt, then organics
20+500	A	Left	West	River	0	6	-
				Grass 100%; Shrubs (dead) 20%	6	29	fine layer of silt above organic soil
				Grass 100%; Shrubs (dead) 100%	29	42	>15 cm silt
				Grass 100%; Trees (dead) 100%	42	100	8 cm silt above peat
	B	Right	East	River	0	6	-
				Grass 100%; Shrubs (dead) 5%	6	25	5 cm silt above peat
				Grass 100%; Shrubs (dead) 40%	25	47	13 cm silt above peat
				Grass 90%; Shrubs (dead) 90%; Bare 10%	47	100	6 cm silt above peat
21+000	A	Left	West	River	0	11	-
				Grass 100%; Shrubs (dead) 20%	11	43	5 cm fine sand above organic soil
				Grass 100%; Trees (dead) 45%; Shrubs 45%	43	100	15 cm of silt above peat
	B	Right	East	River	0	11	-
				Grass 100%; Shrubs (dead) 20%	11	25	8 cm silt above peat
				Shrubs (1/2 dead) 100%	25	53	8 cm silt above peat
				Trees (1/2 dead) 100%	53	100	peat
21+500	A	Left	Southwest	River	0	11	-
				Grass 50%; Shrubs (1/3 dead) 70%	11	26	>13 cm silt
				Trees (dead) 75% (100% herbaceous understory)	26	100	3 cm silt above peat

	B	Right	Northeast	River	0	11	-
				Grass 100%; Shrubs (dead) 75%	11	23	>15 cm fine sand
				Trees (dead) 100%; Grass 50% (herbaceous understory)	23	100	8 cm silt above organic soil
22+000	A	Left	Southwest	River	0	10	-
				Grass 100%; Shrubs (dead) 40%	10	26	3 cm silt above >13 cm sand
				Trees (dead) 100%; Shrubs (1/2 dead) 20%	26	69	5 cm silt above peat
				Trees 100%; Shrubs 10% (sphagnum understory)	69	100	peat
	B	Right	Northeast	River	0	10	-
				Grass 100%; Shrubs (dead) 10%	10	22	5 cm silt above peat
				Grass 100%; Trees (dead) 80%	22	48	5 cm silt above peat
				Trees 100% (100% herbaceous understory)	48	100	peat with trace silt
22+500	A	Left	West	River	0	22	-
				Bare 95%; Grass 5%	22	35	3 cm silt above sand/gravel
				Grass 95%; Trees (dead) 75%; Bare 5%	35	100	13 cm silt above peat
	B	Right	East	River	0	22	-
				Grass 100%; Shrubs (dead) 40%	22	29	3 cm silt above peat
				Trees (dead) 100%; Grass 50% (herbaceous understory)	29	42	-
				Trees 100%; Shrubs 40% (herbaceous and sphagnum understory)	42	100	-
23+000	A	Left	Southwest	River	0	20	-
				Grass 100%; Shrubs (dead) 50%	20	25	3 cm silt above organic soil
				Trees (dead) 75%; Shrubs (dead) 25% (100% herbaceous understory)	25	50	3 cm silt above organic soil
				Trees (dead) 90% (75% herbaceous understory)	50	78	peat
				Trees 100% (75% herbaceous understory)	78	100	peat
	B	Right	Northeast	River	0	20	-
				Grass 100%; Shrubs (dead) 50%	20	31	5 cm silt above organic soil
				Trees (dead) 75% (100% herbaceous understory)	31	45	-
				Trees 100%; Shrubs 25% (100% herbaceous understory)	45	100	peat
23+500	A	Left	South	River	0	6	-
				Grass 95%; Shrubs (dead) 40%	6	46	>10 cm silt

				Trees (dead) 100% (90% herbaceous understory)	46	100	3 cm of silt above organic soil
	B	Right	North	River	0	6	-
				Grass 90%; Shrubs (dead) 25%; Bare 10%; Shrubs 5%	6	16	13 cm organic soil above silt
				Trees 75%; Shrubs 10% (75% herbaceous understory)	16	20	-
				Trees 100% (sphagnum understory)	20	39	peat
				Trees 90%; Shrubs 40% (sphagnum understory)	39	100	peat
24+000	A	Left	West	River	0	12	
				Bare 100%	12	13	silt with gravel
				Shrubs 90%; Trees 10%	13	29	0.5 cm silt over organic soil
				Shrubs (tall) 50%; Trees 30% (100% herbaceous understory)	29	58	-
				Trees 80%; Shrubs 15% (100% herbaceous understory)	58	100	-
	B	Right	East	River	0	12	-
				Grass 100%; Shrubs (dead) 75%; Trees (dead) 10%	12	50	10 cm of silt above organic soils
				Grass 100%; Trees (dead) 90%; Shrubs 25% (wet ground)	50	66	-
				Trees 100%; Grass 50%; Shrubs 50%	66	100	-
24+500	A	Left	West	River	0	15	-
				Grass 90%; Shrubs (dead; on ground) 75%	15	23	5 cm silt above organic soil
				Grass 90%; Shrubs (dead; standing) 75%	23	33	5 cm silt above organic soil
				Shrubs 100% (100% herbaceous understory)	33	41	-
				Trees 100% (100% herbaceous understory)	41	60	-
				Shrubs (tall) 95%; Trees 5% (sphagnum understory)	60	100	peat
	B	Right	East	River	0	15	-
				Grass 75%; Shrubs (dead) 25%; Trees (dead) 5% (25% herbaceous understory)	15	28	5 cm silt above organic soil
				Shrubs (dead) 100%; Grass 50% (50% herbaceous understory)	28	64	>15 cm silt with organics
				Trees (dead) 100%; Grass 50% (50% herbaceous understory)	64	100	
25+000	A	Left	Northwest	River	0	11	-
				Bare 95% (5% herbaceous shrubs)	11	13	silt

				Shrubs 25% (75% herbaceous shrubs)	13	17	-
				Shrubs 75%; Trees 10% (100% herbaceous understory)	17	26	trace silt above organic soil
				Trees (dead) 50%; Shrubs (tall) 50% (100% herbaceous understory)	26	44	-
				Trees 95%; Shrubs 5% (sphagnum understory)	44	58	peat
				Trees 100%; Shrubs 25% (sphagnum understory)	58	100	peat
	B	Right	Southeast	River	0	11	-
				Bare 100%	11	20	cobble
				Grass 100%; Shrubs (dead) 20%	20	38	10 cm silty organic soil above silt
				Grass 100%; Shrubs (dead) 20%	38	83	10 cm silty organic soil above silt
				Trees 50%; Shrubs 50% (sphagnum understory)	83	100	peat
25+500	A	Left	West	River	0	10	-
				Grass 100%; Shrubs (dead) 30%	10	37	5 cm silt above organic soil
				Shrubs (dead) 90%; Grass 50% (50% herbaceous understory)	37	100	8 cm silt, then 3 cm organic soil, then silt
	B	Right	East	River	0	10	-
				Shrubs (dead) 50%; Grass 50% (50% herbaceous understory)	10	18	10 cm organic soil above silt
				Shrubs 100% (100% herbaceous understory)	18	36	-
				Trees 50%; Shrubs 50%	36	53	-
				Shrubs (tall) 90%; Trees 10% (sphagnum understory)	53	100	-
26+000	A	Left	East-Northeast	River	0	7	-
				Bare 100%	7	10	5 cm silt above gravel
				Grass 100%; Shrubs (dead) 20%	10	75	-
				Grass 100%; Shrubs (dead) 65%	75	100	-
	B	Right	West-Southwest	River	0	7	-
				Grass 70%; Shrubs (dead) 50% (20% herbaceous understory)	7	19	silty organic soil
				Shrubs 95%; Trees 5%	19	62	-
				Shrubs (dead) 80%; Grass 80% (20% herbaceous understory)	62	100	-
26+500	A	Left	South-	River	0	8	-

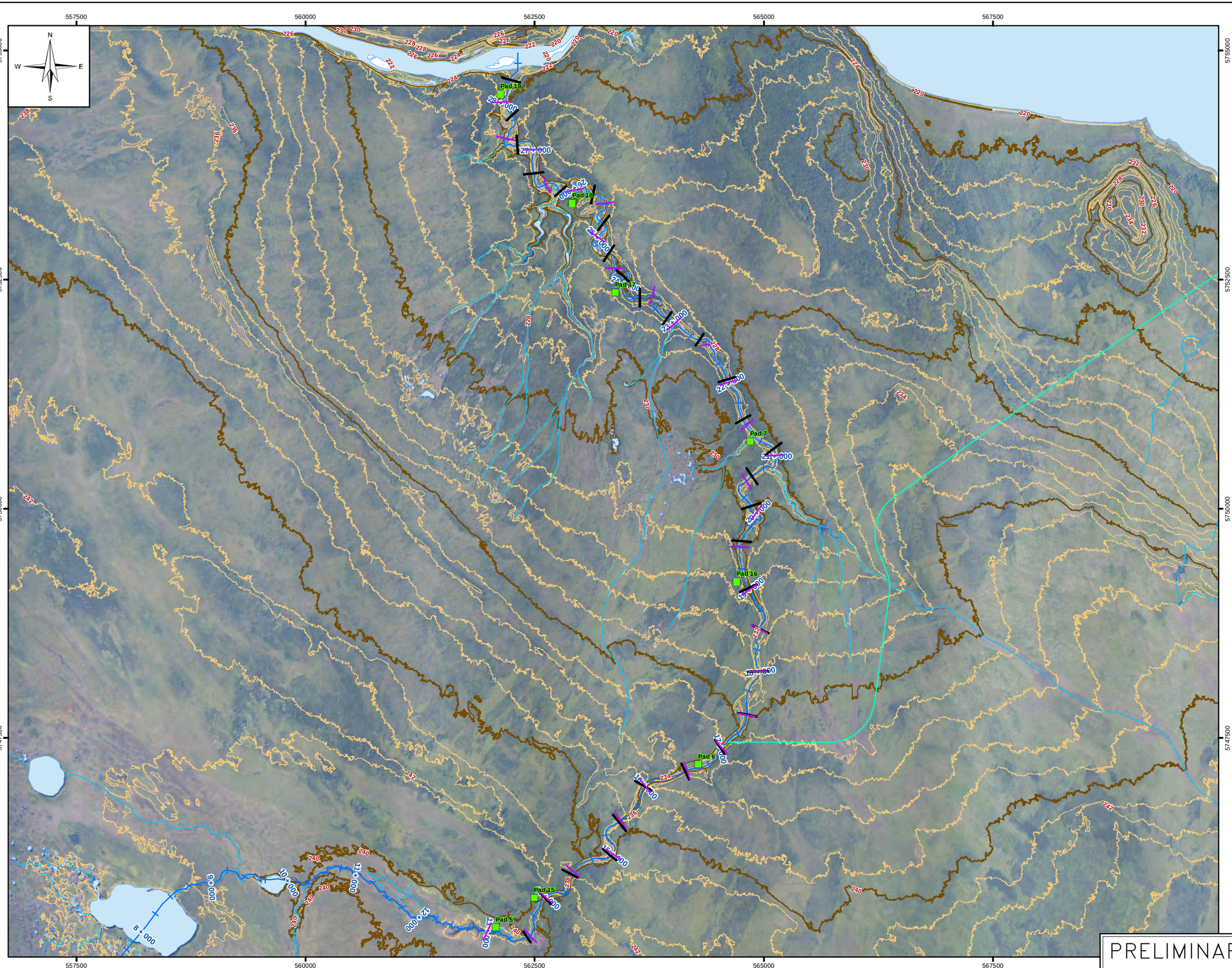
			Southeast	Grass 100%; Shrubs (dead) 20%	8	51	15 cm sandy silt above organic soil
				Shrubs (dead) 50% (100% herbaceous understory)	51	75	-
				Trees (dead) 70% (100% herbaceous understory)	75	100	-
	B	Right	North-Northwest	River	0	8	-
				Grass 100%; Shrubs (dead) 20%	8	34	organic soil
				Shrubs (dead) 100%; Grass 50% (50% herbaceous understory)	34	50	peat
				Shrubs (tall) 100% (100% herbaceous understory)	50	79	-
				Trees 80%; Shrubs (tall) 20% (herbaceous understory)	79	100	-
27+000	A	Left	West	River	0	12	-
				Grass 95%; Shrubs (dead) 30%; Bare 5%	12	27	1 cm silt above >13 cm fine gravel
				Grass 95%; Trees (dead) 75%	27	73	-
				Trees (dead) 100% (75% herbaceous understory)	73	84	-
				Trees 95%; Shrubs (tall) 5% (100% herbaceous understory)	84	100	-
	B	Right	East	River	0	12	-
				Grass 100%; Shrubs (dead) 40%	12	37	1 cm silt above organic soil
				Shrubs 100% (100% herbaceous understory)	37	50	-
				Trees 50%; Shrubs (tall) 50% (100% herbaceous understory)	50	75	-
				Trees 50%; Shrubs (tall) 50% (sphagnum understory)	75	100	-
27+500	A	Left	West	River	0	13	
				Grass 100%; Trees (dead) 5%	13	26	6 cm silt above organic soil
				Shrubs 80%; Trees 20% (herbaceous understory)	26	61	> 13 cm organic soil
				Trees 80%; Shrubs 20%	61	100	very wet
	B	Right	East	River	0	13	-
				Bare 95%; Grass 5%	13	19	>15 cm sand and gravel
				Grass 100%; Shrubs (dead) 5%	19	46	sandy silt
				Shrubs 70%; Trees 30%	46	100	-
28+000	A	Left	East-	River	0	10	-

			Southeast	Grass 100%	10	14	1 cm silt above organic soil
				Shrubs 100%	14	34	-
				Trees 50%; Shrubs 50%	34	65	-
				Trees 100% (sphagnum understory)	65	100	peat
	B	Right	West-Northwest	River	0	10	-
				Bare 75%; Grass 25%	10	14	stones, gravel and silt
				Grass 95%; Bare 5%	14	62	-
				Trees 100%; Shrubs 100%	62	100	-

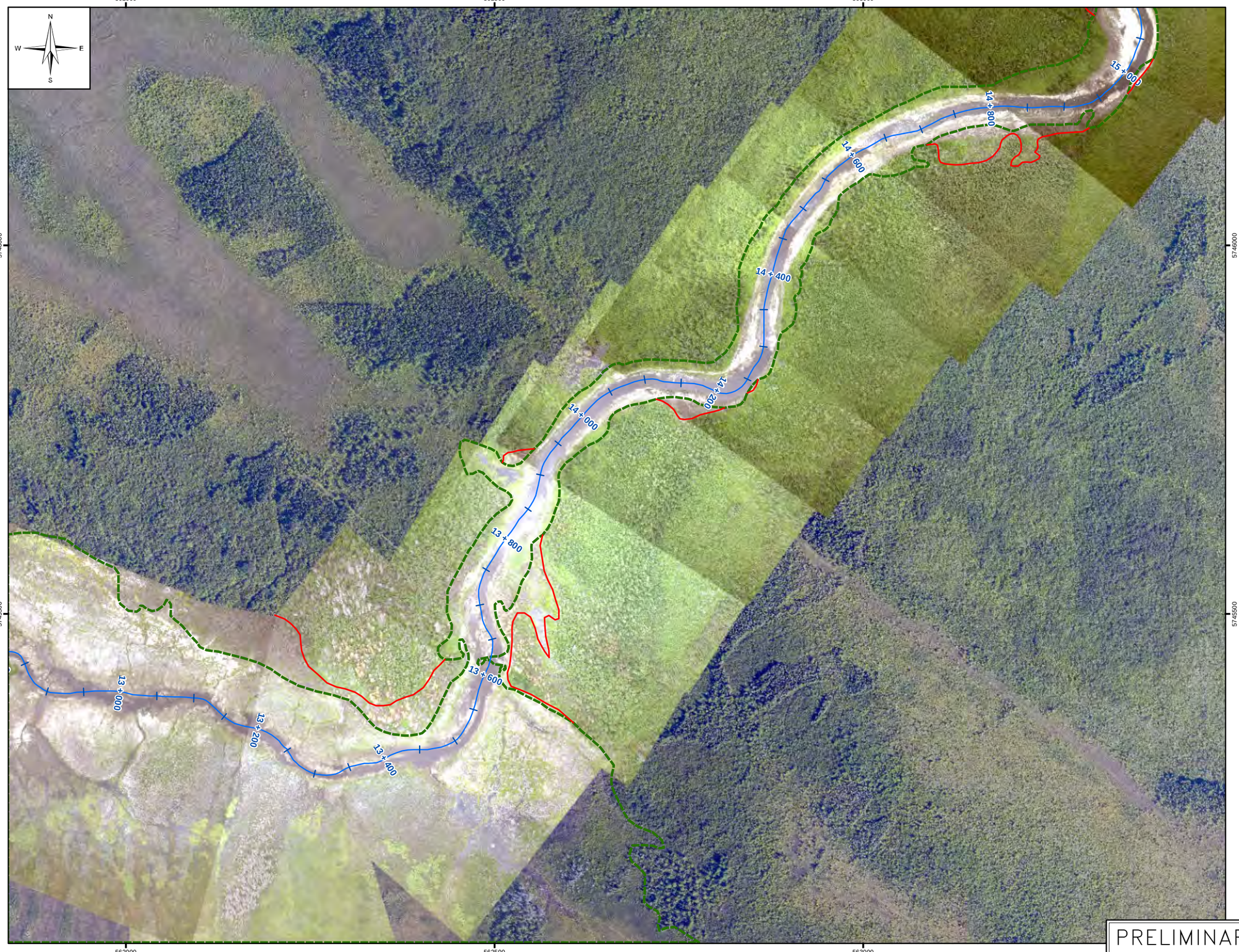
*[1] Note: Bank left or bank right is based on facing downstream.

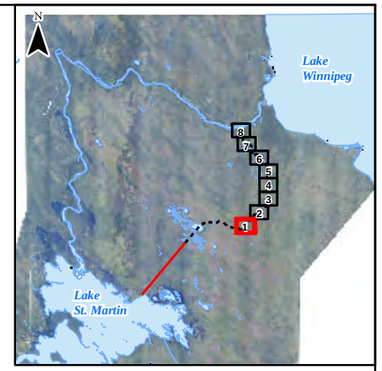
FIGURES

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

NOTES:

1. Georeferenced Aerial Imaging and Mapping (GAIM) flown by TAIGA Air Services Ltd on July 7th, 2013.
2. Background Satellite Image provided by Atlis Geomatics, July 2011
3. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
4. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

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A	14/06/12	ISSUED WITH FIELD INSPECTION FORM	STO

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

VEGETATION IMAPACT ZONES

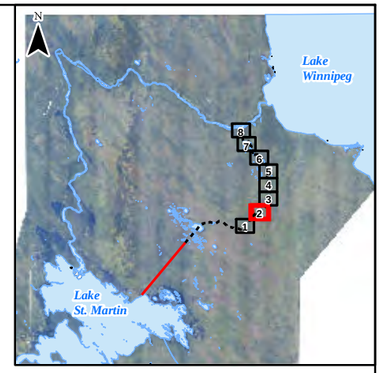
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JUNE 2014 | FIGURE02.01 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

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Metres

SCALE: 1:5,000 METRIC 11"x17"

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

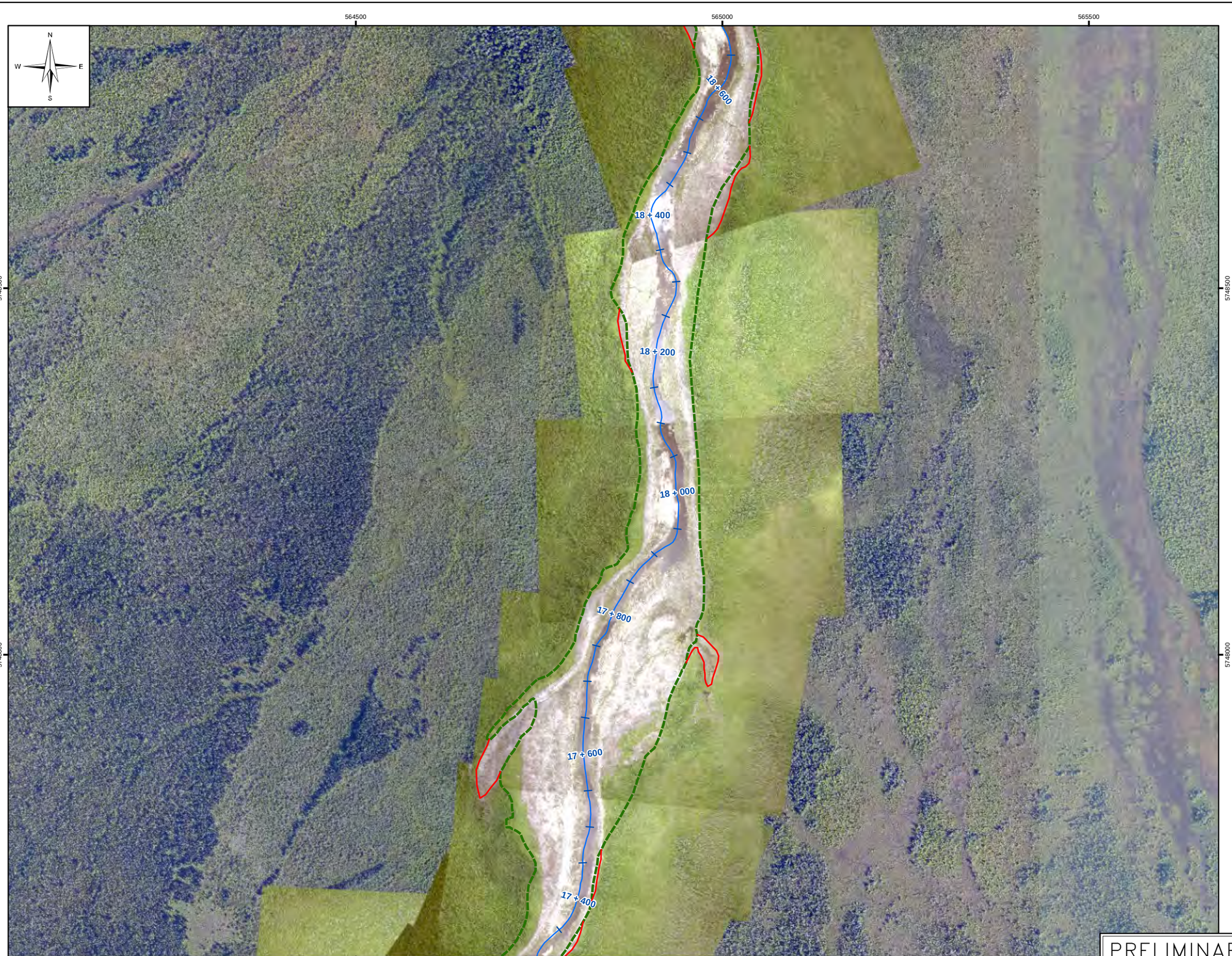
VEGETATION IMAPACT ZONES

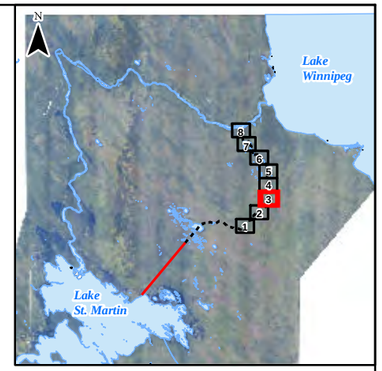
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JUNE 2014 | FIGURE02.02 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

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50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

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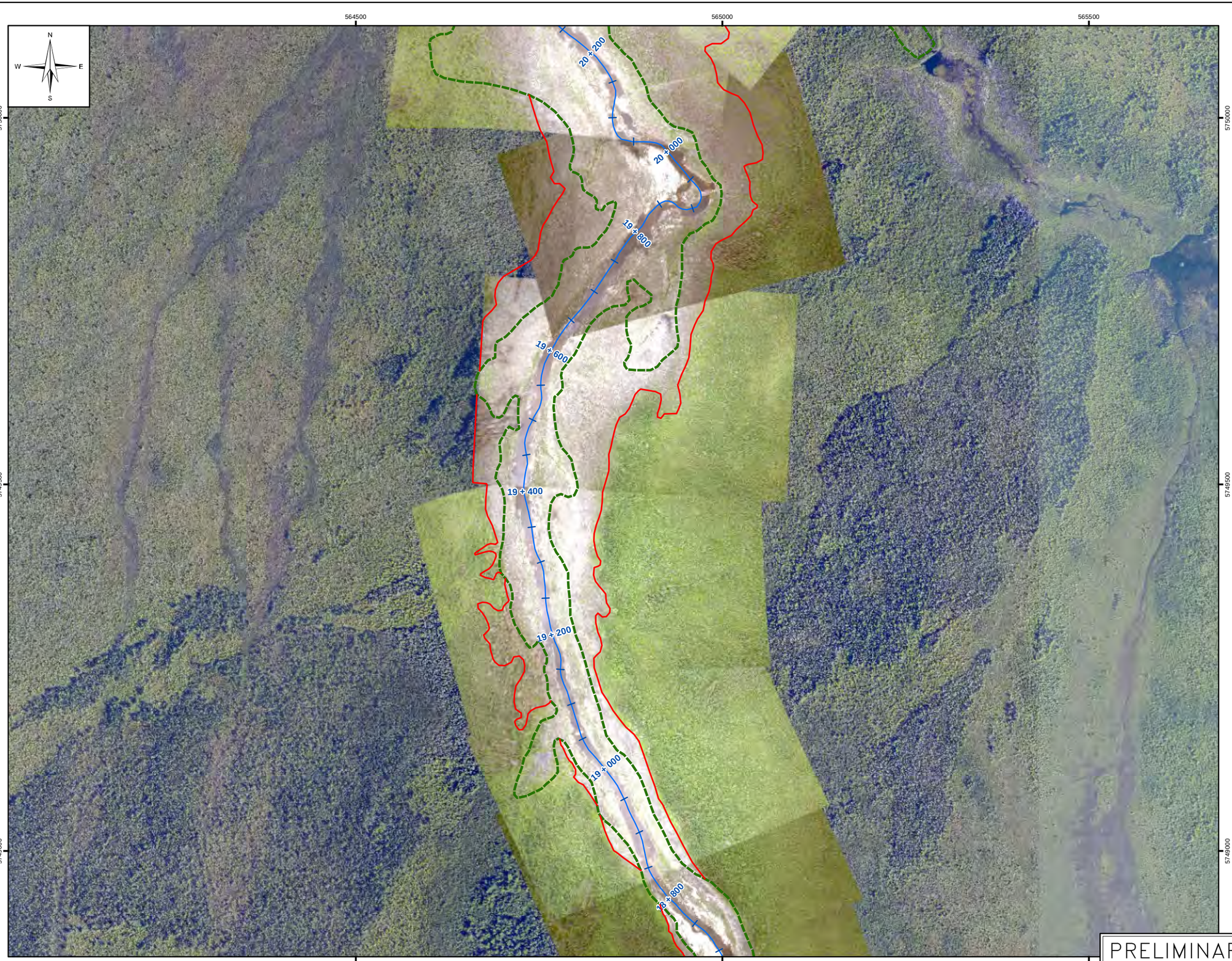
VEGETATION IMAPACT ZONES

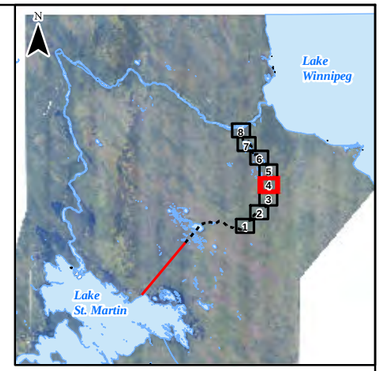
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JUNE 2014 | FIGURE02.03 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

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Metres

SCALE: 1:5,000 METRIC 11"x17"

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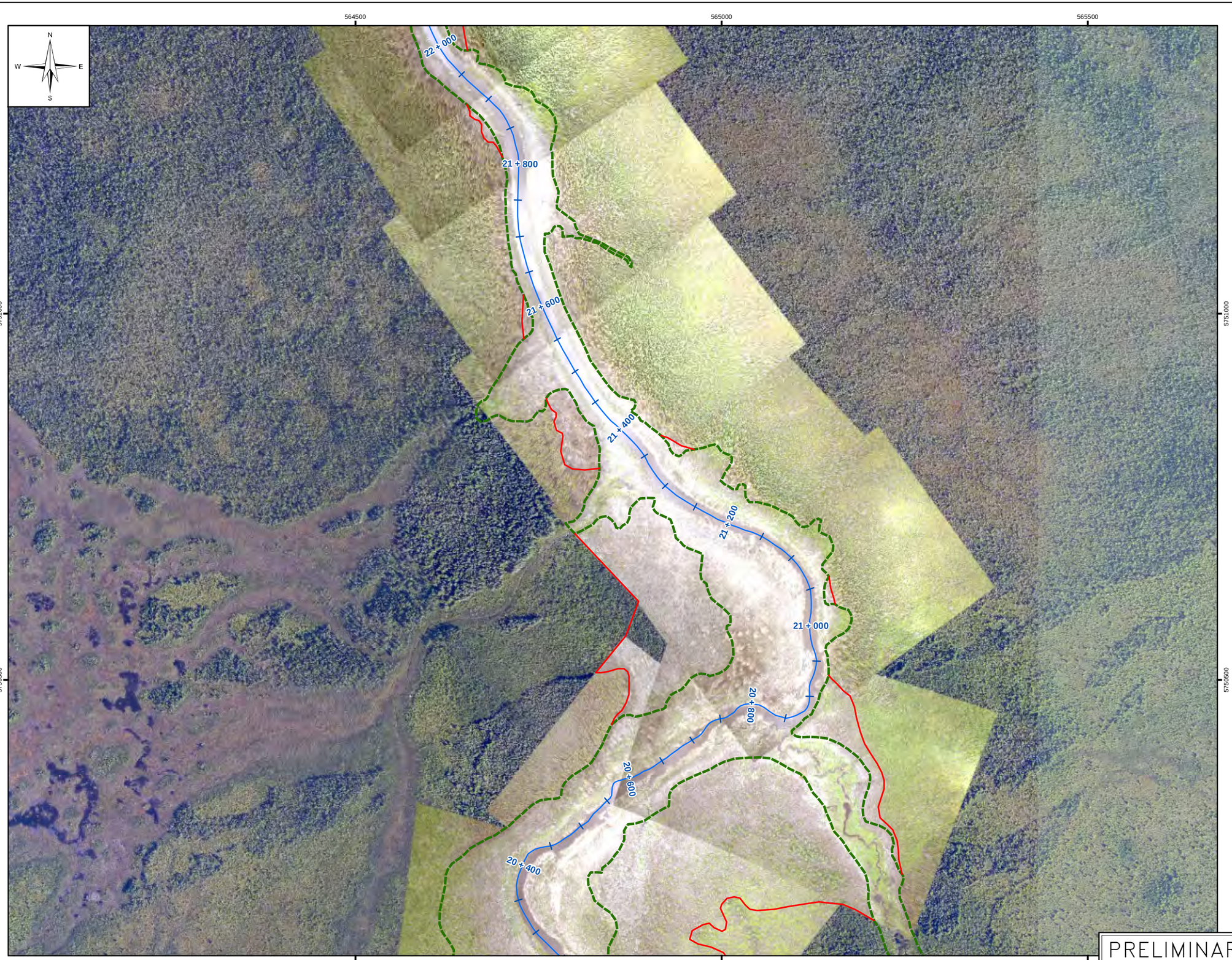
VEGETATION IMAPACT ZONES

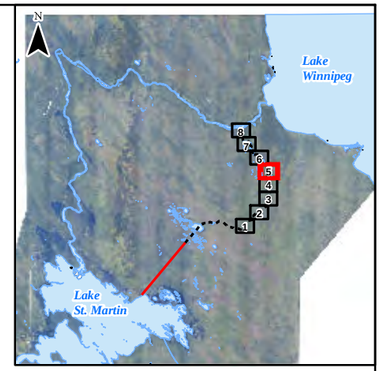
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JUNE 2014 | FIGURE02.04 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

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50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
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KGS GROUP CONSULTING ENGINEERS

Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

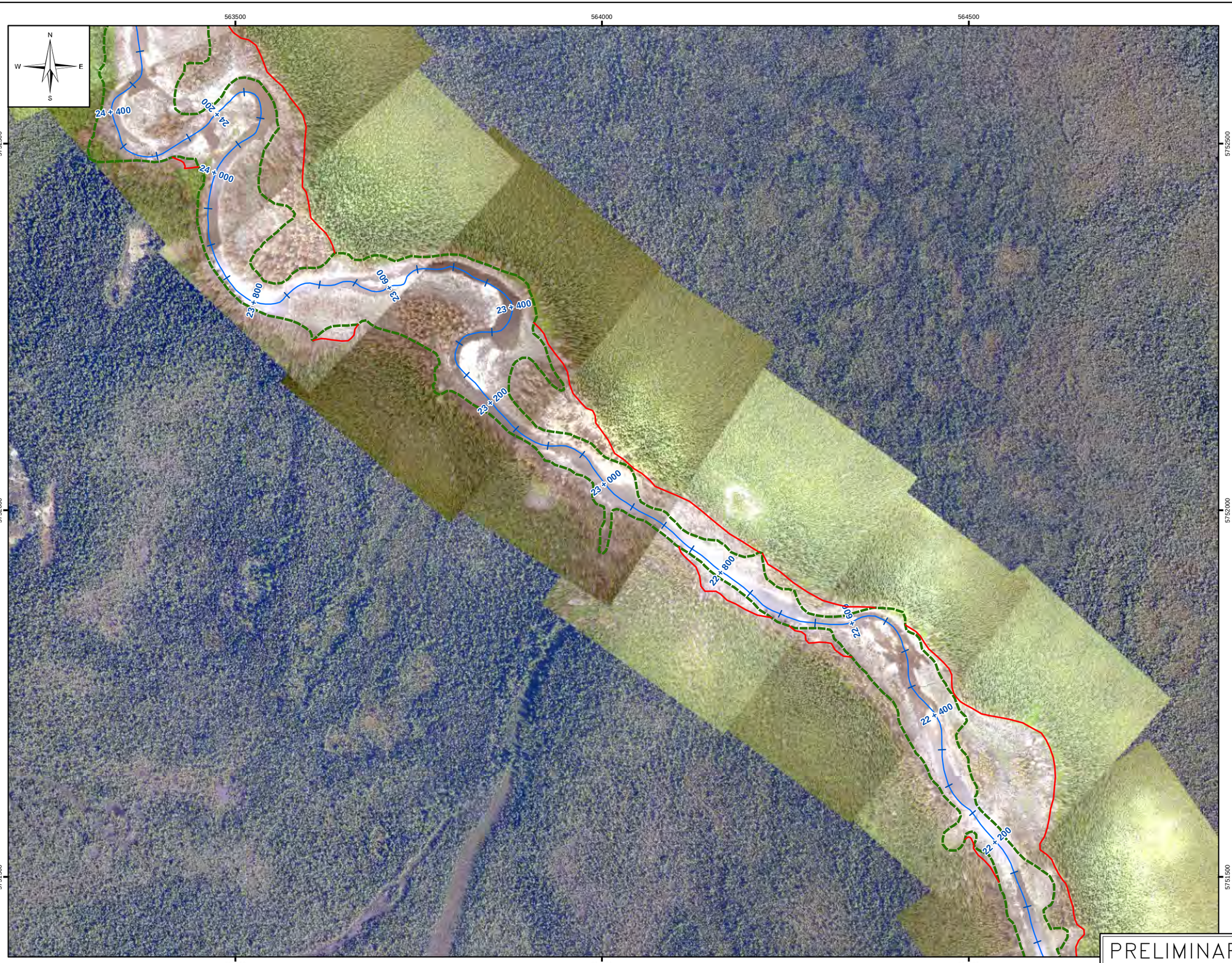
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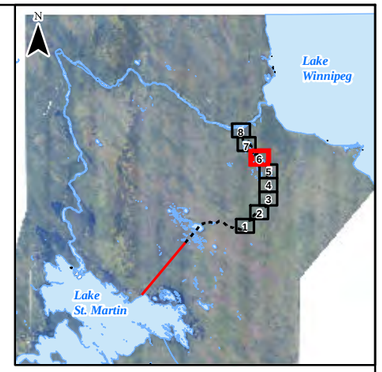
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

JUNE 2014 | FIGURE02.05 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

NOTES:

1. Georeferenced Aerial Imaging and Mapping (GAIM) flown by TAIGA Air Services Ltd on July 7th, 2013.
2. Background Satellite Image provided by Atlis Geomatics, July 2011
3. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
4. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

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SCALE: 1:5,000 METRIC 11"x17"

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

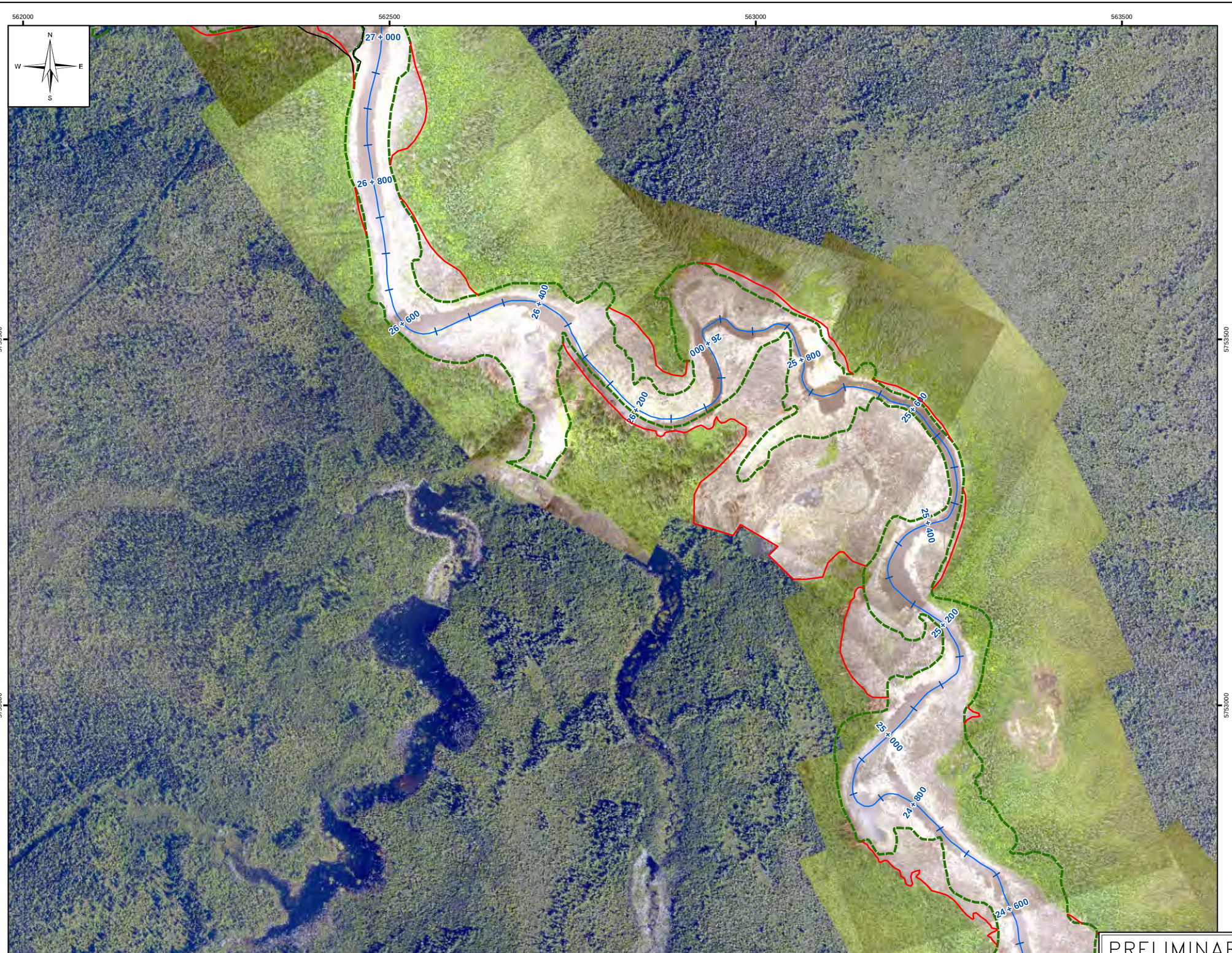
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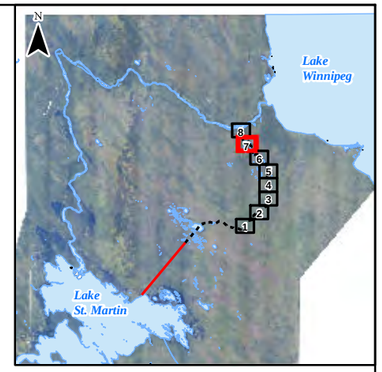
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JUNE 2014 | FIGURE02.06 | REV: A

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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

NOTES:

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4. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

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SCALE: 1:5,000 METRIC 11"x17"

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

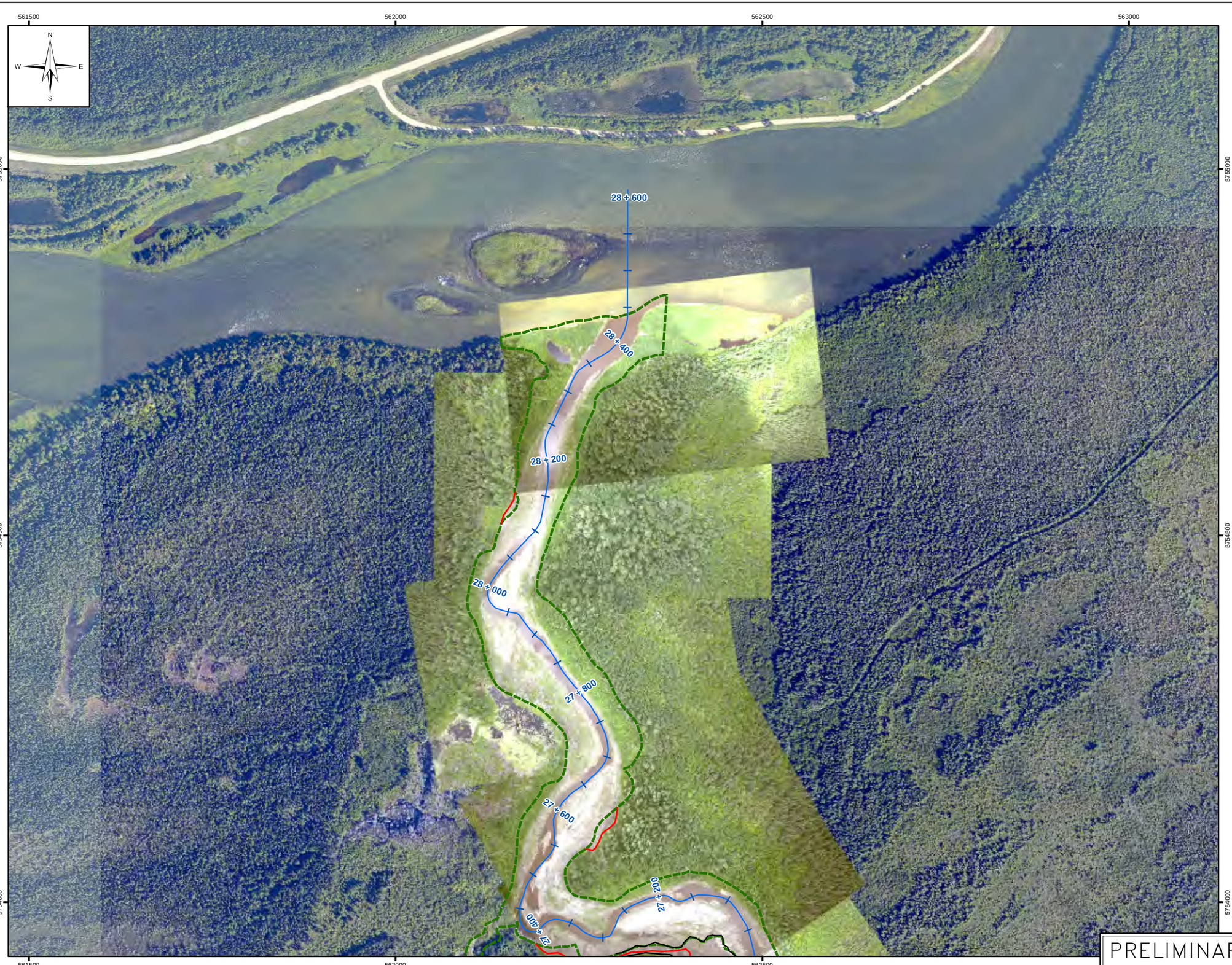
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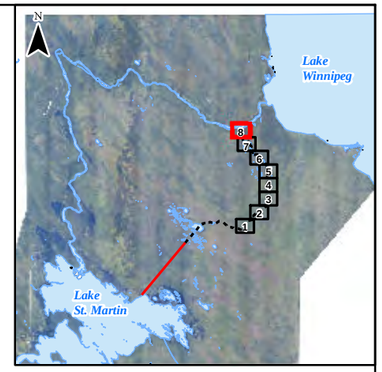
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LEGEND:

- Buffalo Creek Centreline
- Dead Tree Limits
- Extent of Trees

NOTES:

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2. Background Satellite Image provided by Atlis Geomatics, July 2011
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   Elevations are in metres above sea level (MSL)

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Metres

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

VEGETATION IMAPACT ZONES

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

JUNE 2014 | FIGURE02.08 | REV: A

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11"x17" PLOT SCALE 1:1

APPENDICES

KGS GROUP CONSULTING ENGINEERS

Field Inspection Form

PROJECT: **Lake St. Martin Channel Monitoring - 2015**

CLIENT: **North/South Consultants Inc.**

CONTRACTOR:

FILE NO.: **13-0431-001 Task 16**

REPORT DATE: September 3, 2013

BY: Dan Leitch

POSITION TITLE: Environmental Scientist

Buffalo Creek Vegetation Cover Survey Results
July 3-5, 2013

1.0 Introduction

As part of the Buffalo Creek Watershed – Post-Project Evaluation (Task ESH-4) for the Lake St. Martin Emergency Relief Channel – Monitoring and Development of Habitat Compensation project, KGS Group completed 31 vegetation survey transects along Buffalo Creek between station 13+000 m and 28+000 m. Field work was completed between July 3, 2013 and July 5, 2013 with helicopter support for daily access. A canoe was used to navigate down the river between transects.

The purpose of the vegetation survey along the Buffalo Creek was to assist in monitoring and assessing the impacts of the emergency channel operation and changes to the riparian vegetation community as well as erosion along the river. The vegetation survey program involved walking perpendicular 100 m transects on both sides of the creek, and documenting the cover types along this transect. Vegetation cover types were used to estimate the amount of protection from erosion afforded to the soil via plant cover. Representative sample photos were taken. The soil organic layer depth was also measured to compare against pre-project observations as an indication of the quantity of organic fines that may have moved downstream.

In addition to the vegetation cover survey program, a detailed cross section survey program was completed concurrently by the GIS team. The results of the detailed cross section survey will be presented separately.

2.0 Methodology

Sampling locations were set every 500 m along the length of the Buffalo Creek beginning at Station 13+000 m and continuing to just upstream of the confluence with the Dauphin River at Station 28+000 (Figure 1). The vegetation survey transects were run perpendicular to creek when possible, starting from centreline of the stream and continuing for a distance of 100 m on each side of the creek. Transect orientation was modified for those locations where the meander of the creek resulted in overlap of a transect from another location.

The river bank on both sides of the creek was recorded to determine the centreline. Transect orientation (cardinal direction), start and end point, general description of cover types, start and end distance of each cover type within the transect, and depth of soil organic layer were also recorded. Cover types were placed in four broad categories:

- Bare: exposed mineral soil with no vegetation or soil organic layer;
- Grass: vegetation cover consists of Grass, sedge, or rush families;
- Shrub : vegetation cover consists of woody species which do not form distinct trunks or canopies of leaves, especially those which do not normally exceed 10m in height; At times, a distinction was made between short herbaceous shrubs and taller woodier shrubs.
- Treed: vegetation cover consists of woody species which form distinct trunks and leaf canopies, and which normally can or do exceed 10m in height.

Photos 1 to 4 show the four representative cover types. A photo log was compiled with several photos taken along most transects. Photos are stored on the project drive for possible future comparison or verification.

Composites or matrices of these four types were possible, and their corresponding ground cover was provided e.g. 50% area covered by Grass 50% area covered by Shrubs. Due to plant morphology and habit, total percentages greater than 100% were possible.

Organic soil depths were measured from a representative area within each cover change along a transect (i.e. if substrate changes from grass to trees, a soil measurement was taken in each section). Soil was removed using a garden trowel and measured using a tape measure. When the

organic soil depth was greater than could be measured within reason using the garden trowel, soil depth was recorded as greater than the depth that was excavated (i.e. > x cm)

3.0 Results

The following subsections detail the results found for each transect, including orientation, description of terrain, cover types, and organic layer depths in soil. Unique features related to the investigation are also mentioned where appropriate. Where possible, observations were compared against conditions described during the 2011 survey. Due to the accuracy of the GPS, movement of creek banks due to varying water levels, and possible use of different starting points for the transects, detailed comparisons are not feasible. A detailed GIS survey was also conducted along the Buffalo Creek in order to quantify many of these differences. Photos contrasting several locations in 2011 and 2013 are included. Full records for each transect are found in Table 1 with the transect data broken into subsection A (left bank, when facing downstream) and subsection B (right bank, when facing downstream).

The organic soils in several areas, particularly at and beyond 19+500 appeared to be overlain with varying amounts of inorganic soils. When present, the inorganic soil depth was also measured. There was no note of inorganic soils observed in 2011.

General observations include large extents of dead shrubs and trees and bare areas where no vegetation is currently established along the creek. Many areas have recently begun to be colonized by young grass and shrub species. A comparison between the two surveys must consider the different time of year in which the surveys were conducted. The 2013 survey was done in early July following a late spring, while the 2011 survey was conducted in late September. It is possible that much of the bare areas noted in 2013 would be covered with grass and shrubs by late fall of 2013. It was also noted that water levels were lower in 2013 than in 2011. This may affect vegetation composition, transect centerlines and soil sampling. An abundance of beaver dams was also observed in 2011 creating large inundated areas at some of the transects. No beaver dams were observed in 2013.

The following sections provide a brief description of each of the transects surveyed. For more detail, see Table 1.

3.1 13+000

This transect runs in a northeast-southwest orientation. This section is within the vast open bog area surrounding Buffalo Lake. Both sides of the creek show grass and bare areas with some dead shrubs (willows) further away from the creek. The shrubs on the left side where at the beginning of the forest, while the shrubs on the right side were a small slightly elevated 'island' of shrubs which was otherwise surrounded by grass and bare areas. Organic soil depths along this transect varied from 13 to >16 cm. In 2011, this transect had much more water with large areas thick grass (sedges and rushes) being inundated with water. A small component (20%) of shrubs was also noted. No soil samples were taken in 2011 due to the high water levels. Photo 5 contrasts the transect as seen in 2011 and 2013.

3.2 13+500

This transect runs in a northwest-southeast orientation and is comprised of grass, shrubs and bare ground cover. To the southeast, the transect ends in a marshy area with stagnant water with sedges and aquatic vegetation. The vast majority of shrubs on the transect were dead and the ground cover was largely bare, but with a high percentage of young grass species emerging (especially on the northeast side). The organic layer of soil varied between 2 cm and 9 cm. When this transect was surveyed in 2011, the grasses were tall and thick and the wetland described above was drained. The wetland showed bare areas and many dead shrubs, while the shrubs on the northwest side were alive.

3.3 14+000

This transect runs in a northwest-southeast orientation. The ground surface nearest the creek is comprised of bare areas, young grass and dead shrubs. The side slopes are gentle leading to a mixture of trees and shrubs. The left side transect runs into a flooded marsh area comprised of grasses, cattails and willows at approximately 40 m. The right side transect had a slightly steeper bank and led to drier ground where a mixture of trees and shrubs predominated. Organic soil layers ranged from 2 to 5 cm. The 2011 survey made no note of a wetland along this transect, while the area nearest the channel consisted of thick grass and shrub layers at that time.

3.4 14+500

This transect runs in a northwest-southeast orientation. The area nearest the channel was largely bare with exposed soil and cobbles. Young grass species were starting to emerge. Further away from the creek, there is a relatively thin strip of dead shrubs on both banks as the slope increases slightly. Beyond this, both sides transitioned from largely shrubs to largely trees. The organic layer of

soils ranged from <1 to 5 cm. The 2011 survey described very similar vegetation composition, but with grass near the channel, and no mention of any dead vegetation (Photo 6 compares 2011 and 2013 photos). The 2011 survey also observed deeper organic soils (14-15 cm) in the grassy creek bed area.

3.5 15+000

This transect runs in a northwest-southeast orientation. Bare areas of cobble and gravel were observed adjacent to the channel. Exposed roots along the steep slope on the right side suggest recent erosion activity (Photo 7). Above the slope, trees transition to shrubs as the transect enters a sphagnum bog at 52 m. The slope on the left side of the river is much more gradual (inside bend of river) and is bare (cobble, gravel) with dead shrubs for the first 42 m before it transitions to shrubs and then to trees. The organic layer of soils ranged from 0 (adjacent to creek channel) to 9 cm (in sphagnum bog). The 2011 description of this transect described grass and shrubs adjacent to the channel, no bare areas, and slightly higher measurements of organic soil in that area (2-4 cm).

3.6 15+500

The orientation of this transect followed a northwest-southeast direction. Bare areas with dead shrub and young grass were found adjacent to the creek channel. On the right side, shrubs transitioned to trees for approximately 23 m, and then back to shrubs. On the left side, the transect was dominated by trees once up from the river bank. The trees shifted from pine to aspen at 59 m. The organic layer of soil varied between <1 and 6 cm. The 2011 survey noted no bare areas, but a steady transition from grass to shrubs to trees. The soils found near the channel in 2011 were measured at 20 cm on both sides of the creek.

3.7 16+000

This transect is oriented in a northwest-southeast direction. A bare area (cobble, sand) was noted on both banks along with dead shrubs and young grass species. Further from the channel, a dense mixture of shrubs and trees was present. The transect on both sides of the river entered a sphagnum bog. The organic layer of soil varied from <1 cm near the channel to >10 cm in the sphagnum areas. Observations from 2011 noted some bare areas on the left side of the creek, but largely thick grass adjacent to the channel and a mixture of shrubs and trees further from the water. Organic soil depths in 2011 were measured between 0 and 6 cm.

3.8 16+500

This transect runs in a north-northwest to south-southwest orientation. Directly adjacent to the creek channel, a short area of bare cobbles and gravel was observed beneath an eroded bank. The slope on the left side was more gradual, and shows a large area of thick dead shrubs and trees that have been knocked over. Beneath the trees the substrate was largely bare. Once past the dead trees at 81 m, a line of grass and shrubs transitions to predominantly trees. The bank was slightly steeper on the right side and the extent of dead trees was much less. Above the bank, shrubs transition to trees, then to a mixture of shrubs and trees in a sphagnum bog. The depth of organic soil varied from 0 along the creek's edge to >10 in the sphagnum. The 2011 description of the transect noted the entire transect to be comprised of shrubs, and also observed the muskeg along the transect on the right side of the creek.

3.9 17+000

This transect runs in a northwest-southeast orientation. Both sides of the creek show a mix of bare cover, grass and dead shrubs extending 20 to 35 m from the creek centerline. Up the slope on the left side of the river is an area of herbaceous plants and very young poplar trees which transitions into a mixture of trees and shrubs comprised of poplar, willow and alder. A similar mixture of taller shrubs was observed on the right side of the river. The depth of organic soil varied from 0 along the creek's edge to 7 cm in the shrub area. Observations made in 2011 noted a mixture of grass and shrubs along the transect line, but made no mention of bare areas or dead vegetation. Photo 8 compares 2011 and 2013 photos.

3.10 17+500

This transect runs west-northwest to east-southeast. Adjacent to the channel is a mixture of largely bare ground with dead shrubs and grass. The right slope is slightly steeper and leads to small area of short shrubs and herbaceous vegetation and then on to taller shrubs with some young trees and a bog starting at 62 m. The left side had a gentler slope (inside bend of river), a larger area of bare cover and dead vegetation ending up in shrubs at 77 m. The organic layer of soil varied between 1 cm near the river to >10 cm in the bog. 2011 observations mainly grass and shrubs near the river leading into primarily shrubs with some trees. The muskeg area was also observed in 2011. Soil organic layers observed in 2011 were thicker near the channel (5-15 cm) than observed in 2013, while depths further from the creek were similar.

3.11 18+000

This transect runs in a northeast-southwest direction. A large bare area (20 m) of cobble and gravel was observed on the left side of the creek which had a band of dead shrubs beyond it (17 m) which was also bare beneath. Beyond this, as the slope increased, an area of short shrubs (herbaceous and young poplar) transitioned to taller shrubs (alder) and then to trees. On the right side of the river the first 18 m were largely bare soil with grass and some dead shrubs. Up the slope, shrubs transitioned to trees with a largely sphagnum understory. The depth of organic soil varied from 0 cm (cobble, gravel) to >10 cm (sphagnum). Observations made in 2011 noted high concentrations of grass adjacent to the creek as well as deep layers of organic soil (>25 cm) in the same area. Photo 9 compares 2011 and 2013 photos.

3.12 18+500

This transect runs in a northwest-southeast orientation. Bare areas with dead shrubs and grass were observed on both sides of the river, however more extensively on the right side. At 35 m on the left side the understory was largely sphagnum beneath shrubs with a small percentage of trees. On the right side, beyond the dead shrub area, vegetation transitioned to shrubs, then largely trees before ending in a grassy marsh area with standing water. The organic soil depths varied from 0 to 8 cm along this transect. During the 2011 survey, this area was inundated by a beaver dam which flooded areas near the channel. No beaver dam was observed in 2013. The 2011 survey recorded almost exclusively shrubs along this transect with grass on the right side of the river.

3.13 19+000

This transect runs in a northeast-southeast orientation. Both sides of the channel had large areas of bare soil, dead shrubs and young grass for the first 37-57 m. The left side transitions to short shrubs followed by tall shrubs with a high percentage of grass before becoming largely trees. Standing water was present at the end of the transect. The right side has a small area of short shrubs before entering a tree/shrub mixture. At 94 m, the understory became sphagnum-dominated. The organic soil depths varied from 0 to >12 cm. In 2011, the first 12-20 m on either side of the channel was inundated as a result of a beaver dam downstream. Similar compositions of grass/shrubs/trees were noted, as was the sphagnum terrain at the end of the transect on the left side. Organic soil depths measured in 2011 were slightly deeper, particularly close the creek channel. Photo 10 contrasts a shrub area in 2011 with a dead shrub area seen in 2013 at the same transect (we cannot confirm if the photos are from exactly the same locations, but they were both taken at 19+000).

3.14 19+500

This transect followed an east-west alignment. The left side was bare along the creek, followed by a large area of mature dead trees which were largely bare beneath. Many trees were on the ground, as it appeared the mature trees acted as a catch/dam/strainer for dead vegetation moving down the creek from upstream (see Photo 11). Live trees were encountered at 96 m of the left transect. The terrain on the right side of the creek was much flatter. Bare areas were observed near the creek channel, with a combination of dead shrubs and trees for the entire transect distance. Aquatic emergent vegetation was found at several locations on this side. Organic soil depths varied from 0 to 7 cm with several locations being overlain by 1 to 5 cm of inorganic soils (see Photo 12). In 2011, the right side was inundated by beaver activity with a combination of grass and shrub transitioning to largely trees at 21 m, while the left side showed a grass and bare area along the creek, then trees at 21 m which transitioned to shrubs at 91 m. Organic soil depths in 2011 were similar in range (1-12 cm) as those observed in 2013 with >30 cm measured deep along the left transect. No sample was taken from the same area in 2013. There was no mention of inorganic soils overtop of organic soils in 2011.

3.15 20+000

This transect runs in a south-southwest to north-northeast direction. The left side had a large bare area of cobble and gravel which extended to 41 m, followed by an area of dead shrub which was largely bare beneath. The right side had a smaller bare area, followed by dead shrubs underlain by grass, then dead trees underlain by grass. At 73 m the understory became sphagnum. Organic soil depths varied from 0 (near the creek) to >10 (sphagnum). Much of the organic soils on the transect were overlain by inorganic soils between 1 and 5 cm deep. In 2011, the left side was inundated due to beaver activity. The vegetation observed was a mix of grass and shrubs with no mention of any bare of treed areas. Organic soils varied from 4 to >30 cm. The cobble area observed in 2013 was inundated in 2011.

3.16 20+500

This transect was oriented in an east-west orientation. Both sides had bare areas with dead shrubs. On the left side, live trees were encountered at 54 m. On the right side the dead shrubs transitioned to a mixture of dead trees and shrubs. Soils on the entire transect were overlain by inorganic soils of 1 to 13 cm depth. Organic soils beneath varied from >3 to >5 cm. Due to the depth of inorganic soils, the depth of organic soils could only be measured as greater than a certain measurement, therefore, the precise organic soil depth is not known at many locations (deepest measurement to bottom of organic layer was 10 cm). The 2011 survey noted the same transition of grass to shrubs to

trees, but with no mention of dead vegetation or bare areas. Organic soils depths in 2011 were between 5 to >30 cm with no mention of inorganic soils on top.

3.17 21+000

This transect runs in an east-west direction. The left side of the creek was comprised largely of dead shrubs, with bare areas near the creek channel and some dead trees near the end of the transect. The right side had dead shrubs and grass until 19 m, followed by a shrub layer underlain by sphagnum which transitioned to trees at 59 m. Organic soils depths varied from 0 to >10 cm, with some sites containing 4 to 13 cm of inorganic soils. 2011 observations showed high concentrations of grass near the creek channel followed by shrubs on both sides, which transitioned to trees on the right side. Organic soil depths varied from 5 to >30 cm, with no mention of inorganic soils.

3.18 21+500

This transect runs in a southwest-northeast orientation. The left side of the creek was dominated by dead shrubs for the first 32 m, followed by dead trees up to 57 m, followed by live trees. The right side of the creek had dead shrubs, followed by live trees at 25 m which developed a sphagnum understory beyond 36 m. Organic soil depths varied from 3 to >17 cm, with much of the area overlain by inorganic soils of 3 to 7 cm. 2011 observations noted predominantly shrubs and grass along the creek channel with trees beyond that. The first 10 m on the left side was flooded due to beaver activity. Soil depths measured varied from 6 to >30, with most measurements showing farily thick layers of organic soils.

3.19 22+000

This transect runs in a southwest-northeast direction. The first approximately 40 m on both sides of the creek were dominated by dead shrubs, but also had bare areas and grass. Away from the creek, the further half on both sides were dominated by trees with a sphagnum understory beyond approximately 45 m on both sides. Organic soils varied from 0 to >21 cm, much of which was overlain by inorganic soils. In 2011, the transect was described as being dominated by trees and showed organic soil depths from 8 to >30 cm.

3.20 22+500

This transect runs in an east-west direction. The creek is particularly wide in this reach (44 m across). The left side had a large bare area, followed by dead trees at 39 m and then live trees at 73 m. The right side had an area of dead trees immediately adjacent to the creek which ran until 43 m where the trees were alive. Soil depths varied from 0 to >21 cm, with some areas have deposits of

inorganic soil above the organic soil. In 2011, a similar tree-dominated transect was observed, but with all trees being alive. Soil depths noted in 2011 varied from 6 to >30 cm.

3.21 23+000

This transect runs in a southwest-northeast direction. Dead shrubs ringed the creek channel on both sides which transitioned to trees at 49 and 33 m on the right and left sides of the creek respectively. On the right side, the trees were dead for the first 15 m, with live trees starting at 48 m. On the left side, trees were alive from 49 m to the end of the transect. Organic soils were 0 to >14 cm in depth, with 5-9 cm of inorganic soils on top of much of the organic soils. 2011 observations showed a similar progression of shrubs to trees with organic soils of 3 to >30 cm.

3.22 23+500

This transect runs in a north-south orientation. All vegetation on the left side of the river was dead with shrubs from the creek bank to 50 m and trees from 50 m to 100 m. On the right side, dead trees were adjacent to the creek bank for the first 21 m, part of which was underlain by herbaceous shrubs. The remainder of the right side transect consisted of live trees with a sphagnum understory. Organic soil depths varied from 0 to >20 cm, some of which was under up to 10 cm of inorganic soil. 2011 observations showed a high concentration of shrubs on the left side of the river as well as grass (where dead shrubs and bare ground was found in 2013). The remainder of the transect was noted be treed. Organic soil depths varied from 6 to >30 cm.

3.23 24+000

This transect runs in an east-west orientation. The left bank was steep and showed signs of erosion. At the top of the bank was a mixture of deciduous shrubs and trees for the duration of the transect. At 61 m, where the transect approached the river bank further down stream, the trees and shrubs were dead. On the right side of the river, the slope was much gentler, and the sediments were largely wet and muddy. Dead trees and shrubs dominated the first 68 m of the transect. The understory of that section was largely bare, but with increasing concentrations of grass as the transect progressed away from the river. Live trees began at 68 m. Due to the amount of inorganic sediment overlying the organic sediments in most locations, we were not able to get to the bottom of the organic layer. Inorganic sediments varied from 8 to 13 cm. In 2011 the transect was dominated by shrubs and trees, with a grass component on the right side of the river. Organic soil depths measured in 2011 varied from 8 to >30 cm.

3.24 24+500

This transect is oriented in an east-west direction. The left side of the river is composed of dense dead shrubs with a bare understory until 34 m where a layer of live shrubs begins. Beyond this, the vegetation becomes largely treed with a sphagnum understory. On the right side, bare areas with dead shrubs and trees span the entire transect. The bottom of the organic soils was not reached using our sampling methodology as they were beneath sizable amounts of inorganic soils (2-15 cm). 2011 observations noted similar compositions of shrubs and trees and organic soil depths of 9 to >30 cm.

3.25 25+000

This transect is oriented in a northwest-southeast direction. The left side of the creek had a steeper bank and the presence of slump suggested recent erosion (see Photo 13). At the top of the slope were shrubs which were followed by deciduous trees and then coniferous trees. The right side was less steep and had dead shrubs and a bare understory until 36 m. Much of the area consisted of cobbles, gravel and sand. Beyond this was a mixture of live trees and shrubs. The organic soil depths varied from 0 (cobble, gravel, sand) to >13 cm with some areas having 1-4 cm of inorganic soils on top. In 2011, a similar shrub and tree mixture was described. Organic soils depths were between 7 and >30 cm. There was no mention of bare ground or dead vegetation during the 2011 survey.

3.26 25+500

This transect was oriented in an east-west direction. The left side of the creek had a very gentle slope and consisted of dead shrubs and a largely bare understory for the entire left-side transect. The right side of the creek had a thin layer of dead shrubs, followed by a progression of live shrubs to live trees with a sphagnum understory starting at 54 m. Organic soil depths varied from 7 to >13 cm. In 2011, organic soil depth measurements were lower (3-8 cm) with the exception of near the end of the transects were depths were >30 m. In 2011, extensive grass and shrub concentrations align with what was observed to be dead shrub and bare understory in 2013.

3.27 26+000

This transect runs in a east-northeast to west-southwest direction. The left transect approximately paralleled the river and there was very little topography. The cover was entirely comprised of dead shrubs and bare understory, with a small percentage of grass. The transect on the right side of the river had a similar area of dead shrub and bare understory adjacent to the river until the transect went up the slope and a dense shrub coverage was encountered. Due to the winding nature of the

creek at this point, this transect approaches the creek near its end. In this area, dead shrubs and trees and a bare understory were encountered. Organic soils were 2 to >9 cm in depth. All sites had some inorganic soils above the organic soils, which was deeper on the lower left side. In 2011, it was noted that the level terrain in the area appeared to be a flood plain for the creek. Similar grass/shrub compositions were observed with organic soils of 4 to 17 cm in depth.

3.28 26+500

This transect runs in a south-southeast to north-northwest direction. The left side was fairly low and flat and was comprised entirely of dead shrubs and trees with a small amount of grass, but largely with a bare understory. The right side was also largely bare adjacent to the river, but with a higher coverage of grass. Dead shrubs were found until 59 m where the transect entered 100% trees. Organic soils were 3 to >10 cm in depth, with most areas buried beneath 2-5 cm of inorganic soil. Similar shrub/grass and tree compositions were observed in 2011, but without the bare areas or dead vegetation. Organic soil depths were measured from 2 to 20 cm in 2011.

3.29 27+000

This transect runs in an east-west direction. The left side of the river was composed of mainly dead shrubs with a smaller portion of grass and a largely bare understory. At 77 m the transect entered live trees. On the right side, a similar composition of dead shrubs, grass and bare understory was encountered. At 42 m, the transect transitioned to shrubs and at 58 m, there was a mixture of shrubs and trees. The organic soil depths varied from 1 to >11 cm, with 2-3 cm of inorganic soil overlaying several of the soil sample locations. The 2011 survey recorded similar compositions of shrubs and trees, but with grass where the 2013 survey noted bare ground. Organic soil depths of 5 to >30 cm were observed in 2011.

3.30 27+500

This transect runs in an east-west direction. The left side of the river had an area of dead shrubs with some grass but largely bare until the slope increased at 34 m. Beyond this is a mixture of thick shrubs and trees until 59 m where 100% trees were encountered along with a sphagnum understory. The right side had a larger flat area which was largely bare (cobble, sand) until 25 m. Beyond this, an area of dead shrubs with grass and bare understory transitions to largely trees at 51 m, and then back to shrubs at 92 m. Organic soils depths varied from 0 to >8 cm, with 1-5 cm of inorganic soils overlaying organic soils. In 2011, similar compositions were observed, but with high concentrations of grass adjacent to the creek. Organic soils measured in 2011 were between 5 and 25 cm.

3.31 28+000

This transect runs in an east-southeast to north-northwest direction. There is a fairly steep rise in topography on the left side of the creek where a small bare/grass patch transitions to shrubs and then to trees. On the right side of the creek, a large flat and largely bare area leads to a band of shrubs, followed by trees. Organic soils varied from 0 to >16 cm. In 2011 the vegetation description was similar to what was observed in 2013, with the exception of a large grassy area noted where it was observed to be largely bare in 2013 (on the right side). Organic soils in 2011 varied from 6 to 23 cm deep.

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
13+000	A	Left	Northeast	River	0	6	-
				Bare 50%; Grass 50%	6	47	16
				Shrub (dead) 80%; Grass 50%	47	100	16
	B	Right	Southwest	River	0	6	-
				Bare 50%; Grass 50%; Shrub (dead) 40%	6	65	14
				Grass 90%; Shrub 10%	65	82	>16
				Shrub (dead) 90%; Grass 10%	82	100	13
13+500	A	Left	Northwest	River	0	7	-
				Grass 90%; Bare 10%	7	13	4
				Grass 70%; Shrub 30%	13	27	5
				Shrub 100%	27	59	4
				Grass 100%	59	66	5
				Shrub 80%; Grass 20%	66	100	2
	B	Right	Southeast	River	0	7	-
				Bare 70%; Grass 30%	7	18	9
				Bare 40%; Grass 40%; Shrub 20%	18	22	5
				Grass 80% (~½ flooded≈marsh); Treed 20%	22	48	6
				Grass 70% (~¾ flooded≈marsh); Shrub 20%	48	100	5
14+000	A	Left	Northwest	River	0	13	-
				Bare 90%; Grass 10%	13	18	4
				Shrub 60%; Grass 40%	18	22	2
				Grass 80% (~¼ flooded≈marsh); Shrub 20%	22	41	4 (wet)
				Trees 50%; Grass (marsh) 50%	41	48	3 (wet)
				Grass 80%; Shrub 20% (all marsh)	48	68	not sampled - too much water
				Shrub 90%; Grass 10% (all marsh)	68	100	not sampled - too much water
	B	Right	Southeast	River	0	13	-
				Bare 80%; Grass 20%	13	24	2
				Grass 90%; Shrub 10%	24	31	2
				Trees 40%; Shrub 40%; Grass 20%	31	41	5
				Trees 100%	41	97	4
				Shrub 80%; Trees 20%	97	100	3

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
14+500	A	Left	Northwest	River	0	9	-
				Bare 70%; Grass 30%	9	16	3
				Bare 60%; Shrub (dead) 40% (bare understory)	16	17	4
				Shrub 50%; Grass 40%; Tree 10%	17	30	2
				Tree 80%; Shrub 20%	30	100	4
	B	Right	Southeast	River	0	9	-
				Bare 100%	9	19	4
				Shrub (dead) 80%; Bare 20%	19	25	<1
				Shrub 80%; Grass 20%	25	34	5
				Trees 80%; Shrub 20%	44	100	5
15+000	A	Left	Northwest	River	0	7	-
				Bare (cobble, gravel) 100%	7	23	0
				Shrub (dead) 100% (bare understory)	23	42	4
				Shrub 100%	42	59	4
				Tree 80%; Shrub 20%	59	100	7
	B	Right	Southeast	River	0	7	-
				Bare 100%	7	9	0
				Trees 100%	9	37	5
				Trees 50%; Shrub 50%	37	52	8
				Shrub 60%; Trees 40% (sphagnum understory)	52	100	9 (sphagnum)
15+500	A	Left	Northwest	River	0	5	-
				Bare 80%; Grass 20%	5	10	<1
				Shrub (dead) 70%; Bare 30% (bare understory)	10	14	3
				Bare 60%; Shrub 40%	14	16	<1
				Trees 100% (transitions from pine to aspen at 59 m)	16	100	4
	B	Right	Southeast	River	0	5	-
				Shrub (dead) 50%; Bare 40%; Grass 30%	5	22	5
				Shrub 100%	22	25	5
				Trees 100%	25	48	3
				Shrub 100%	48	100	6

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank [*1]	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
16+000	A	Left	Northwest	River	0	9	-
				Bare (cobbles) 100%	9	10	<1
				Grass 80%; Bare 10%; Shrub (dead) 10%	10	19	7
				Shrub 100%	19	23	3
				Trees 100%	23	37	7
				Shrub 100%	37	55	7
				Shrub 70% (sphagnum understory)	55	86	>10 (sphagnum)
				Trees 100%	86	100	7
	B	Right	Southeast	River	0	9	-
				Bare 50%; Shrub (dead) 40%; Grass 10% (bare understory)	9	37	<1
				Shrub 100%	37	82	9
				Trees 80% (100% sphagnum bog)	82	100	>10 (sphagnum)
16+500	A	Left	North-Northwest	River	0	9	-
				Bare 100%	9	11	0
				Grass 60%; Shrub (dead) 30%; Bare 30%	11	31	6
				Trees (dead) 100% (bare understory)	31	81	1
				Shrub 50%; Grass 50%	81	90	5
				Trees 80%; Shrub 20%	90	100	4
	B	Right	South-Southeast	River	0	9	-
				Bare 100%	9	12	0
				Shrub (dead) 100% (bare understory)	12	15	8
				Shrub 100%	15	19	8
				Trees 100%	19	33	6
				Shrub 80%; Trees 20%	33	47	8
				Trees 50% (100% sphagnum bog)	47	100	>10
17+000	A	Left	Northwest	River	0	13	-
				Grass 50%; Bare 50%	13	22	1
				Shrub (herbaceous and young trees) 100%	22	39	4
				Shrub (tall) 90%; Trees 10%	39	100	7
	B	Right	Southeast	River	0	13	-

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank [*1]	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
				Bare 90%; Shrub (dead) 10%	13	24	0
				Shrub (dead) 90%; Bare 10%	24	35	3
				Shrub 100%	35	100	5
17+500	A	Left	West-Northwest	River	0	9	-
				Tree/Shrub (dead) 80%; Grass 10% (bare understory)	9	77	1
				Shrub 100%	77	100	5
	B	Right	East-Southeast	River	0	9	-
				Bare 90%; Grass 10%	9	19	1
				Shrub (herbaceous, short) 100%	19	22	4
				Shrub (tall) 100%	22	62	8
				Shrub (short, young trees) 100% (sphagnum understory)	62	100	>10
18+000	A	Left	Northeast	River	0	7	-
				Bare 100%	7	27	0
				Shrub (dead) 60%; Grass 10%; Bare 30%	27	44	3
				Shrub (short) 100%	44	47	3
				Shrub (tall) 100%	47	68	5
				Trees 100%	68	100	7
	B	Right	Southwest	River	0	7	-
				Bare 50%; Grass 50%; Shrub (dead) 10%	7	25	4
				Shrub (short) 100%	25	28	7
				Shrub (tall) 90%; Trees 10% (sphagnum understory)	28	93	5
				Trees 100% (sphagnum understory)	93	100	>10
18+500	A	Left	Northwest	River	0	13	-
				Bare 70%; Shrub (dead) 40%; Grass 30%	13	24	5
				Shrub (short) 80%; Grass 20%	24	25	5
				Shrub (½ short, ½ tall) 90%; Grass 10%	25	35	7
				Shrub 70%; Trees 30% (sphagnum understory)	35	95	8
				Shrub 80% (100% sphagnum understory)	95	100	
	B	Right	Southeast	River	0	13	-
				Bare 100%	13	15	0
				Grass 50%; Shrub (dead) 50%; Bare 10%	15	74	2

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank [*1]	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
				Shrub 100%	74	75	5
				Trees 70% Shrub 30%	75	89	7
				Grass (marsh) 100%	89	100	not sampled - too much water
19+000	A	Left	Southwest	River	0	6	-
				Bare 100%	6	8	0
				Shrub (dead) 70%; Bare 40%; Grass 40%	8	37	10
				Shrub (short) 70%; Grass 30%	37	47	11
				Shrub (short) 70%; Trees 50%	47	60	-
				Grass 100%; Shrub (tall) 70%	60	70	>12
				Trees 70%; Shrub (tall) 20%; Grass 10%	70	100	not sampled - too much water
	B	Right	Northeast	River	0	6	-
				Shrub (dead) 70%; Grass 50%; Bare 10%	6	57	2
				Shrub (short) 60%; Grass 40%	57	65	8
				Trees 60%; Shrub (tall) 40%	65	84	7
				Shrub (tall) 100%	84	94	7
				Shrub (tall) 100% (sphagnum understory)	94	100	>10 (sphagnum)
19+500	A	Left	East	River	0	11	-
				Bare 80%; Grass 20%	11	16	7 (under 3 cm inorg.)
				Trees (dead) 90%; Grass 10% (bare understory)	16	96	3 (under 1 cm inorg.)
				Trees 100%	96	100	-
	B	Right	West	River	0	11	-
				Bare 100%	11	13	0
				Shrub (dead) 40%; Bare 40%; Grass 20%	13	31	6
				Trees (dead) 100%; Grass 40%; Bare 10%	31	100	>5 (under 5 cm inorg.)
20+000	A	Left	South-Southwest	River	0	8	-
				Bare (cobble, gravel) 100%	8	41	0
				Shrub (dead) 70%; Bare 20%; Grass 10% (bare understory)	41	100	8 (under 1 cm inorg.)
	B	Right	North-Northeast	River	0	8	-
				Bare 100%	8	11	0
				Grass 70%; Shrub (dead) 50%; Bare 30%	11	32	9 (under 3 cm inorg.)

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
				Trees (dead) 100%; Grass 50%	32	73	>5 (under 5 cm inorg.)
				Trees (dead) 100% (sphagnum understory)	73	100	>10
20+500	A	Left	West	River	0	7	-
				Shrub (dead) 40%; Bare 30%; Grass 30%	7	35	10 (under 2 cm inorg.)
				Shrub (dead) 100%; Grass 70%	35	54	>5 (under 13 cm inorg.)
				Trees 100%	54	100	>3 (under 8 cm inorg.)
	B	Right	East	River	0	7	-
				Bare 80%; Shrubs (dead) 10%; Grass 10%	7	24	>5 (under 5 cm inorg.)
				Shrub (dead) 90%; Bare 10%	24	62	6 (under 1 cm inorg.)
				Tree (dead) 50%; Shrub (dead) 50%	62	100	>4 (under 6 cm inorg.)
21+000	A	Left	West	River	0	11	-
				Bare 100%	11	16	0
				Shrub (dead) 70%; Bare 30%; Grass 10% (bare understory)	16	77	4 (under 6 cm inorg.)
				Shrub (dead) 70%; Tree (dead) 30%; Grass 10% (bare understory)	77	100	>2 (under 13 cm inorg.)
	B	Right	East	River	0	11	-
				Grass 70%; Shrub (dead) 60%; Bare 30%	11	31	>6 (under 4 cm inorg.)
				Shrub 70%; Grass 30% (sphagnum understory)	31	59	>10
				Trees 100% (sphagnum understory)	59	100	>10
21+500	A	Left	Southwest	River	0	11	-
				Shrub (dead) 70%; Shrub 30% (bare understory)	11	19	3 (under 3 cm inorg.)
				Shrub (dead) 100% (bare understory)	19	32	>4 (under 3 cm inorg.)
				Trees (dead) 100% (bare understory)	32	57	7
				Trees 100%	57	100	>17
	B	Right	Northeast	River	0	11	-
				Shrub (dead) 70%; Bare 30%; Grass 10%	11	25	>3 (under 7 cm inorg.)
				Trees 100%	25	36	>3 (under 7 cm inorg.)
				Trees 100% (sphagnum understory)	36	100	>10

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank [*1]	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
22+000	A	Left	Southwest	River	0	9	-
				Shrub (dead) 60%; Bare 40% (bare understory)	9	13	0 (I>13)
				Shrub (dead) 100% (bare understory)	13	27	>5 (under 5 cm inorg.)
				Trees 100%	27	45	>5 (under 6 cm inorg.)
				Trees 100% (sphagnum understory)	45	100	>21 cm
	B	Right	Northeast	River	0	9	-
				Shrub (dead) 70%; Grass 50%	9	21	>1 (under 11 cm of inorg.)
				Trees (dead) 100% (bare understory)	21	42	13 (under 7 cm of inorg.)
				Trees 80%; Shrub 20% (sphagnum understory)	42	100	>10
22+500	A	Left	West	River	0	22	-
				Bare 100%	22	39	0
				Trees (dead) 100% (bare understory)	39	66	0
				Trees (dead) 90%; Grass 10% (bare understory)	66	73	>6 (under 9 cm inorg.)
				Trees 100%	73	98	-
				Trees 90%; Shrubs 20%	98	100	>12
	B	Right	East	River	0	22	-
				Trees (dead) 100% (bare understory)	22	43	>5 (under 5 cm inorg.)
				Trees 100%; Grass 30%	43	100	>21
23+000	A	Left	Southwest	River	0	19	-
				Shrub (dead) 100% (bare understory)	19	49	6 (under 5 cm inorg.)
				Trees 100%	49	74	>4 (under 9 cm inorg.)
				Trees 100%; Grass 30%	74	100	>23
	B	Right	Northeast	River	0	19	-
				Shrub (dead) 50%; Bare 40%; Grass 10%	19	33	0 (I>16)
				Trees (dead) 100%	33	48	>4 (under 8 cm inorg.)
				Trees 100%; Grass 30%	48	100	>14
23+500	A	Left	South	River	0	5	-
				Shrub (dead) 80%; Bare 20% (bare understory)	5	50	>4 (under 10 cm inorg.)
				Trees (dead) 100% (bare understory)	50	100	0 (I>20)
	B	Right	North	River	0	5	-
				Trees (dead) 100% (bare understory)	5	9	>4 (under 6 cm inorg.)

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
				Trees (dead) 100% (herbacious understory)	9	21	10
				Trees 100% (sphagnum understory)	21	100	>20
24+000	A	Left	West	River	0	11	-
				Shrub 100%	11	20	>4 (under 8 cm inorg.)
				Trees 100%; Shrubs (short) 50%	20	61	>13
				Trees (dead) 50%; Shrub (dead) 50% (bare understory)	61	100	>15
	B	Right	East	River	0	11	-
				Trees (dead) 80%; Shrub (dead) 20% (bare understory)	11	42	0 (I>13)
				Trees (dead) 80%; Shrub (dead) 20%; Grass 50%	42	68	>6 (under 12 cm inorg.)
				Trees 100%	68	100	>1 (under 13 cm inorg.)
24+500	A	Left	West	River	0	13	-
				Shrub (dead) 90%; Grass 10% (bare understory)	13	21	>1 (under 14 cm inorg.)
				Shrub (dead) 80%; Trees (dead) 20% (bare understory)	21	34	>1 (under 15 cm inorg.)
				Shrub 100%	34	43	>8 (under 2 cm inorg.)
				Trees 100% (sphagnum understory)	43	62	>15
				Trees 50%; Shrubs 50% (sphagnum understory)	62	100	>15
	B	Right	East	River	0	13	-
				Trees (dead) 40%; Shrub (dead) 40%; Bare 20% (bare understory)	13	28	0 (I>19)
				Shrub (dead) 100%; Grass 50%	28	64	>3 (under 6 cm inorg.)
				Trees (dead) 60%; Shrub (dead) 40% (bare understory)	64	100	>6 (under 6 cm inorg.)
25+000	A	Left	Northwest	River	0	12	-
				Shrubs 100%	12	27	7 (under 4 cm inorg.)
				Trees (deciduous) 100%; Shrubs 80%	27	53	9
				Trees (coniferous) 100%; Shrubs 80%	53	100	>10
	B	Right	Southeast	River	0	12	-
				Shrubs (dead) 60%; Bare 40% (bare understory)	12	35	0
				Shrubs (dead) 100% (bare understory)	35	36	10 (under 3 cm inorg.)
				Trees 100%	36	86	>13 (under 1 cm inorg.)
				Trees 50%; Shrubs 50%	86	100	-

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank [*1]	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
25+500	A	Left	West	River	0	11	-
				Shrub (dead) 100%; Grass 10% (bare understory)	11	91	7 (under 4 cm inorg.)
				Shrub (dead) 90%; Tree (dead) 10% (bare understory)	91	100	-
	B	Right	East	River	0	11	-
				Shrub (dead) 100% (bare understory)	11	15	9 (under 1 cm inorg.)
				Shrub (short) 100%	15	18	>6
				Shrub (tall) 100%	18	54	>10
				Shrub 80%; Trees 20% (sphagnum understory)	54	85	>13
				Trees 100%	85	100	>13
26+000	A	Left	East-Northeast	River	0	8	-
				Shrub (dead) 60%; Grass 20% (bare understory)	8	77	2 (under 1 cm inorg.)
				Shrub (dead) 100% (bare understory)	77	100	-
	B	Right	West-Southwest	River	0	8	-
				Shrub (dead) 50%; Bare 50% (bare understory)	8	25	>9 (under 5 cm inorg.)
				Shrub 100%	25	66	>6 (under 13 cm inorg.)
				Shrub (dead) 80%; Trees (dead) 20% (bare understory)	66	100	>6 (under 4 cm inorg.)
26+500	A	Left	South-Southeast	River	0	9	-
				Shrub (dead) 70%; Grass 10% (bare understory)	9	80	7 (under 2 cm inorg.)
				Shrub (dead) 60%; Trees (dead) 40% (bare understory)	80	100	>8 (under 5 cm inorg.)
	B	Right	North-Northwest	River	0	9	-
				Bare 60%; Grass 40%; Shrub (dead) 30%	9	32	6 (under 3 cm inorg.)
				Shrub (dead) 100%; Grass 20% (bare understory)	32	59	3
				Trees 100%; Shrub (short) 100%	59	100	>10
27+000	A	Left	West	River	0	13	-
				Shrub (dead) 80%; Grass 40% (bare understory)	13	77	1 (under 2 cm inorg.)
				Trees 100%	77	100	>11
	B	Right	East	River	0	13	-
				Shrub (dead) 70%; Grass 20% (bare understory)	13	42	5 (under 3 cm inorg.)
				Shrub 90%; Grass 10%	42	58	>11
				Trees 60%; Shrub (tall) 40%	58	100	-

TABLE 1 – RESULTS OF VEGETATION COVER SURVEY

Station	Sub-Section	Bank *1	Transect Orientation	Cover Type	Start (m)	End (m)	Organic Layer (cm)
27+500	A	Left	West	River	0	7	-
				Shrub (dead) 60%; Grass 10% (bare understory)	7	34	5 (under 1 cm inorg.)
				Trees 50%; Shrubs 50%	34	59	4 (under 1 cm inorg.)
				Trees 100%; Shrubs 80% (sphagnum understory)	59	100	-
	B	Right	East	River	0	7	-
				Bare 90%; Grass 10%	7	25	0
				Shrubs (dead) 60%; Grass 50% (bare understory)	25	51	>8 (under 5 cm inorg.)
				Trees 80% Shrubs 30%	51	92	>7 (under 3 cm inorg.)
				Shrubs 100%	92	100	-
28+000	A	Left	East-Southeast	River	0	5	-
				Grass 50%; Bare 50%	5	10	11
				Shrubs 100%	10	23	6
				Trees 50%; Shrubs 50%	23	45	>8
				Trees 100%	45	100	>16
	B	Right	West-Northwest	River	0	5	-
				Bare 70%; Grass 30%	5	45	0
				Grass 50%; Bare 50%	45	68	12 (under 1 cm inorg.)
				Shrub 90%; Trees 10%	68	75	>10
				Trees 80%; Shrub 40%	75	100	>10

*1 Note: Bank left or bank right is based on facing downstream.



Photo 1. “Bare” substrate observed at 18+000.



Photo 2. “Grass” vegetation observed at 13+500.



Photo 3. “Shrub” vegetation observed at 26+000.



Photo 4. “Treed” vegetation observed at 25+000.



Photo 5. Buffalo Creek at transect 13+000 (left photo: 2011; right photo: 2013)



Photo 6. Looking downstream from 14+500 (left photo: 2011; right photo: 2013)



Photo 7. Steep bank along Buffalo Creek at 15+000.



Photo 8. Looking downstream from 17+000 (left photo: 2011; right photo: 2013)



Photo 9. Looking downstream from 18+000 (left photo: 2011; right photo: 2013)



Photo 10. Shrub area adjacent to creek channel at 19+000 (left: 2011; right: 2013)



Photo 11. Left side of river at 19+500 showing large amount of dead trees.

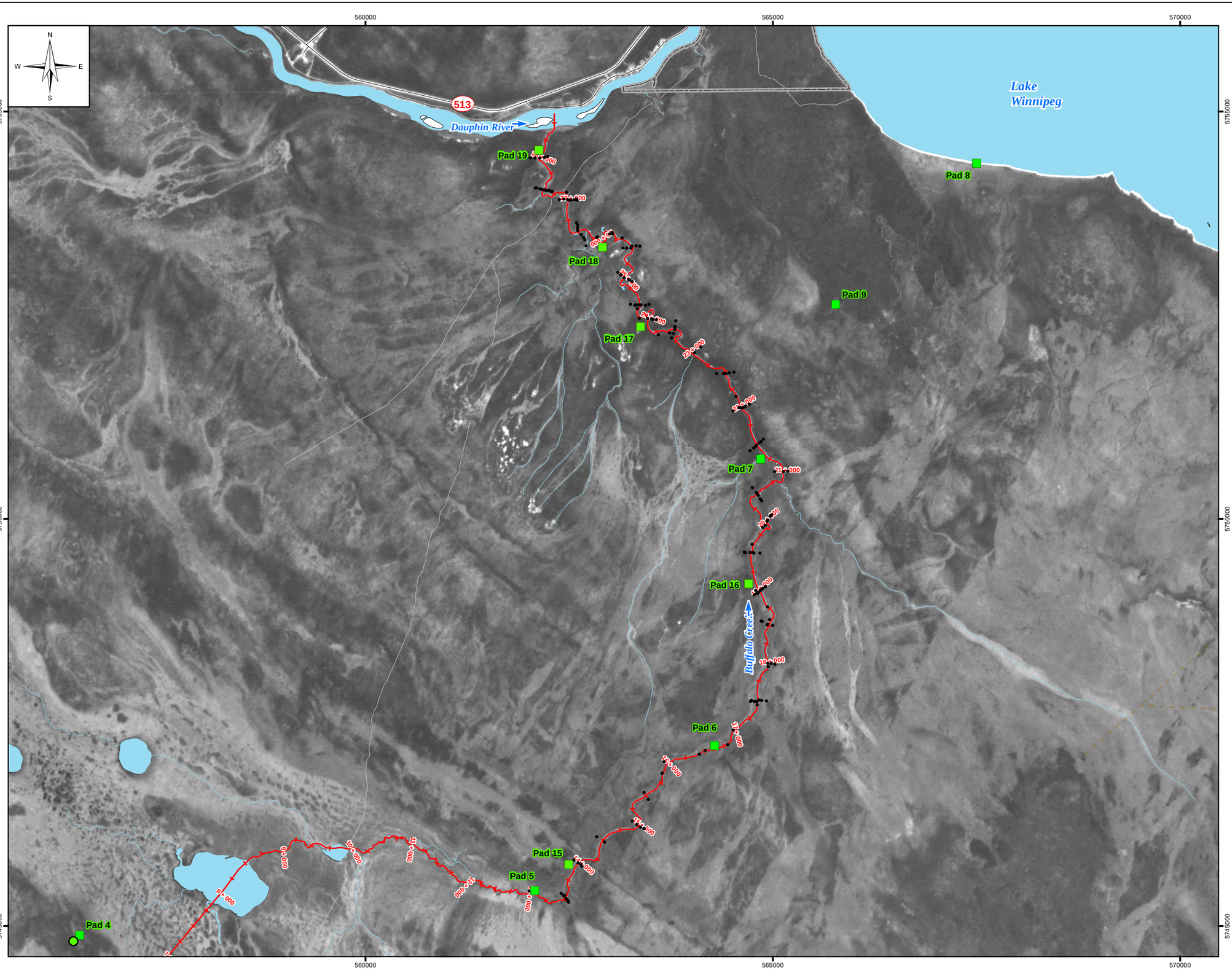


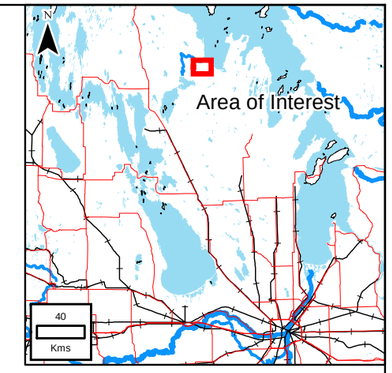
Photo 12. Soil sampling hole at 19+500 showing organic soils (black) overlain by inorganic soils (grey).



Photo 13. Slump on left side of creek at 25+000 (looking upstream).

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LEGEND:

- Vegetation Survey Transect Location
- Helicopter Landing Pad
- Lake St. Martin Channel Option L
- Road Paved 2 or more lanes
- Paved Street or Road
- Gravel Road
- Unclassified Road
- Accessway or Backlane
- Trail
- Railway
- Ditch
- River/Stream, Indefinite
- River/Stream
- Dugout; Pond;
- Lake
- Aboriginal Lands

DRAFT

0.5 0 0.5 1 1.5
Kilometres

SCALE: 1:45,000 METRIC 11"x17"

All units are metric and in metres unless otherwise specified.
Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

NO.	YY/MM/DD	DESCRIPTION	BY
0	13/08/30	ISSUED WITH DRAFT REPORT	STO

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LAKE ST. MARTIN EMERGENCY RELIEF CHANNEL

TRANSECT LOCATIONS OF VEGETATION COVER SURVEY

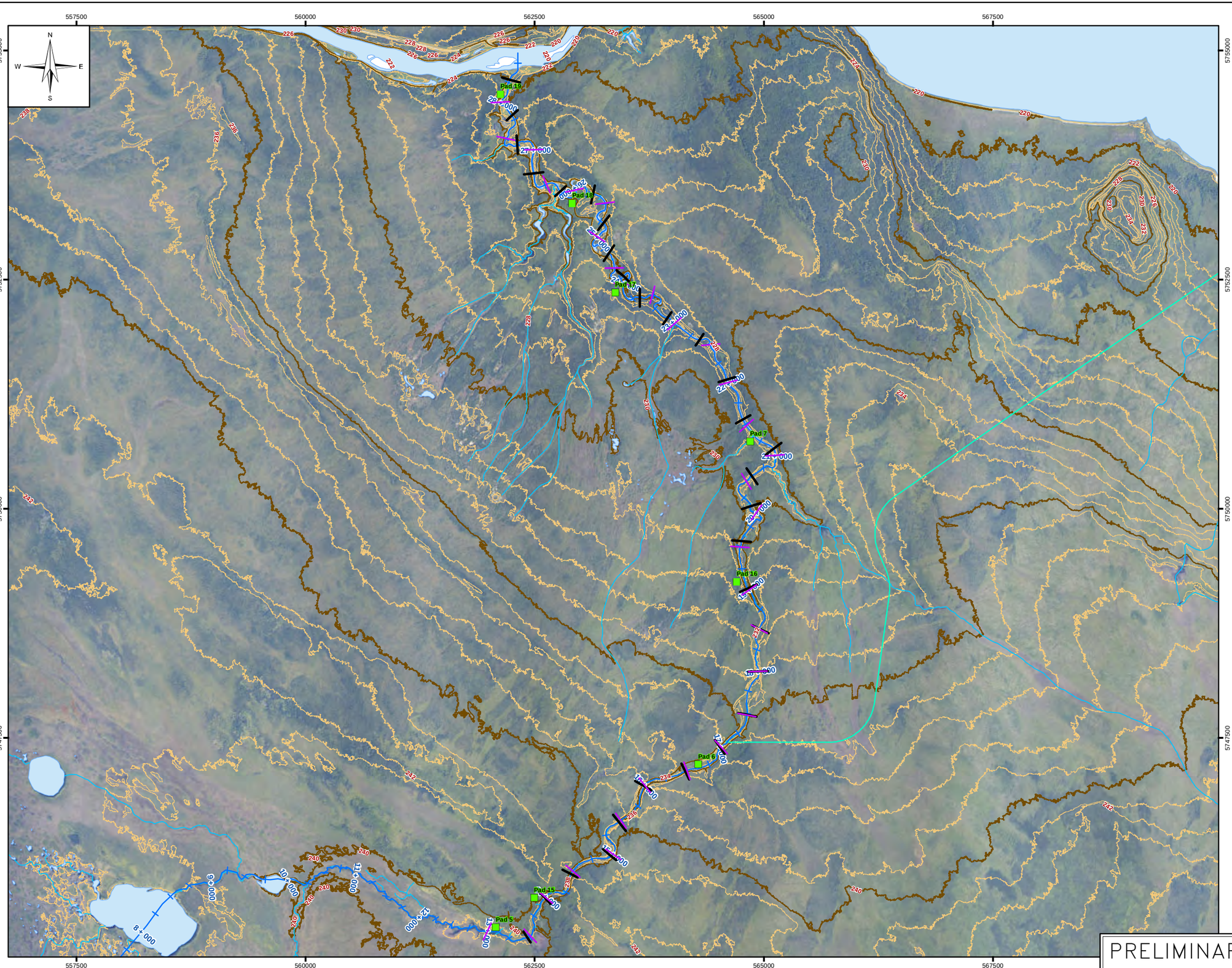
AUGUST 2013 | FIGURE 01 | REV: 0

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11"x17" PLOT SCALE 1:1

Appendix 4B. Buffalo Creek Vegetation Surveyed Cross Sections

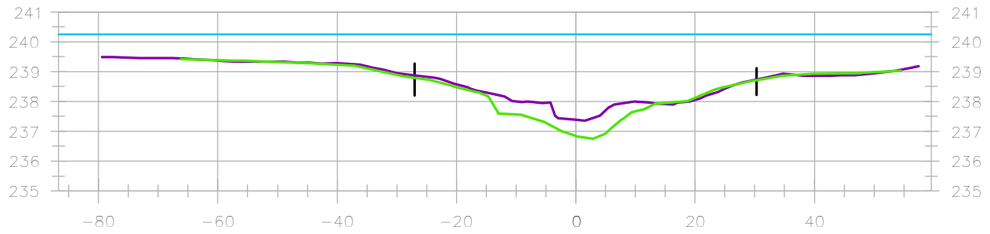
Provided Within: Graphs showing cross sections surveyed in Buffalo Creek.

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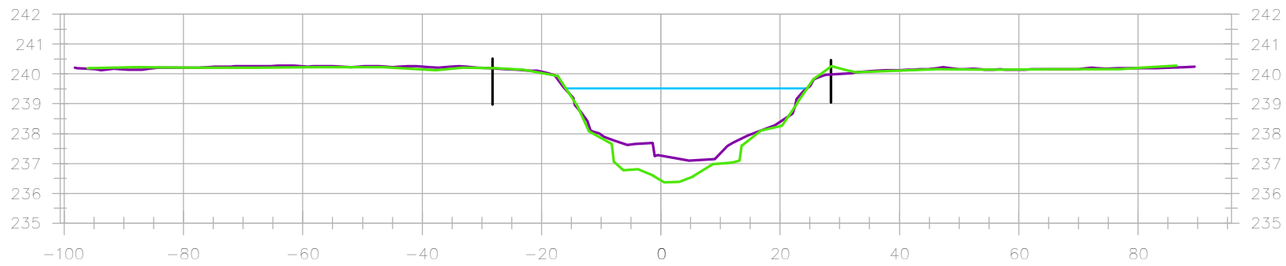


Portions of data presented are owned by the Province of Manitoba and are produced under the licence agreement with the Province of Manitoba 2014 Queen's Printer.

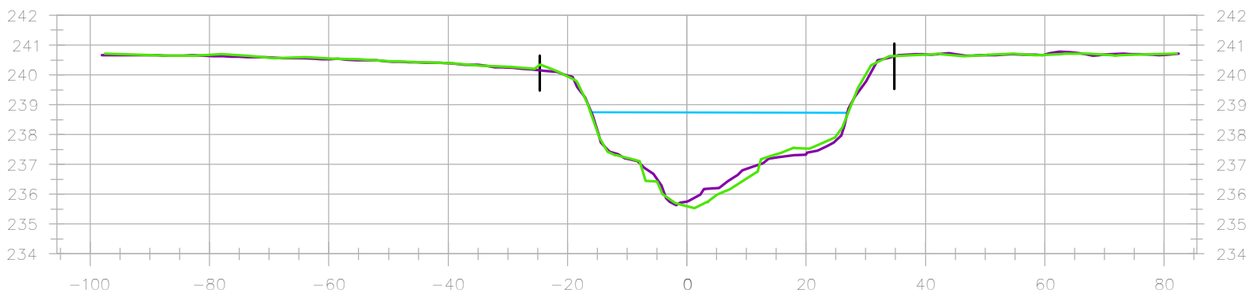
13+474



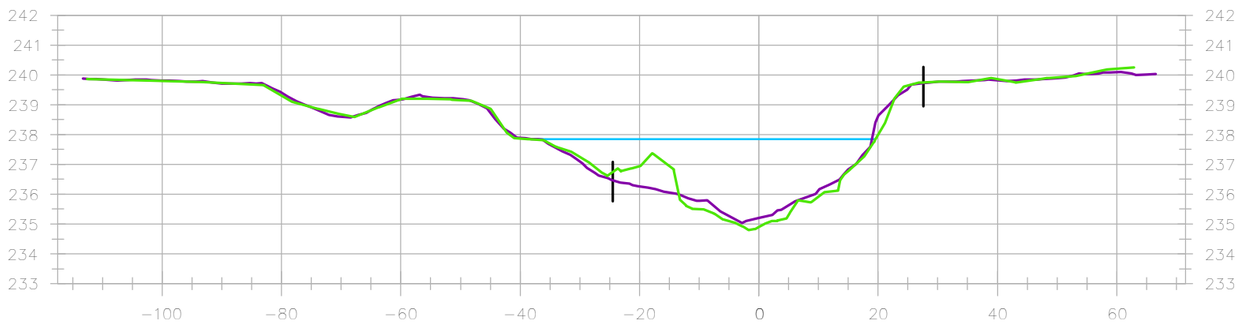
13+984



14+457



14+968



LEGEND:

- 2011 Survey
- 2013 Survey
- Average Water Level during operation of LSMEOC (computed)
- Rebar

GENERAL NOTES:

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CROSS SECTION NOTES:

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5. Data was not collected during the 2011 Survey.

DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
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LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

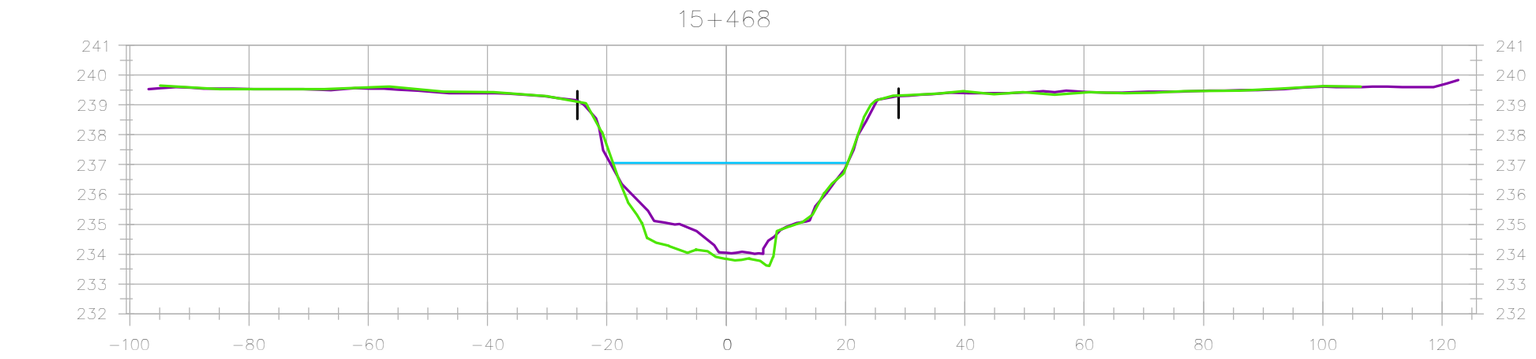
BUFFALO CREEK CROSS SECTIONS

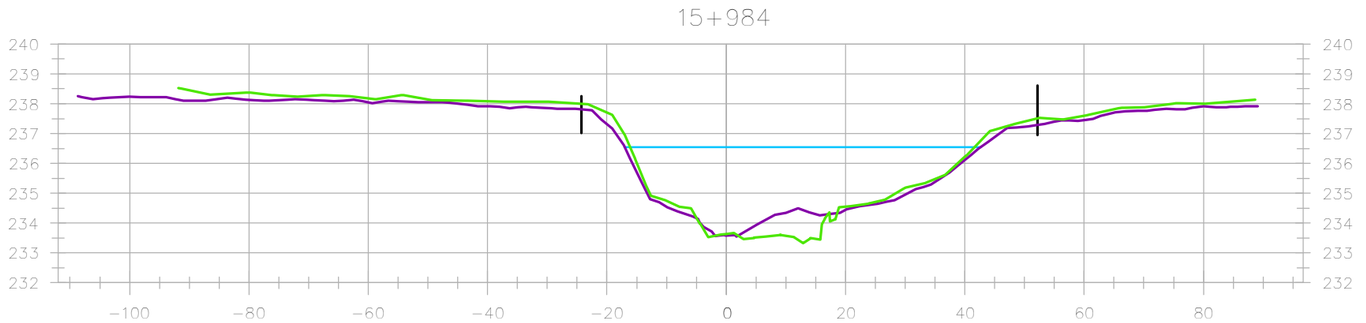
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

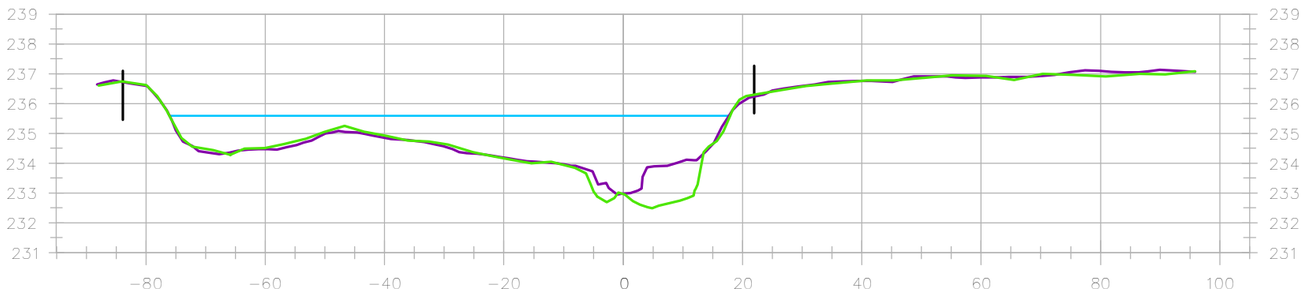
JANUARY 2015 | DRAWING 09.01 | REV: B

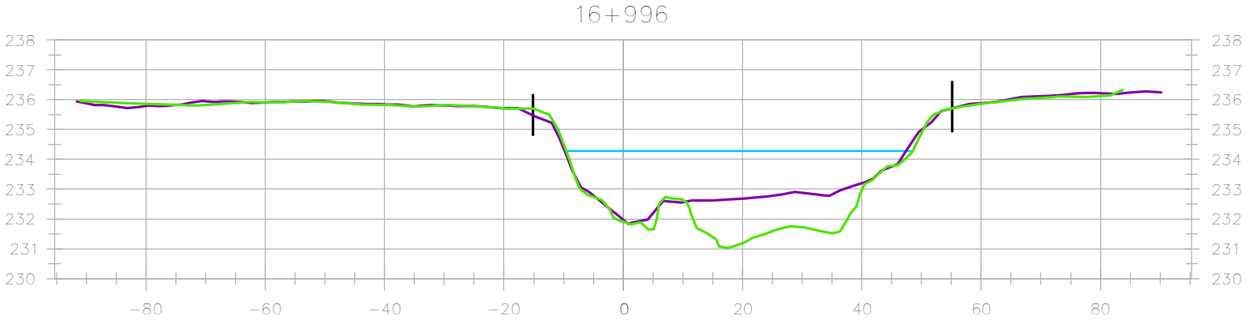
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11"x17" PLOT SCALE 1:1

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LEGEND:

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- 2013 Survey
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- Rebar

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DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
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LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

BUFFALO CREEK CROSS SECTIONS

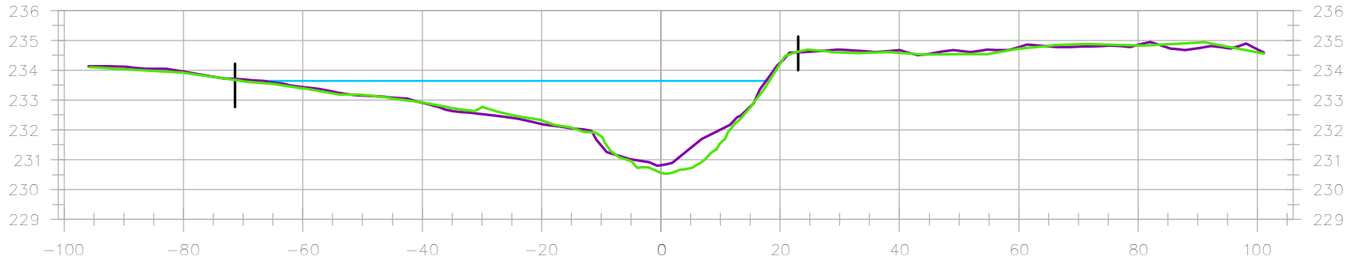
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JANUARY 2015 | DRAWING 09.02 | REV: B

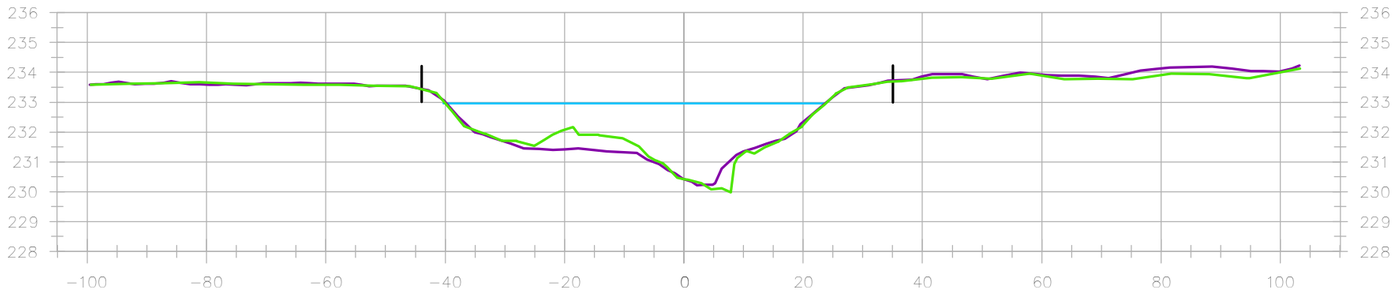
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11"x17" PLOT SCALE 1:1

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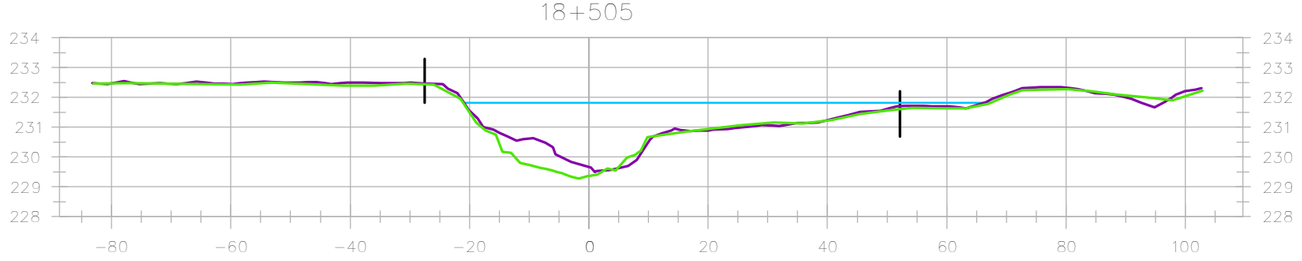
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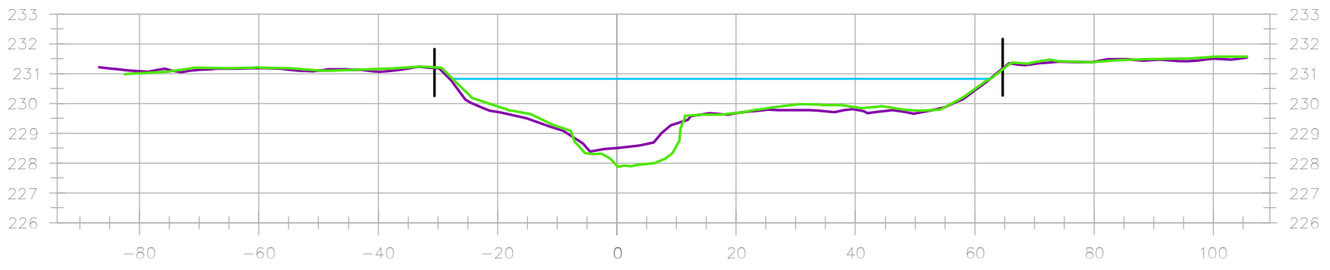
18+005



18+505



19+023



LEGEND:

- 2011 Survey
- 2013 Survey
- Average Water Level during operation of LSMEOC (computed)
- Rebar

GENERAL NOTES:

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DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
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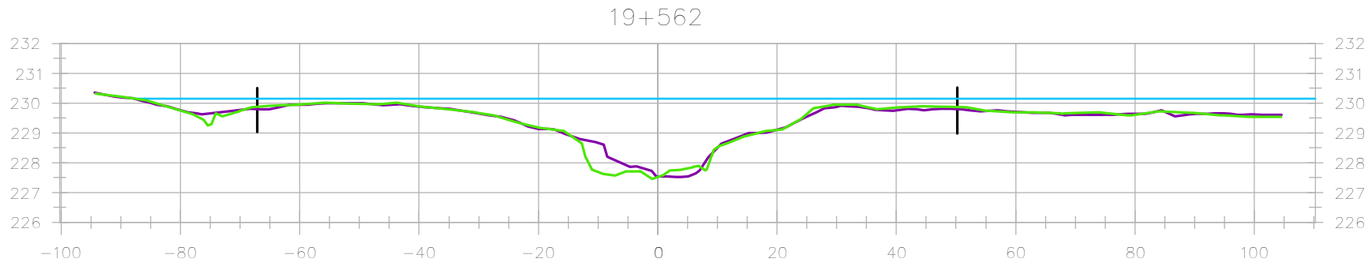
BUFFALO CREEK CROSS SECTIONS

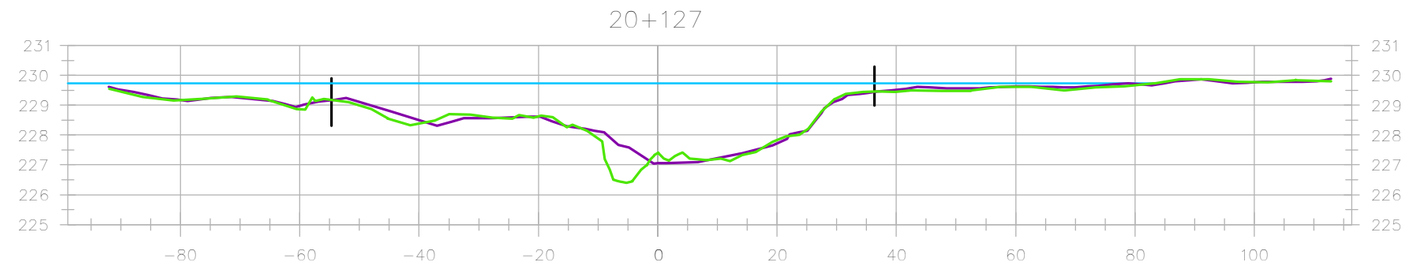
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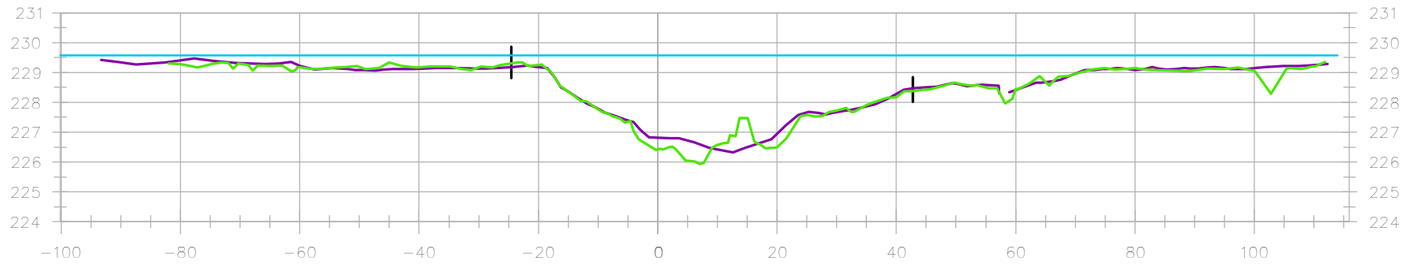
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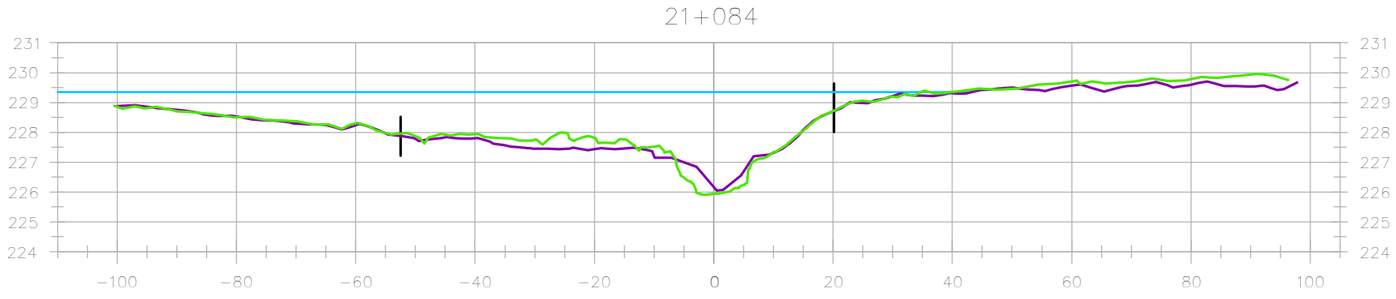
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11"x17" PLOT SCALE 1:1

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LEGEND:

- 2011 Survey
- 2013 Survey
- Average Water Level during operation of LSMEOC (computed)
- Rebar

GENERAL NOTES:
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DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

BUFFALO CREEK CROSS SECTIONS

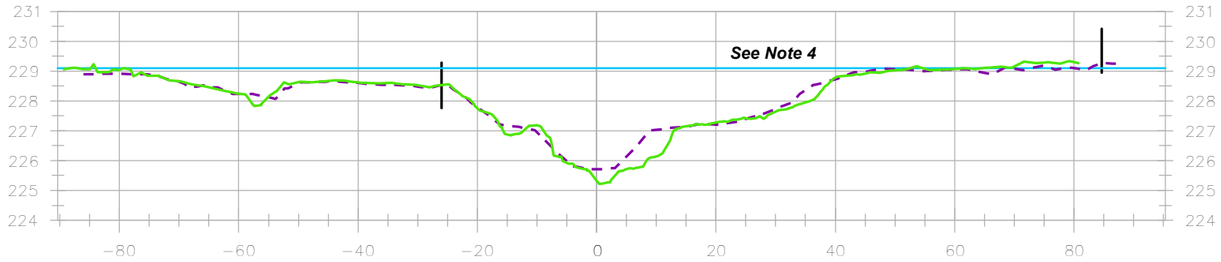
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JANUARY 2015 | DRAWING 09.04 | REV: B

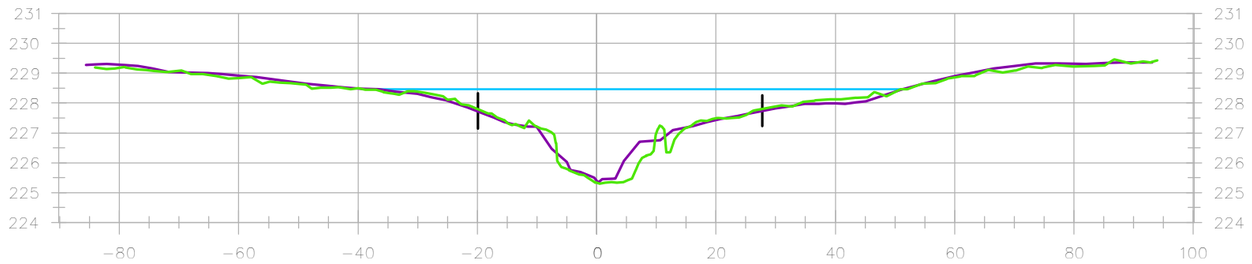
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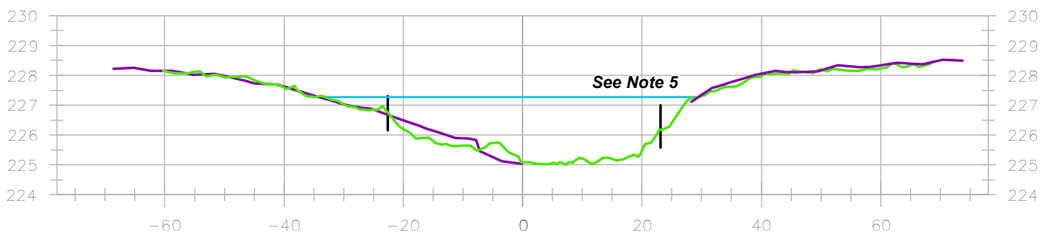
21+560



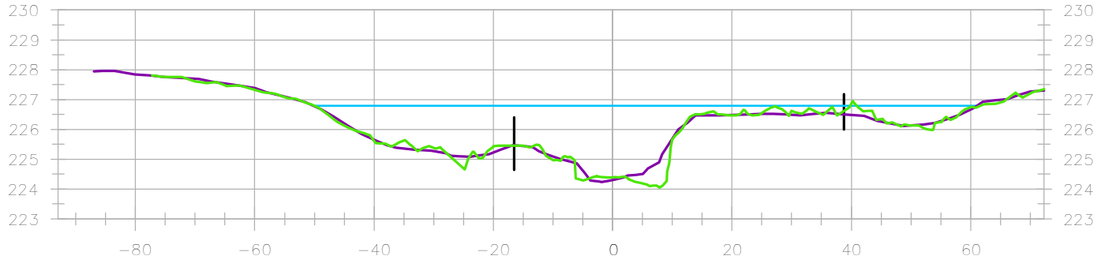
22+048



22+642



23+073



LEGEND:

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DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
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LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

BUFFALO CREEK CROSS SECTIONS

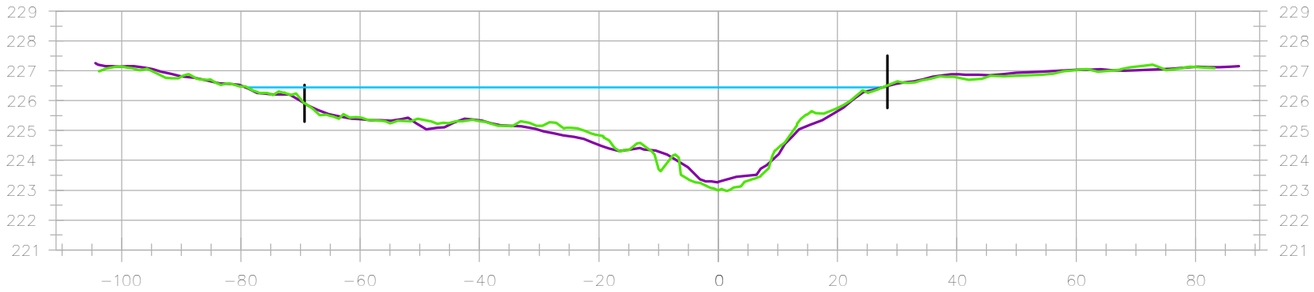
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JANUARY 2015 | DRAWING 09.05 | REV: B

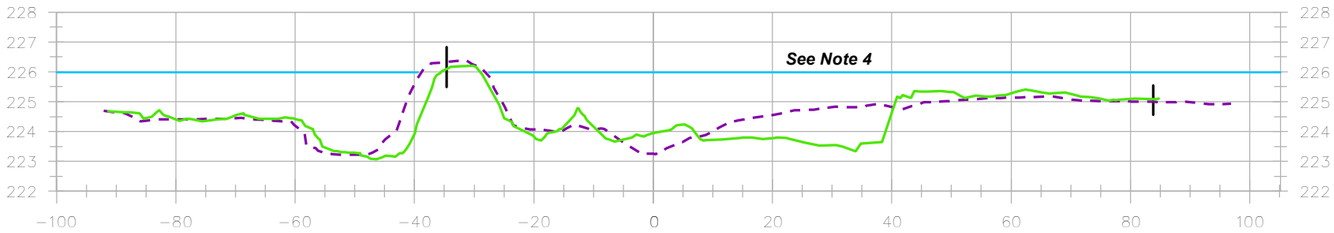
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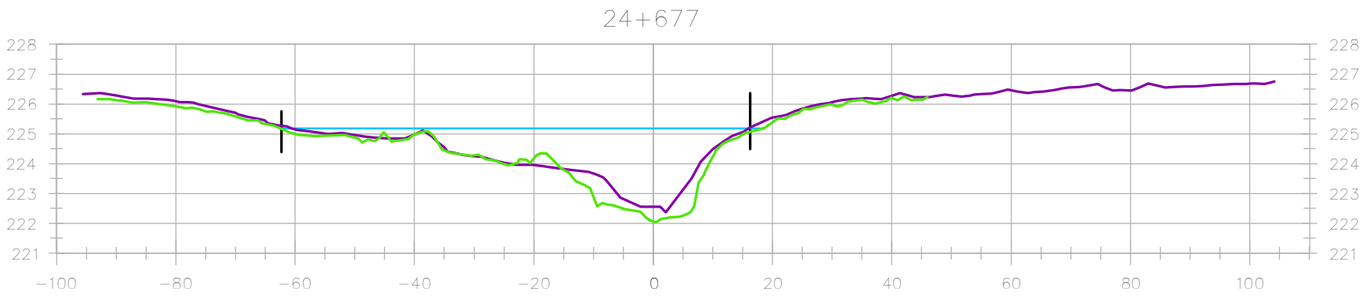
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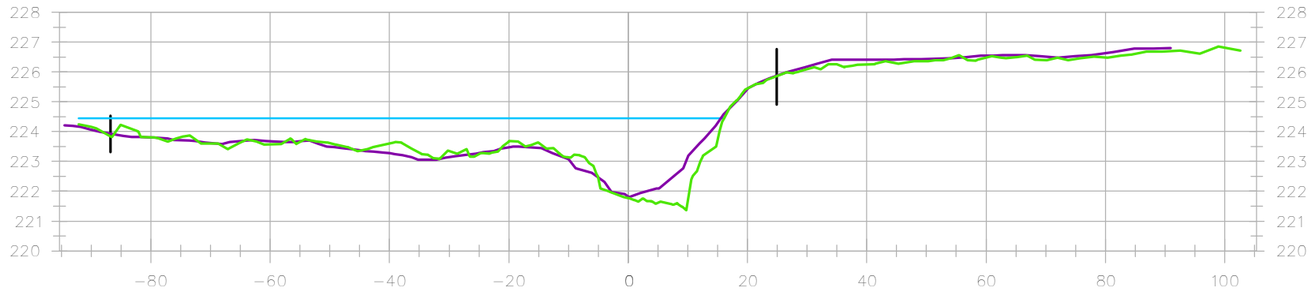
24+203



24+677



25+209



LEGEND:

- 2011 Survey
- 2013 Survey
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DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
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A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

BUFFALO CREEK CROSS SECTIONS

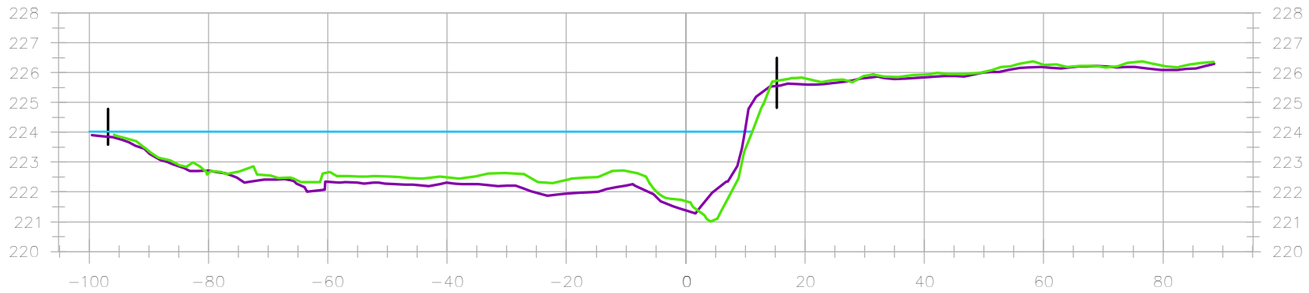
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

JANUARY 2015 | DRAWING 09.06 | REV: B

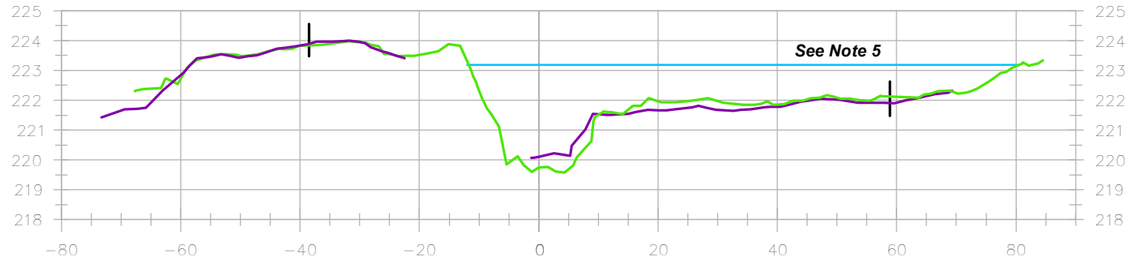
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11"x17" PLOT SCALE 1:1

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25+683

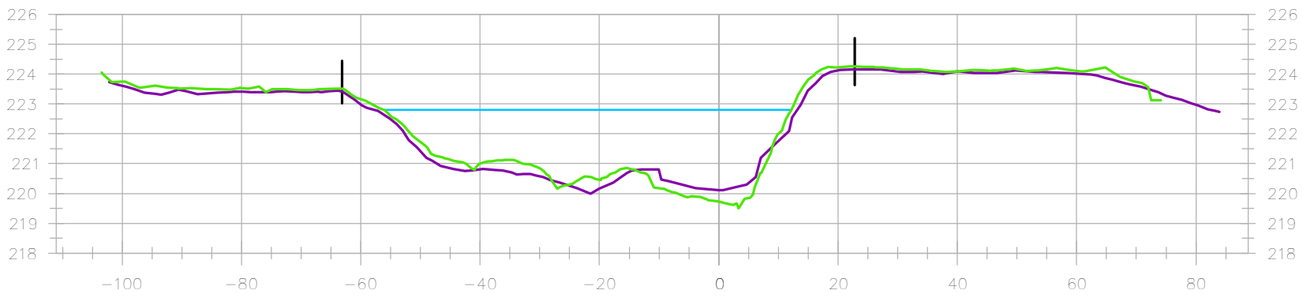


26+281



26+743

27+254



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4. Section alignment was re-established during the 2013 survey.
5. Data was not collected during the 2011 Survey.

DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

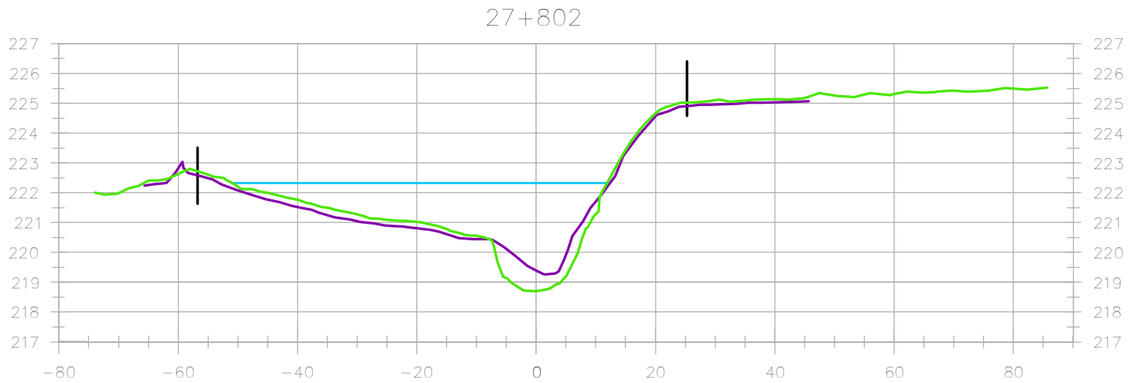
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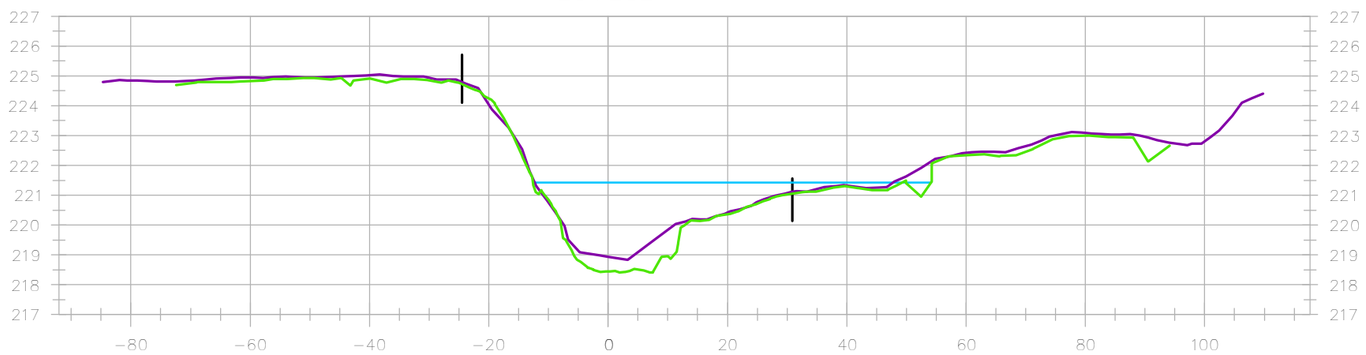
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

JANUARY 2015 | DRAWING 09.07 | REV: B

FileName: P:\Projects\2013\13-0431-001\Dwg GIS\MXDs\RevB\Physical_Process_Report\13-0431-001-Fig09_RevB.mxd
11"x17" PLOT SCALE 1:1

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LEGEND:

- 2011 Survey
- 2013 Survey
- Average Water Level during operation of LSMEOC (computed)
- Rebar

GENERAL NOTES:

1. See Drawings 7 or 8 for Cross Section locations.
2. Sections are orientated looking downstream.
3. Normal changes in the peat between 2011 and 2013 can result in slight differences when comparing cross sections.

CROSS SECTION NOTES:

4. Section alignment was re-established during the 2013 survey.
5. Data was not collected during the 2011 Survey.

DRAFT

2 0 2 4 6 8
Metres

VERTICAL SCALE: 1:200 (5x Vertical Exaggeration)

10 0 10 20 30 40
Metres

HORIZONTAL SCALE: 1:1,000 (5x Vertical Exaggeration)

NO.	YY/MM/DD	DESCRIPTION	BY
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LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

BUFFALO CREEK CROSS SECTIONS

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

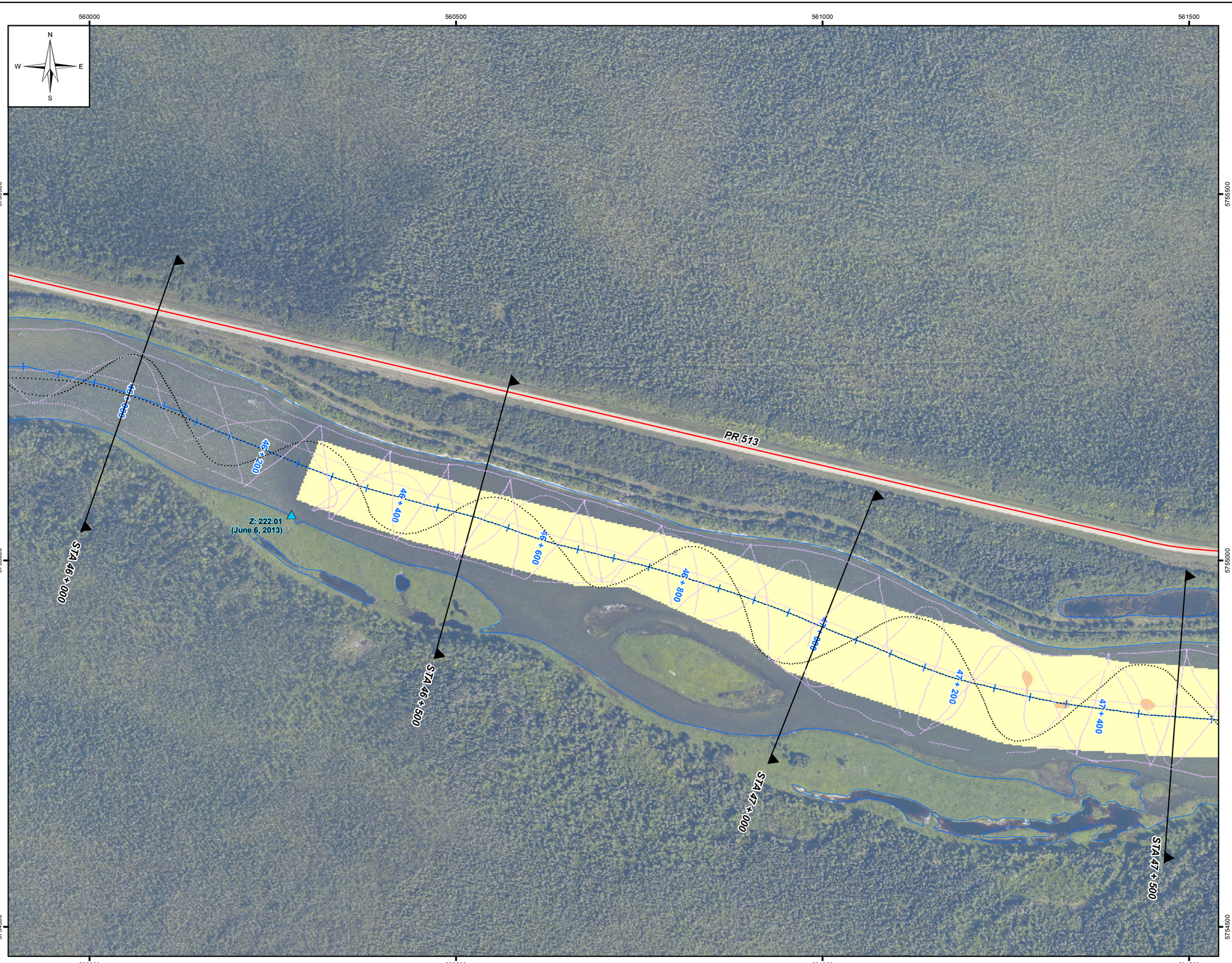
JANUARY 2015 | DRAWING 09.08 | REV: B

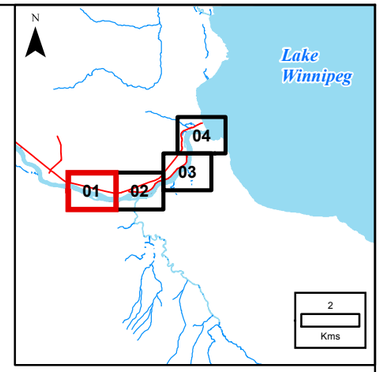
FileName: P:\Projects\2013\13-0431-001\Dwg\GIS\MXDs\RevB\Physical_Process_Report\13-0431-001-Fig09_RevB.mxd
11"x17" PLOT SCALE 1:1

Appendix 4C. Dauphin River Bathymetric Survey Comparisons

Provided Within: Maps showing bathymetric survey comparisons for the lower Dauphin River

Portions of data presented are owned by the Province of Manitoba and are produced under the licence agreement with the Province of Manitoba 2014 Queen's Printer.





LEGEND:

- 2013 Sonar Point
- 2011 Sonar Point
- Water Level (June 5–7th, July 22–23, 2012)
- Survey Control 2011 (See Note 3 Below)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2011 to 2013 Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1.0
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2011 Sonar completed by KGS Group on June 29 – July 2, 2011.
   2013 Sonar completed by KGS Group on June 5–7, and July 22–23, 2013.
3. 2013 Control is outside map extents. Please see Figure 10.01–10.03 for 2013 Control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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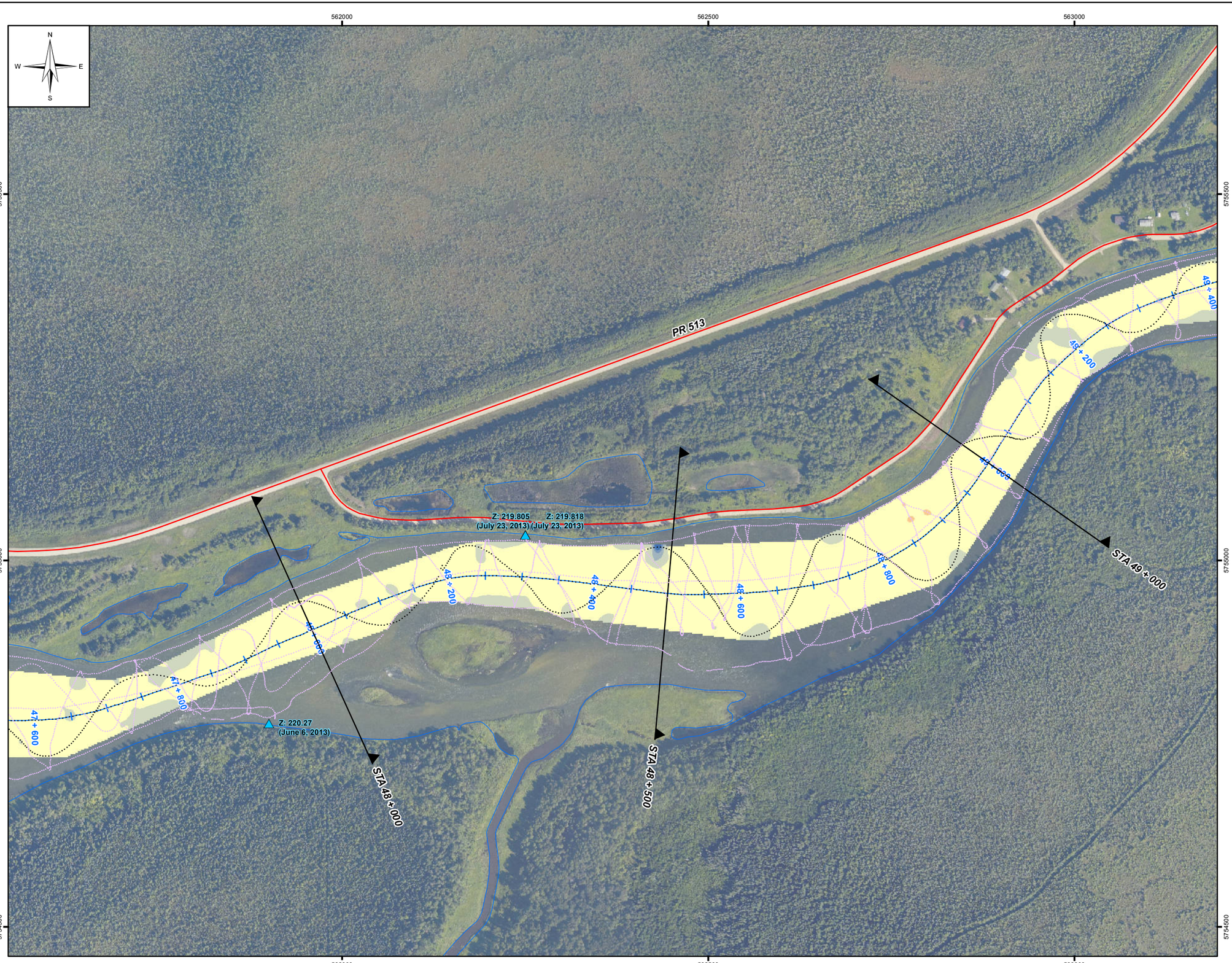
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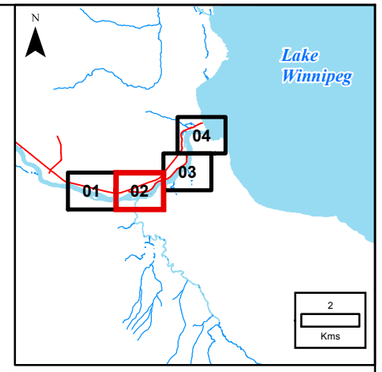
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2011 TO 2013

JANUARY 2015 | DRAWING 15.01 | REV: B

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11"x17" PLOT SCALE 1:1

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LEGEND:

- 2013 Sonar Point
- 2011 Sonar Point
- Water Level (June 5–7th, July 22–23, 2012)
- Survey Control 2011 (See Note 3 Below)
- X–Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2011 to 2013 Elevation Variation (m)

- < –2
- –2.0 – –1.5
- –1.5 – –1.0
- –1.0 – –0.5
- –0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2011 Sonar completed by KGS Group on June 29 – July 2, 2011.
   2013 Sonar completed by KGS Group on June 5–7, and July 22–23, 2013.
3. 2013 Control is outside map extents. Please see Figure 10.01–10.03 for 2013 Control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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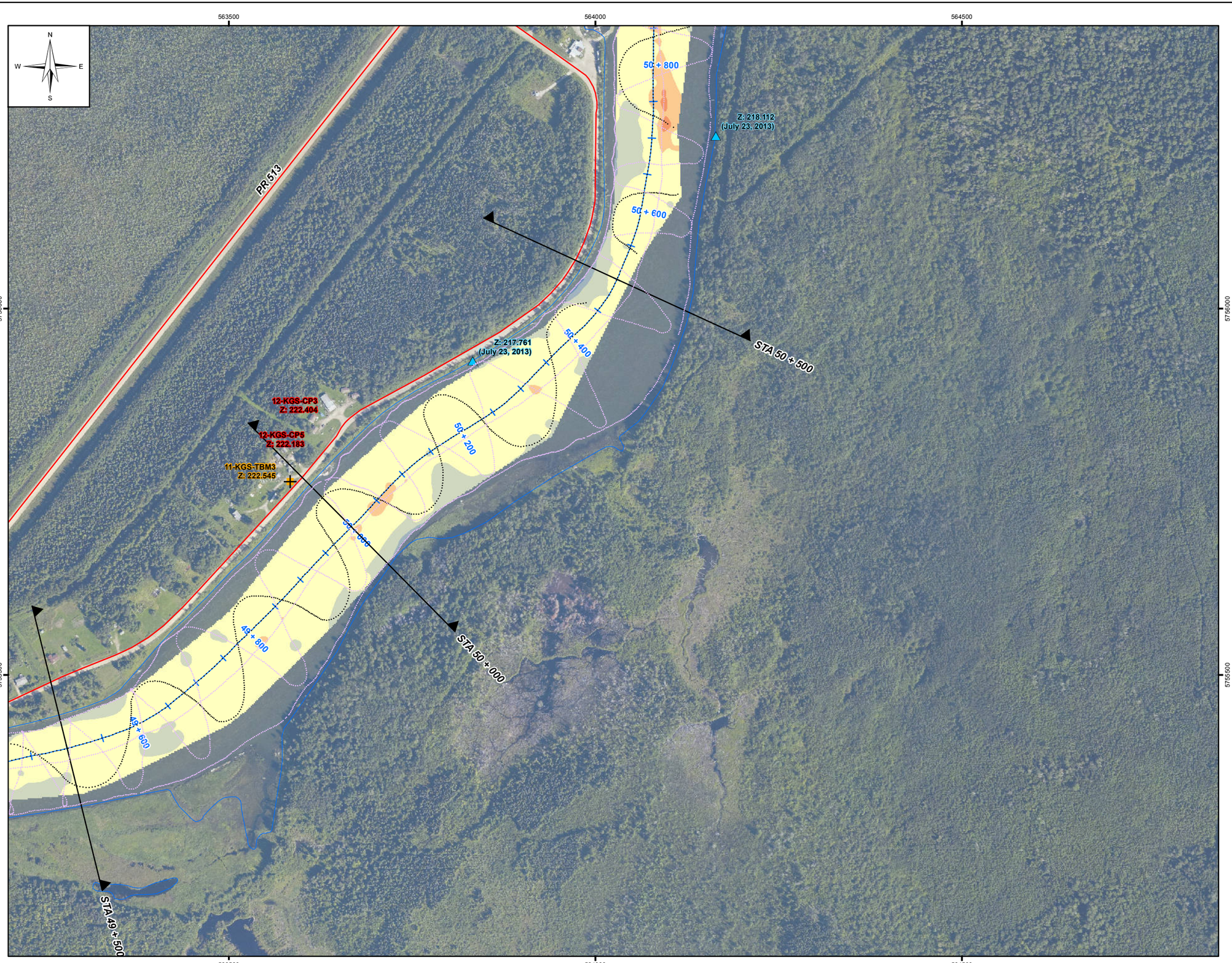
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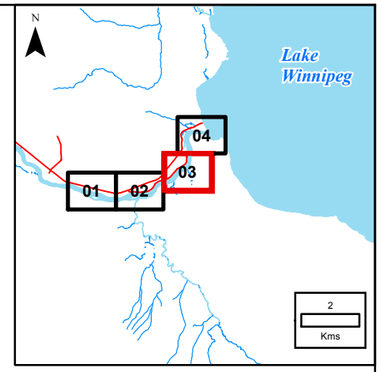
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2011 TO 2013

JANUARY 2015 | DRAWING 15.02 | REV: B

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11"x17" PLOT SCALE 1:1

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LEGEND:

- 2013 Sonar Point
- 2011 Sonar Point
- Water Level (June 5–7th, July 22–23, 2012)
- Survey Control 2011 (See Note 3 Below)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2011 to 2013
Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1.0
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2011 Sonar completed by KGS Group on June 29 – July 2, 2011.
   2013 Sonar completed by KGS Group on June 5–7, and July 22–23, 2013.
3. 2013 Control is outside map extents. Please see Figure 10.01–10.03 for 2013 Control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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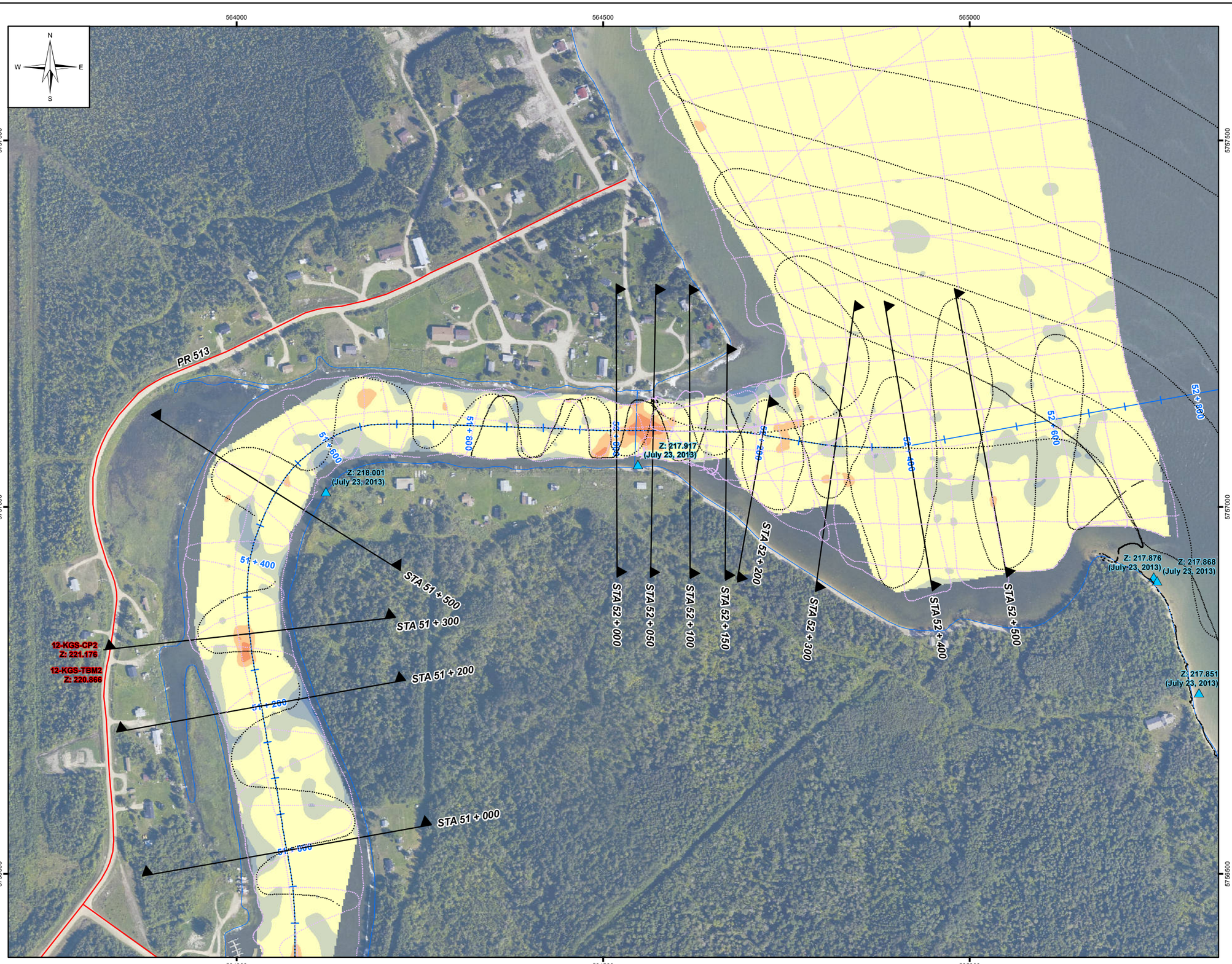
LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

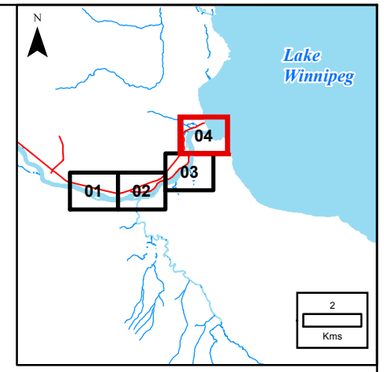
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2011 TO 2013

JANUARY 2015 | DRAWING 15.03 | REV: B

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11"x17" PLOT SCALE 1:1

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LEGEND:

- 2013 Sonar Point
- 2011 Sonar Point
- Water Level (June 5–7th, July 22–23, 2012)
- Survey Control 2011 (See Note 3 Below)
- X–Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2011 to 2013 Elevation Variation (m)

- < –2
- –2.0 – –1.5
- –1.5 – –1.0
- –1.0 – –0.5
- –0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2011 Sonar completed by KGS Group on June 29 – July 2, 2011.
   2013 Sonar completed by KGS Group on June 5–7, and July 22–23, 2013.
3. 2013 Control is outside map extents. Please see Figure 10.01–10.03 for 2013 Control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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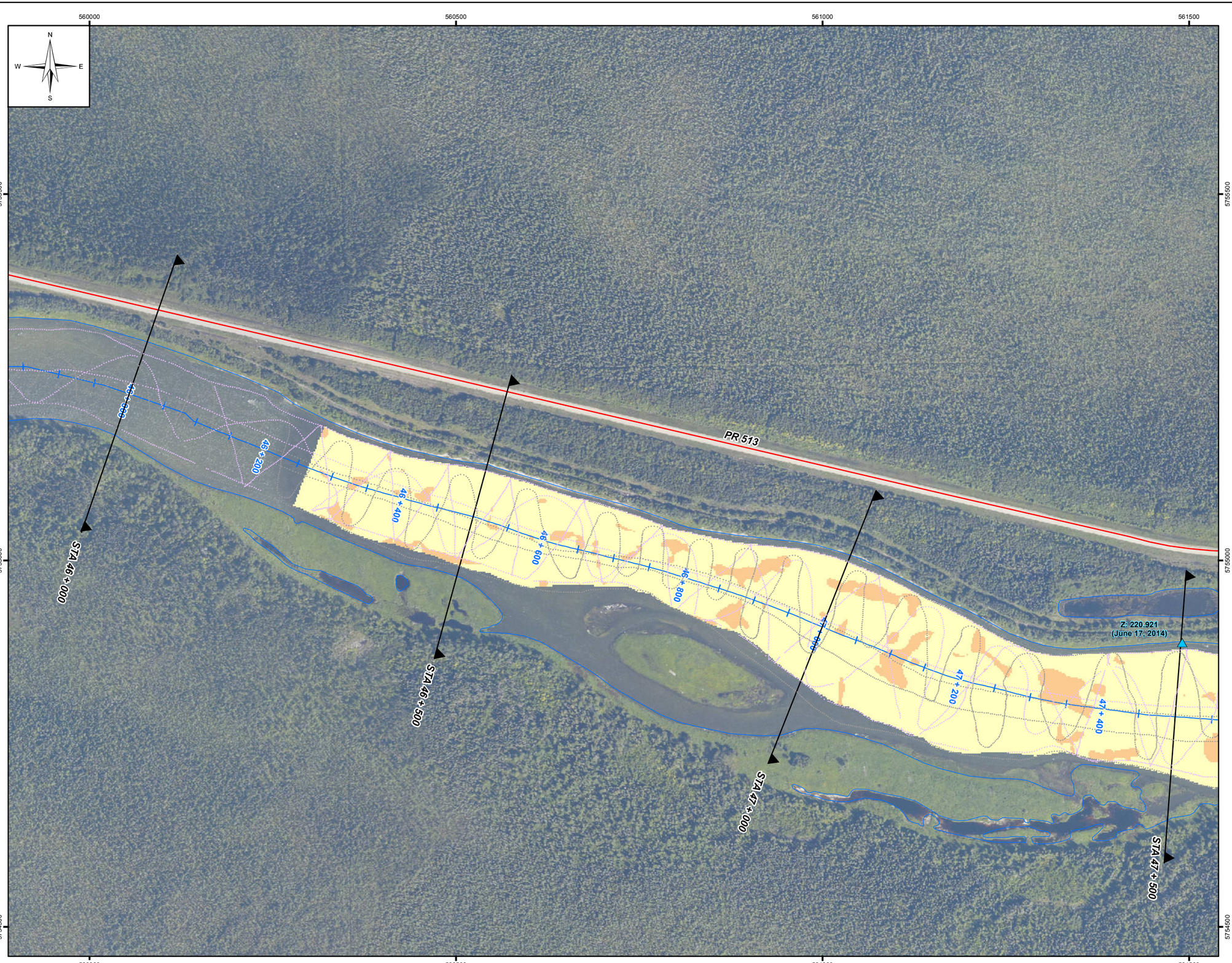
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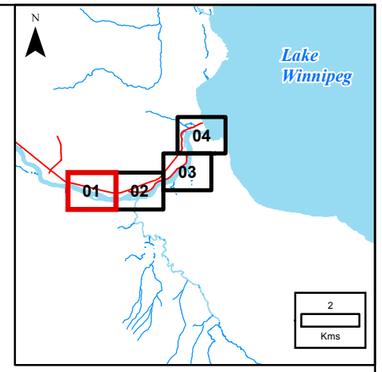
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2011 TO 2013

JANUARY 2015 | DRAWING 15.04 | REV: B

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11"x17" PLOT SCALE 1:1

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LEGEND:

- 2014 Sonar Point
- 2013 Sonar Point
- Water Level (June 17–21, 2014)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2013 to 2014 Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2013 Sonar completed by KGS Group on June 5–7th, and July 22–23, 2013. 2014 Sonar completed by KGS Group on June 17–21, 2014.
3. 2013 & 2014 are outside map extents. Please see Figure 10.01–10.03 for control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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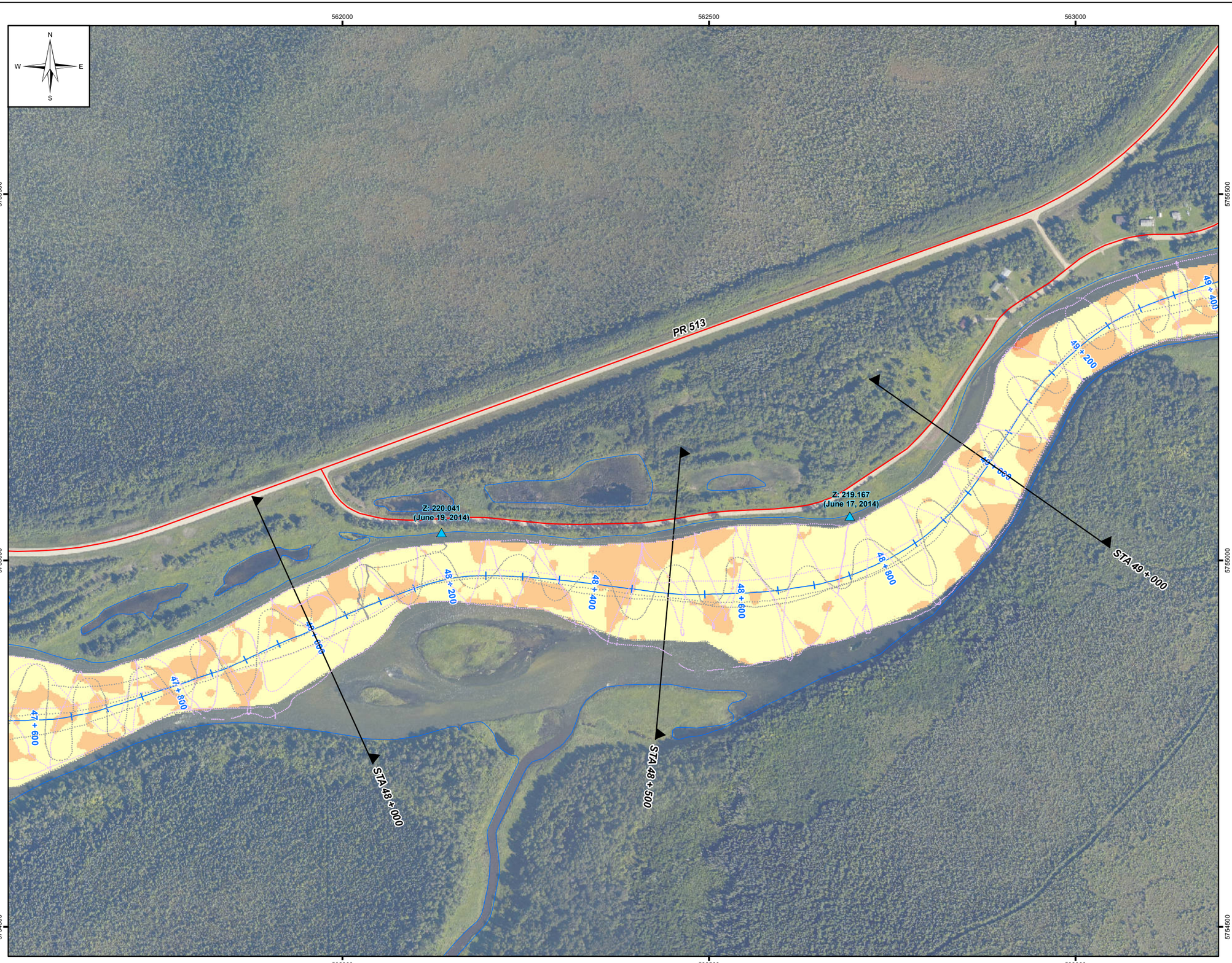
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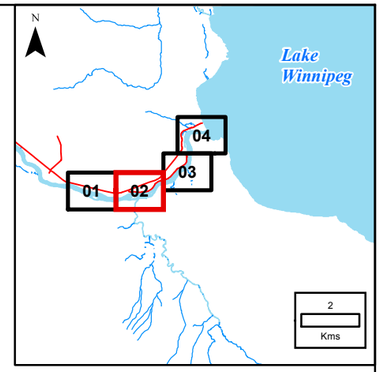
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2013 TO 2014

JANUARY 2015 | DRAWING 16.01 | REV: B

FileName: P:\Projects\2013\13-0431-001\Dwg\GIS\MXDs\RevB\Physical_Process_Report_2014\13-0431-001_Fig16_RevB.mxd
11"x17" PLOT SCALE 1:1

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LEGEND:

- 2014 Sonar Point
- 2013 Sonar Point
- Water Level (June 17–21, 2014)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2013 to 2014 Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2013 Sonar completed by KGS Group on June 5–7th, and July 22–23, 2013. 2014 Sonar completed by KGS Group on June 17–21, 2014.
3. 2013 & 2014 are outside map extents. Please see Figure 10.01–10.03 for control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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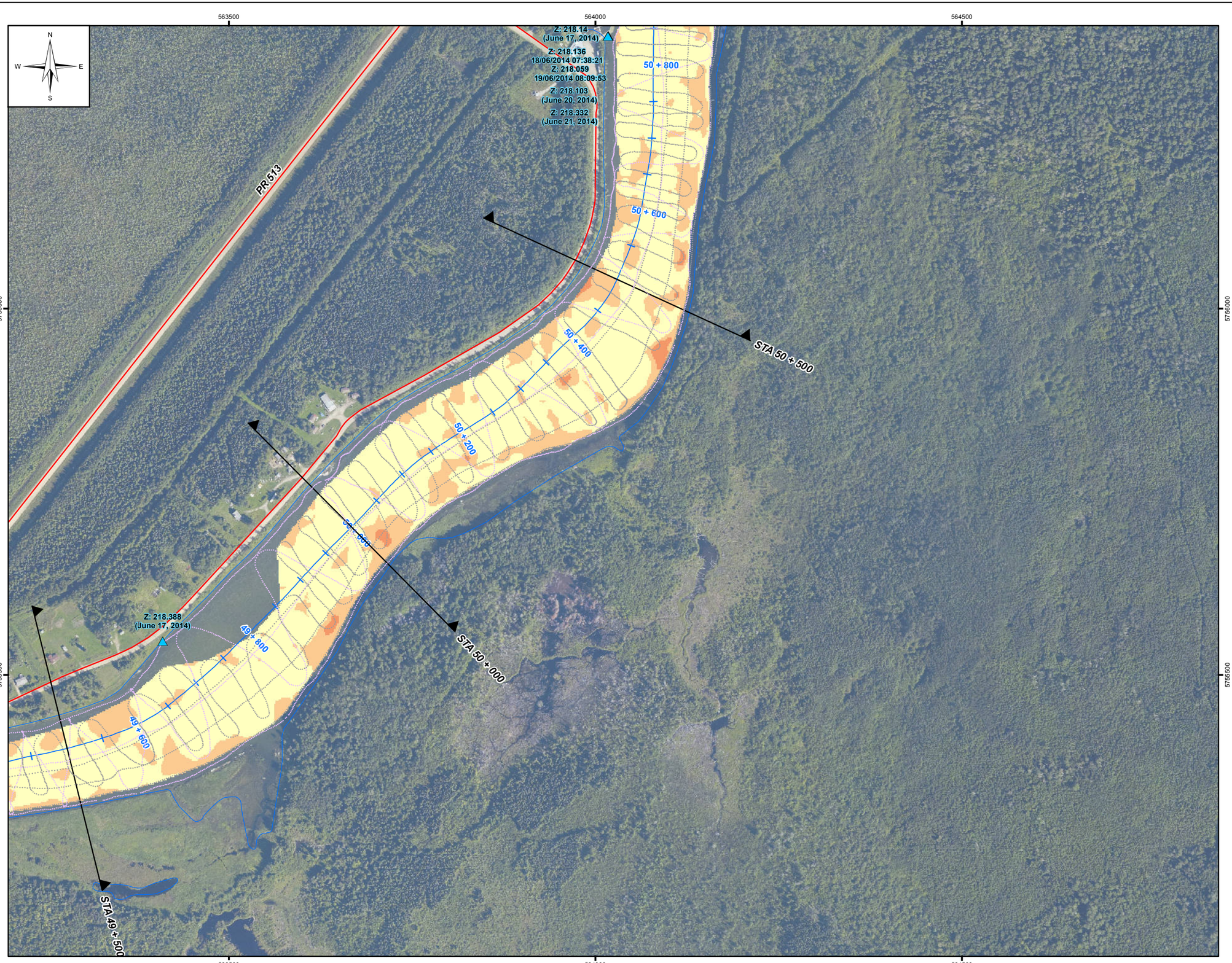
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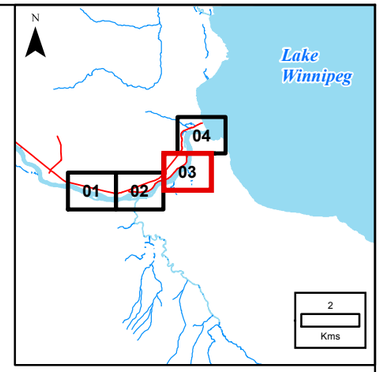
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2013 TO 2014

JANUARY 2015 | DRAWING 16.02 | REV: B

FileName: P:\Projects\2013\13-0431-001\Dwg\GIS\MXDs\RevB\Physical_Process_Report_2014\13-0431-001_Fig16_RevB.mxd
11"x17" PLOT SCALE 1:1

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LEGEND:

- 2014 Sonar Point
- 2013 Sonar Point
- Water Level (June 17–21, 2014)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2013 to 2014 Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2013 Sonar completed by KGS Group on June 5–7th, and July 22–23, 2013. 2014 Sonar completed by KGS Group on June 17–21, 2014.
3. 2013 & 2014 are outside map extents. Please see Figure 10.01–10.03 for control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200

Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

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Manitoba INFRASTRUCTURE AND TRANSPORTATION

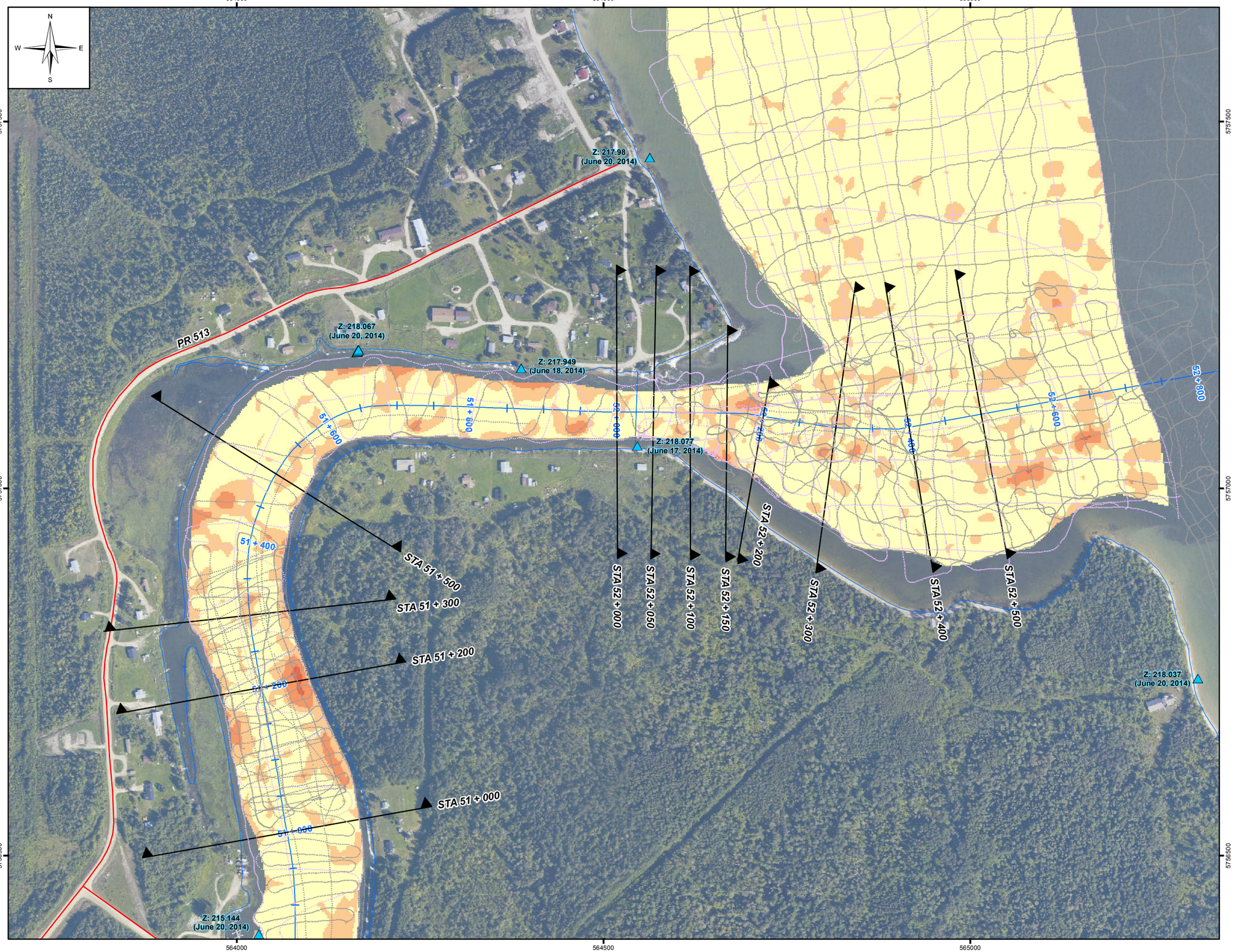
LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

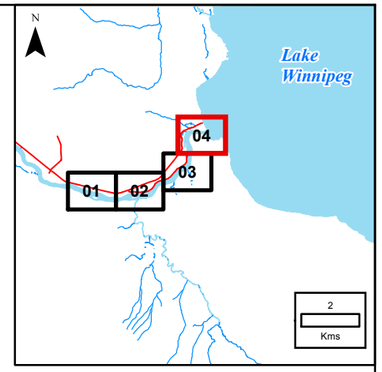
LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2013 TO 2014

JANUARY 2015 | DRAWING 16.03 | REV: B

FileName: P:\Projects\2013\13-0431-001\Dwg\GIS\MXDs\RevB\Physical_Process_Report_2014\13-0431-001_Fig16_RevB.mxd
11"x17" PLOT SCALE 1:1

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LEGEND:

- 2014 Sonar Point
- 2013 Sonar Point
- Water Level (June 17–21, 2014)
- X-Section
- Dauphin River Centreline

TRANSPORTATION

- Gravel Road
- Trail
- Edge of Water (LiDAR)

From 2013 to 2014 Elevation Variation (m)

- < −2
- −2.0 – −1.5
- −1.5 – −1
- −1.0 – −0.5
- −0.5 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- > 2.0

* SEE NOTE 1 FOR EXPLANATION

NOTES:

1. Negative elevation values indicates erosion and positive indicates deposition.
2. 2013 Sonar completed by KGS Group on June 5–7th, and July 22–23, 2013. 2014 Sonar completed by KGS Group on June 17–21, 2014.
3. 2013 & 2014 are outside map extents. Please see Figure 10.01–10.03 for control.
4. Satellite image provided by Atlis Geomatics, July 2011
5. Original ground surface based on LiDAR provided by Atlis Geomatics (June/July 2011)
6. All units are metric and in metres unless otherwise specified
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

50 0 50 100 150 200
Metres

SCALE: 1:5,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	BY
B	15/01/08	ISSUED WITH DRAFT REPORT	PAL
A	14/10/17	ISSUED WITH PRELIMINARY DRAFT REPORT	PAL

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba INFRASTRUCTURE AND TRANSPORTATION

LSM EMERGENCY RELIEF CHANNEL MONITORING & DEVELOPMENT OF HABITAT COMPENSATION

LOWER DAUPHIN RIVER BATHYMETRY DIFFERENCES OF 2013 TO 2014

JANUARY 2015 | DRAWING 16.04 | REV: B

FileName: P:\Projects\2013\13-0431-001\Dwg\GIS\MXDs\RevB\Physical_Process_Report_2014\13-0431-001_Fig16_RevB.mxd
11"x17" PLOT SCALE 1:1

Lake St. Martin Emergency Outlet Channel
Assessment of Effects and Development of Offsetting

Aquatic Habitat Supporting Volume (AHSV)

May 2015

A report prepared for
Manitoba Infrastructure and Transportation
by
North/South Consultants Inc. and KGS Group

PREFACE

The following document was prepared to provide the information required under Schedule 1 of the *Applications for Authorization under Paragraph 35(2) (b) of the Fisheries Act Regulations.* As requested by Fisheries and Oceans Canada (DFO), key information from all relevant materials provided during the environmental review of the Lake St. Martin Emergency Relief Channel Project has been summarized in this document, following the subsections identified in Schedule 1 to the extent possible.

It should be noted that, because of the emergency requirement to complete this Project, it was exempted from a review under Canada's *Canadian Environmental Assessment Act (CEAA)* and *The Environment Act (Manitoba)*. In the absence of a formal screening, DFO issued *Fisheries Act* authorizations for the Project. The requirement for documentation and possible offsetting for any residual serious harm to fish that have arisen due to the Project was identified within the authorizations.

The following document is one of a series of reports listed below to address reporting requirements stipulated in the Fisheries Act authorizations. The report series is comprised of an assessment of Project-related effects determined from ongoing project monitoring, an offsetting plan in which the needs for offsetting measures are discussed, and a series of support volumes that summarize Project monitoring data collections and results by major ecosystem component (i.e., Physical Environment, Water Quality, Aquatic Habitat, and Fish). Reports and supporting volumes include the following:

- Assessment of Effects to Aquatic Habitat and Fish (AEHF)
- Offsetting Plan
- Physical Environment Supporting Volume (PESV)
- Water Quality Supporting Volume (WQSV)
- Aquatic Habitat Supporting Volume (AHSV; this volume)
- Fish Supporting Volume (FSV)

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Appendix 6A. Aquatic Habitat Assessment Analysis Results

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6.0 AQUATIC HABITAT

Sections within this supporting volume are numbered to match the corresponding section within the "Effects to Aquatic Habitat and Fish" document.

6.1 INTRODUCTION

6.1.1 Project Background

Widespread record flooding throughout southern Manitoba during 2011 led to water levels in Lake Manitoba and Lake St. Martin that were several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin. As part of emergency relief measures, the Province of Manitoba, through Manitoba Infrastructure and Transportation (MIT), constructed the Lake St. Martin Emergency Outlet Channel System (LSMEOC system), which is comprised of two emergency channels (Figure 6.1-1).

The Reach 1 Emergency Outlet Channel (Reach 1) begins at the northeast shore of the north basin of Lake St. Martin and extends approximately 6 km to the bog area surrounding Big Buffalo Lake. Water from Reach 1 inundates the bog area and then follows the natural Buffalo Creek Drainage System until flowing into the lower Dauphin River and ultimately into Sturgeon Bay (Figures 6.1-1 and 6.1-2). Water began to flow through Reach 1 on 01 November 12011 and the channel was operated until 21 November 2012.

Computer models of potential water levels at the mouth of the Dauphin River indicated that there was a significant risk of major flooding of the Dauphin River communities in spring 2012. Consequently, a second channel (Reach 3 Emergency Channel; Reach 3) was constructed during winter 2011/2012. Reach 3 was designed to divert excess flow from Reach 1 and Buffalo Creek and away from the lower Dauphin River. Due to extremely mild winter conditions in 2011/2012, ice effects on both Reach 1 and the Dauphin River were much less severe than forecasted. Consequently, the proposed operation of Reach 3 was no longer required.

Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, prompting MIT to re-open Reach 1 at the beginning of July 2014. The channel was re-opened in two stages. The first occurred during in July 2014 when approximately 35 m of the berm closing Reach 1 was removed. The second stage occurred in November 2014, when an additional 10 m of the closure berm were removed to allow additional flow into the channel. Reach 1 currently remains in operation, and will remain so until at least 15 June 2015.

Collectively, construction and operation of Reach 1, as well as construction of Reach 3, are referred to hereafter as "the Project".

Concurrent with construction of Reach 1 in summer 2011, MIT initiated studies and monitoring to help describe and assess environmental effects arising from the Project. These included studies to document

changes to the physical environment (e.g., measurement of water flow through Reach 1 and the Dauphin River; sedimentation and erosion studies) and possible subsequent effects to the biological environment (e.g., possible change to fish community in Buffalo Creek). Environmental studies began in August 2011 and remain ongoing.

6.1.2 Study Area

The emphasis of aquatic monitoring is to determine what effects construction and operation of Reach 1 may have had on waterways downstream of the channel. These include the Buffalo Creek watershed (comprised of Big Buffalo Lake and the surrounding bog complex, and Buffalo Creek), the lower reach of Dauphin River, and the southwest portion of Sturgeon Bay in Lake Winnipeg. However, these waterways are also affected by conditions occurring upstream of Reach 1 and, in some instances, fish move between areas upstream and downstream of Reach 1. Consequently, some components of the aquatic monitoring program (water quality monitoring and fisheries investigations) include waterways upstream of Reach 1.

While aquatic habitat in waterbodies upstream of the Project was generally not expected to be affected by Reach 1 operation, there is a small Project footprint along the north shore of Lake St. Martin where the inlet to Reach 1 was constructed. For the aquatic habitat portion of this assessment, waterbody boundaries were defined as follows (Figure 6.1-2):

- Lake St. Martin in the vicinity of the Reach 1 inlet;
- Reach 1;
- Big Buffalo Lake and the associated bog complex;
- Buffalo Creek
- the lower reach of the Dauphin River from its confluence with Buffalo Creek to its outflow into Sturgeon Bay (hereafter referred to as “the lower Dauphin River”); and
- nearshore and offshore areas of Sturgeon Bay to the east and south of the Dauphin River mouth.

6.1.3 Phases of the Project

For the assessment of effects to aquatic habitat the phases of the Project are defined as:

- Pre-Operation - historic, up to 31 October 2011;
- 2011/2012 Operation - 01 November 2011 to 21 November 2012;
- 2011/2012 Closure - 22 November 2012 to 04 July 2014; and
- 2014/2015 Operation - began 04 July 2014 and is ongoing.

For the purposes of describing the effects of water regime changes on aquatic habitat, the Pre-Operation phase of the Project has been divided into the Pre-flood (1977-2010) and 2011 Flood (April to October 2011) periods.

6.1.4 Purpose of the Document

A diverse range of monitoring studies has been conducted annually. Aquatic habitat monitoring programs have focussed on documenting substrate composition and bathymetry, waterbody

morphology, and vegetation (aquatic and riparian) in Reach 1, the Buffalo Creek watershed, the lower reach of Dauphin River to its mouth at Sturgeon Bay, and Sturgeon Bay to the east and south of the Dauphin River mouth. The outputs from hydraulic models developed to describe the physical environment were also used to characterize habitat conditions such as wetted area, water depth, and water velocity during different phases of the Project.

This volume provides a summary of available pre-Project information on aquatic habitat in study area waterbodies. It also includes a detailed description of Project monitoring, including the timing of field campaigns and the methods employed, as well as a synthesis of the results of the monitoring activities. Results are discussed by waterbody and are presented in relation to Project phase. This volume is intended to compliment the "Lake St. Martin Emergency Outlet Channel –Assessment of Effects and Development of Offsetting: Assessment of Effects to Aquatic Habitat and Fish" document.

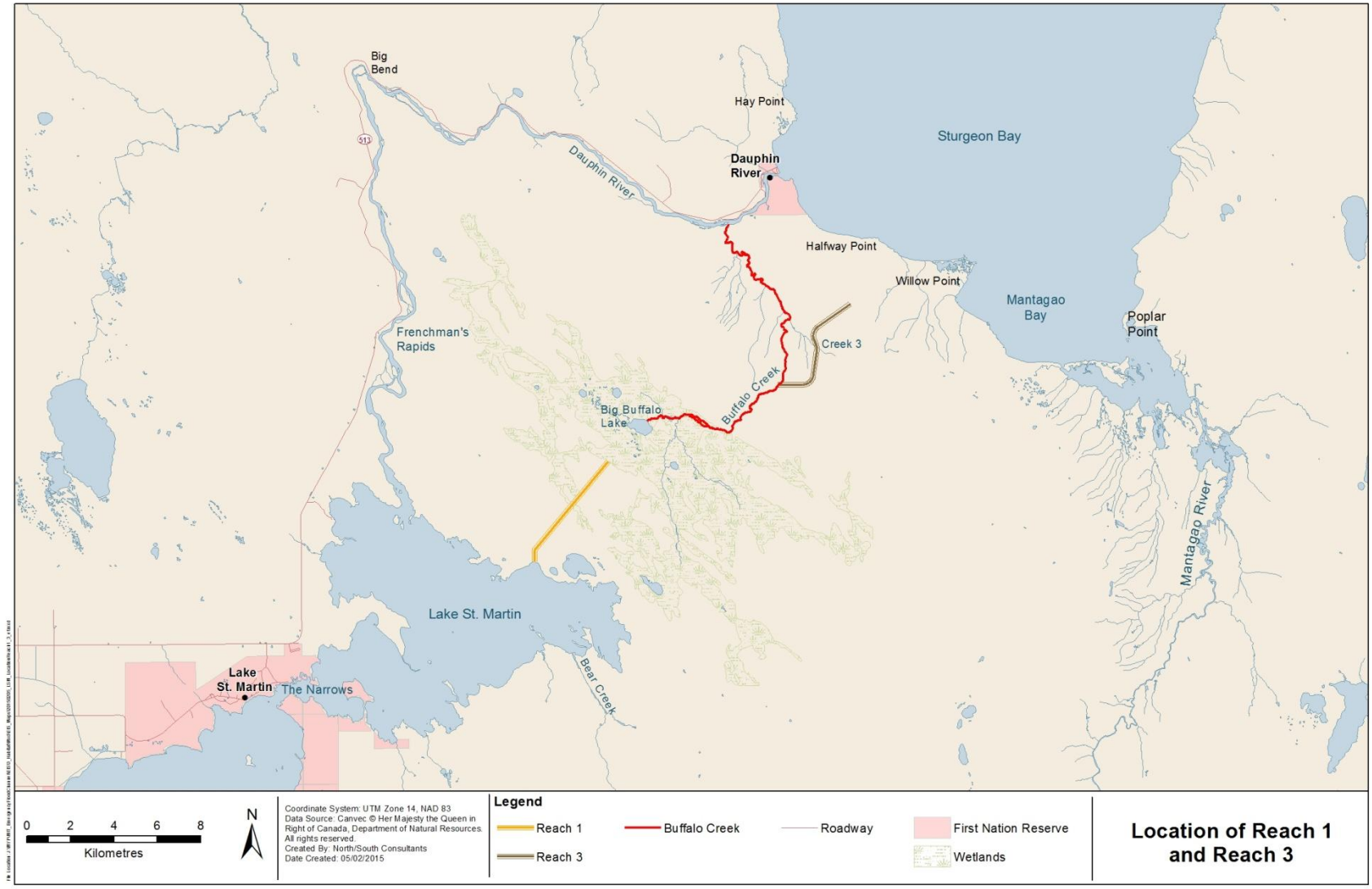


Figure 6.1-1. Location of the Reach 1 Emergency Outlet Channel, the Reach 3 Emergency Channel, and the Buffalo Creek Drainage System in relation to Lake St. Martin, the Dauphin River and Sturgeon Bay.

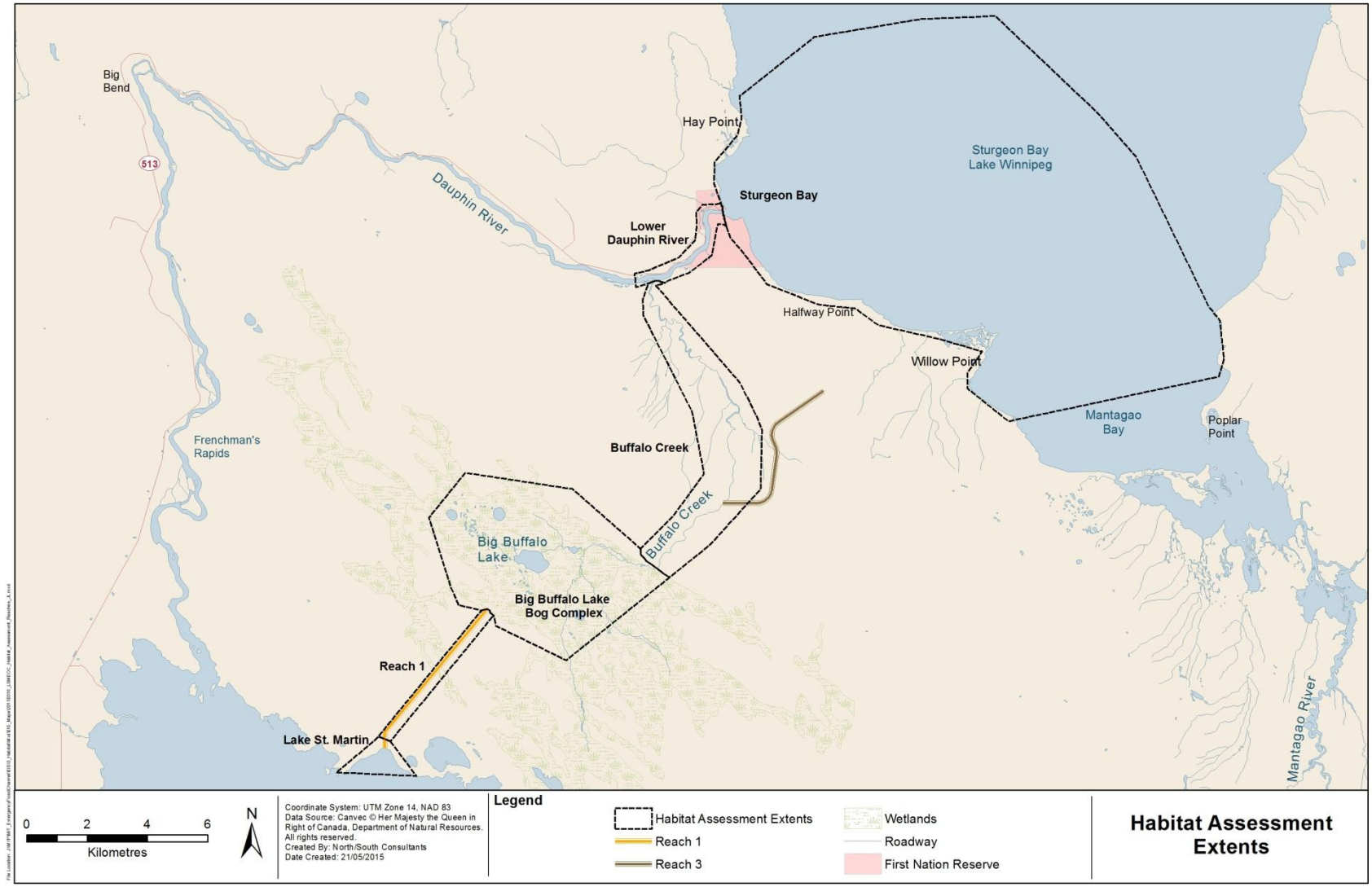


Figure 6.1-2. Waterbody extents identified for the aquatic habitat component of the effects assessment.

6.2 METHODS

Information collected during field investigations was used in conjunction with outputs from hydraulic models (see PESV) to determine habitat conditions within the study area waterbodies. In general, the aquatic habitat assessment focused on documenting changes in the quantity and type of aquatic habitat in waterbodies downstream of Lake St. Martin at 50th percentile flow or water level.

Several sampling methods were used to collect aquatic habitat data before (2011; Pre-Operation) and after (2013 and 2014; 2011/2012 Closure) Project operation. Field activities that informed the aquatic habitat effects assessment are listed below by waterbody/watershed (Table 6.2-1). As some of the data collected under physical environment monitoring were integral to assessing the effects of the Project on aquatic habitat in the study area, particular field campaigns and imagery collections belonging to that discipline are included below.

Field campaigns have not been conducted to assess aquatic habitat conditions in Lake St. Martin, although a small amount of daily water temperature data was collected from Lake St. Martin in 2013 (see Section 6.2.2). Satellite imagery was used to determine Project effects in the vicinity of the inlet to Reach 1(Section 6.2.5).

In Reach 1, field investigations included the following:

- Deployment of a water temperature logger to collect daily water temperature data during the 2014 open water season; and
- Surveys to describe the availability of suitable habitat for fish, including the measurement of water depth, ice thickness (when appropriate) and dissolved oxygen (DO) concentration, were conducted in March and May of 2013.

In the Buffalo Creek watershed, field investigations included the following:

- Deployment of a water temperature logger to collect daily water temperature data from the downstream end of Buffalo Creek during the open water season from 2011-2014, and from Big Buffalo Lake and the upstream end of Buffalo Creek during the 2014 open water season;
- Surveys to describe the availability of suitable habitat for fish in Big Buffalo Lake, including the measurement of water depth, ice thickness (when appropriate) and DO concentration, were conducted in March and May of 2013. A similar survey was also conducted in Buffalo Creek in March 2013;
- Aquatic habitat surveys to measure water depth, water temperature, and DO, and collect substrate information were conducted in Big Buffalo Lake in 2011, 2013 and 2014;
- Aquatic habitat surveys to measure water depth, wetted width, and collect stream morphology, substrate, and aquatic vegetation information, were conducted in Buffalo Creek in 2011, 2013 and 2014;
- Digital geo-referenced photographs were collected along the entire length of the Buffalo Creek watershed in 2011;

- Digital orthometric data for the entire Buffalo Creek watershed collected to support physical environment monitoring in 2011, 2013 and 2104;
- Riparian vegetation surveys conducted in support of hydraulic modeling provided information on plant species abundance and diversity along Buffalo Creek in 2011, 2013 and 2014; and
- Cross-section surveys conducted in support hydraulic modeling.

In the Dauphin River, field investigations included the following:

- Deployment of a water temperature logger to collect daily water temperature data from the Dauphin River downstream of its confluence with Buffalo Creek during the 2011 open water season, and both upstream and downstream of its confluence with Buffalo Creek during the open water season from 2012-2014; and
- Collection of bathymetric and substrate data using sonar technology in 2011, 2013 and 2014.

In Sturgeon Bay, field investigations included the following:

- Deployment of a water temperature logger to collect daily water temperature data from Sturgeon Bay during the open water season from 2011-2014;
- Collection of bathymetric and substrate data using sonar technology in 2011, 2013 and 2014;
- Visual assessment of substrate grabs; and
- Collection of substrate samples for laboratory analysis of particle size.

The following sections provide a detailed description of aquatic environment monitoring program data collection and analysis methods. Also included is a description of how data from particular components of the physical environment monitoring program were analyzed to help inform the aquatic habitat effects assessment.

6.2.1 Aquatic Habitat Assessment Parameters

A number of physical habitat parameters can be used to assess the quantity and quality of aquatic habitat. Aquatic habitat is often classified on the basis of water depth, water velocity, substrate type, and cover (including large rooted plants, terrestrial debris, riparian vegetation, and other large structures). In general, the study area waterbodies is a composite of lacustrine (Lake St. Martin, Big Buffalo Lake, Sturgeon Bay), riverine (Dauphin River), and creek (Buffalo Creek) habitats (Figure 6.2-1). These coarse habitats can be further classified according to specific habitat parameters. The following physical habitat parameters are considered for this assessment approach based on the availability of certain data sets and their importance in characterizing and assessing change to aquatic habitat.

6.2.1.1 Available Habitat Area

Areas of total habitat given for a specific water regime and inflow or water level condition provided the context to estimate overall habitat gains, alterations, and/or losses. The habitat assessment considered habitat under a range of flow conditions: low (5^{th} percentile flows); intermediate or median (50^{th} percentile flows) and high (95^{th} percentile flows). In order to abridge the assessment a median (50^{th} percentile) flow condition was used to assess change across project phases.

6.2.1.2 Water Level Habitat Zones

Water level habitat zones are defined by the water regime. The maximum available habitat area could be defined as the habitat area available under a 95th percentile flow or water level. However that habitat is not sustained for the entire temporal extent or project phase and therefore habitats can be classified according to their availability to aquatic biota.

- Intermittently exposed zone (IEZ) habitats can be defined as habitats that are not sustained for a given water regime period, or the area of habitat between the 95th and 5th percentile flow or water levels (Figure 6.2-1).
- Predominantly wetted zone (PWZ) habitats or the areas below 5th percentile water levels remain almost entirely wetted for the duration of the given water regime, providing constant habitat to biota, the quality of this habitat changes with changes to flow (Figure 6.2-1).

6.2.1.3 Water Depth

Water depth is an important aquatic habitat feature. Deep areas in water bodies can provide crucial overwintering habitat, refuge from predation or high water velocities. Shallow areas of water bodies can provide important habitat for aquatic and riparian plant species, which in turn provides important habitat for some fish species. In this assessment deep and shallow depth zones are defined as the areas above and below 2 metres (Figure 6.2-1) and are further defined as follows:

- Shallow habitats are defined as areas less than 2 metres. The 2 metre depth division was selected to indicate areas of shallow littoral habitat. Often this boundary indicates the depths to which light penetrates to the benthic zone, which has implications for the growth of rooted aquatic macrophytes and can be an indication of overall water clarity.
- Deep habitats are defined as areas that are deeper than 2 metres. Deep water habitats can provide fish with refuge from strong currents, and crucial overwintering habitat.

6.2.1.4 Water Velocity

The distribution of habitat and the biota that use them is strongly influenced by the velocities inherent within a water body. Lentic or standing water habitats, often characterize lacustrine environments and the peripheries of riverine and creek habitats (Figure 6.2-1). Lotic or flowing water habitats, typically dominate riverine and creek habitats. Certain velocities can attract some fish species to move upstream. Some fish species may find high water velocities to be a deterrent. The following water velocity classes are defined for this assessment, the classes follow those defined for other aquatic habitat assessments (Keeyask Hydropower Limited Partnership 2012):

- Lentic or standing water habitats are defined as areas of standing water which have flow below 0.2 m/s. Generally lentic habitats support organisms that avoid flowing water and are adapted to live in standing waters, including many species of aquatic plants. Some fish species tend to prefer these habitats when carrying out there life history stages (i.e., Northern Pike). During flooding riverine systems such as the Dauphin River can cause backwatering in tributary creeks (i.e., Buffalo Creek) creating a net lentic environment in a habitat that normally has flow.

- Lotic habitats having low flow are defined as areas of flowing water that have water velocities ranging from 0.2 to 0.5 m/s.
- Lotic habitats having moderate flow are defined as areas of moderately flowing water that have velocities ranging from 0.5 to 1.5 m/s.
- Lotic habitats having high flow are defined as areas of high flowing water that have velocities extending beyond 1.5 m/s.

6.2.1.5 Substrate

The benthic structure of a water body is important in sustaining various fish life history stages for different species of fish in addition to all other biota inhabiting the bottoms of water bodies. Changes to the overall composition of the benthic structure can impact the habitats of various fish species. This assessment generally classifies substrates as being hard and coarse (bedrock, boulder and cobble, and gravels), or soft and fine (sand, silt, and clay).

6.2.1.6 Vegetation and Cover

Aquatic and riparian vegetation are important features of aquatic habitat. Instream aquatic macrophytes and debris provide structure and cover from predation, temperature, and refuge from high velocities. Riparian vegetation functions to trap sediment from runoff and prevents erosion due to slope failure.

6.2.2 Water Temperature

In addition to the aquatic habitat parameters listed in Section 6.2.1, water temperature impacts fish use of aquatic habitat, so water temperature data were collected during open water periods since fall 2011.

6.2.2.1 Sampling Sites

At the beginning of fisheries investigations each year, Onset HOBO Water Temperature Pro v2 loggers (Model U22-001) were installed throughout the study area (Figure 6.2-2). The following eight locations were monitored at least once since 2011:

- Lake St. Martin approximately 1.5 km west of Reach 1, TL-05 (2012-2014);
- the downstream end of Reach 1, EC-02 (2014);
- Big Buffalo Lake, BBL-01 (2014);
- the upstream end of Buffalo Creek, BC-01 (2014);
- Buffalo Creek mouth upstream of the Dauphin River, TL-04 (2011-2014) and BC-TM (2014);
- the Dauphin River upstream of Buffalo Creek, TL-06 (2012-2014);
- the Dauphin River downstream of Buffalo Creek, TL-03 (2011-2014); and,
- Sturgeon Bay north of the Dauphin River mouth, TL-01a, -01b and -01c (2011-2014).

6.2.2.2 Field Methods

Three temperature loggers were installed at various depths at each of the two Sturgeon Bay sites in 2011 to collect vertical temperature profiles. Single loggers were deployed on all other occasions.

While deployed, temperature loggers were operated continuously and were programmed to record water temperature at one- (2011) or four-hour (2012-2014) intervals. Water temperature data were downloaded periodically from the loggers using software provided by the manufacturer (Onset HOBOware Pro ver. 2.3.1). Temperature data were collected from an additional four loggers installed by KGS in Reach 1 and the Buffalo Creek watershed during 2014. The KGS loggers recorded temperature information every 15 minutes.

6.2.2.3 Data Analysis

Daily mean water temperature was plotted to illustrate daily changes throughout the monitoring period and to compare trends between years.

6.2.3 Aquatic Habitat Field Surveys

6.2.3.1 Ice Cover Season Habitat Assessments

Sampling sites in Reach 1, Big Buffalo Lake, and Buffalo Creek were accessed by snowmobile and holes were drilled through the ice using a Stihl power auger. The location of each sampling station was recorded using a handheld Garmin GPSMap 76S GPS, and the time at which sampling occurred was noted. At each sampling location, snow cover on top of the ice was measured (± 0.1 m), ice thickness was measured (± 0.01 m), and effective water depth was measured (± 0.01 m). Effective water depth is defined as the depth of water occurring beneath the bottom surface of the ice and is determined by measuring the overall water depth (top of ice to bottom of water body) minus the thickness of ice occurring from the top of ice to the bottom of the ice surface.

Where water depth was sufficient, *in situ* measurements of water quality parameters including pH, conductivity, turbidity, and water temperature were collected using a Horiba® W22-XD water quality meter. As the DO sensor on the Horiba meter could not be correctly calibrated, all DO measurements were collected using a handheld YSI-550a DO meter.

6.2.3.2 Open Water Season Habitat Assessments

6.2.3.2.1 Big Buffalo Lake

Aquatic habitat in Big Buffalo Lake was characterized by collecting depth measurements and describing substrate compaction and size characteristics at a series of locations across the lake in both years. Location of sampling sites was recorded using a Garmin GPSMap 76S GPS receiver. Depth measurements were collected with a hand-held depth sounder.

Substrate compaction was a qualitative assessment of the firmness of the substrate completed by probing the bottom of the lake with a pole. Two compaction categories, hard or soft, were used. Substrate size classification was assessed visually (it was possible to see to the bottom of the lake at all locations). Substrate size classes were defined based on Wentworth (1922), and included the following size categories:

- Boulder > 256 mm
- Cobble 64-256 mm

- Gravel (aggregate) 2-64 mm
- Sand (aggregate) 62.5 µm – 2 mm
- Silt 3.9-62.5 µm
- Clay < 3.9 µm

6.2.3.2.2 Buffalo Creek

Habitat information was also collected from a series of locations along Buffalo Creek. Location of sampling sites was recorded using a Garmin GPSMap 76S GPS receiver. At each location, the following habitat parameters were measured, categorized, or described:

- Habitat category (riffle, pool, run; after Bisson et al. 1982);
- Wetted width (m);
- Water depth at 5 locations across the creek (m);
- Substrate composition;
- Substrate compaction; and,
- Presence/absence and type of instream vegetation.

Substrate compaction was a qualitative assessment of the firmness of the substrate underfoot. Two compaction categories, hard or soft, were used. Substrate size was assessed visually and classification was based on Wentworth (1922; see above). At each location, other habitat attributes of interest such as the occurrence of beaver dams were noted.

6.2.3.3 Water Depth Measurement and Substrate Classification

Water depth and substrate mapping studies were conducted in 2011, 2013, and 2014 (North/South Consultants Inc. 2013). Surveys focused on the lower Dauphin River and Sturgeon Bay in the immediate vicinity of the Dauphin River outflow (Figures 6.2-3 to 6.2-5). A more extensive survey of Sturgeon Bay was conducted in 2013; the survey spanned the southwest shore of Sturgeon Bay from the Dauphin River outflow to just south of Willow Point (Figure 6.2-4).

6.2.3.3.1 Sonar Data Collection

Bathymetric and bottom-typing sonar surveys in both years were conducted from a 5.5 m foot boat operated at approximately 5 to 10 km/h. In 2011, spring 2013 and spring 2014, depth, positional data, and bottom-type data were acquired concurrently using a Quester Tangent Corporation (QTC) Series 5.5 scientific-grade 50 kHz echosounder paired with a Trimble Pro-XRS real-time differential global positioning system (DGPS). In fall 2013, similar data were acquired concurrently using a BioSonics Habitat MX scientific grade echosounder with an internal differential GPS. The BioSonics Habitat MX uses a 200 kHz transducer to record Sonar echoes. Both systems recorded at 1 second intervals. Substratum distribution patterns in the Dauphin River were also interpreted in specific areas in 2013 using images produced by a Lowrance HDS Gen2 side scan sonar.

In all surveys, the echosounder transducer was positioned 0.61 m below the surface of the water, adjacent to the hull in the middle of the boat. The DGPS receiver National Marine Electronics Association (NMEA) GGA output coordinates and time stamps were logged to a notebook computer

along with the sonar depth and bottom-type data, using either QTC's QTRT acquisition software (2011 and spring 2013 data) or BioSonics Visual acquisition MX software (fall 2013 data). All surveys of the river consisted of longitudinal shoreline and centre channel transects and zig-zag, bank-to-bank, transects. Transect patterns are presented in Figures 6.2-3 to 6.2-5.

6.2.3.3.2 Substrate Validation

Dauphin River

During all sonar surveys, substrate samples were collected from areas of low water velocity along the lower Dauphin River to provide information used to validate the interpretation of the sonar data. Substrate samples were collected using a petite Ponar grab. At each site, Ponar penetration depth and relative proportion (%) of each substrate type within the sample was visually estimated and recorded. Substrate size classification was based on Wentworth (1922) (see Section 6.2.3.2.1).

In areas of the Dauphin River where high water velocity or hard substrates precluded the use of a substrate sampler, bottom structure and substrate and validation were achieved through a series of rebar drags. An 18" length of steel rebar was attached to a braided nylon rope and dragged along the river bed. The vibration and movement of the rebar on the river bed provides some indication of the substrate material: soft, fine substrate areas have very little vibration and jump, whereas complicated and hard bottoms have increased levels of vibration and jump. For each rebar drag transect, aggregate size was estimated and noted (aided by visual assessment where possible).

Sturgeon Bay

During all sonar surveys, substrate samples were collected from Sturgeon Bay to provide information used to validate the interpretation of the sonar data. Substrate samples were collected using a petite Ponar grab. Rebar drags were only rarely conducted in Sturgeon Bay.

In addition to validation sites to support sonar data collection, substrate samples were collected and analysed along several transects in Sturgeon Bay (see the Ponar grab dots on Figure 6.2-4 for an indication the location of these transects). The initial transect surveys in 2011 were intended to provide information to support the incomplete fall 2011 sonar data collection. Substrate samples from fall 2013 and fall 2014 were collected to provide substrate data comparative to that collected in 2011.

Along each transect, site locations (UTM NAD 83), water depths (m), and Secchi depths (m) were recorded. One petite Ponar substrate grab was collected per site, where possible. At each site, Ponar penetration depth and relative proportion (%) of substrate type within the sample was visually estimated and recorded. Substrate size classification followed the Wentworth scale (see Section 6.2.3.2.1).

A five centimeter (outer diameter) core tube (0.002 m^2 surface area) was used to collect a 100 mL sediment sub-sample from each site's single substrate grab. Sub-samples were transferred to individually labelled polyethylene bags and kept in a cool storage container until they could be refrigerated. Samples were then submitted to a Canadian Association for Laboratory Accreditation

(CALA) certified analytical laboratory (ALS Laboratories Group, Winnipeg, MB; ALS) for particle size (PSA) and total organic carbon (TOC) analyses.

6.2.3.3.3 Digital Photography

GPS-linked digital photography was used in 2011 to document shoreline conditions in the Dauphin River and to aid in the development of the substrate map. GPS-linked digital photography allows each image taken to be imprinted with geographic coordinates so that they can be mapped and displayed accordingly post-survey.

6.2.3.3.4 Habitat Classification and Quantification

As with analysis of Buffalo Creek watershed data, a GIS-based approach was used to classify and quantify aquatic habitat in the Dauphin River during 2011, 2013 and 2014. The following sections describe the specific methods used to create detailed bathymetry and substrate maps and to make comparisons between years.

Bathymetry

Results of the depth and substrate type analysis for both years were exported to a CSV file which was then imported into Microsoft Excel for additional processing, including correction for transducer depth. The corrected sonar depths were combined with vertices extracted from the shoreline polyline file, which had been assigned zero depth values using ArcGIS 10 (2011) or 10.2 (2013 and 2014) software. The merged shapefile was imported into Surfer® 9 (2011) or 11 (2013 and 2014; Golden Software) and a Kriging spherical variogram model interpolation was used to produce a 5 m pixel resolution depth grid. The raster grid was imported back into ArcGIS for vector contouring at 0.5 m intervals and final cartographic presentation for the report. Depths were corrected further with manual editing where the depth algorithm had noticeable errors.

Substrate

The characteristics of acoustic echoes returned from a river or lake bottom are unique to each bottom type. An acoustic pulse impacting the substratum is reflected and scattered at the substratum-water interface and by the material in the sub-surface. The shape of the acoustic echo provides a means to discriminate between different bottom types and is determined mainly by the acoustic impedance of the sediment and/or the scattering characteristics of the substrate-water interface and the frequency of the acoustic pulse.

Although the acoustic data from both years were classified into groups using principal component analysis (PCA) followed by K-means clustering, the specific analysis methods and software differed between years. The following two paragraphs describe the analytical differences between the two years.

The 2011 and spring 2013 and 2014 QTC acoustic data were exported from QTC Impact and then imported to and analyzed with the statistical package SPSS. A PCA reduced the 166 acoustic waveform variables related to bed roughness and hardness down to 5 principal component variables representing

over 90% of the variability within the data set. The K-means clustering approach then produced five discrete acoustic classes, representing five different substrate types. The classified acoustic tracks were imported into ArcGIS 10 to identify the acoustic classes that co-occurred with the bottom-type validation classes. In addition, the GPS-linked digital shoreline photographs were used to validate the acoustic bottom-type classes and to increase mapping resolution in the near-shore zone. Substrate classes were digitized as polygons from the classified acoustic tracks, and a final substrate data set was mapped and class areas calculated in ArcGIS 10.

BioSonics data from fall 2013 were analysed with Visual Habitat MX software. Visual Habitat MX software was first used to detect the bottom depth using a rising edge method. Analyzing hydroacoustic data in Visual Habitat MX for bottom or substrate types is a two-step process: in step 1, the software extracts features from the bottom echo signal, and in step 2, the software determines the number of types by clustering the features extracted in step 1. By defining E1 (bottom echo – first part) and E2 (bottom echo – second part), Visual Habitat MX defines where the algorithm starts to extract features for bottom classification from the first and second parts of the bottom echo. Setting a reference depth allows the algorithm to compensate for the effect the depth has on the shape of the bottom echo envelope by normalizing it to that reference depth. The user-supplied number of clusters informs the algorithm how many bottom types to sort the data into.

In order to facilitate assessment of change in substrate composition, substrate classifications were standardized into four assessment classes (Table 6.2-2). Changes in substrate composition in the Dauphin River and Sturgeon Bay were examined by comparing the area (m^2; ha) and proportion of area that each substrate class occupied within the respective surveyed areas. To conduct the analyses, substrate composition maps were standardized to spatial extent (i.e., slightly different areas were mapped during each survey) and the area of each substrate class for each survey was extracted using ArcGIS 10. Results were compared in tabular format and degree of change was expressed as change in area (m^2; ha) and proportion of each substrate class.

6.2.4 Analysis of Hydraulic Model Outputs

Two hydraulic models were used in to support the aquatic habitat assessments for study area waterbodies. These included the following:

1) MIKE 21 2D Hydraulic Model (steady state) – used to model water depth and water velocity based on flow conditions in the lower Dauphin River. Total wetted area was also derived from model outputs. Habitat parameters were modeled under a variety of flow conditions;

2) HEC RAS 1D Backwater Model – used to model water surface elevation, maximum channel depth, wetted width, and mean water velocity at cross-sections along Buffalo Creek. Habitat parameters were modeled under a variety of flow conditions.

6.2.4.1 Analysis of MIKE 21 Hydraulic Modeling Outputs

The Mike 21 2D hydraulic modeling (see PESV) modeling extent covers a small portion of the mouth of Buffalo Creek (300 m), the lower Dauphin River from 600 metres upstream of Buffalo Creek downstream to Sturgeon Bay, and the immediate area of Sturgeon Bay at the Dauphin River outflow (Figure 6.2-6). The flow parameters used to generate the MIKE 21 2D hydraulic model results are listed in Table 6.2-3. Three water regime scenarios were provided: Pre-flood (1977 – 2010), 2011 Flood (based on data from 01 April to 01 November 2011), and 2011/2012 Operation; the Pre-flood and 2011 Flood periods are two separate components of the Pre-Operation phase of the Project. In order to provide an estimate of the variation (90%) experienced for each water regime period, simulated flows for low flow (5^{th} percentile flow,) median flow (50^{th} percentile flow), and high flow (95^{th} percentile flow) were modeled.

The MIKE 21 modelling software produces a computational mesh of data points. At each modeled point in the computational mesh attributes such as UTM coordinates, bed elevation, depth, and velocity are included (Figure 6.2-7).

Depth and Velocity Rasters

The MIKE 21 computational mesh outputs were provided in Microsoft Excel format for each of the 9 model runs. Data were imported into ESRI ArcGIS 10.3 GIS software as an ESRI shapefile format. Each of the 9 model runs (Table 6.2-3) were queried for zero depths and removed in order to determine the shoreline boundary and available data points for each model run (Figure 6.2-3). A triangulated irregular network (TIN) analysis was conducted in order to interpolate velocities and depths between the modeled computational grid data points (Figure 6.2-7). ArcGIS uses Delauney criterion for the triangulation method. TINs are typically used as a digital representation of surface morphology (i.e., elevation or depth); however, the technique can be applied to other variables such as water velocity. The final processing step converted the TIN data format to a 3 m resolution raster data set. ArcGIS 10.3 Spatial Analyst was used to generate depth and velocity statistics (mean and maximum depths and velocities) for each of the 9 MIKE 21 model runs.

Shorelines (Habitat Area)

Following the triangulation processing a step was taken to delineate the TIN data area eliminating extraneous extrapolation outside of the wetted extents of the waterbodies. Vector shorelines were then produced by first executing a TIN Domain processing step, which generates a bounding vector polygon of the data points that were included in the analysis. The vector polygons were then further processed to remove internal islands and any additional geometric errors. Areas were then calculated within the GIS for all 9 MIKE 21 modeled shorelines and exported to Microsoft® Excel for tabulation and formatting.

Water Level Habitat Zones

Water level habitat zones, intermittently exposed zone (IEZ) and predominantly wetted zone (PWZ), were defined for the three water regime periods (Table 6.2-3). Intermittently exposed habitats are defined by the area of aquatic habitat that may become dewatered during a defined water regime

period. The low flow (5th percentile) and high flow (95th percentile) are used to define the range of flow variation (90%) or intermittently exposed habitat. Predominantly wetted habitats are the areas that remain wetted even under low flow conditions. Water level habitat zone data sets were created in ArcGIS 10.3 using a geoprocessing technique known as a Union. Essentially the Union geoprocessing function overlays two GIS feature classes and allows the user to define the attributes for distinct areas in the overlay. In this case the 5th percentile and 95th percentile shorelines derived from the MIKE 21 model were entered as inputs to the Union. The resulting output feature class is a composite of the areas above and below the 5th percentile shoreline habitat extent, which can then be defined in the attribute tables as being intermittently exposed and predominantly wetted habitat zones.

6.2.4.2 Analysis of HEC-RAS Modeling Outputs

Buffalo Creek and Reach 1: Modeled Cross Section Variables

A HEC-RAS V.4.1.0 from the US Army Corps of Engineers backwater model was developed to simulate the hydraulic conditions on the reach of river between Big Buffalo Lake and Dauphin River and for the Reach 1 emergency channel during 2011/2012 Operation and 2011/2012 Closure.

The geometry of the HEC-RAS model utilized cross sections obtained from a combination of LiDAR and surveyed cross sections prior to the 2011/2012 Operation of the channel. A total of 30 stations were modeled using HEC-RAS hydraulic modeling software. The surveyed cross sections were located approximately 500 m apart, as shown on Figure 6.2-4. Modeled habitat parameters for the 5th, 50th, and 95th percentile flows were provided for each cross section and included:

- Wetted width;
- Mean velocity;
- Maximum channel depth;
- Water surface elevation.

These four parameters were summarized in Microsoft Excel by averaging across the 30 stations. Averages were tabulated and are included in Appendix 6A.

Buffalo Creek and Reach 1: HEC-RAS and LiDAR Shorelines

Vector shorelines of Buffalo Creek during 2011/2012 Operation were modeled. The HEC-RAS model along with the LiDAR DEM data was used to generate shoreline vectors at 5th, 50th, and 95th percentile flows during operation (Figure 6.2-8). The shoreline vectors were mapped and areas were calculated in the GIS and exported to Microsoft Excel for tabulation and formatting.

For Reach 1, wetted widths provided from the HEC-RAS model for eight cross sections under simulated 5th, 50th, and 95th percentile flows were used in concert with satellite imagery (Worldview-1 August 23, 2013) to produce shoreline vectors during 2011/2012 Operation and following 2011/2012 Closure. The GIS was used digitize vector polylines between the cross section wetted widths overlaid on the satellite imagery. Generally the satellite image and cross sections had good geometric agreement. The polylines produced for the 5th, 50th and 95th percentile shorelines were converted to polygons and areas were summarized and exported to Microsoft Excel for tabulation.

There was a minimal amount of overlap between the habitat products produced from the MIKE 21 and HEC-RAS models in the lower 300 metres of Buffalo Creek at the confluence with the Dauphin River. The GIS was used segment and remove the overlap from the HEC-RAS modeling in order to produce final habitat areas that were not 'double-counted' between the two models.

6.2.5 Analysis of Aerial and Satellite Imagery

Satellite and aerial imagery were used to quantify habitat areas for a number of locations throughout the study area. Table 6.2-4 provides an index of all satellite images used in the analysis. The sections below summarize the methods used to quantify habitat within the GIS for various study areas.

6.2.5.1 Lake St. Martin

Record construction drawings for the Reach 1 channel were provided by MIT. The drawings were compared to satellite imagery collected during closure of Reach 1 in the summer of 2013. Habitat areas created during the construction of the Reach 1 inlet at Lake St. Martin were digitized within the GIS and total habitat areas were calculated and tabulated.

6.2.5.2 Buffalo Creek Watershed

Habitat Boundary Determination

In order to quantify the composition of aquatic habitat, stream channel boundaries needed to be derived and combined with the habitat polygons to calculate habitat area and composition of the pre- and post-Project environments in the Buffalo creek watershed.

Aquatic habitat boundaries were derived from the high resolution digital orthometric aerial or satellite imagery. In 2011, the first step included a multivariate, unsupervised spectral classification of the blue green and red visible bands of the orthometric mosaic, completed using ArcGIS software. In 2013, the first step was to threshold the image band into land and water classes by selecting a digital number value (0-255) and qualitatively review the separation between land and water in the image. These classification approaches allow the user to specify the number of clustered spectral classes into which the image should be segmented. After the image has been classified, the user can then interpret the classes and assign them to a land cover type. In this case, a general classification of land and water was all that was required to delineate the land and water boundary. Once the imagery was reclassified into land and water cover types, it was converted from a raster to a vector GIS format. A smoothing algorithm (polynomial approximation with exponential kernel; PAEK) was used to remove the relic grid pattern remaining in the vector shoreline data set.

In areas where shadows were confused with the open water class, a manual interpretation of the shoreline was required, which involves 'heads up' digitization of the creek banks using ArcGIS software. After the digitization was completed the polylines representing the shorelines where converted to polygons.

The following analyses were conducted:

- The July 2011 aerial imagery (Table 6.2-4) was used to digitize a Pre-Operation shoreline for Buffalo Creek from Big Buffalo Lake to the confluence with the Dauphin River;
- The April 2012 Landsat 7 ETM+ (Table 6.2-4) image was used to delineate and estimate the maximum extent of open water in the Buffalo Lake Bog Complex during the 2011/12 operation;
- The August 2013 Worldview-1 image (Table 6.2-4) was used to digitize a shoreline for Buffalo Creek from Big Buffalo Lake to the confluence with the Dauphin River following 2012/2013 Closure.

Habitat Classification

The July 2011 aerial imagery, the high-resolution August 2013 Worldview-1 imagery, and the 07 July 2013 GAIM™ imagery (Table 6.2-4) were examined in ArcGIS to delineate polygons of discrete aquatic habitat types within the watershed. Geo-referenced digital photographs and field data were used to help validate the habitat type assigned to each polygon. Six habitat types were delineated (all adapted from Bisson et al. 1982, with the exception of Peat-Pool), including:

1) Riffle — Characterized by moderate to high gradients, stream velocities, and turbulence, below average depths, and the presence of hard substrates that range from fine to coarse, such as pebble, gravel, and cobbles;
2) Pool — Characterized by relatively low gradients, above-average depths, below-average water velocities and turbulence and substrata consisting of fine materials (i.e., silt or sand);
3) Run — Characterized by moderate gradients, average depths and velocities, controlled channel boundaries, low turbulence with an absence of any stream obstructions, and substrata consisting of small gravel and/or cobble;
4) Beaver Pool — Characterized by water impounded upstream of a complete or nearly complete channel obstruction typical of beaver dams. Pool locations reflect the current (photo date) location of beaver dams, which can shift from year to year;
5) Beaver Dam — Characterized as a full or partial obstruction of a stream consisting of woody debris and mud; and,
6) Peat-Pool — Characterized by low to stagnant velocities, organic substrates, and the absence/paucity of defined channel boundaries.

Habitat polygons were either stored in a centroid file where the boundary of each polygon was manually digitized in ArcGIS to generate a mosaic of habitat polygons (2011) or they were segmented and attributed with the matching habitat type within ArcGIS, producing a continuous polygon (2013). These polygons represented the distribution of various habitat types within the watershed. The geo-referenced digital photographs and field data were used to help validate the habitat type assigned to each polygon.

Habitat quantification in both years was conducted by calculating habitat class areas of the polygon mosaic within the GIS. The areas for each habitat type were then exported and tabulated in Microsoft Excel. The 2011 Pre-Operation habitat type classification of Buffalo Creek was tabulated along with the

2011/2012 Closure habitat classification from 2013 in Microsoft Excel. Habitat change was examined by comparing the amount of area (m^2; ha) occupied by each habitat type in 2011 (Pre-Operation) to the amount of area occupied by each habitat type in 2013 (2011/2012 Closure).

6.2.5.3 Sturgeon Bay

Selected Landsat images (Table 6.2-4) were used to show the dynamic and turbid nature of Sturgeon Bay during variable wind conditions.

Table 6.2-1. Timing of digital data collection and field campaigns in support of aquatic habitat monitoring.

Waterbody	Physical or Aquatic Environment Monitoring	Pre-operation (flood)	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation
Lake St. Martin					
Temperature Logger	Aquatic and Physical	-	14 Apr - 29 May, 2012	2013 Logger Lost	2014 Logger Lost
Reach 1					
Temperature Logger	Aquatic and Physical	-	-	18 Jun - 04 Jul, 2014	04 Jul - 22 Oct, 2014
Fish habitat surveys	Aquatic	15-17 Aug 2011	-	28 Mar 2013 28-29 May 2013	-
Cross-section surveys [1]	Physical	Oct 2011	-	03-07 July 2013	-
Big Buffalo Lake					
Temperature Logger	Aquatic and Physical	-	-	18 Jun - 04 Jul, 2014	04 Jul - 22 Oct, 2014
Atlis Geomatics [2]	Physical	Jul 2011	-	-	-
Geo-referenced photos	Aquatic	15-17 Aug 2011	-	-	-
Fish habitat surveys	Aquatic	15-17 Aug 2011	-	28 Mar 2013 28-29 May 2013 04-06 Jul 2013 18-20 Jun 2014	-
GAIM [3]	Physical	-	-	04-06 July 2013 June 2014	-

Table 6.2-1. Continued.

Waterbody	Physical or Aquatic Environment Monitoring	Pre-operation (flood)	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation
Buffalo Creek					
Temperature Logger [4]	Aquatic and Physical	19 Oct - 01 Nov, 2011	01-04 Nov, 2011 16 Apr - 08 Nov, 2012	14 May - 07 Nov, 2013 15 May - 04 Jul, 2014	04 Jul - 23 Oct, 2014
Atlis Geomatics [2]	Physical	Jul 2011	-	-	-
Geo-referenced photos	Aquatic	15-17 Aug 2011	-	-	-
Cross-section surveys [1]	Physical	Oct 2011	-	03-07 July 2013	-
Fish habitat surveys	Aquatic	15-17 Aug 2011	-	28 Mar 2013 04-06 Jul 2013 18-20 Jun 2014	-
Vegetation Survey	Physical	Oct 2011	-	03-05 July 2013 18-20 Jun 2014	-
GAIM [3]	Physical	-	-	04-06 July 2013 June 2014	-
Dauphin River					
Temperature Logger	Aquatic and Physical	19 Oct - 01 Nov, 2011	01-29 Nov, 2011 16 Apr - 08 Nov, 2012	14 May - 07 Nov, 2013 13 May - 04 Jul, 2014	04 Jul - 04 Nov, 2014
Sonar surveys - bathymetry	Physical	01-04 Jul 2011	18-20 Jun 2012	05-07, 22-24 Jul 2013 18-22 Jun 2014	18-20 Jun 2012
Sonar surveys - substrate and bathymetry	Aquatic	13-14 Oct 2011	-	09 Jun 2013 11 Sep 2013 18-22 Jun 2014	-

Table 6.2-1. Continued.

Waterbody	Physical or Aquatic Environment Monitoring	Pre-operation (flood)	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation
Sturgeon Bay					
Temperature Logger	Aquatic and Physical	19 Oct - 01 Nov, 2011	01-15 Nov, 2011 18 Apr - 07 Nov, 2012	02 Jun - 06 Nov, 2013 2014 Logger Lost	2014 Logger Lost
Sonar surveys - bathymetry and substrate	Aquatic	14 Oct 2011	-	09-13 Sep 2013 18-25 Jun 2014	-
Visual assessment of substrate composition	Aquatic	14 Oct 2011	-	09-13 Sep 2013 18-25 Jun 2014	-
Particle size analysis of sediment samples	Aquatic	14 Oct 2011	-	09-13 Sep 2013 18-25 Jun 2014	-

1 - Cross section surveys provided information on channel scour. Data also used in HEC-RAS modeling (see PESV).
2 - Digital orthometric imagery.
3 - GAIM^{TM} = Geo-referenced Aerial Imagery and Mapping, see Appendix 6B.
4 - Data from the downstream end of Buffalo Creek (logger TL-04) in all years except 2014 when the logger was lost; data from BC-01 (upstream end of Buffalo Creek) and BC-TM (downstream end of Buffalo Creek) in 2014 (see Figure 6.2-8).

Table 6.2-2. Re-classification of substrates used to assess substrate change over multiple time periods prior to and after operation of Reach 1.

Original Classification	Assessment Classification
Bedrock- Limestone	Bedrock
Boulder/Cobble Cobble/Gravel	Boulder/Cobble
Compacted Gravel Gravel/Sand	Gravel
Sand Sand/Silt Clay/Silt	Fines

Table 6.2-3. Hydraulic modeling flow parameters used as inputs in Mike 21, and Lake Winnipeg water levels.

Water Regime	Flow Percentile	Percentile Date	Total Dauphin River Outflow (m^3/s)	Dauphin River Flow (m^3/s)	Buffalo Creek Flow (m^3/s)	Mean Lake Winnipeg Water Level (m ASL)
Pre-flood (1977 -2010)	5th	-	8	7	1	217.52
	50th	-	58	57	1	217.52
	95th	-	213	212	1	217.52
2011 Flood	5th	-	292	291	1	218.2
	50th	-	527	526	1	218.2
	95th	-	589	588	1	218.2
2011/2012 Operation	5th	30-Oct-12	188	142	46	217.58
	50th	16-May-12	343	221	123	217.58
	95th	12-Nov-12	521	380	141	217.66

Table 6.2-4. Summary of satellite and aerial imagery data sets used to assess aquatic habitat.

Date	Type	Platform	Resolution (m)	Area Coverage	Lake St. Martin Water Level (m)	Lake Winnipeg Water Level (m)	Dauphin River Discharge (m^3/s)	Buffalo Creek Discharge (m^3/s)	Wind Speed (km/h)	Wind Direction
19-Sep-09	Pan	Worldview-1	0.5	LSM,BC,DR	244.12	217.901	194	-	9	SSW
10-Jun-11	MS	Landsat 5 TM	30	LSM,BC,DR,SB	245.306	218.406	532	-	7	ESE
18-Jun-11	MS, RGB	Quickbird	0.5	LSM,BC,DR,SB	245.382	218.428	542	-	7	ESE
26-Jul-11	RGB	Atlis Geomatics Airphoto	0.3	LSM,BC,DR,SB	245.526	218.472	597	-	11	SSE
07-Sep-11	MS	Landsat 5 TM	30	LSM,BC,DR,SB	245.449	218.249	567	-	-	-
30-Sep-11	MS	Landsat 5 TM	30	LSM,BC,DR,SB	245.295	217.862	512	-	20	ESE
01-Apr-12	MS	Landsat 7 ETM+	30	LSM,BC,DR,SB	244.375	217.427	252	-	28	ESE
23-Aug-13	Pan	Worldview-1	0.5	LSM,BC,DR,SB	244.548	217.813	304	0.5	19	S
18-Jun-14	MS	Landsat 8	30	LSM,BC,DR,SB	244.724	218	323	4.4	-	-
22-Sep-14	MS	Landsat 8	30	LSM,BC,DR,SB	244.683	-	302	-	14	W

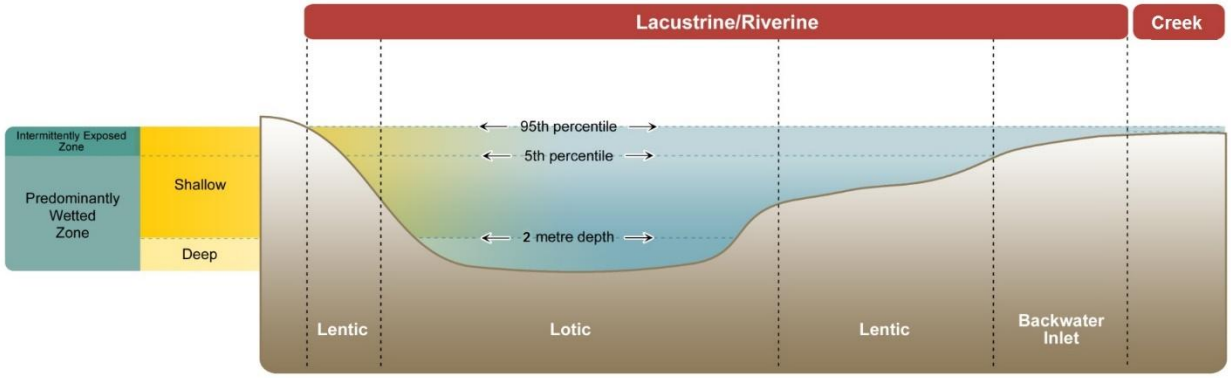


Figure 6.2-1. Schematic diagram of aquatic habitat parameters used in this assessment

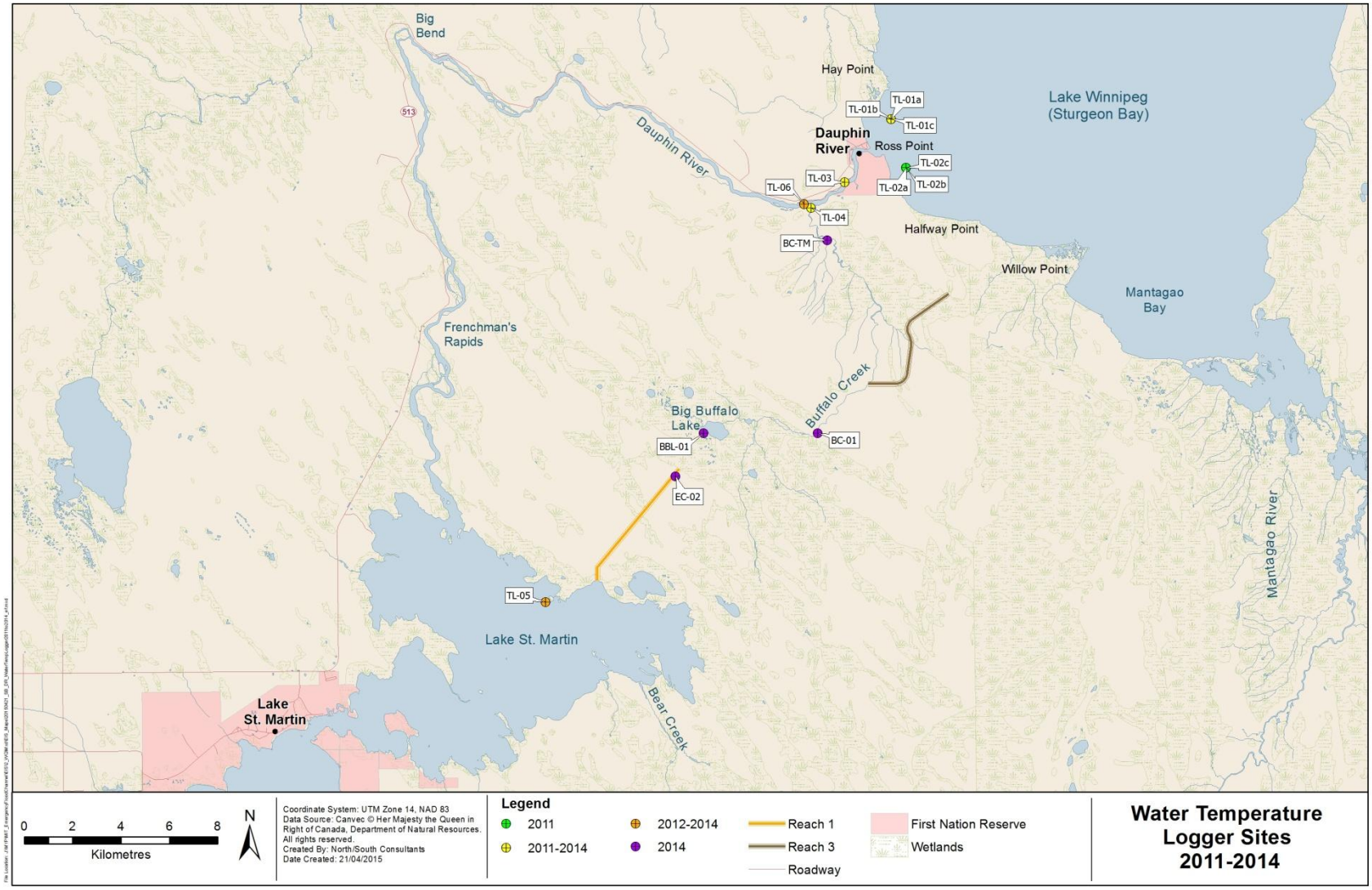


Figure 6.2-2. Locations of water temperature loggers installed in Lake St. Martin, Buffalo Creek, the Dauphin River, and Sturgeon Bay, 2011-2014.

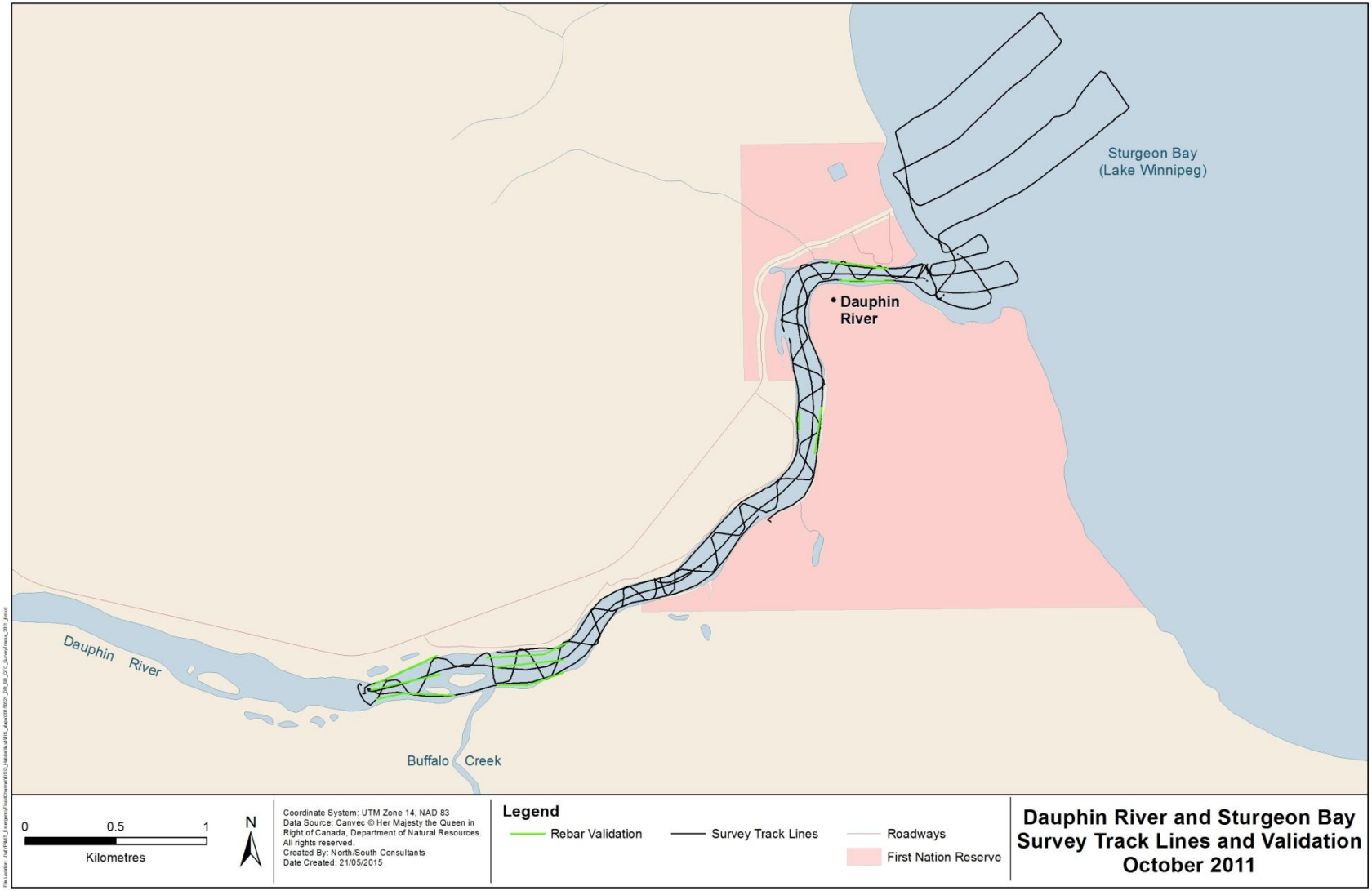


Figure 6.2-3. Map showing the pattern of transects traveled during echosounder surveys and substrate validation sites in the Dauphin River, fall 2011.

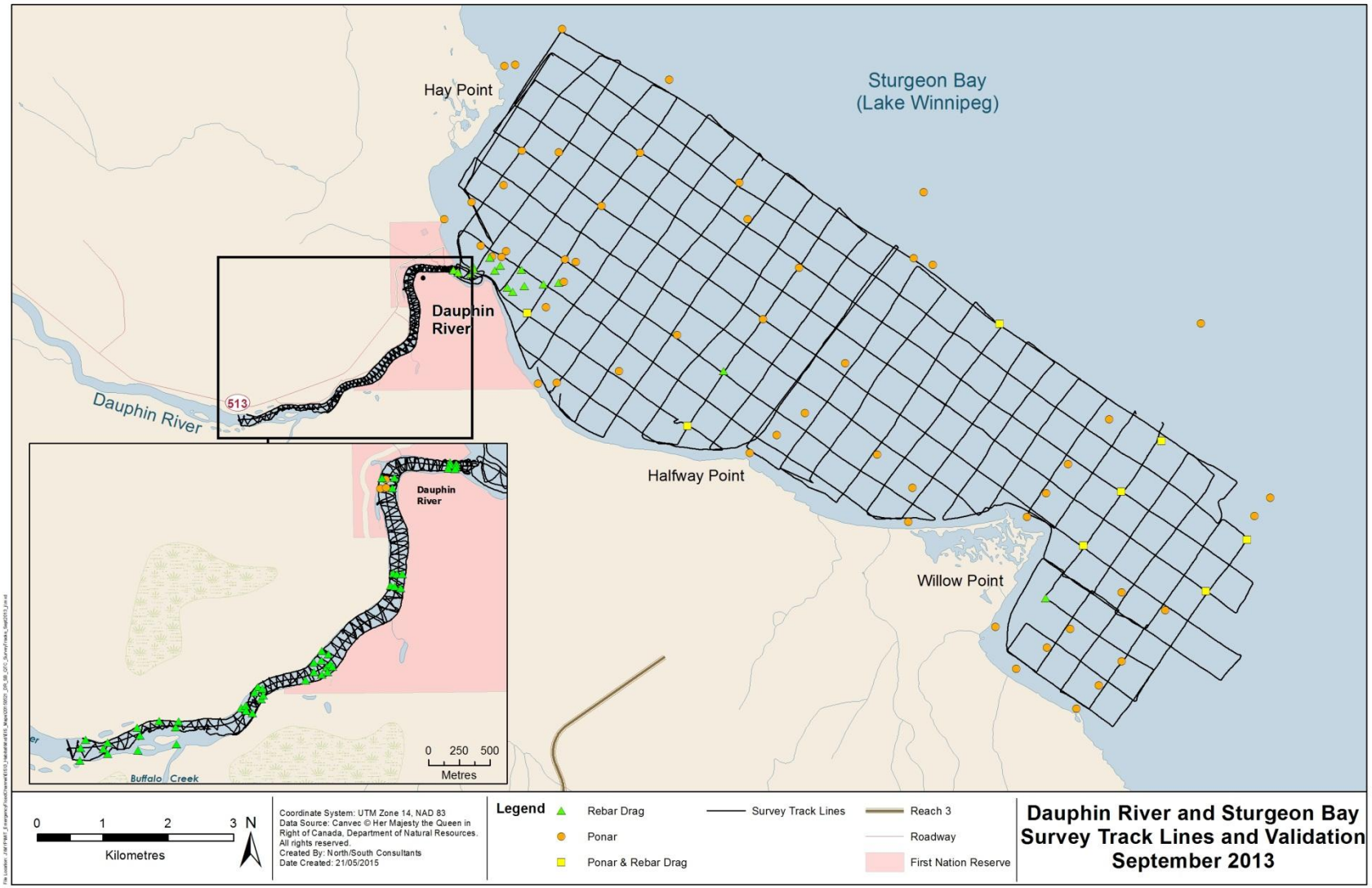


Figure 6.2-4. Map showing the pattern of transects traveled during echosounder surveys and substrate validation sites in Dauphin River and Sturgeon Bay, fall 2013.

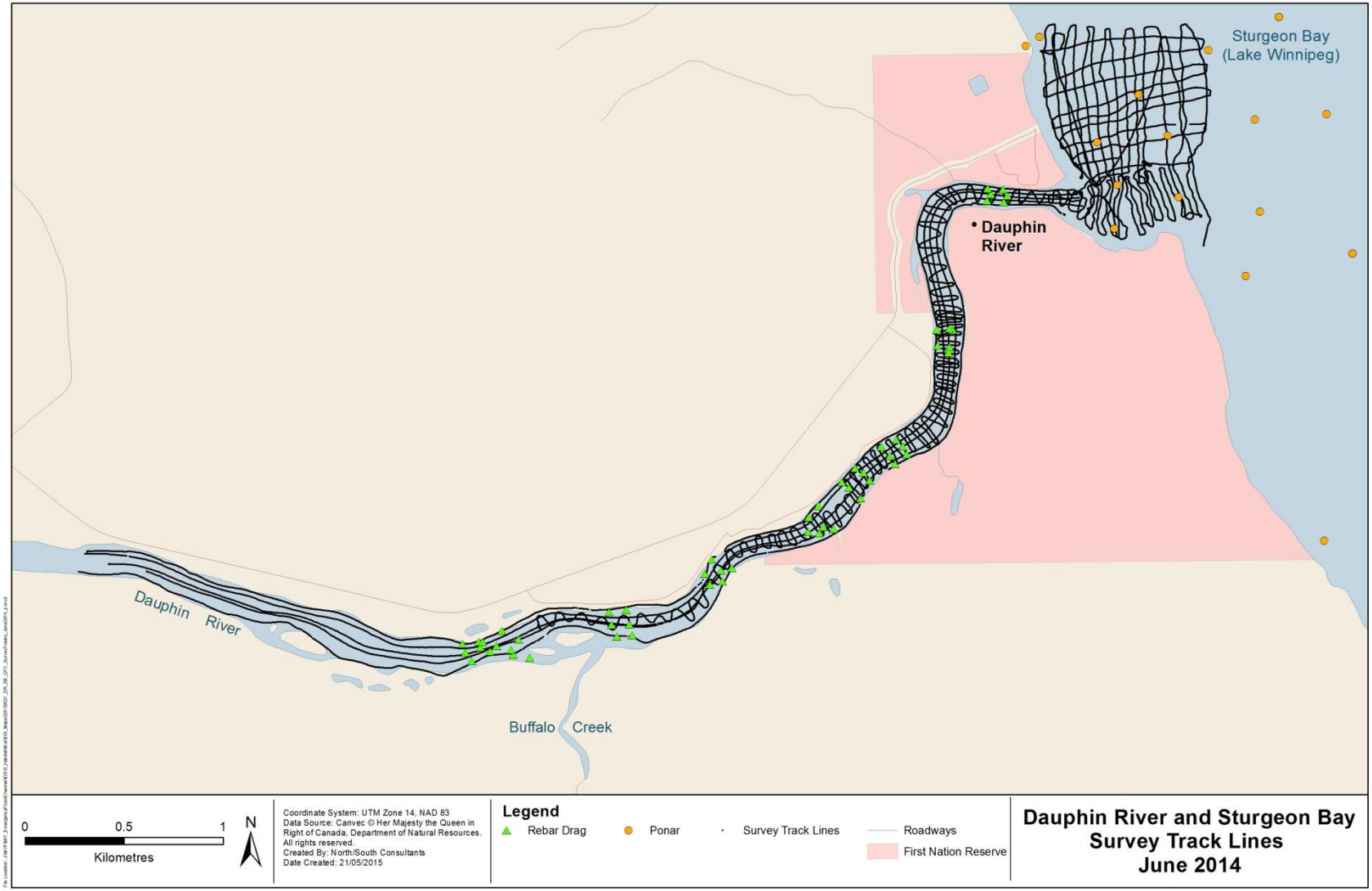


Figure 6.2-5. Map showing the pattern of transects traveled during echosounder surveys and substrate validation sites in Dauphin River and Sturgeon Bay, June 2014.

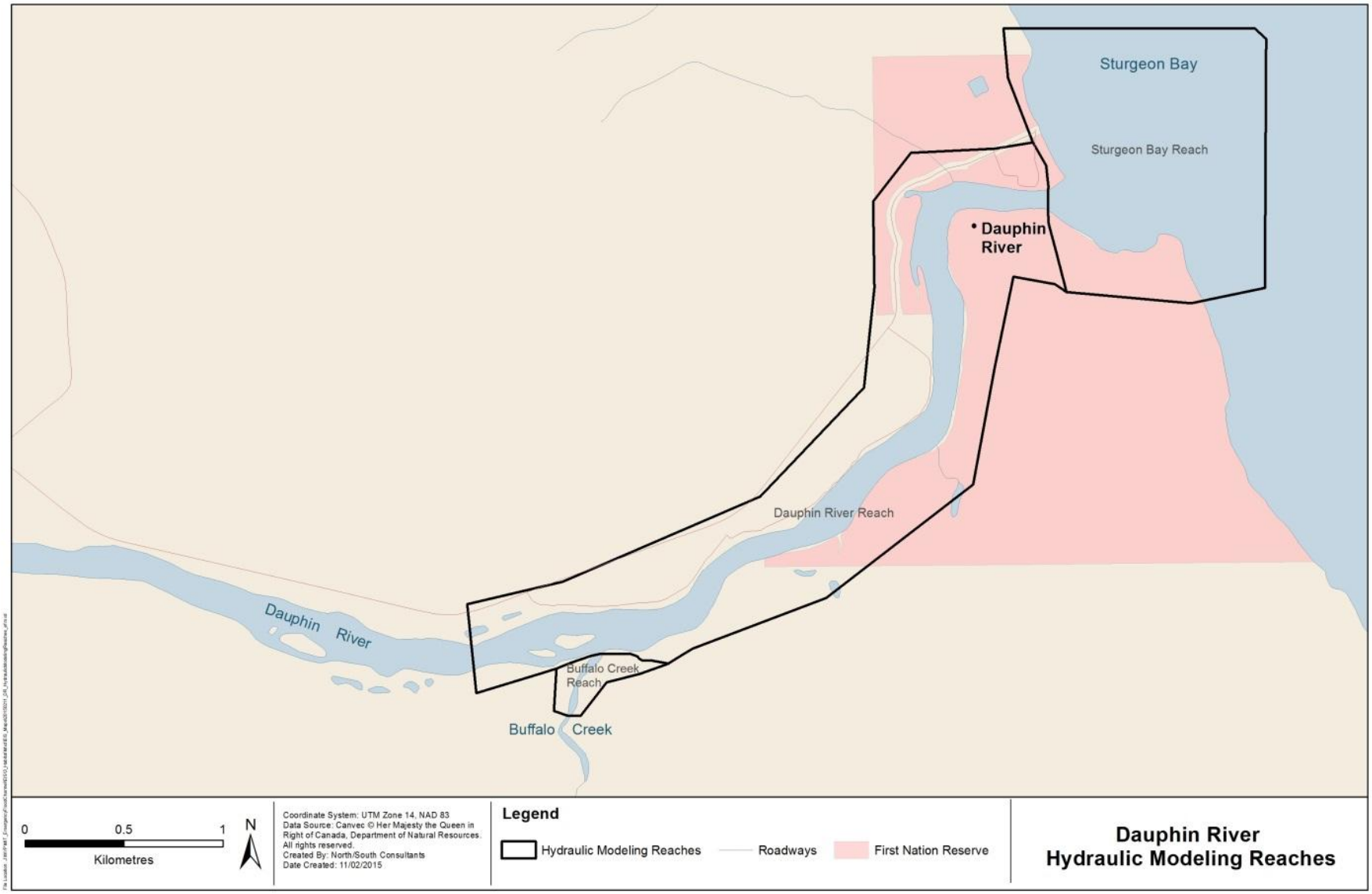


Figure 6.2-6. Reach boundaries created for the analysis of the MIKE 21 hydrodynamic model outputs.

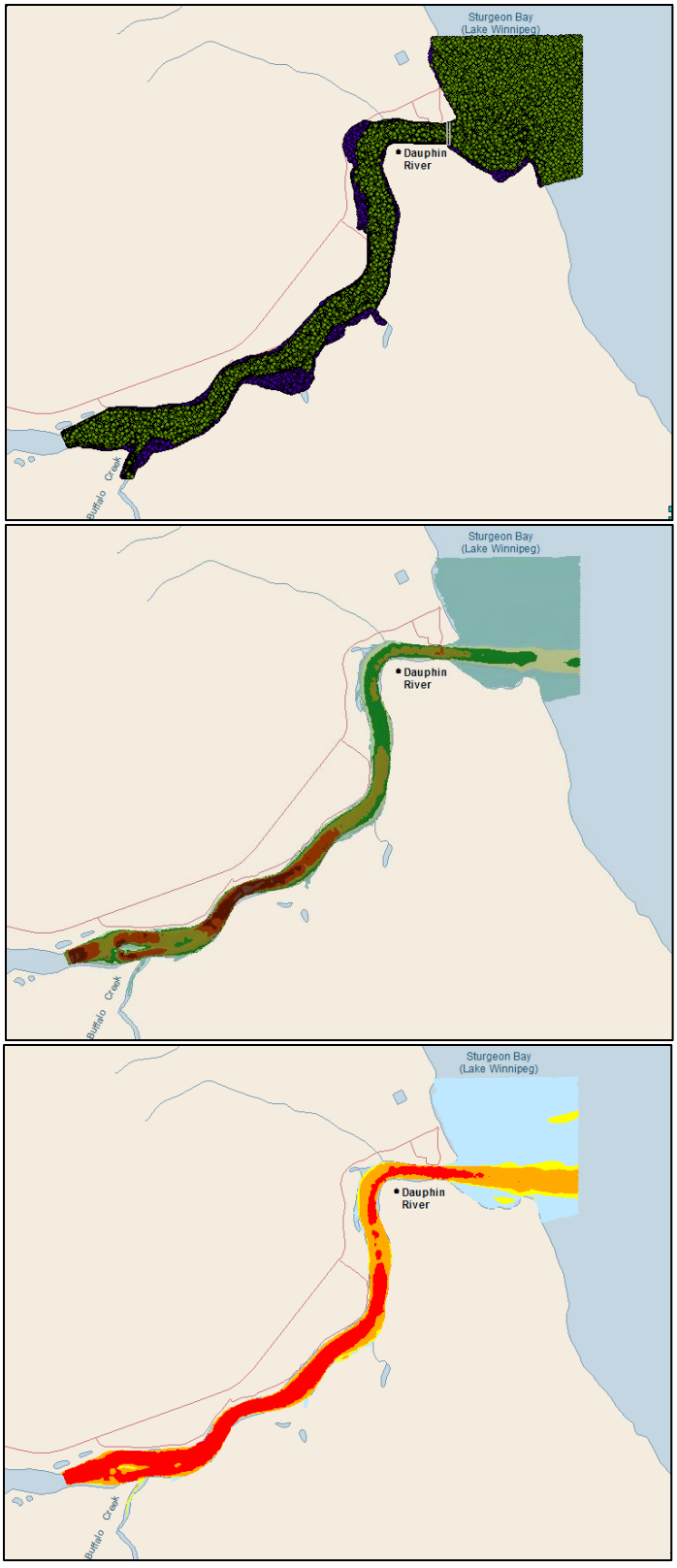


Figure 6.2-7. The MIKE 21 computational mesh output (top), productions of a TIN (middle) from the model output; and conversion and classification of the velocity raster data (bottom).

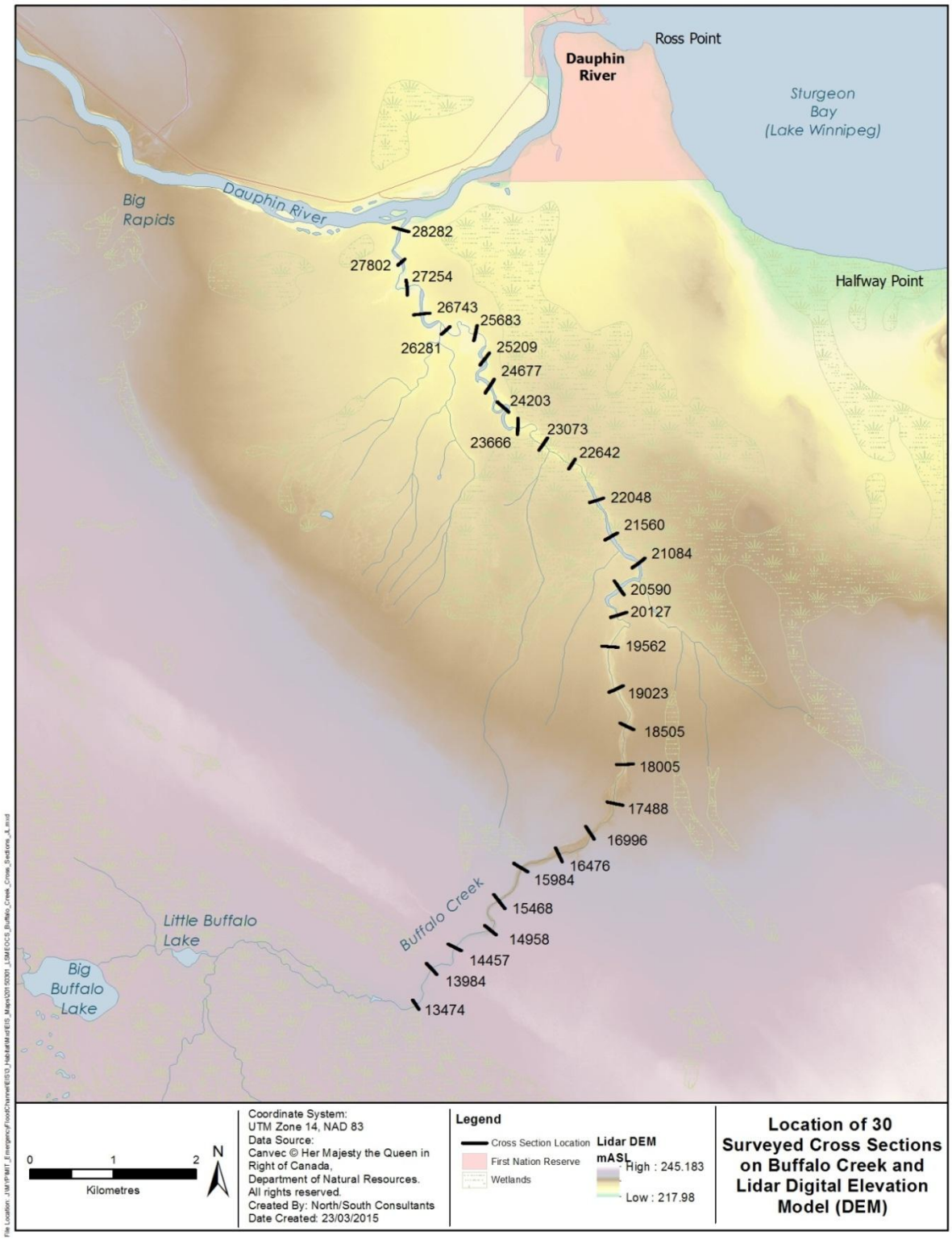


Figure 6.2-8. Map showing the location of the 30 surveyed cross sections along Buffalo Creek, the LiDAR based digital elevation model is shown in the background.

6.3 LAKE ST. MARTIN MONITORING RESULTS

6.3.1 Pre-Operation

6.3.1.1 Pre-flood

Lake St. Martin is comprised of a north and a south basin connected by a narrow constriction (Figure 6.1-1). This area is commonly referred to as the Narrows.

The substrate in Lake St. Martin is primarily composed of soft mud; however, there is an extensive area of gravel, sand, and compacted mud along the lake's western shore near the mouth of the Fairford River. Parts of the north basin and the Narrows contain large areas of bare bedrock; extensive gravel bars and boulders are also abundant, which provide suitable spawning habitat for several fish species (North/South Consultants Inc. 2013). Much of the area immediately surrounding Lake St. Martin is wetland-herb/shrub habitat.

During the open water period, water level data is collected By Water Survey of Canada (Gauge # 05LM005) at a location in the south basin approximately 5 km southeast of the Fairford River. Traverse (1999) reported that, since the construction of the Fairford River Water Control Structure (FRWCS) in 1961 and the Portage Diversion in 1970, Lake St. Martin has been repeatedly exposed to flooding which has altered the water regime and vegetation in the lake. Wardrop Engineering Inc. (2001) found that regulated maximum and minimum water levels on Lake St. Martin are 0.79 m higher and 0.66 m lower, compared conditions prior to the FRWCS.

On average, the Pre-flood water surface elevation on Lake St. Martin was 243.3 mASL and ranged from 242.7 m to 244.3 m (Table 6.3-1; PESV Section 4.3.1); which was more variable than the desirable range of 242.9 m to 243.8 m (PESV Section 4.3.1).

A solid ice cover is typical in Lake St. Martin from November until April or May (PESV Section 4.3.2).

6.3.1.2 2011 Flood

The Lake St. Martin flood stage water level is defined as 244.4 m, and 50th percentile water level on Lake St. Martin was 244.9 mASL in 2011 (Table 6.3-1; Section 4.3.1).

The Project was designed to decrease water levels within Lake St. Martin (and more upstream waterbodies including Lake Manitoba) by providing an alternate route for water to flow out of the lake into Sturgeon Bay. Construction of Reach 1 necessitated that a portion of the northeast shoreline of the north basin of Lake St. Martin, as well as surrounding wetland/aquatic vegetation, be excavated to create the Reach 1 inlet and a barge channel. As aquatic habitat surveys were not conducted in the Reach 1 inlet area of Lake St. Martin, the amount of habitat impacted by construction of Reach 1 were estimated from WorldView high-resolution satellite imagery (Figures 6.3-1 and 6.3-2).

Construction of the Reach 1 inlet resulted in an overall increase in the amount of aquatic habitat in Lake St. Martin (Table 6.3-1). Excavation of the inlet itself accounted for the majority of this increase (4.7 ha), while excavation of the barge channel led to an additional 1.5 ha of created habitat (Table 6.3-1). A

total of 6.2 ha of terrestrial habitat was excavated during Reach 1 inlet construction, creating an equivalent amount of new aquatic habitat.

A total of 1.9 ha of aquatic habitat was permanently altered through the removal of wetland/aquatic vegetation. There was an assumed increase in water depth in the channel construction areas as the result of dredging, with no changes in water velocity or water surface elevation. Substrate composition likely changed due to dredging of the original benthic material, but the nature of this change is unknown.

Reach 1 construction also resulted in the loss of 200 m of Lake St. Martin shoreline habitat, but 1600 m of new shoreline habitat were created along the edges of the inlet and barge channels (each of which is 400 m long). Although not comparable to the shoreline habitat lost, the majority of the new shoreline was not armoured or stabilized and it is expected that, with time, will be modified by naturally occurring physical processes and will resemble naturally occurring shoreline conditions in the area.

6.3.2 Operation

Reach 1 operation caused water velocity to increase (not measured) in the vicinity of the Reach 1 inlet, converting habitat in this area from lentic to primarily lotic.

Operation of Reach 1 altered the ice regime in the vicinity of the Reach 1 inlet: While this area was ice-covered during the winter of 2010/2011 (Pre-Operation), open water conditions were predominant during the winter of 2011/2012 Operation (PESV Section 4.3.2). Similar to 2011/2012 Operation, open water was present at the inlet to Reach 1 during the winter of 2014/2015.

6.3.3 Closure

After Reach 1 was closed in November 2012, habitat in the vicinity of the Reach 1 inlet changed from primarily lotic to primarily lentic. With the reduction of water velocity, it is expected that the mobilization of sediments slowed and sedimentation occurred within the inlet area. Re-establishment of aquatic vegetation in dredged areas also likely resulted from the cessation of flows. During the two winters that Reach 1 was closed, (2012/2013 and 2013/2014), the inlet to Reach 1 was ice-covered (PESV Section 4.3.2).

Table 6.3-1. Aquatic habitat parameters used for assessment of effects to the Reach 1 inlet area of Lake St. Martin.

Habitat Parameters	Units	*Measured values/Observations*		
		Construction	Operation	Closure
Effect to habitat as a result of Project operation?		*yes*	*yes*	*no*
50th: Water Surface Elevation	mASL	244.9	244.2 (2011/2012) 244.7 (2014/2015)	244.4
50th: Aquatic Habitat (available wetted area)				
Reach 1 Inlet Excavation	ha	+4.7	No change	No change
Barge Channel Excavation	ha	+1.5	No change	No change
Shoreline Habitat	m	+1400	No change	No change
Water Depth	m	Increase [1]	No change	No change
Water Velocity	m^3/s	No data	Increase [1]	Decrease [1]
Wetland/Aquatic Vegetation	ha	-1.9	No change	Potential increase with removal of flow [1]
Substrate Conditions	-	No data	No data	Potential sedimentation with removal of flow [1]

1 - Not measured.



Figure 6.3-1. DigitalGlobe™ Wordview-1 Satellite image showing the area of Lake St. Martin prior to construction of Reach 1, and during 2011/2012 Closure.

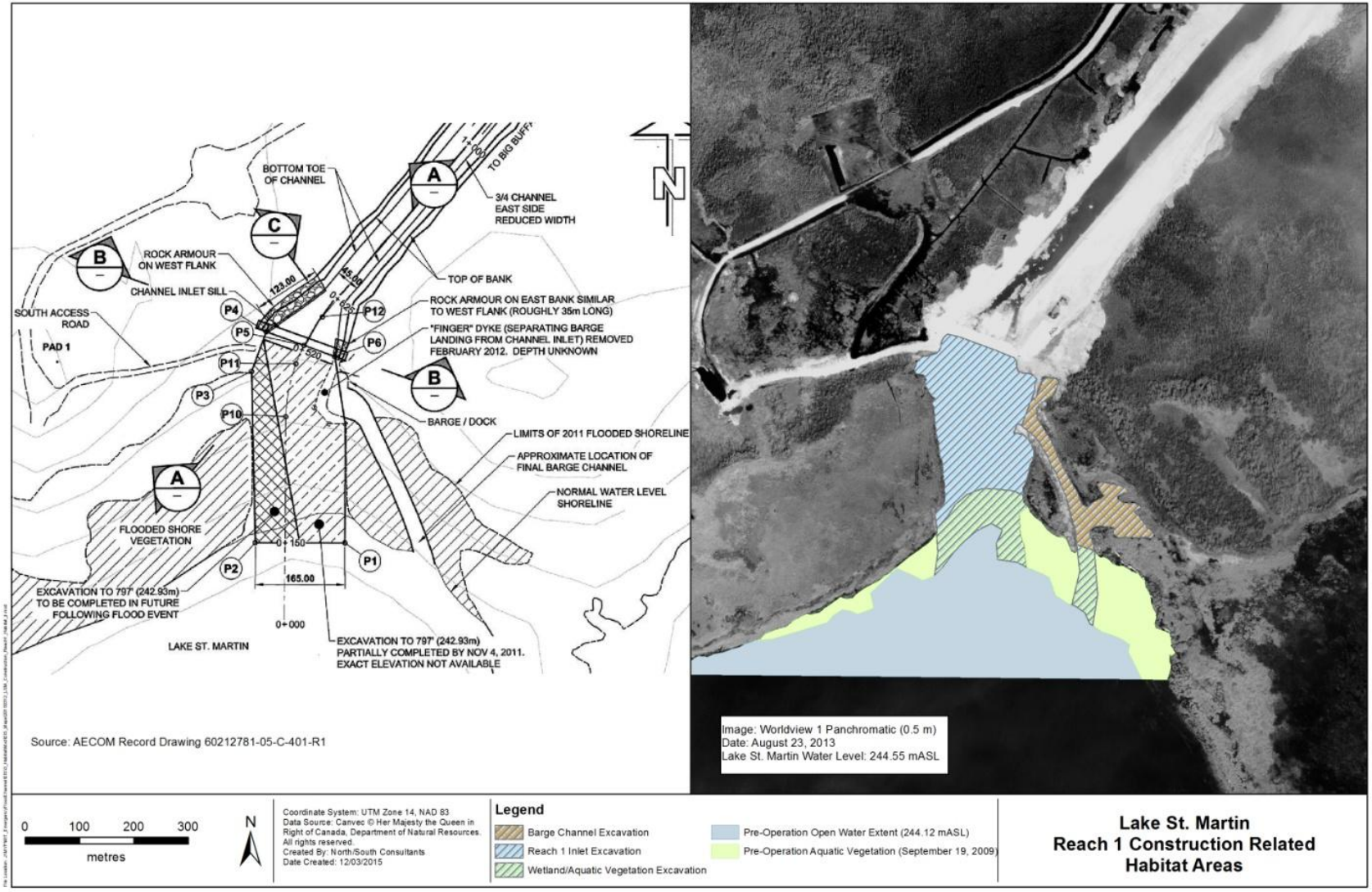


Figure 6.3-2. Detailed drawing (left) and DigitalGlobe™ Wordview-1 Satellite image (right) showing the areas where construction was conducted to create the Reach 1 inlet and barge channel.

6.4 REACH 1 AND THE BUFFALO CREEK WATERSHED MONITORING RESULTS

The Buffalo Creek watershed has a drainage area of 38,700 ha and is situated between Lake St. Martin to the south and the Dauphin River and Sturgeon Bay to the north (Figure 6.4-1). Prior to operation of Reach 1, the watershed was isolated and did not receive water from other waterways; all flow was due to local run off. The headwaters of the watershed are comprised of a bog complex including Big Buffalo Lake (55 ha) and several other ponds. Buffalo Creek originates in Big Buffalo Lake and flows for approximately 17 km to its confluence with the Dauphin River. For approximately the first 4 km downstream of Big Buffalo Lake, the creek flows through a sparsely treed wetland/bog complex before becoming a more defined creek channel with greater gradient and habitat diversity. The creek discharges into the Dauphin River approximately 4 km upstream of Sturgeon Bay.

Reach 1 allowed for the diversion of water from Lake St. Martin into the Buffalo Creek watershed. The inlet to Reach 1 is located along the northeast shore of the Lake St. Martin north basin (Figure 6.4-2). The channel extends northeast for approximately 6 km to the bog area surrounding Big Buffalo Lake. Water from Reach 1 flows through the bog complex into Big Buffalo Lake and Buffalo Creek. down Buffalo Creek into the lower Dauphin River.

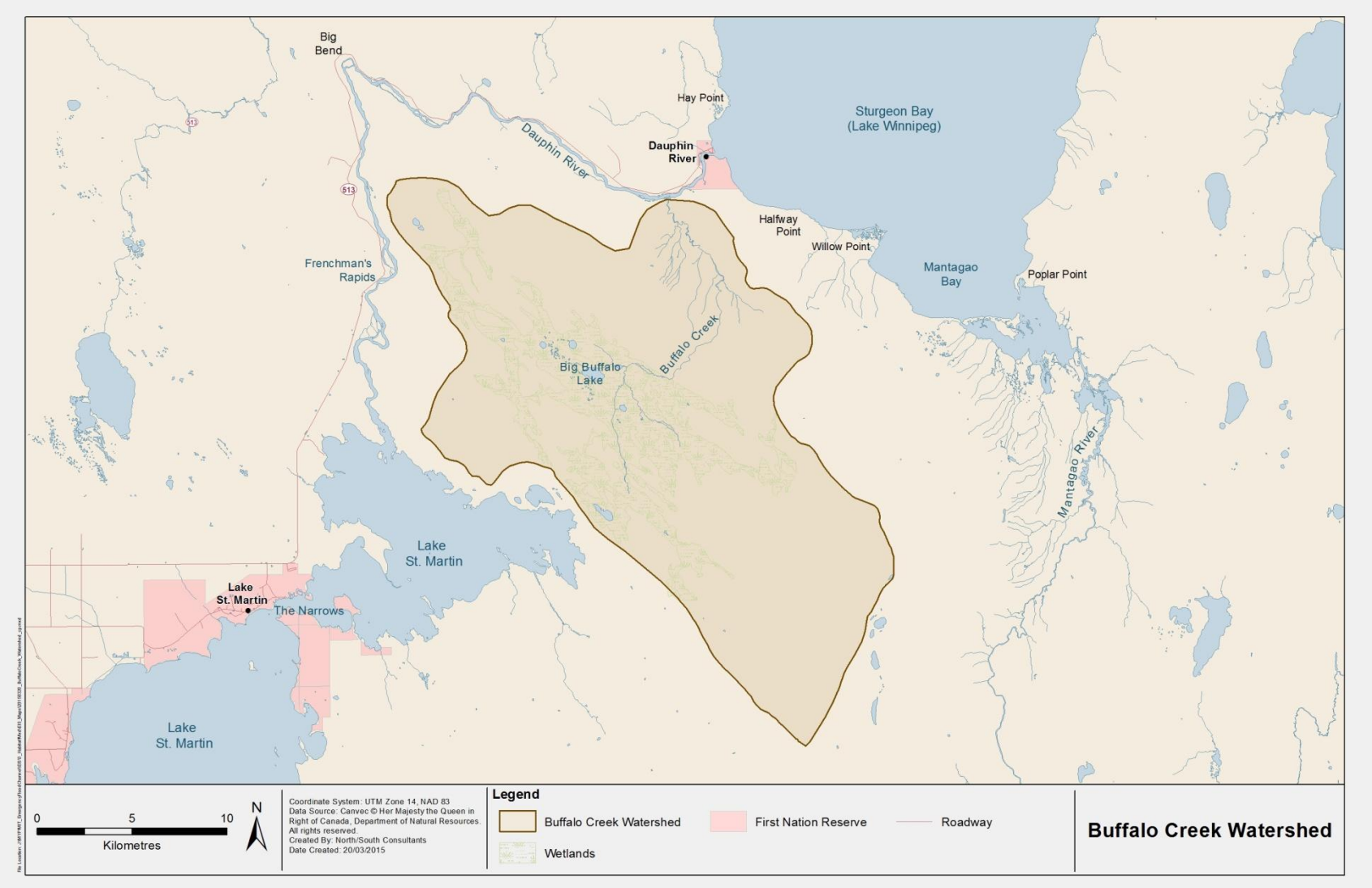


Figure 6.4-1. Pre-Operation extent and drainage area of the Buffalo Creek watershed.

6.4.1 REACH 1

6.4.1.1 Pre-Operation

Reach 1 did not exist prior to 2011.

6.4.1.2 2011/2012 Operation

As a result of Reach 1 operation, a 35.5 ha area within Reach 1 became wetted, lotic habitat with average flows of 125 m^3/s (Table 6.4-1). HEC-RAS model outputs indicate that maximum water depth and average water velocity were fairly consistent along the entire length of the channel; mean maximum water depth was 2.5 m and mean velocity was 0.97 m/s (Table 6.4-1; Figure 6.4-3). Wetted width was more variable, ranging from approximately 60-75 m throughout the upstream 5 km of the channel and then increasing to approximately 110 m within the final kilometer before its confluence with the bog complex (Table 6.4-1; Figure 6.4-3). Compact fines and exposed larger materials comprise the substrate within Reach 1.

An empirical model estimated that approximately 27,100 m^3 of sediment were eroded from Reach 1 during the 2011/2012 Operation. While erosion within Reach 1 would be not expected to affect habitat quality in the channel itself, suspended sediments were ultimately transferred to areas farther downstream.

In the winter during 2011/2012 Operation, ice conditions in Reach 1 consisted of open water with some border ice, and the production of frazil ice was observed within the channel (PESV Section 4.4.5).

6.4.1.3 2011/2012 Closure

The flow of water from Lake St. Martin into Reach 1 was halted in November 2012. This was achieved by constructing a dyke across the Reach 1 inlet in Lake St. Martin (Figure 6.4-4).

HEC-RAS modeling results indicate that the extent of aquatic habitat in Reach 1 during the open water season decreased to 30.5 ha during 2011/2012 Closure (Table 6.4-1). Mean maximum water depth decreased to 0.98 m and water flow became negligible, shifting the habitat from lotic to lentic. The wetted width of the channel also decreased, ranging from approximately 48 to 61 m along the first 5 km of the channel, and expanding to approximately 91 m at the downstream end (Appendix 6A). During winter 2012/2013, the channel was completely ice covered and DO levels in water within the channel declined to anoxic conditions. In May 2013, following the spring freshet, water remained in Reach 1 because the water level in the downstream bog had not fully receded to Pre-Operation levels.

6.4.1.4 2014/2015 Operation – Effects to December 2014

The onset of Reach 1 operation in early July 2014 re-introduced flow to the channel and re-connected waters within the channel to Lake St. Martin and the downstream bog complex. Median flows through Reach 1 between 3 July and 22 October, 2014 were 109 m^3/s (PESV Section 4.4.1); as similar flows occurred during 2011/2012 Operation (125 m^3/s), water depth and velocity conditions within the channel, as well as rates of erosion, were likely also comparable.

Ice conditions in Reach 1 during winter 2014/2015 were similar to those observed during the 2011/2012 Operation. Open water occurred through the center of the channel, with some border ice and the presence of frazil ice (PESV Section 4.4.5).

Table 6.4-1. Parameters used to describe habitat conditions in Reach 1.

Habitat Parameters	Units	*Measured values/Observations*			
		Pre-Operation	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation [1]
Effect to habitat as a result of the Project?		-	*yes*	*yes*	
50th: Discharge	m^3/s	-	125	No flow	109
50th: Aquatic Habitat (available wetted area)	ha	-	35.5	30.5	-
Water Depth					
50th: mean maximum depth	m	-	2.5	1.0	-
50th: min. maximum depth			2.3	0.5	-
50th: max. maximum depth			2.8	1.9	-
Water Velocity					
50th: mean velocity	m/s	-	0.97	0.00	-
50th: min. velocity			0.83		-
50th: max. velocity			1.05		-
Wetted Width					
50th: min. wetted width	m	-	59.9	47.6	-
50th: max. wetted width			109.7	90.7	-
Substrate Composition	ha	-	Primarily fines (sand/silt)	Primarily fines (sand/silt)	Primarily fines (sand/silt)
Dissolved Oxygen [2]	mg/L	-	8.3-14.9	0.2-12.3 < 1.00 (March) [3] 9.32-10.65 (May) [3]	Below PAL guidelines for 2 days following re-opening

1 - Conditions expected to be similar to those that occurred during the 2011/2012 Operation.
2 - Data from WQSV Section 5.4 unless otherwise noted.
3 - Data collected during 2013 fish habitat field studies.

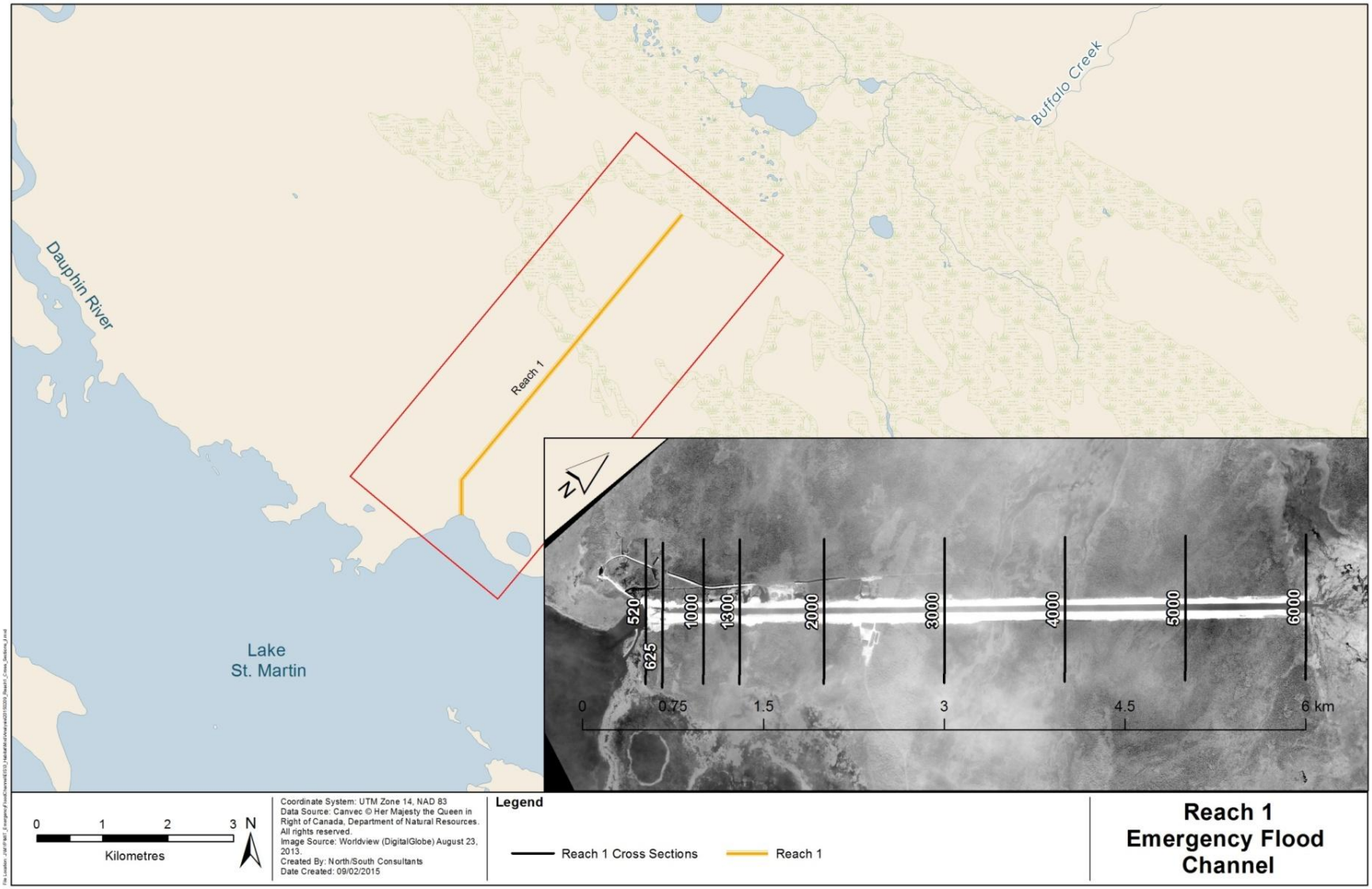


Figure 6.4-2. The location and orientation of Reach 1 relative to the north basin of Lake St. Martin and the Buffalo Creek watershed.

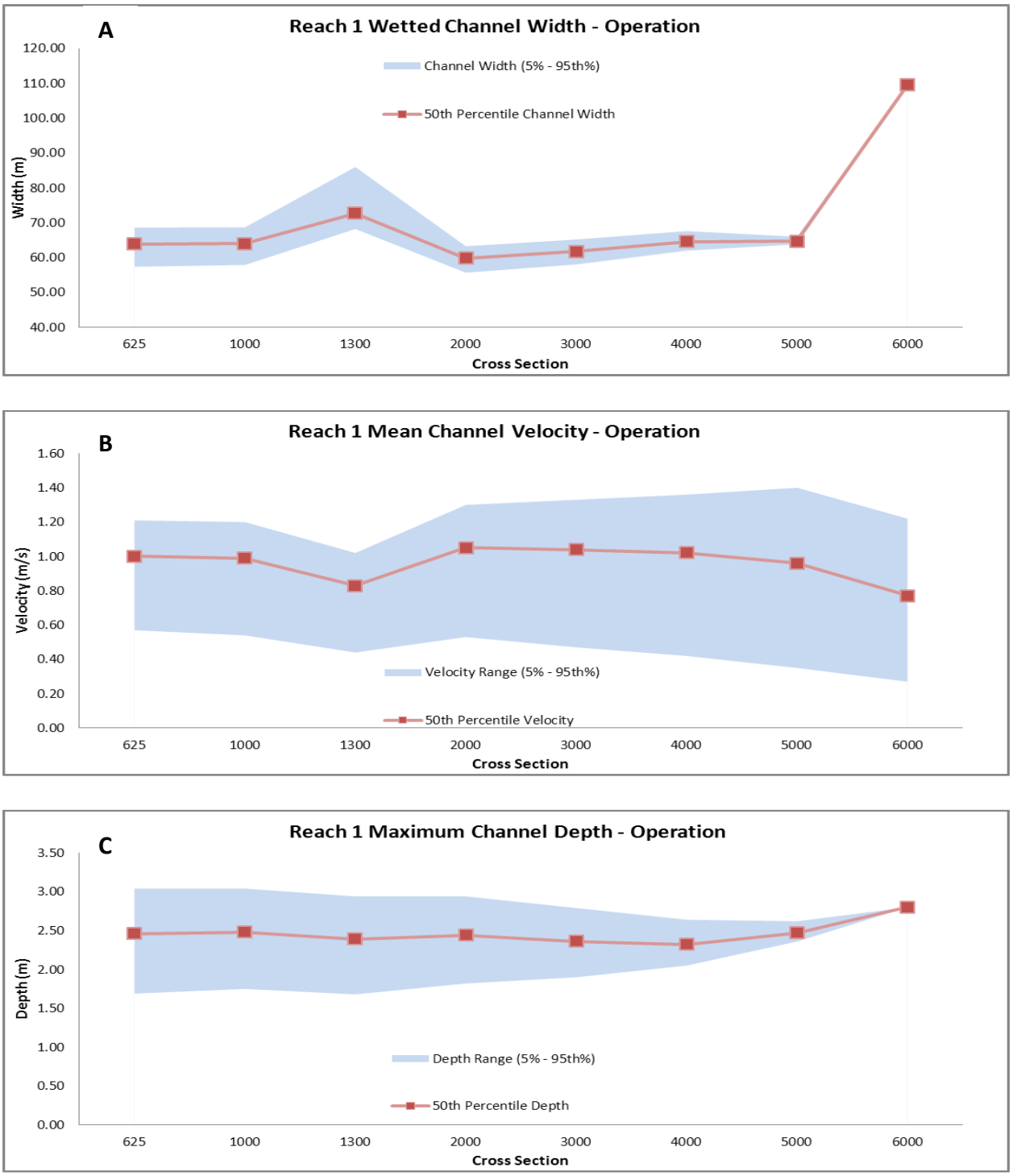


Figure 6.4-3. HEC-RAS output for Reach 1 during 2011/2012 Operation at 9 cross-sectional transects for three flow scenarios (5th, 50th, and 95th percentiles): (A) mean wetted channel width, (B) mean channel velocity, and (C) maximum channel depth.



Figure 6.4-4. Aerial photographs of the Reach 1 at the (A) inlet from Lake St. Martin, and (B) outlet into the Big Buffalo bog complex during 2011/2012 Closure.

6.4.2 BUFFALO CREEK WATERSHED – OVERVIEW

6.4.2.1 Pre-Operation

Aquatic habitat in the Buffalo Creek watershed prior to operation of Reach 1 was characterized and quantified to describe habitat conditions. Digital orthometric imagery and high-resolution satellite imagery were used to map aquatic boundaries, and classify and quantify the habitat throughout the watershed (Section 6.2.3). Habitat information collected during an August 2011 field program was used to help validate interpretations from the geo-referenced digital imagery. Aerial imagery of the Buffalo Creek watershed was also collected to provide a baseline record of riparian vegetation.

During 2011, the maximum wetted extent within the Buffalo Creek watershed was 90.20 ha (Table 6.4-2; Figure 6.4-5). Aquatic habitat was classified into six different habitat types (Table 6.4-2; Figure 6.4-6), and the majority of wetted habitat in the watershed was categorized as peat pool (70.11 ha). This habitat type occurred exclusively in the upper reaches of the watershed within the confines of the wetland/bog complex, and included Big Buffalo Lake and Little Buffalo Lake (Figure 6.4-7). Most of Buffalo Creek downstream of the wetland/bog complex was comprised of run habitat (15% of available habitat within the watershed). Twenty-one beaver dams, partial or complete obstructions of the creek, were identified from the aerial imagery (Figures 6.4-8 to 6.4-11).

6.4.2.2 2011/2012 Operation

During 2011/2012 Operation, the estimated maximum wetted area of the Buffalo Creek watershed was 1974.2 ha (at 95th percentile inflow) (Table 6.4-2; Figure 6.4-5), which corresponded to a large increase in the amount of aquatic habitat (+1884.0 ha).

6.4.2.3 2011/2012 Closure

Monitoring data collected during two field programs (July 2013 and June 2014), together with digital orthometric imagery and high-resolution satellite imagery, were used to classify and quantify the aquatic habitat throughout the watershed.

Following closure of Reach 1, the maximum wetted extent of the watershed was 98.30 ha (Table 6.4-2), indicating that approximately 8 ha of new aquatic habitat had been created by Reach 1 operation. There was a net increase in the extents of riffle, pool, and run habitats. The amount of peat pool habitat also increased slightly, while habitat losses were limited to a reduction in beaver pool (-0.70 ha) and beaver dam (-0.10 ha) habitat types.

Aerial imagery of the Buffalo Creek watershed taken during Pre-Operation and 2011/2012 Closure illustrates the changes to riparian vegetation that occurred due to increased water volumes from the operation of Reach 1 (Figure 6.4-12).

6.4.2.4 2014/2015 Operation – Effects to December 2014

Water temperature data collected from Buffalo Creek during the 2014 open water season (Figure 6.4-13) shows that when Reach 1 is closed, water temperatures in Buffalo Creek were quite variable and

generally slightly higher than water temperatures in the Dauphin River. Following the re-opening of Reach 1 on 04 July, water temperatures on Buffalo Creek remained slightly higher than those measured in Reach 1 and the Dauphin River, but were less variable. Trends similar to those described for 2014 were seen during all during the open water season in all other years: Buffalo Creek water temperatures were always slightly higher than water temperatures in the Dauphin River, but they were less variable when Reach 1 was operating (as opposed to closed; Appendix 6C).

6.4.3 BIG BUFFALO LAKE AND THE SURROUNDING BOG COMPLEX

6.4.3.1 Pre-Operation

Using digital orthomethric imagery, the maximum wetted extent of Big Buffalo Lake during 2011 was determined to be 70.10 ha (Table 6.4-3; Figure 6.4-5). Results from an August 2011 field investigation indicate that habitat water depths in Big Buffalo Lake ranged from 1.2 to 2.1, with a mean depth of 1.7 m (Table 6.4-3; Figure 6.4-14). Aquatic vegetation was primarily pondweed (*Potamogeton* sp.) which was limited to the littoral zone. The riparian zone was comprised of emergent aquatic plants such as sedges (*Carex* sp.), cattails (*Typha* sp.), and bulrushes (*Scirpus* sp.). The lake and surrounding area was largely bog habitat consisting of floating peat bog mats, with few areas able to support trees (Figure 6.4-15a). Substrate compaction was soft and was almost entirely composed of organic material (Table 6.4-3).

There are no data for sediment transport or ice conditions prior to operation of Reach 1. Ice processes are assumed to resemble those observed during 2011/2012 Closure (i.e., ice cover on lake with some open water areas in bog).

6.4.3.2 2011/2012 Operation

Based on digital orthomethric imagery, Big Buffalo Lake bog complex had an estimated maximum area of 1772.0 ha during 2011/2012 Operation (Table 6.4-3), representing a 1701.9 ha increase in the amount of aquatic habitat in Big Buffalo Lake and surrounding bog complex. While HEC-RAS modeling was not completed for Big Buffalo Lake and the bog complex during 2011/2012 Operation, data collected during 2014/2015 Operation suggest that there was an approximate 1 m increase in water surface elevation with correlated increases in water depth and flow.

Changes to lake substrates were also assumed to occur within the bog complex due to sedimentation and erosion processes resulting from increased water velocities. An empirical model was used to estimate the amount of suspended sediment originating from Lake St. Martin, which combined with the estimated volume of suspended sediment from Reach 1, and ultimately deposited into the Big Buffalo Lake bog complex (PESV Section 4.4.6.1). During 2011/2012 Operation, it is estimated that 41,000 m^3 of suspended material was deposited into the lake and bog area. See Section 6.4.3.3 for a description of changes to the substrate in Big Buffalo Lake (assessed during a 2011/2012 Closure field campaign).

The amount of riparian vegetation decreased during 2011/2012 Operation due to the extent and duration of flooding (Figure 6.4-12). During winter 2011/2012, there was ice cover on Big Buffalo Lake and the bog complex, with areas of open water along the main paths of flow.

6.4.3.3 2011/2012 Closure

After the closure of Reach 1, water level within Big Buffalo Lake and the bog complex gradually receded. Big Buffalo Lake was ice-covered during the winters of 2012/2013 and 2013/2014. There were some open water areas throughout the bog but to a lesser extent than during 2011/2012 Operation. A brief field campaign in March 2013 revealed that between 0.6 and 0.7 m of ice had formed on the lake during winter 2012/2013, water depth ranged from 0.07-0.96 m, and the lake was anoxic (DO ranged from 0.12 to 0.20 mg/L). Anoxic conditions within the lake were a seasonal occurrence during 2011/2012 Closure; a survey of 16 sites in Big Buffalo Lake in May 2013 revealed DO concentrations between 9.72 and 12.52 mg/L, and water quality monitoring results indicate that DO levels were generally suitable for fish throughout the open water season (Table 6.4-3; WQSV Figure 5.4-4).

While the closure of Reach 1 resulted in an overall decrease in water surface elevation, water depth, and water velocity compared to 2011/2012 Operation, water surface elevation, on average, remained approximately 0.6 m higher than the Pre-Operation water level and average water depth was also slightly deeper (Table 6.4-3). Big Buffalo Lake and the associated bog complex also contained an additional 4.2 ha of available aquatic habitat (as compared to Pre-Operation conditions) (Table 6.4-3); the net increase in wetted habitat is related to the water storage capacity of the bog complex.

Riparian vegetation decreased as the result of the flooding that occurred during 2011/2012 Operation (Figures 6.4-12 and 6.4-15b).

Sediment and erosion processes that occurred during 2011/2012 Operation and 2011/2012 Closure altered the substrate composition within Big Buffalo Lake (Table 6.4-4). The substrate assessment conducted during June 2014 identified conditions that were more variable than those seen during Pre-Operation. In addition to the organics that were present prior to operation, fine sediments were prevalent at all sites surveyed, and coarser materials like gravel were present at a few sites, suggesting that flows through the lake may have exposed bed materials beneath the organics (Table 6.4-3).

6.4.3.4 2014/2015 Operation – Effects to December 2014

Water levels in Big Buffalo Lake and the bog complex during 2014/2015 Operation were 242.1 mASL at 50^{th} percentile flow. Water level was not measured during 2011/2012 Operation, but is assumed to have been similar; therefore the amount of aquatic habitat and effects to riparian vegetation are also expected to be similar between the two Project phases.

Just prior to the beginning of 2014/2015 Operation, DO concentrations in Big Buffalo Lake were high enough to support fish, and they were not affected by the re-opening of Reach 1 (WQSV Section 5.4.4).

A smaller volume of sediment, primarily resulting from erosional processes along Reach 1, was deposited in the Big Buffalo Lake and bog area during the first sixteen weeks of 2014/2015 Operation (15,800 m^3). There are no ice process data for 2014/2015 Operation, however ice process conditions are assumed to be similar to those observed during 2011/2012 Operation because flow magnitude is similar.

6.4.3.5 Summary

Table 6.4-5 provides a summary of aquatic habitat data from Big Buffalo Lake and the surrounding bog complex for all phases of the Project.

6.4.4 BUFFALO CREEK

6.4.4.1 Pre-Operation

Historically, flows on Buffalo Creek were low because it was isolated from other waterways and only received water from local run-off within the watershed. From satellite imagery, the median wetted area of Buffalo Creek was estimated as 20.1 ha (Table 6.4-6). Cross sections along Buffalo Creek were surveyed in order to develop a HEC-RAS hydraulic and sediment transport model for the creek (Figure 6.4-16). Model results indicate that the average wetted width of Buffalo Creek during 2011 was 12.97 m, average water velocity was 0.74 m/s, and average depth was 0.65 m (Table 6.4-6).

Aquatic habitat information was collected from sites at the upstream and downstream ends of Buffalo Creek during an August 2011 field campaign (Figure 6.4-17), and site photographs were taken to record Pre-Operation channel and riparian features (Figure 6.4-18). Wetted width was generally between 7 and 15 m and water depths were almost always less than 1.0 m; exceptions included the occasional pool upstream of a beaver dam and the extreme downstream end of Buffalo Creek, where high water on the Dauphin River was having a backwater effect (Table 6.4-7; Figure 6.4-19). As indicated by the digital orthometric and satellite imagery, a wide variety of habitat types (run, pool, riffle) existed within the creek, and while substrate type varied from site to site, softer substrates were more frequently observed in pool habitat (Table 6.4-7). Limited water quality data from the Pre-Operation phase indicate that DO levels within the creek were generally high enough to support a wide range of fish species, but DO was somewhat variable along the length of the creek (WQSV Section 5.4.1). Aquatic plants were present at all sites surveyed.

Shoreline vegetation cover surveys were also conducted. Prior to the 2011/2012 Operation, vegetation cover was described as dense, comprised of thick grasses immediately adjacent to the creek, with a substantial shrub and tree line farther up both banks.

A list of the representative aquatic and riparian plants found throughout the Buffalo Creek corridor was generated from field surveys and site photographs. Submerged aquatic plants typically found in this area are common duckweed (*Lemna minor*), pondweeds (*Stuckenia* sp.), watercelery (*Vallisneria americana*), and water plantain (*Alisma plantago-aquatica*). The vegetation covering the shoreline and banks were comprised of a variety of emergent aquatic plants such as sedges (*Carex sp.*), common spike rush (*Eleocharis palustris*), bur reeds (*Sparganium sp*.), arrowheads (*Sagittaria* sp.), cattails (*Typha sp*.), common reed grass (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), and hard-stemmed bulrush (*Schoenoplectus acutus*).

There are no data for sediment transport or ice conditions in Buffalo Creek prior to 2011/2012 Operation. Pre-Operation ice processes are assumed to have resembled those observed during 2011/2012 Closure (i.e., mostly ice-covered except for some open water areas with flow).

6.4.4.2 2011/2012 Operation

Aquatic habitat areas during 2011/2012 Operation were estimated using the HEC-RAS and MIKE 21 model outputs (Section 6.2.2; Appendix 6A). The wetted area of Buffalo Creek increased to a maximum of 202.20 ha during this phase of the Project (Table 6.4-6; Figure 6.4-5), and was comprised of 145.5 ha of intermittently exposed habitat and 56.7 ha of predominantly wetted habitat. At 50th percentile flow, wetted width, water depth and water velocity were all greatly increased compared to Pre-Operation conditions (Table 6.4-6).

Dissolved oxygen in Buffalo Creek occasionally and for short durations decreased below Manitoba Water Quality Guidelines (MWQSOGs) and Canadian Council of the Ministers of the Environment (CCME) guidelines for the protection of aquatic life (PAL) (Table 6.4-6; WQSV Figure 5.4-4). These brief decreases generally occurred during winter and rarely occurred simultaneously throughout the entire creek. As high flows had removed all the beaver dams along the creek, fish were able to move freely along its length and avoid areas of low DO.

Contrary to what was seen in Big Buffalo Lake, water entering Buffalo Creek during 2011/2012 Operation contained lower concentrations of suspended sediment than water flowing out of the creek. Comparison of 2011 and 2013 cross-section survey data confirmed that erosion occurred along most of the creek during 2011/2012 Operation, with the majority occurring along the main channel. The estimated total *in situ* volume of material that eroded from the channel between 2011 and 2013 was 86,500 m^3, and it is estimated that 17,400 m^3 of this total volume remained in suspension and was transported downstream into the Dauphin River.

Substantial hydraulic increases during 2011/2012 Operation resulted in increased suspension and transport of fine to sandy sediments, and erosion and deposition of the coarser materials, leading to shifts in the locations and extents of erosional and depositional habitats identified prior to operation of Reach 1. HEC-RAS modeling shows that flows and water velocities through Buffalo Creek during 2011/2012 Operation were sufficient to move gravel size and smaller material, and even cobble was susceptible to erosion in some areas (PESV Section 4.4.6.2). While there was a low potential for gravel size and smaller materials to deposit with the main channel, gravel size and smaller sized materials were more likely to deposit in the overbanks and there were many areas of low velocity where sand had the potential to deposit.

During the winter of 2011/2012 Operation, ice only formed along the borders of Buffalo Creek. In the middle of the creek, there was a 1 km-long ice jam and the production of frazil ice.

6.4.4.3 2011/2012 Closure

During 2011/2012 Closure, Buffalo Creek was mostly ice-covered. There was open water and frazil ice production in areas of flow, but to a lesser extent than during 2011/2012 Operation. Open areas of low flow (0.15 m deep) were observed at the upstream and downstream ends of Buffalo Creek in March 2013. Dissolved oxygen concentrations at the downstream end of the creek were higher than at the upstream end, where conditions were unsuitable for most species of fish (Table 6.4-6).

The median amount of aquatic habitat in Buffalo Creek during 2011/2012 Closure was 24.0 ha, a 3.9 ha increase from the Pre-Operation phase (Table 6.4-6). Cross section surveys were conducted along Buffalo Creek in 2013 and 2014 to characterize hydraulic conditions during 2011/2012 Closure. From the HEC-RAS model results, mean wetted width increased by 4.68 m and mean maximum water depth increased by 0.14 m, while mean water velocity decreased by 0.19 m/s (Table 6.4-6). These differences are related to the erosion and ice scour that occurred during 2011/2012 Operation and changed the morphology of the Buffalo Creek channel. Similar changes to instream habitat were observed during aquatic habitat field surveys conducted in 2013 and 2014 (Table 6.4-7).

The erosion and ice processes that occurred during 2011/2012 Operation widened banks and deepened the Buffalo Creek channel. This change in stream morphology changed the distribution of habitat types along the length of the creek. Following 2011/2012 Operation, there was an increase in the amount of run and pool habitat types, and a decrease in beaver dams (and associated pools) and partial stream obstructions (Table 6.4-2; Figures 6.4-7 to 6.4-11). A new creek channel was formed in a meander bend in Buffalo Creek where water flows or ice action caused a breach in the creek bank; the new channel cut across two bends in the creek to form a direct route channel farther downstream (Figure 6.4-10). In 2014, several beaver dams were observed, indicating that beavers were beginning to re-establish themselves in the absence of the high flows associated with Reach 1 operation.

Substrate compaction and sediment composition data collected during habitat field surveys were variable between years (Table 6.4-7). Empirical model results indicated that sediment transport in Buffalo Creek continued during 2011/2012 Closure; it was assumed that the 1,500 m^3 of suspended sediment that originated in Buffalo Creek was the result of local erosion inputs due to the gradual recession of water levels and bank slumping (PESV Section 4.4.6.1). As a result, substrate conditions within Buffalo Creek may have continued to change during 2011/2012 Closure, as HEC-RAS modeling suggested that deposition was more likely during this phase of the Project (PESV Section 4.4.6.2).

Ground survey and aerial imagery indicate that channel morphology and riparian vegetation in Buffalo Creek changed as a result of the flooding that occurred during 2011/2012 Operation (Figures 6.4-6 and 6.4-12). In July 2013, the Buffalo Creek channel was almost entirely devoid of riparian and nearshore aquatic vegetation (Table 6.4-6; Figure 6.4-20). Areas where grasses, shrubs, and trees were flooded by 2011/2012 Operation appear bright white in the satellite imagery and illustrate the extents of bare soils/ substrates, while the light to dark brown areas are dead woody shrubs and trees (Figure 6.4-12). Several areas of erosion, deposition, and bank slumping were also observed. In June 2014 (more than one growing year after the end of 2011/2012 Operation), herbaceous vegetation such as grasses and sedges were observed to have re-established along the creek margins; the extents of dead woody shrubs and trees were observed to have increased (Table 6.4-6; Figure 6.4-17e and f).

6.4.4.4 2014/2015 Operation – Effects to December 2014

Buffalo Creek discharge was estimated at 109 m^3/s during the first sixteen weeks of 2014/2015 Operation, which is similar to the modeled discharge for 2011/2012 Operation, therefore it is expected that habitat conditions within Buffalo Creek will also resemble those calculated for 2011/2012 Operation.

During the first two days of 2014/2015 Operation, DO levels in Buffalo Creek decreased below the guidelines (WQSV Section 5.4.4, Figure 5.4-4). While levels quickly returned to normal (i.e., within guidelines) at the downstream end of the creek, they remained low at the upstream end for approximately one month. From August to November 2014, DO levels throughout the creek were high enough to support a wide variety of fish species.

Empirical model results indicate that erosion within Buffalo Creek resumed during 2014/2015 Operation. Figure 6.4-21 illustrates how the turbidity of the water flowing out of Buffalo Creek increased during the first week of 2014/2015 Operation, and then decreased shortly thereafter. An estimated 9,200 m^3 of suspended sediment was transported into the Dauphin River during the first sixteen weeks of 2014/2015 Operation. This is equivalent to more than half of the total material transported out of Buffalo Creek during the year-long 2011/2012 Operation, but based on HEC-RAS model results, sediment transport processes in Buffalo Creek during 2014/2015 Operation are expected to be similar to those seen during 2011/2012 Operation.

There are limited data for ice conditions during 2014/2015 Operation, however since flow is similar to 2011/2012 Operation it is assumed that ice formation on Buffalo Creek has been minimal. Contrary to observations during 2011/2012 Operation, ice cover formed at the confluence with Dauphin River in November 2014.

6.4.4.5 Summary

Table 6.4-8 provides a summary of aquatic habitat data from Buffalo Creek for all phases of the Project.

Table 6.4-2. Aquatic habitat parameters used for assessment of effects to the Buffalo Creek watershed.

Habitat Parameters	Units	*Measured values/Observations*			
		Pre-Operation	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation [1]
Effect to habitat as a result of the Project?		-	*yes*	*yes* [2]	-
50th: Aquatic Habitat (available wetted area)	ha	90.2	-	98.3	-
95th: Aquatic Habitat (available wetted area) [3]	ha	-	1974.20	-	-
Riffle	ha	2.1	-	2.1	-
Run	ha	13.4	-	16.3	-
Pool	ha	3.7	-	5.6	-
Beaver Dam	ha	0.2	-	0.1	-
Beaver Pool	ha	0.8	-	0.1	-
Peat-Pool	ha	70.1	-	74.1	-

1 - Monitoring not yet completed for 2014/2015 Operation.

2 - Residual effects of 2011/2012 Operation.

3 - Maximum extent of the wetted area of Big Buffalo Lake and the bog complex during 2011/2012 Operation was calculated from satellite imagery, therefore the amount of aquatic habitat is only known for 95th percentile flow (not 5th or 50th).

Table 6.4-3. Aquatic habitat parameters used for assessment of effects to Big Buffalo Lake and the associated bog complex.

Habitat Parameters	Units	*Measured values/Observations*			
		Pre-Operation	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation [1]
Effect to habitat as a result of the Project?		-	*yes*	*yes*	-
50th: Water Surface Elevation	mASL	241.0	Increase[2]	241.6	242.1
50th: Aquatic Habitat (available wetted area)	ha	70.10	No data	74.3 [3]	-
95th: Aquatic Habitat (available wetted area) [4]		No data	1772.00	No data	
50th: Water Depth	m	1.71	Increase [2]	1.77 [3]	-
50th: Water Velocity	m/s	No data	Increase [2]	No data	-
Substrate Composition	ha	Soft organics	No data	Varied: silt/clay/gravel/organics	-
Dissolved Oxygen [5]	mg/L	No data	No data	0.00-12.3 0.12-0.20 (March) [3] 9.72-12.52 (May) [3]	6.2-11.7

1 - Monitoring not yet completed for 2014/2015 Operation. Dissolved oxygen measurements for July-November 2014 (see WQSV Section 5.4.4.2).
2 - Not measured.
3 - Residual effect of 2011/2012 Operation.
4 - Maximum extent of the wetted area of Big Buffalo Lake and the bog complex during 2011/2012 Operation was calculated from satellite imagery, therefore the amount of aquatic habitat is only known for 95th percentile flow (not 5th or 50th).
5 - Unless otherwise noted, DO ranges taken from Section 5.4 of the WQSV.
6 - DO during fish habitat field studies in 2013.

Table 6.4-4. Comparison of substrate in Bug Buffalo Lake during Pre-Operation (2011) and 2011/2012 Closure (2014).

2011				2014			
Site	Water Depth (m)	Substrate Compaction	Substrate Composition	Site	Water Depth (m)	Substrate Compaction	Substrate Composition
1	1.2	soft	organics	WP-25	1.3	soft	silt/organics
2	1.5	soft	organics	WP-27	1.6	medium	silt/clay
3	2.0	soft	organics	WP-28	1.9	-	-
4	2.0	soft	organics	GN-03 Start	1.6	soft	silt/organics
8	2.1	soft	organics	WP-39	2.0	-	-
9	2.1	soft	organics	WP-44	2.0	-	-
11	1.7	soft	organics	WP-32	1.8	medium	silt/clay
22	1.6	soft	organics	WP-35	1.3	medium	silt/clay
15	2.0	soft	organics	WP-41	1.8	medium	silt/clay
16	1.9	soft	organics	WP-42	1.7	medium	silt/clay
19	1.6	soft	organics	GN-01 Start	1.7	-	-
20	1.4	soft	organics	WP-52	1.7	hard	silt/clay/gravel
21	1.4	soft	organics	WP-51	1.7	hard	silt/clay/gravel
24	1.4	soft	organics	WQ-01	2.2	-	-

Table 6.4-5. A summary of habitat data collected from Big Buffalo Lake and the surrounding bog complex.

Project Phase	Flow	Water Depth & Level	Water Velocity (m/s)	Aquatic Habitat (wetted area)	Substrate Composition	Aquatic and Riparian Vegetation	Dissolved Oxygen (DO)
Pre-Operation	- No flow except at the outlet to Buffalo Creek. - Discharge not measured.	- Depths ranged from 1.2-2.1 m.	- No velocities	- 70.1 ha of peat pool habitat.	- Loosely compacted organic substrate	- No data	- No data
2011/2012 Operation	- Discharge increased during operation, but was not measured.	- No data, but based on measurements during 2014/2015 Operation, water depth likely increased by approximately 1m.	- No data, but an increase is assumed.	- Almost 1,800 ha of peat pool habitat.	- Based on observations during 2011/2012 Closure, a portion of loosely compacted surface layer was scoured away by high flows during 2011/2012 Operation, leaving patches of coarser material, and sediment deposited in off-current areas.	- Based on observations during 2011/2012 Closure, riparian vegetation decreased in areas wetted by 2011/2012 Operation but quantities were not measured.	- No data
2011/2012 Closure	- No flow except at the outlet to Buffalo Creek. - Discharge not measured.	- Depths generally ranged from 1.3-2.2 m.	- No velocities	- 74.3 ha of habitat, the vast majority of which (74.1 ha) was peat pool habitat.	- Loosely compacted organic/silt substrate with patches of gravel.	- No data	- Winter DO levels were frequently too low to support most species of fish. - Due to a lack of baseline data, it is not known whether this is a natural seasonal decrease or is a result of the Project.
2014/2015 Operation [1]	- TBD	- Based on changes to water surface elevation, water depth increased by approximately 1 m.	- TBD	- TBD	- TBD	- TBD	- TBD

1 - Data collection not yet complete for the 2014/2015 Operation phase; will be updated following closure in 2015.

Table 6.4-6. Aquatic habitat parameters used for assessment of effects on Buffalo Creek.

Habitat Parameters	Units	*Measured values/Observations*			
		Pre-Operation	2011/2012 Operation	2011/2012 Closure	2014/2015 Operation [1]
Effect to habitat as a result of the Project?		-	*yes*	*yes*	-
Discharge	m^3/s	4	125	4	109
50th: Aquatic Habitat (available wetted area) [2]	ha	20.1	128.6	24.0 [3]	-
95th: Aquatic Habitat (available wetted area) [4]	ha	-	202.2	-	-
Intermittently Exposed/ Predominantly Wetted	ha	-	145.5/56.7	-	-
Wetted Width [5]					-
50th: mean wetted width	m	12.97	96.69	17.65 [3]	
50th: minimum wetted width	m	8.06	38.36	11.13	
50th: maximum wetted width	m	23.68	205.6	27.03	
Water Depth [5]					-
50th: mean maximum depth	m	0.65	3.24	0.79 [3]	
50th: range of maximum depth	m	0.51-0.90	2.55-3.90	0.58-1.10	
Water Velocity [5]					-
50th: mean velocity	m/s	0.74	1.07	0.53	
50th: velocity range	m/s	0.45-1.14	0.50-1.70	0.31-0.82	
Substrate Composition	ha	Variable	No data	Shifted due to erosion and sedimentation [3]	-
Aquatic Vegetation	-	Present at all habitat assessment sites	No data	Present at few sites in 2013[3] Present at most sites in 2014	
Riparian Vegetation		Abundant along survey transects	No data	Absent/sparse in 2013 Grasses present in 2014	
Dissolved Oxygen [6]	mg/L	6.4-12.2	2.9-12.5	2.1-11.9 2.11 (US), 7.16 (DS) [7]	2.9-11.4

1 - Monitoring not yet completed for 2014/2015 Operation. Dissolved oxygen measurements for July-November 2014 (see WQSV Section 5.4.4.2).
2 - Pre-Operation and 2011/2012 Closure wetted area approximated from satellite imagery; 2011/2012 Operation wetted area was calculated using HEC-RAS and MIKE 21 model outputs.
3 - Residual effect of 2011/2012 Operation.
4 - Operation intermittently exposed, predominantly wetted and total water level derived from HEC-RAS and area corrected MIKE 21 models.
5 - Depth and velocity measures derived from HEC-RAS model outputs.
6 - Unless otherwise noted, DO ranges taken from Section 5.4 of the WQSV.
7 - DO measured at the upstream (US) and downstream (DS) ends of Buffalo Creek during fish habitat field studies in March 2013.

Table 6.4-7. Habitat survey data collected at sites on Buffalo Creek during Pre-Operation (2011) and 2011/2012 Closure (July 2013 and June 2014). BO = boulder; CO = cobble; GR = gravel; SA = sand; CL = clay; OM = organic matter.

	Pre-Operation (2011)						Closure (2013)						Closure (2014)					
Site	Hydraulic Habitat	Wetted Width (m)	Water Depth (m, range)	Substrate Composition	Substrate Compaction	Aquatic Vegetation	Hydraulic Habitat	Wetted Width (m, range)	Max. Water Depth (m, range)	Substrate Composition	Substrate Compaction	Aquatic Vegetation	Hydraulic Habitat	Wetted Width (m)	Water Depth (m, range)	Substrate Composition	Substrate Compaction	Aquatic Vegetation
T-1 (EF-26)	run /pool	7.2	0.1-0.2	SA/GR; CO; OM	loose OM on top of hard	present	--	--	--	--	--	--	95% run, 5% pool	15	0.7	75% SI/OM, 20% GR, 5%CO	soft	present
T-2 (EF-16)	run /pool	7.1	0.2-0.3	CL	hard	present	60% pool, 40% run	15-25	1.0-2.0	40% GR, 15% SA, 15% OM, 15% CL, 10% CO, 5% BO	upstream 80 m hard (GR/CO), downstream 20 m soft (CL)	absent	--	--	--	--	--	--
T-3 (EF-15, EF-27)	pool	7.5	> 1.0	CL	hard	present	60% pool, 40% run	9-15	1.4	45% CL, 25% BO, 15% GR, 10% CO, 5% SA	soft areas of clay along shore; otherwise hard	absent	50% run, 40% pool, 10% riffle/rapids	15	0.6	50% CO, 25% GR, 25% SI/OM	hard	present
T-4 (EF-28)	riffle/pool	12.2	0.0-0.3	riffle: CO/BO pool: GR/BO; OM	hard loose OM on top of hard	present	--	--	--	--	--	--	70% riffle/rapid, 30% pool	12	0.3-0.6	50% CO, 40% GR, 10% SI/OM	hard	present
T-5 (EF-14, EF-29)	run/pool	8.1	0.2-0.3	CO/GR/SA; BO/OM	loose OM on top of hard	present	70% run, 30% pool	5-10	0.9	40% GR, 40% CO, 10% SA, 5% BO, 5% CL	hard under organic layer	present	50% riffle/rapid, 25% pool, 25% run	12	0.3-0.5	75% CO, 20% GR, 5% SA	hard	present
EF-17 (EF-35)	--	--	--	--	--	--	60% run, 30% pool, 10% pool	6-20	0.8	75% GR, 10% SA, 10% CL, 5% CO	hard	absent	75% riffle/rapid, 20% run, 5% pool	10	0.6-0.8	90% CO, 10% SI/OM	hard	present
T-12 (Hab-14)	pool	29	< 1.0	CL/OM	hard	present	--	--	--	--	--	--	70% run, 20% pool, 10% other	20	n.r.	90% SI/OM, 10% GR	soft	present
T-11 (EF-23, Hab-15)	riffle	7	0.1-0.3	CO/BO	hard	present	60% run, 20% riffle, 20% pool	4-27	~ 1.0	50%CO, 20% GR, 15% BO, 10% CL, 5% SA	n.r.	absent	40% riffle/rapid, 30% pool, 30% run	12	n.r.	60% SI/OM, 40% CO	soft	present
T-8 (EF-22)	backwater	10	1.2	CL along stream margin GR/BO in centre of channel	hard hard	present	50% run, 30% riffle, 20% pool	5-9	> 1.0	60% CO, 20% GR, 15% BO, 5% SA	n.r.	absent	--	--	--	--	--	--
T-7 (EF-21)	backwater	22	> 1.5	GR/CO/BO	hard	present	90% run, 10% pool	11-15	> 1.0	50% BO, 25% CO, 15% CL, 10% GR	hard	present	--	--	--	--	--	--

Table 6.4-8. A summary of data collected from Buffalo Creek for key aquatic habitat parameters.

Project Phase	Flow	Water Depth & Level	Water Velocity (m/s)	Aquatic Habitat (wetted area)	Substrate Composition	Aquatic and Riparian Vegetation	Dissolved Oxygen (DO)
Pre-Operation	- Low flow habitat consisting of runs interspersed with beaver dams and associated pools. - Discharge not measured	- Depths typically less than 1.0 m.	- Modeled50th percentile velocities ranged from 0.45-1.14 /s	- Contained 20.1 ha of aquatic habitat. - Wide variety of habitat types including riffle, pool, run, beaver dam and beaver pool.	- Fines in low flow areas. - Gravel/cobble in areas of higher flow.	- Dense riparian vegetation consisting of grasses, shrubs and trees. - Aquatic vegetation present at all habitat assessment sites.	- DO levels were suitable for fish.
2011/2012 Operation	- 125 m^3/s flow.	- No data	- Modeled50th percentile velocities ranged from 0.5-1.7 m/s.	- 106.8 ha of additional wetted habitat at 50th percentile flow.	- Some fines remain in low flow areas. - Coarse material dominant in high flows.	- Observations indicate riparian vegetation to be largely absent from flooded. - Presumed loss of aquatic vegetation.	- DO levels were almost always suitable for fish. - DO levels were often lower at the upstream end of Buffalo Creek (sometimes below guidelines [2]) than at the downstream end. - Fish were able to move freely within the creek during 2011/2012 Operation and could avoid areas of low DO.
2011/2012 Closure	- Low flow (3.9 m^3/s) habitat consisting of runs, riffles and pools; beavers starting to re-establish themselves by spring 2014.	- Water depths increased by approximately 0.3 m as a result of erosion due to increased flows during 2011/2012 Operation.	- Modeled50th percentile velocities ranged from 0.3-0.8 m/s.	- Net increase of 3.9 ha of aquatic habitat. - Increases in pool and run habitat types. - Decreases in beaver dam and beaver pool habitat types as no beaver dams remained. - Beavers beginning to re-establish in the creek in spring 2014.	- Fines in low flow areas. - Gravel/cobble in high flow areas. - New areas of deposition in areas outside the banks of the creek that were flooded during 2011/2012 Operation.	- No riparian vegetation in 2013, but some grasses had re-established by 2014. - Patchy aquatic vegetation in 2014.	- DO levels in Buffalo Creek were more frequently below guidelines [2] during 2011/2012 Closure, particularly in winter. - Fish were still able to move freely within the creek during 2011/2012 Closure and could avoid areas of low DO. Some may even have moved into the Dauphin River.
2014/2015 Operation	- TBD [1]	- TBD	- TBD	- TBD	- TBD	- TBD	- TBD

1 - Data collection not yet complete for the 2014/2015 Operation phase; will be updated following closure in 2015.

2 - Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOGs) and Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life (PAL).

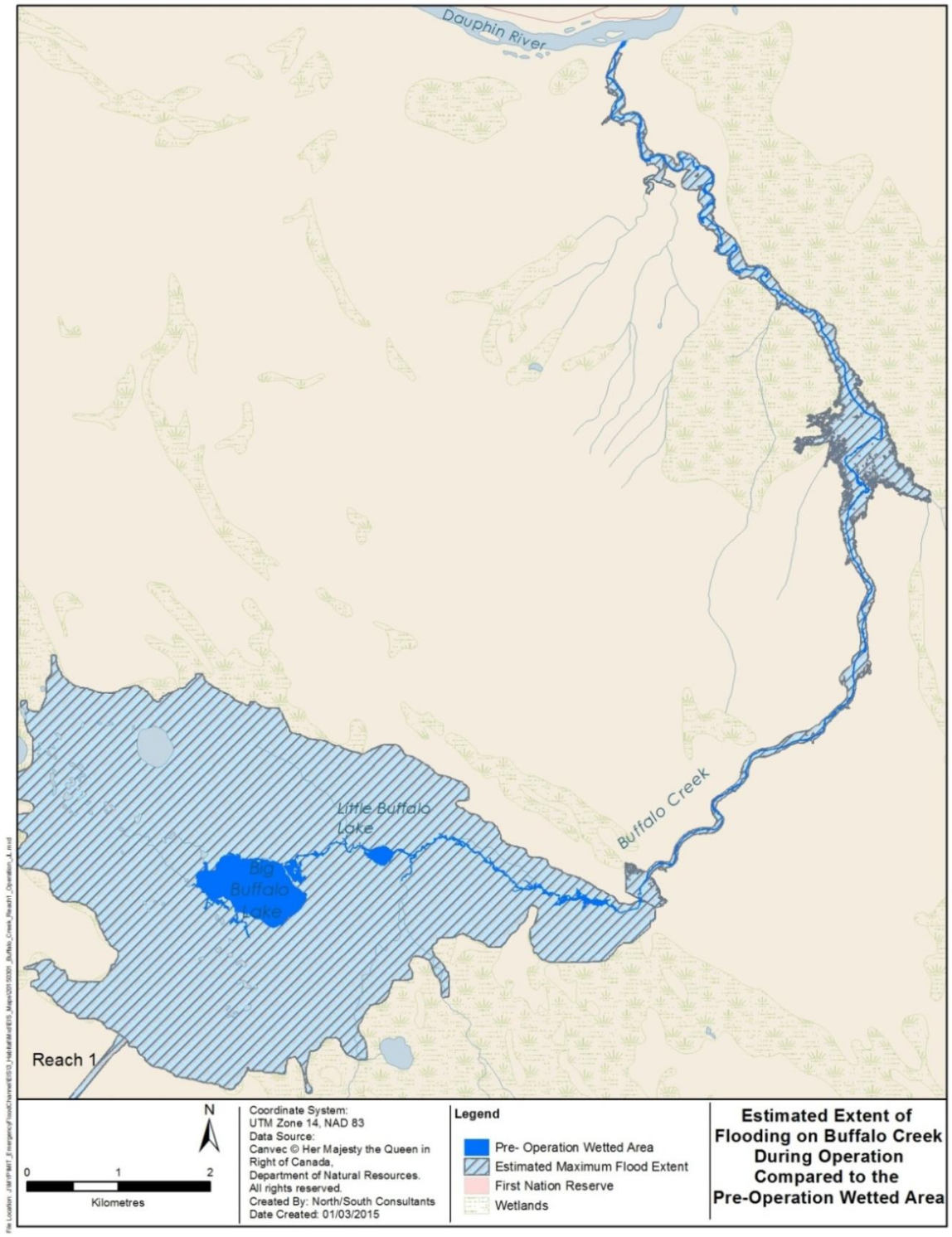


Figure 6.4-5. Maximum wetted extent (95th percentile flow) during 2011/2012 Operation compared to the estimated wetted extent of Pre-Operation conditions within the Buffalo Creek watershed.

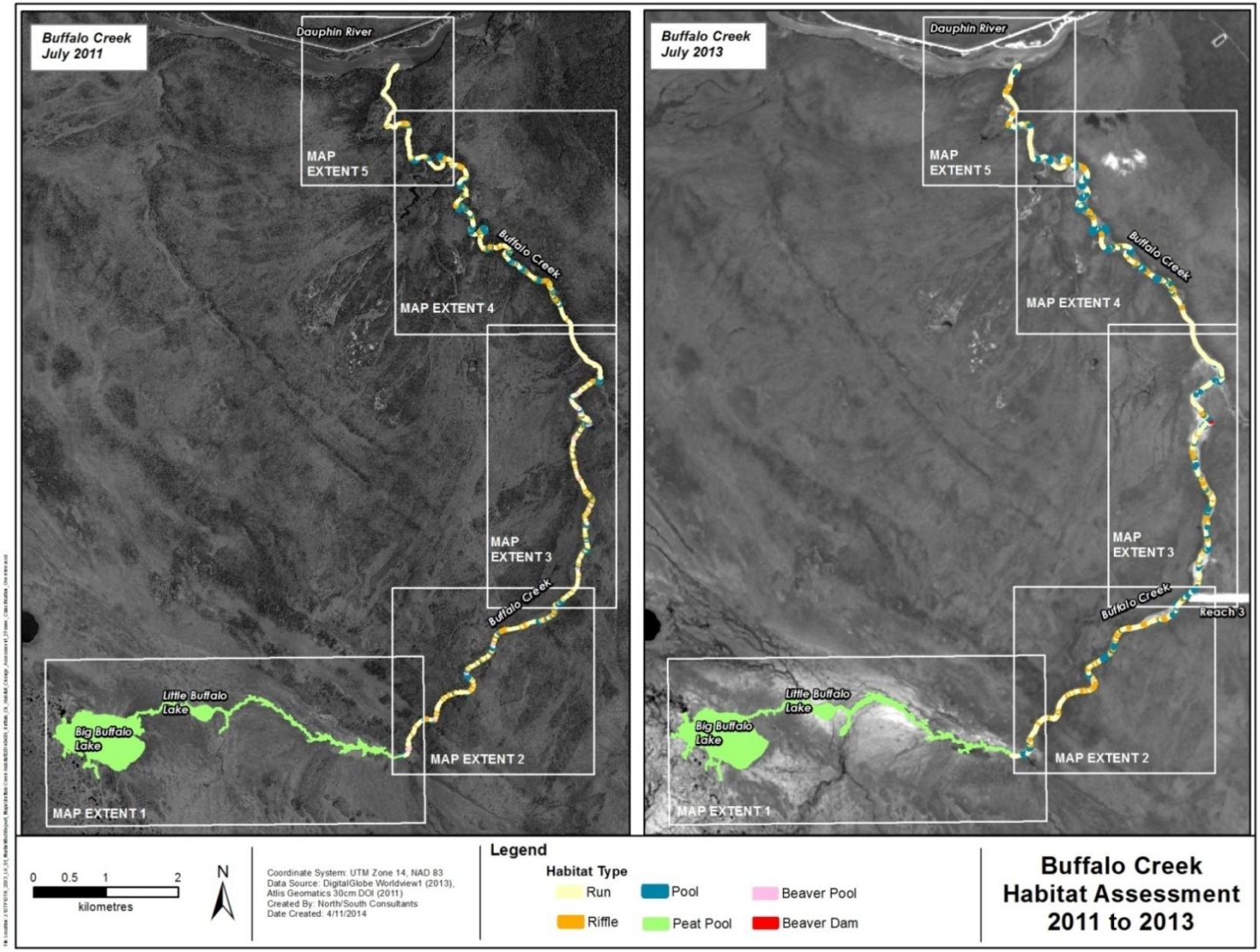


Figure 6.4-6. A comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

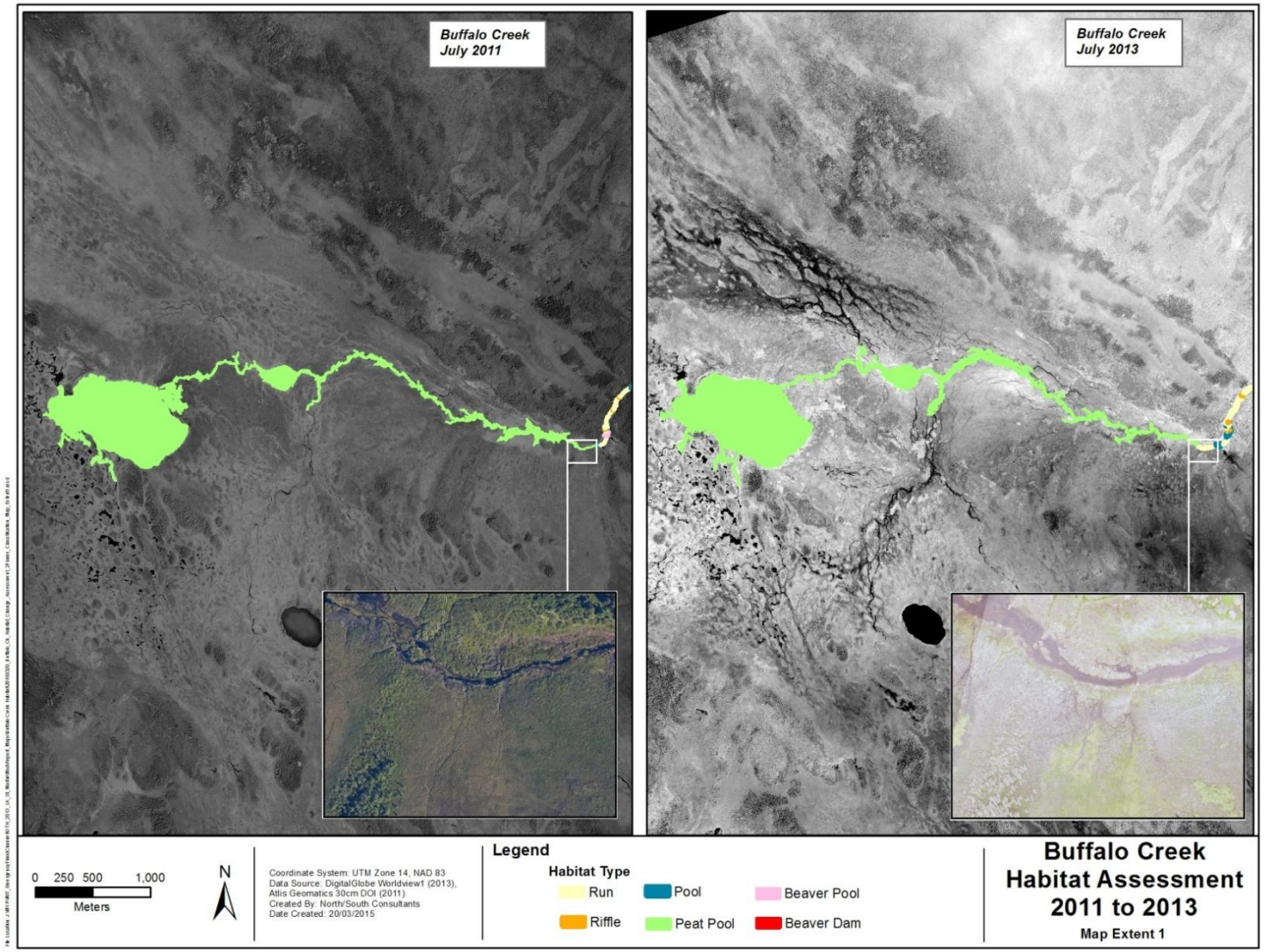


Figure 6.4-7. Extent 1: a comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

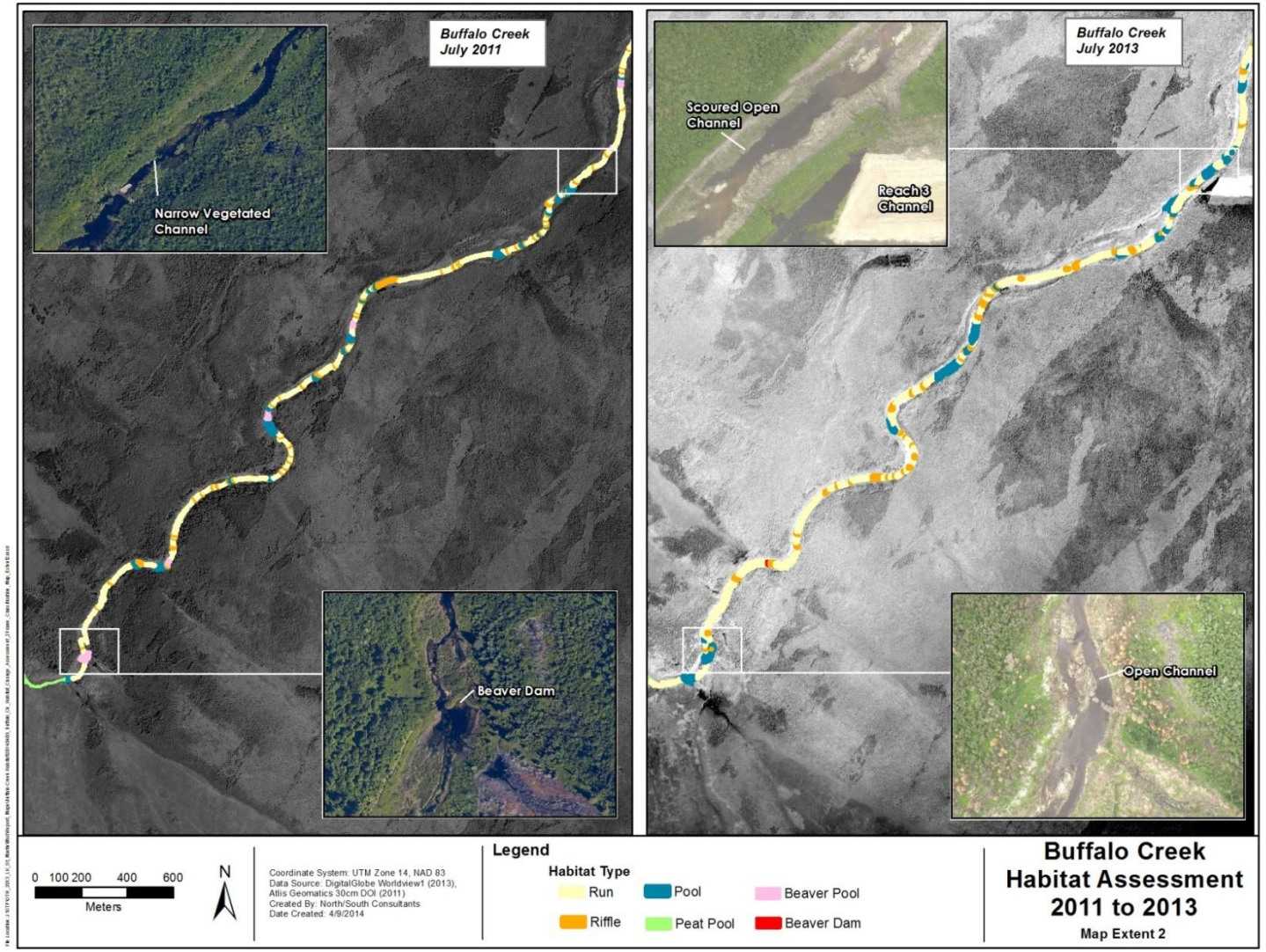


Figure 6.4-8. Extent 2: a comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

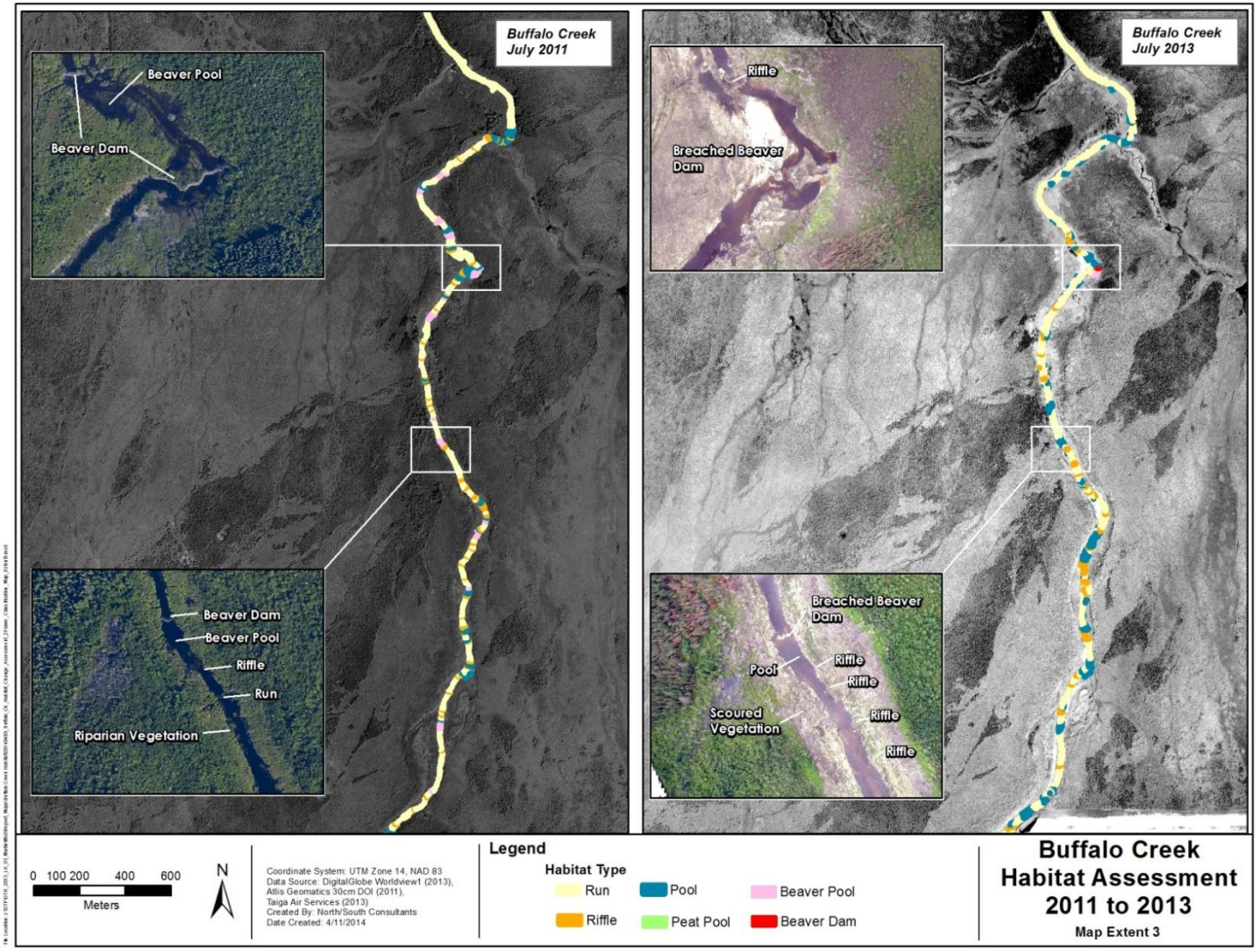


Figure 6.4-9. Extent 3: a comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

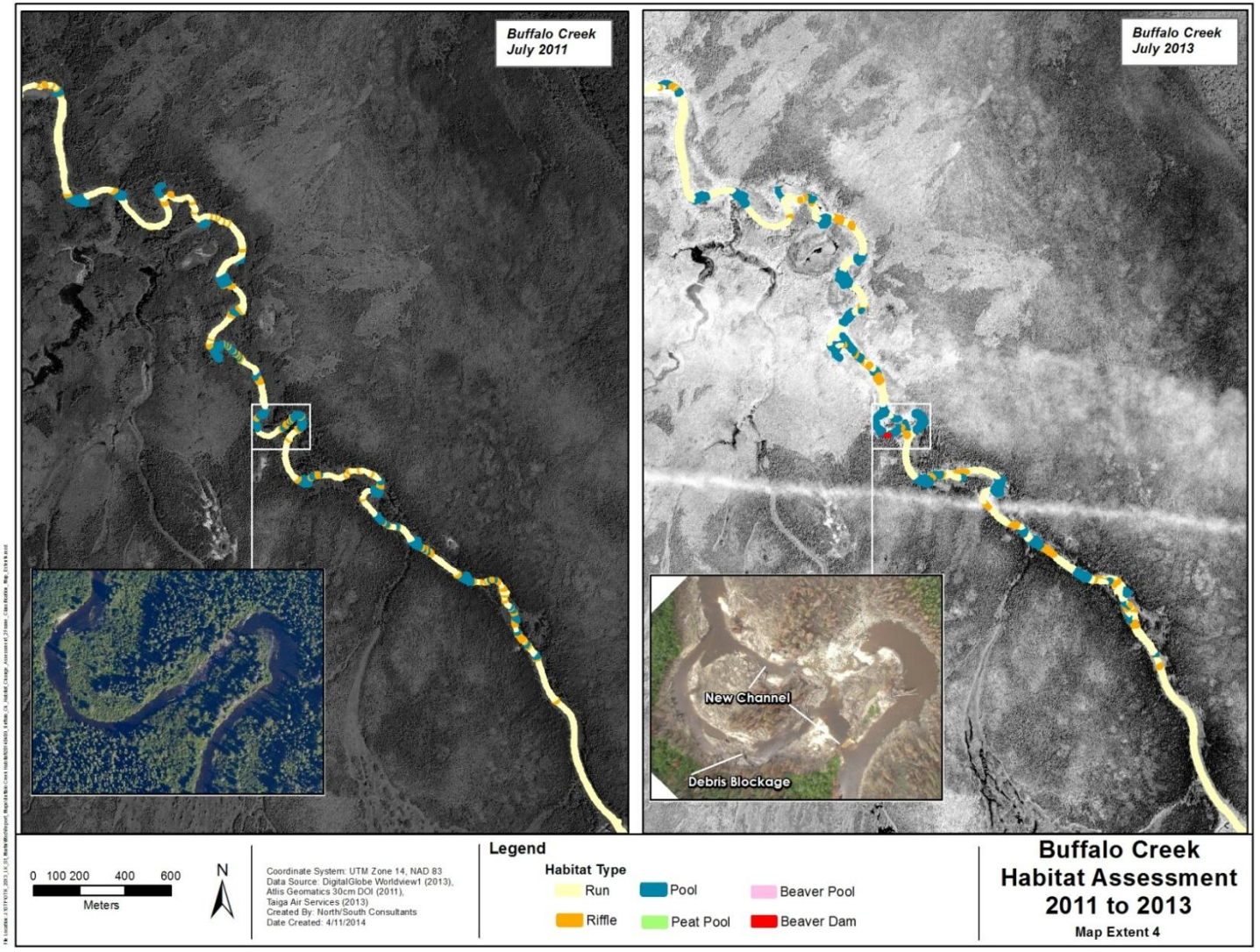


Figure 6.4-10. Extent 4: a comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

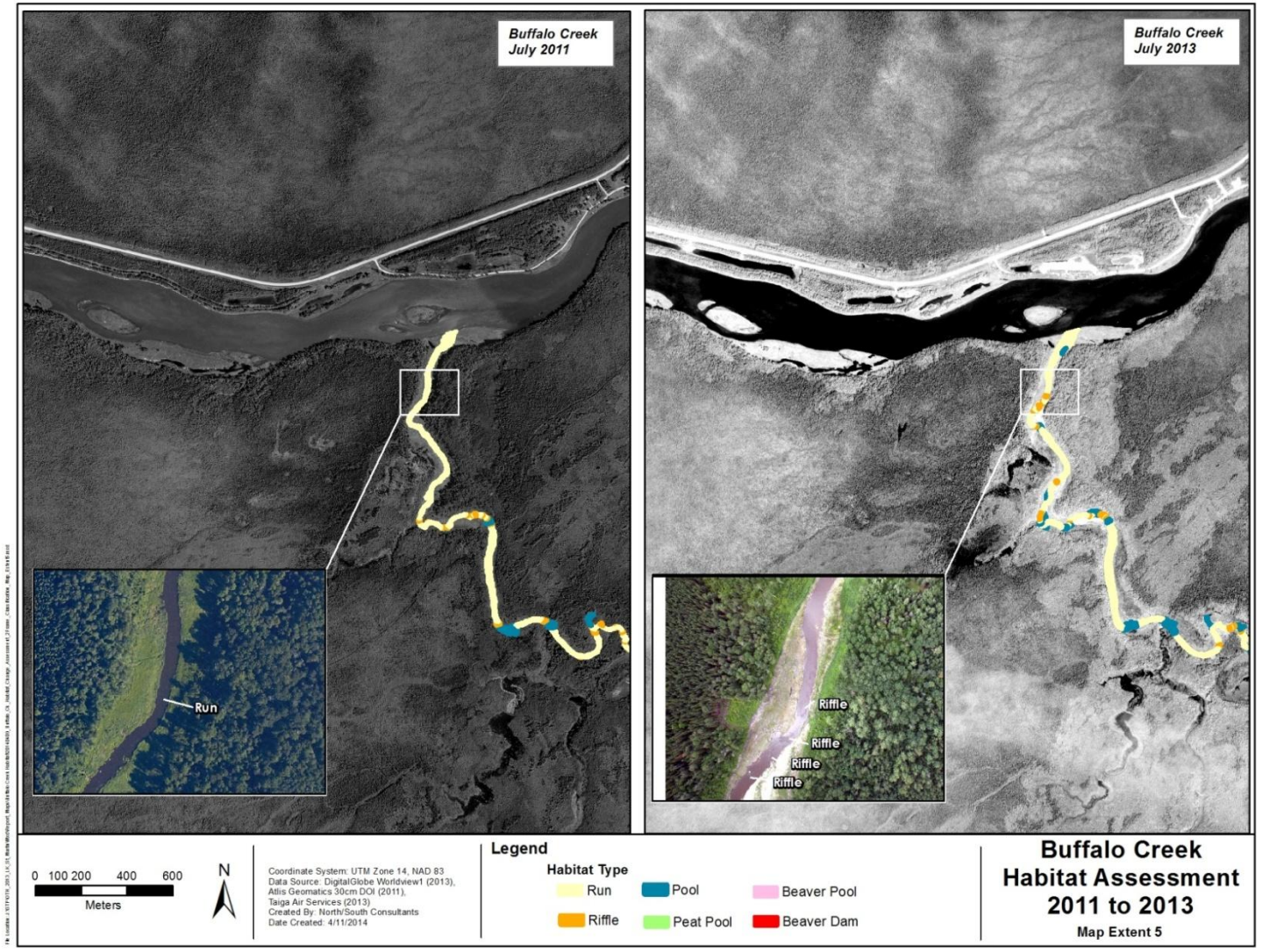


Figure 6.4-11. Extent 5: a comparison of the distribution of habitat classes within the Buffalo Creek watershed during Pre-Operation (2011) and 2011/2012 Closure (2013).

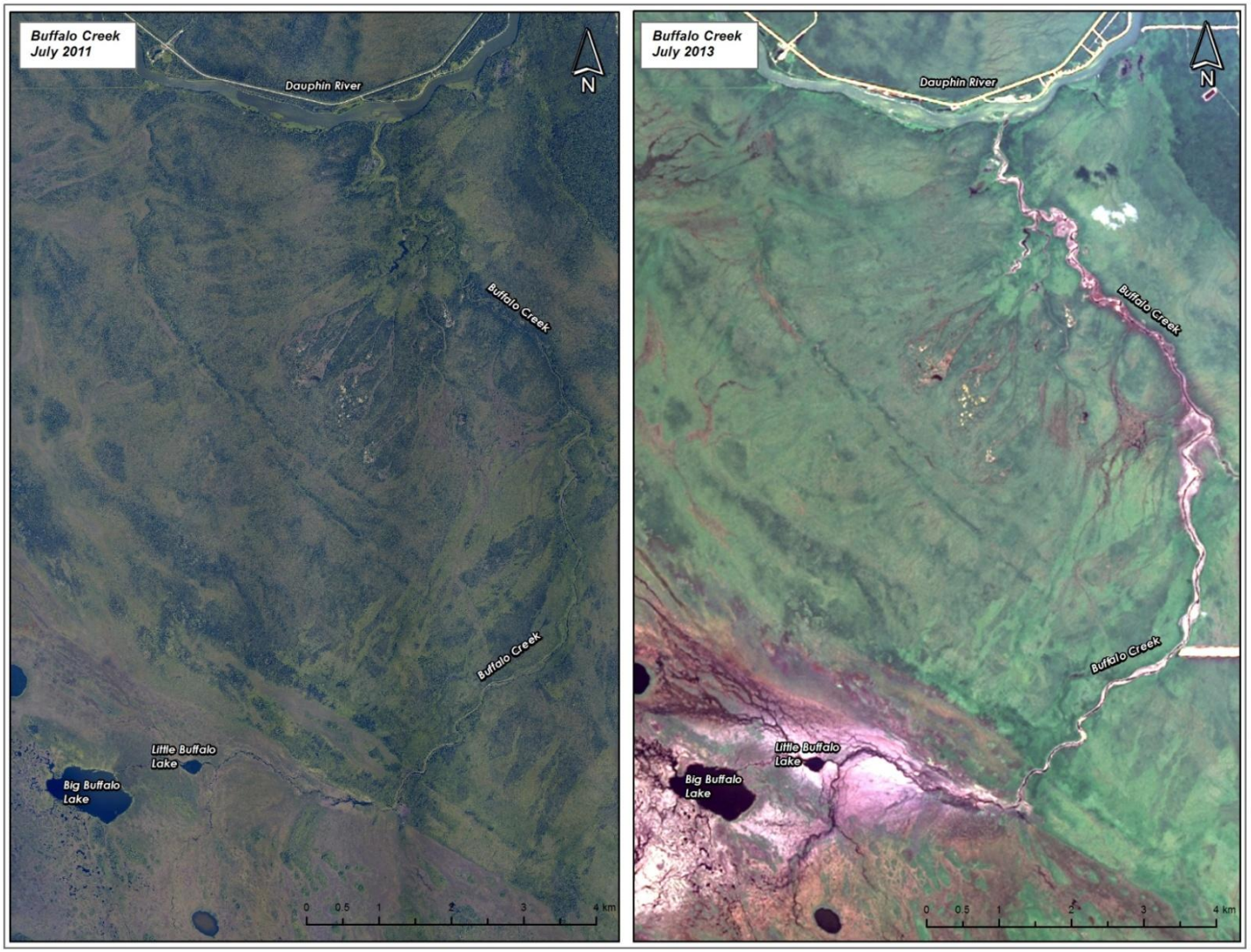


Figure 6.4-12. Satellite image overview of the Buffalo Creek watershed comparing Pre-Operation (July 2011) and 2011/2012 Closure (July 2013). Areas of bare soil resulting from flooding appear bright white, while light to dark brown areas are dead shrubs and trees.

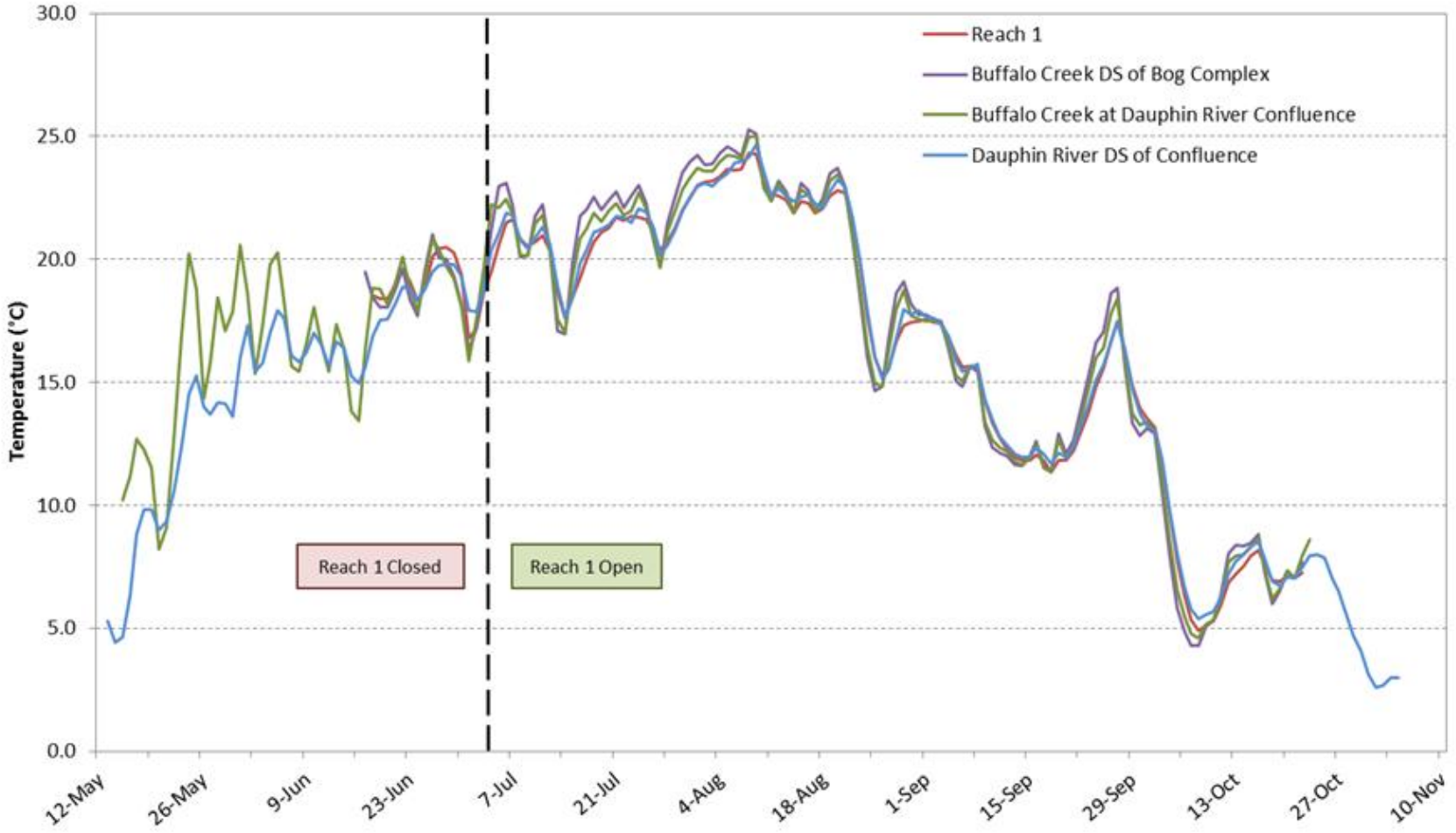


Figure 6.4-13. Water temperature data from Reach 1, Buffalo Creek, and the Dauphin River during the 2014 open water season.

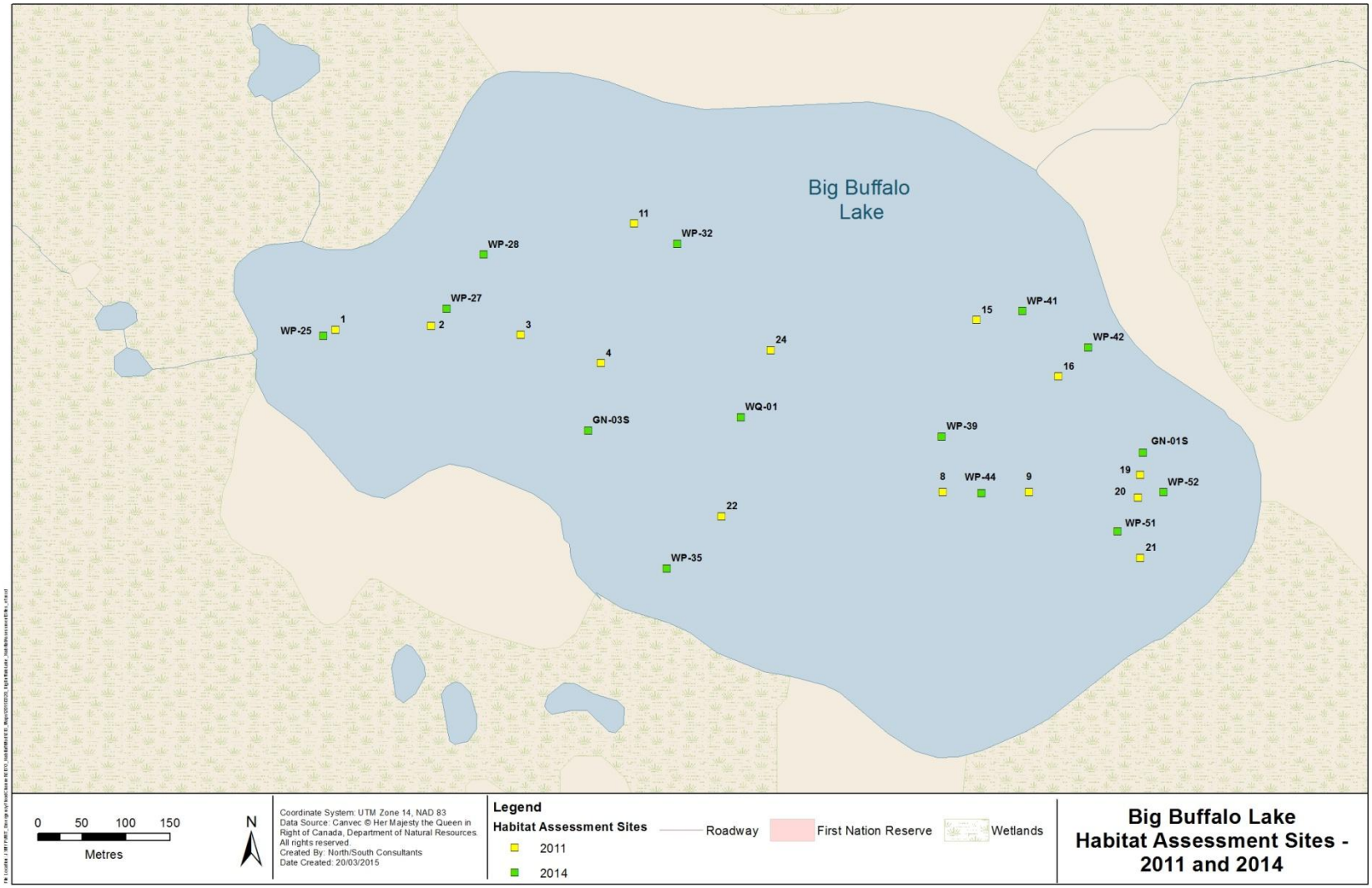


Figure 6.4-14. Aquatic habitat field survey locations in Big Buffalo Lake during Pre-Operation (2011) and 2011/2012 Closure (2014).

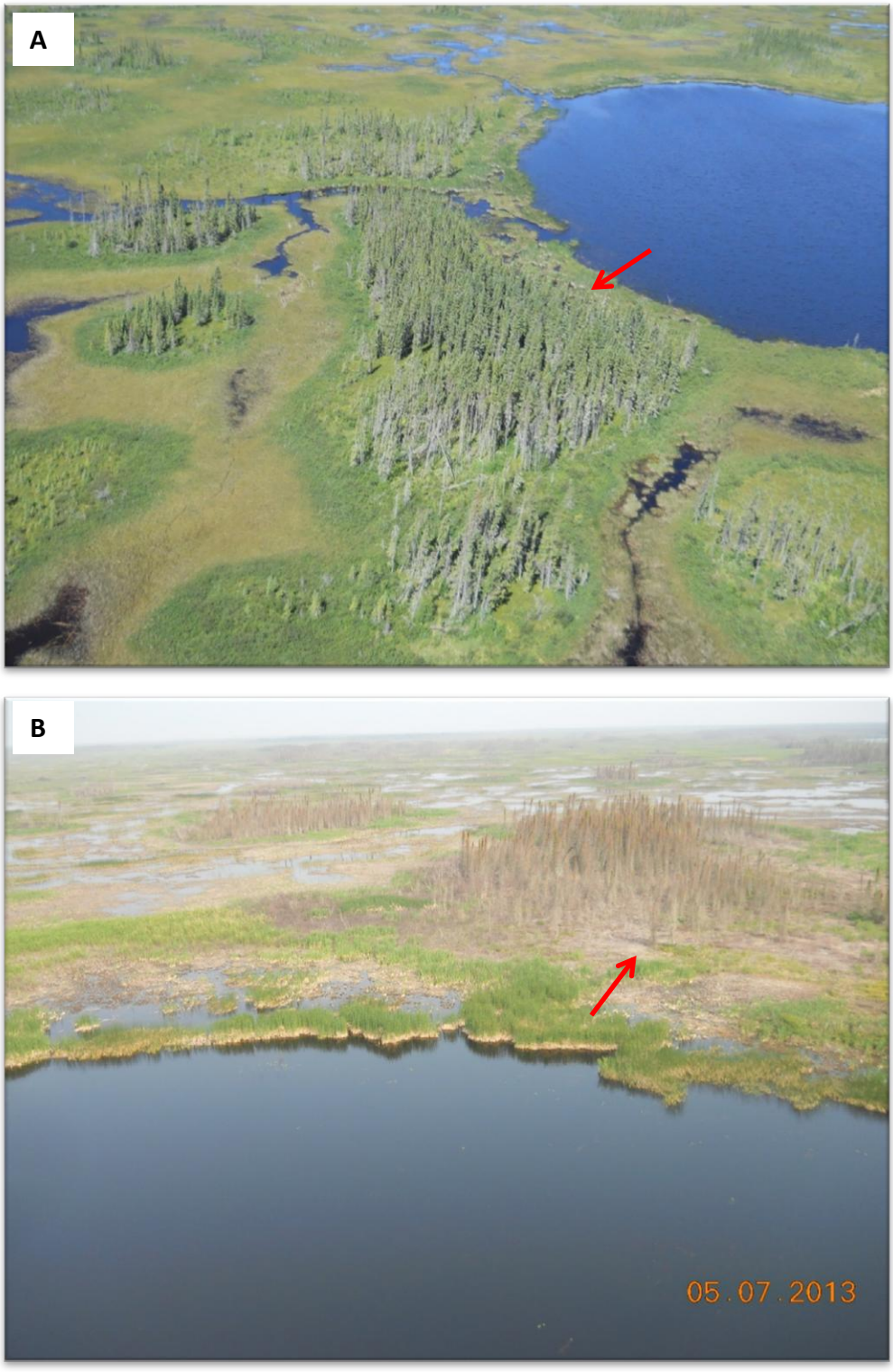


Figure 6.4-15. Aerial photographs of the shoreline vegetation in Big Buffalo Lake and its surrounding bog complex during (A) Pre-Operation and (B) 2011/2012 Closure. Red arrow points to the same cluster of trees in each photo.

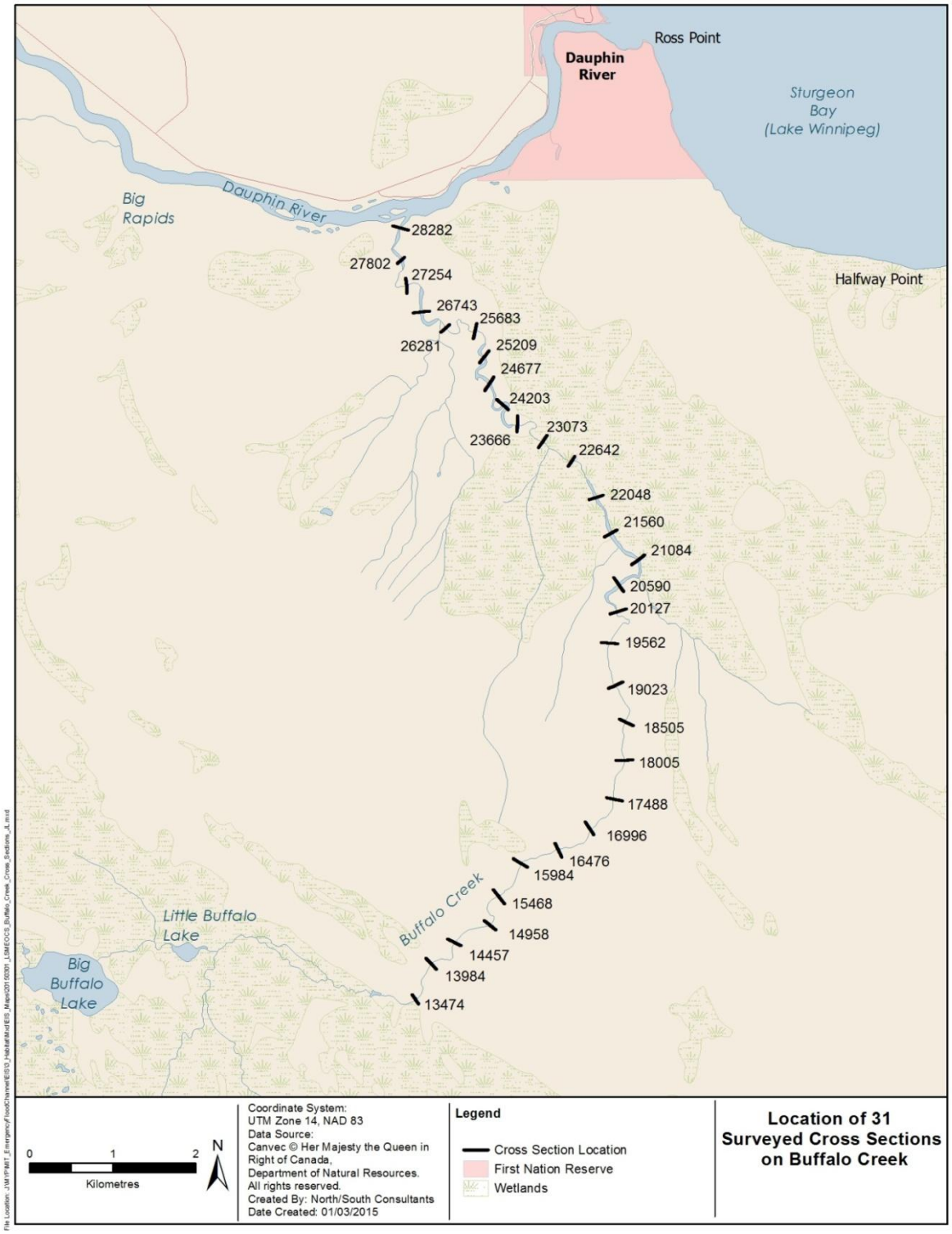


Figure 6.4-16. Cross-sectional transect locations used to measure hydraulic parameters along Buffalo Creek during Pre-Operation (2011) and 2011/2012 Closure (2013).

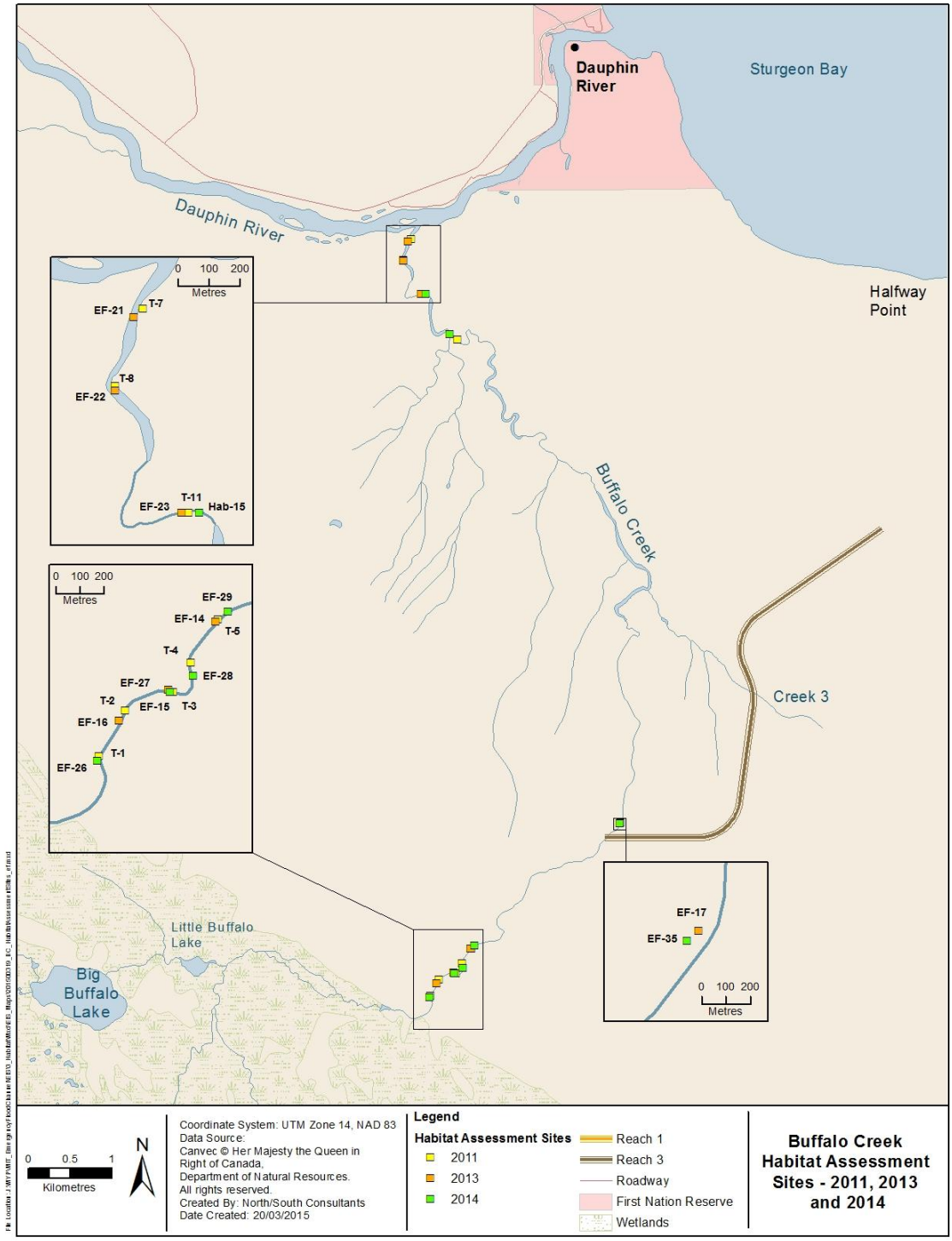


Figure 6.4-17. Aquatic habitat field survey sites in Buffalo Creek during Pre-Operation (2011) and 2011/2012 Closure (2013 and 2014).

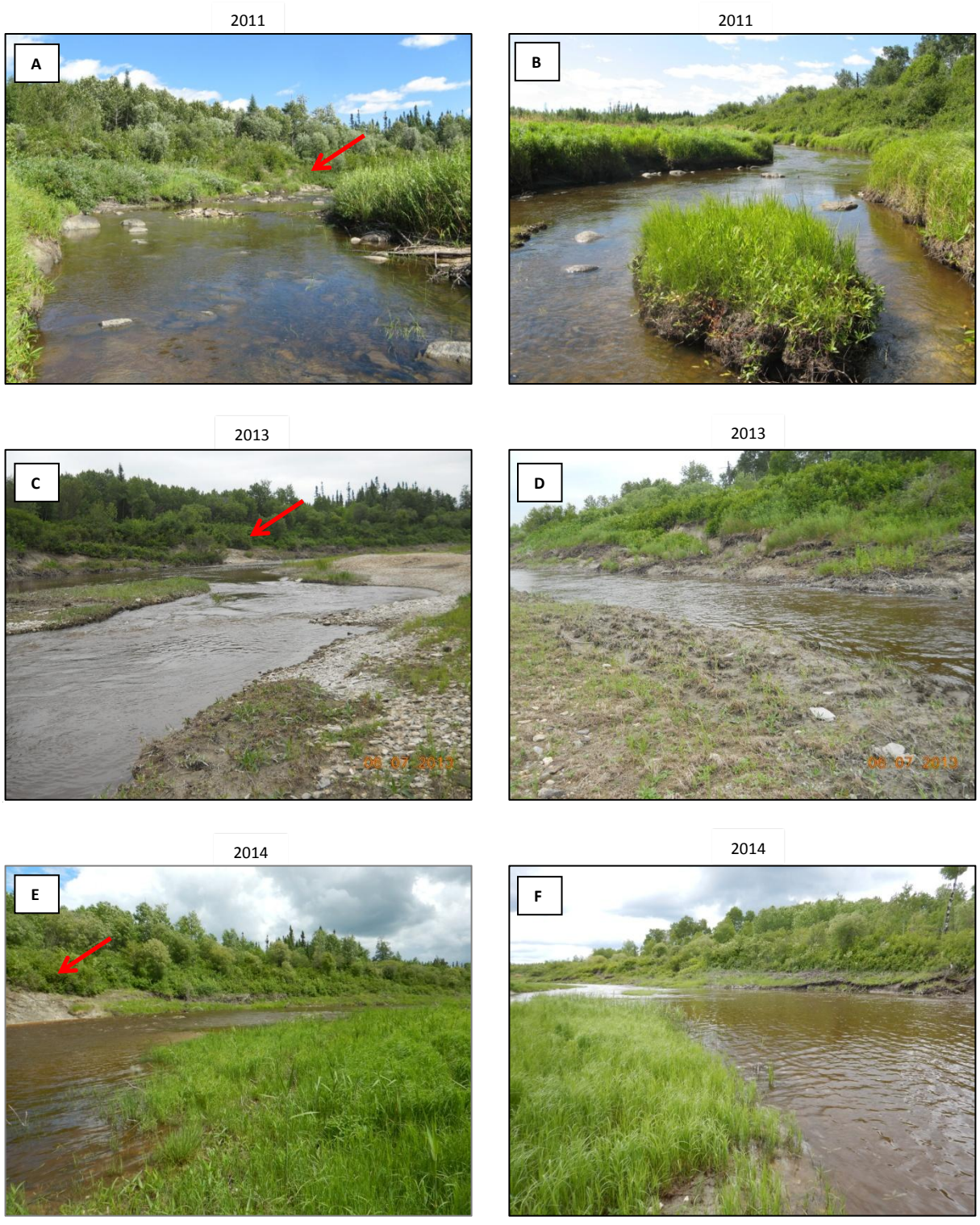


Figure 6.4-18. Aquatic habitat survey photographs taken in Buffalo Creek at site T-11 (EF-23, Hab-15) during Pre-Operation (A, B) and 2011/2012 Closure (C, D and E, F). Red arrow points to the same piece of shoreline in each photo. Note the partial stream obstruction observed during Pre-Operation (B) is absent during 2011/2012 Closure (D and F).



Figure 6.4-19. Aerial photograph of the Buffalo Creek and Dauphin River confluence during Pre-Operation.



Figure 6.4-20. Aerial photograph of the dead vegetation along Buffalo Creek during 2011/2012 Closure.

July 4, 2014



July 9, 2014



July 18, 2014



Figure 6.4-21 Time-lapse photographs of the Buffalo Creek and Dauphin River confluence during 2014/2015 Operation.

6.5 DAUPHIN RIVER MONITORING RESULTS

Reach 1 was designed to decrease flood stage water levels on Lake St. Martin by diverting water through the constructed channel into the Buffalo Creek watershed, and ultimately the lower Dauphin River. Although operation of Reach 1 reduced flow along the upper Dauphin River (i.e., between Lake St. Martin and the confluence of the Dauphin River and Buffalo creek), habitat within this portion of the river was not expected to be altered by Reach 1 operation as flows remained at the upper range of what had been recorded historically (see PESV 4.5.1). Effects to habitat within the downstream-most 4 km of lower Dauphin River are described below; modeled results pertain the habitat within this area (Figure 6.1-2).

6.5.1 Pre-Operation

6.5.1.1 Pre-flood

Water level and discharge on the Dauphin River are monitored by Water Survey of Canada (Gauge 05LM006) at a location approximately 25 km downstream of Lake St. Martin. Dauphin River discharge ranged from 8 m^3/s to 212 m^3/s and had a median discharge of 58 m^3/s (Appendix 6A) prior to the flood.

Pre-flood habitat conditions in the lower Dauphin River were derived from a spatial analysis of the MIKE 21 model (Section 6.2.2). The amount of aquatic habitat during the Pre-flood period was 61.1 ha (Table 6.5-1), average water depth was 1.2 m, and average water velocity was 0.5 m/s. The majority (78%) of the habitat was shallow, and low to moderate velocity habitat predominated (Table 6.5-1; Figures 6.5-1 and 6.5-2).

Notable habitat features within the Dauphin River include a series of rapids approximately 6 km upstream from the river mouth, where water depth is 4-5 m (0.5 m along the rapids). Sand bars are present throughout the river (McMahon and Evans 1992), and according to a report by LMRRAC (2003), gravel deposits are thought to provide spawning grounds for Lake Whitefish and Walleye.

Wide variation in slope along the Dauphin River results in diverse ice processes along its length. In the upper Dauphin River, slopes are low and the resultant slow water velocity can develop an ice cover due to border ice advancement, skim ice formation, and bridging of moving slush ice between border ice edges even before the ice cover advances from downstream. In the lower reaches of the river where slopes are greater and water velocities are higher, frazil begins to form and travels downstream to Sturgeon Bay. The area of Sturgeon Bay near the Dauphin River mouth generally ices over by early November. Ice them begins to amass and back up the Dauphin River. During spring break up, increased flow and velocity due to open water conditions at Dauphin River inlet at Lake St. Martin can lead to the formation of ice jams and elevated water levels along the Dauphin River (PESV Section 4.5.4).

6.5.1.2 2011 Flood

During the 2011 Flood period, Dauphin River discharge increased from 58 m^3/s to 527 m^3/s (Figure 6.5-2), and the amount of aquatic habitat in the lower Dauphin River increased by 9.00 ha (Table 6.5-1). At

the same time, the amount of intermittently exposed habitat decreased, indicating less variation in flow conditions (Table 6.5-1).

MIKE 21 model outputs indicate that average water depth increased to 2.0 m, resulting in a 17.90 ha increase in the amount of deep water habitat (Table 6.5-1; Figure 6.5-1). Average water velocity increased to 1.6 m/s, and 56% of the modeled area was characterized by water velocities in excess of 1.5 m/s (Table 6.5-1; Figure 6.5-2).

Under normal conditions, sediment transport and distribution in the lower Dauphin River are dynamic due to its flow patterns and velocities. Finer sediments up to the size of sand typically move downstream through the Dauphin River system and settle into Sturgeon Bay; coarser materials, such as gravel and even cobble, move, erode, and shift around within the lower Dauphin River channel (PESV Section 4.5.5.2). Based on substrate data collected using sonar technology, substrate composition in the lower Dauphin River during fall 2011 was classified as predominantly boulder/cobble (Table 6.5-1; Figure 6.5-3).

There are no sediment transport data for conditions prior to operation of Reach 1, but it is assumed that because flows on the lower Dauphin River during the 2011 Flood period exceeded those seen during 2011/2012 Operation, transport processes similar to those modeled for 2011/2012 Operation (Section 6.5.2) probably also occurred during the 2011 Flood period.

6.5.2 2011/2012 Operation

Flows on the upper Dauphin River decreased as a result of Reach 1 operation but, due to the volume of water exiting Buffalo Creek, Dauphin River discharge during 2011/2012 Operation (343.0 m^3/s) was approximately the same as it would have been without the Project (337.0 m^3/s) (Table 6.5-1).

In general, habitat conditions in the lower Dauphin River during 2011/2012 Operation were intermediate to those seen during the Pre-Operation phase: water depths and velocities were higher than they were during the Pre-flood period, but they were lower than during the 2011 Flood period (Table 6.5-1; Figures 6.5-1 and 6.5-2). MIKE 21 modeling suggests an increase in wetted area during 2011/2012 Operation compared to 2011 Flood, even though flow on the Dauphin River was nearly 200 m^3/s greater during 2011 Flood. The difference in wetted area is an artefact of modeling resulting from the use of a steady state model in 2011 and a dynamic state model during 2011/2012 Operation, and the inclusion of small backwater areas in the 2011/2012 Operation model. It is expected that the differences in wetted area between 2011 Flood and 2011/2012 Operation are less than indicated by the modeling.

During 2011/2012 Operation, the amount of intermittently exposed habitat was higher than it had been during 2011 Flood but lower than Pre-flood values, indicating that water levels were more variable during 2011/2012 Operation than they has been during 2011 Flood, but less variable than under normal (i.e., Pre-flood) conditions (Table 6.5-1).

The proportions of shallow and deep water habitat in the lower Dauphin River were similar during the Pre-flood period and 2011/2012 Operation, with shallow habitat being three to four times more

prevalent than deep water habitat (Table 6.5-1; Figure 6.5-1). Despite a decrease in mean velocity between 2011 Flood and 2011/2012 Operation, the majority of aquatic habitat was still within the moderate and high velocity categories (Table 6.5-1; Figure 6.5-2).

Results of empirical modeling indicate that the combined volume of suspended sediment from the upper Dauphin River and from Buffalo Creek during 2011/2012 Operation was estimated at 82,200 m^3, of which 8,900 m^3 was attributed to operation of Reach 1 (PESV Section 4.5.5.1). Due to the high velocities in the Dauphin River, suspended sediment was transported into Sturgeon Bay.

There were no evident changes in ice processes along the lower Dauphin River.

6.5.3 2011/2012 Closure

Following closure of Reach 1, flows on the Dauphin River remained elevated (205 m^3/s at 50th percentile flow) compared to Pre-flood levels, but they were within the range of historic flows (Table 6.5-1). They were similar enough to Pre-flood 95th percentile flows (212 m^3/s), that model results for that Project phase and flow condition were used as a proxy to describe habitat conditions within the lower Dauphin River during 2011/2012 Operation.

Surveys conducted in the lower Dauphin River showed changes in substrate distribution between the 2011 Flood period and 2011/2012 Closure (Table 6.5-1; Figure 6.5-3). Compared to 2011 Flood conditions, a slightly higher proportion of the surveyed area was covered in gravel substrate during 2011/2012 Operation (Table 6.5-1). The associated reduction in the area of boulder/cobble substrate suggested that the observed shifts in substrate composition likely resulted from an increased downstream transport of gravel that deposited within the boulder/cobble and bedrock areas. Substrate distributions continued to shift throughout 2011/2012 Closure (Figure 6.5-3), indicating continued transport of substrate materials. As noted in Section 6.5.1.2, of materials up to gravel and cobble size in diameter are eroded and transported under normal flow and velocity conditions in the lower Dauphin River. Results of bathymetric surveys conducted by KGS Group also indicate that changes to riverbed elevations cannot be directly attributed to operation of Reach 1 (PESV Section 4.5.3).

Results of the empirical model suggest that residual effects of Reach 1 operation (bank slumping and localized erosion resulting from the recession of flows and water levels in Buffalo Creek combined with natural drainage of Big Buffalo Lake and surrounding bog complex) led to the introduction of an additional 2,200 m^3 of suspended sediment into the Dauphin River during 2011/2012 Closure. Velocities were still sufficient (averaging greater than 0.5 m/s) to transport the majority of this material (suspended fines) into Sturgeon Bay (Table 6.5-1).

Although ice processes in the lower Dauphin River were not monitored during 2011/2012 Closure, conditions were expected to be similar to Pre-Operation conditions when the lower Dauphin River had frazil ice with some open water in paths of flow (center of channel) during winter.

6.5.4 2014/2015 Operation – Effects to December 2014

Median Dauphin River discharge during the first sixteen weeks of 2014/2015 Operation (July to October 2014) was higher than the median discharge during 2011/2012 Operation (Table 6.5-1), but it is expected that this value will decrease (and become more similar to the median discharge recorded for 2011/2012 Operation) when flows for the entire 2014/2015 Operation phase are taken into consideration. The amount of aquatic habitat present during 2014/2015 Operation is also expected to resemble that of the 2011/2012 Operation condition.

The combined volume of suspended sediment from the upper Dauphin River and Buffalo Creek was estimated at 25,400 m^3 during the first sixteen weeks of 2014/2015 Operation (PESV Section 4.5.5.1). This volume was similar in proportion to the amount of sediment transported into the Dauphin River over an equivalent duration during 2011/2012 Operation. Given that average velocities in both Buffalo Creek and the Dauphin River are greater than 0.5 m/s, transport of suspended sediment is expected to resemble 2011/2012 Operation conditions, as are the erosion and downstream movements of coarser materials within the lower Dauphin River.

There were no evident changes in ice processes along the lower Dauphin River.

Table 6.5-1. Aquatic habitat parameters used for assessment of effects in the lower Dauphin River during the Project phases.

Habitat Parameters	Units	*Measured Values/Observations*				
		Pre-Operation (Pre-flood)	Pre-Operation (2011 Flood)	2011/2012 Operation	2011/2012 Closure [1]	2014/2015 Operation [2]
Effect to habitat as a result of the Project?		-	-	*no*	*no*	-
50th: Discharge	m^3/s	58	527	343	212	430
50th: Aquatic Habitat (available wetted area)	ha	61.1	70.1	75.5 [3]	64.7	-
95th: Water Surface Elevation						-
Intermittently Exposed	ha	14.78	3.56	11.87	-	
Predominantly Wetted	ha	49.93	67.38	64.60	-	
Total Water Level Zones	ha	64.70	70.93	76.47	-	
Water Depth						-
50th: Deep (> 2 m)	ha	13.68	31.60	17.31	15.16	
50th: Shallow (< 2 m)	ha	47.39	38.56	58.11	49.55	
50th: mean depth	m	1.2	2.0	1.4	1.4	
50th: max depth	m	4.2	4.9	4.5	4.2	
Water Velocity						-
50th: 0 - 0.2 (Standing - Lentic)	ha	13.33	1.83	7.60	1.99	
50th: 0.2 - 0.5 (Low)	ha	24.36	2.94	1.85	5.24	
50th: 0.5 - 1.5 (Moderate)	ha	22.23	25.91	41.62	41.67	
50th: >1.5 (High)	ha	1.15	39.48	24.40	15.81	
50th: mean velocity	m/s	0.5	1.6	1.2	1.1	
50th: maximum velocity	m/s	2.7	4.4	3.8	3.0	
Substrate Composition [4]						-
Bedrock	ha	-	2.20	-	2.30, 0.80, 0.80	
Boulder/Cobble	ha	-	58.30	-	55.00, 57.00, 57.50	
Gravel	ha	-	11.90	-	16.00, 18.50, 14.90	
Fines	ha	-	0.10	-	0.00	

1 - Due to flow similarities, 95th percentile Pre-Operation model results are provided as a proxy.
2 - Monitoring not yet completed for 2014/2015 Operation.
3 - The difference in wetted area is an artefact of modeling. It is expected that the differences in wetted area between 2011 Flood and 2011/2012 Operation are less than indicated.
4 - Substrate composition measured three times during 2011/2012 Closure. Results listed in chronological order: June 2013, September 2013, June 2014.

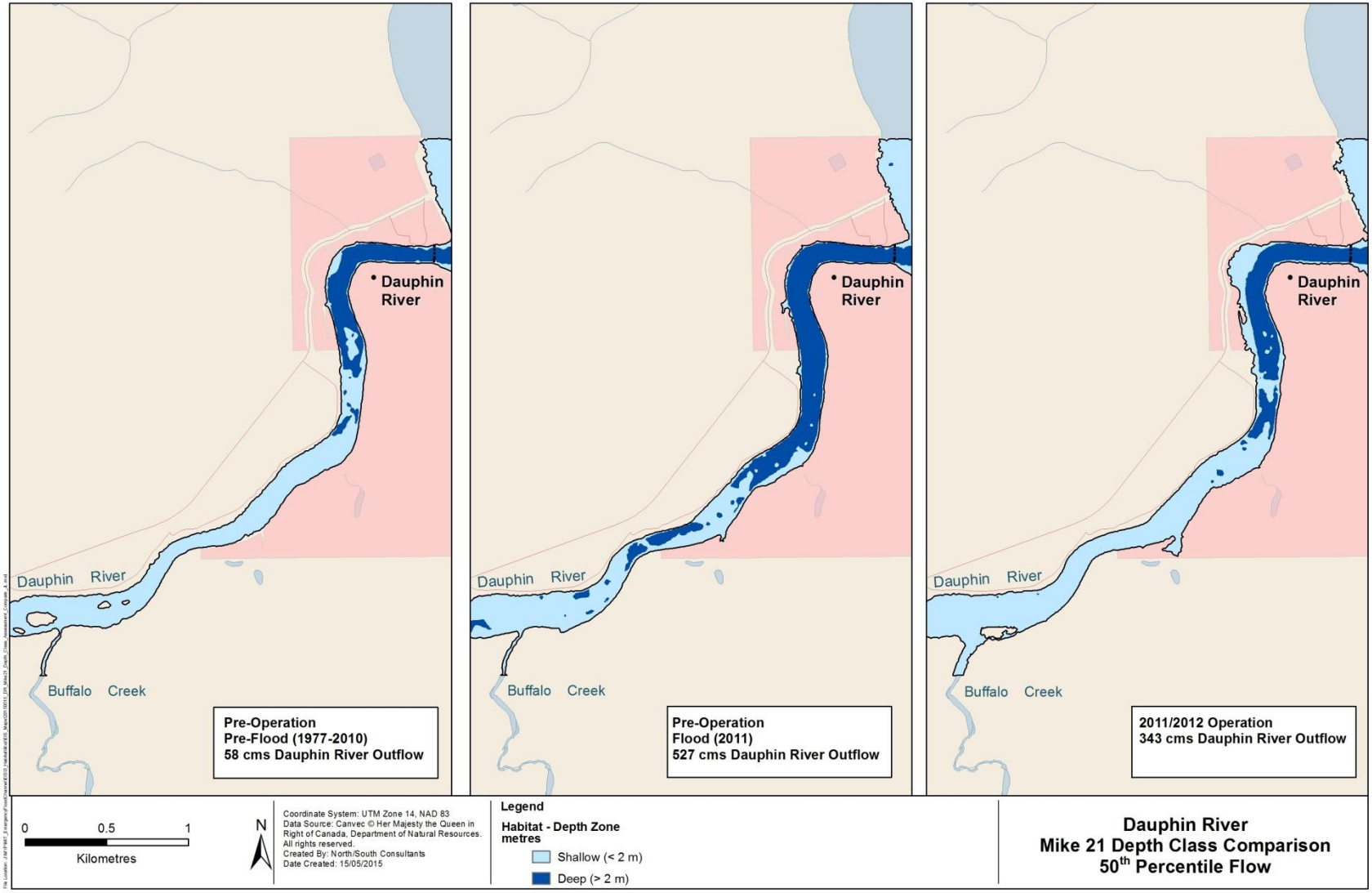


Figure 6.5-1. MIKE 21 model output for water depth (at 50th percentile flow) in the lower Dauphin River during the Pre-flood period, the 2011 Flood period, and 2011/2012 Operation phase of the Project.

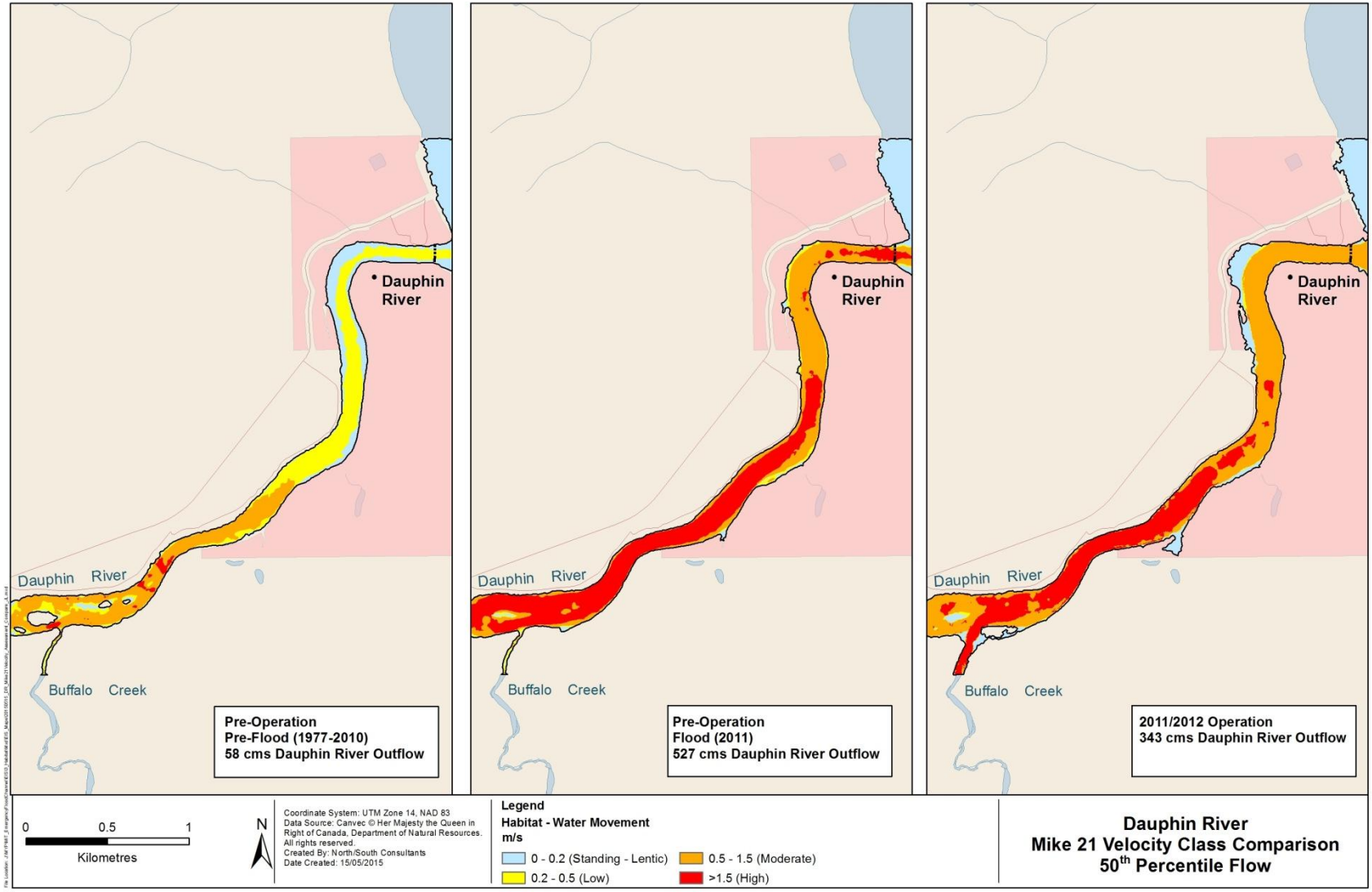


Figure 6.5-2. MIKE 21 model output for water velocities (at 50th percentile flow) in the lower Dauphin River during the Pre-flood period, the 2011 Flood period, and the 2011/2012 Operation phase of the Project.

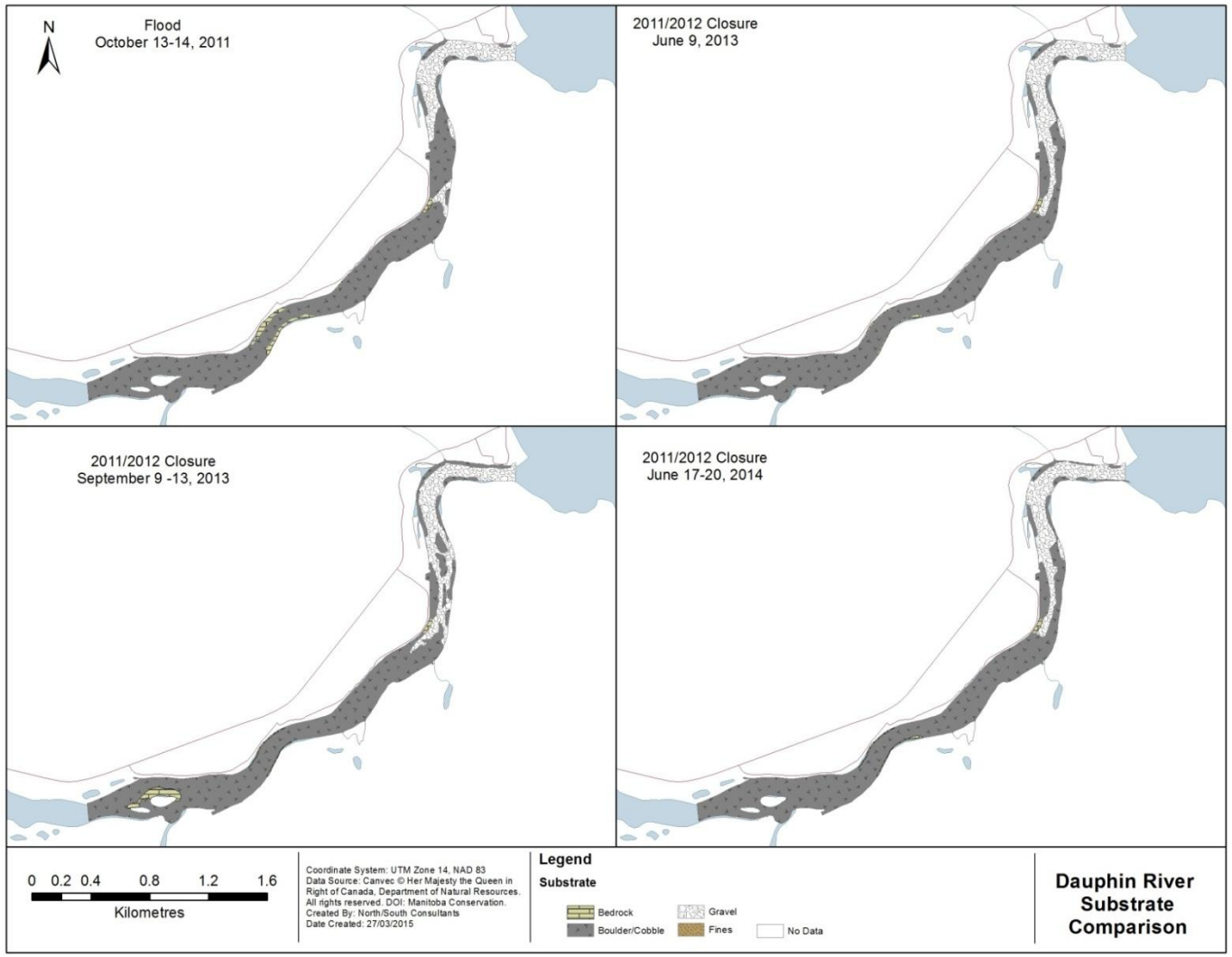


Figure 6.5-3 A comparison of the substrate distribution within the lower Dauphin River during the 2011 Flood period and three time periods during 2011/2012 Closure.

6.6 STURGEON BAY MONITORING RESULTS

6.6.1 Pre-Operation

The Partners for the Saskatchewan River Basin (2009) reported that a large proportion of the bottom terrain of Lake Winnipeg is underlain with hummocky, undulating Precambrian Shield bedrock. Lake Agassiz clays extend to approximately 50 m deep in the south basin and over 100 m deep in the north basin, while more recent sediment deposits rarely exceed 10 m in depth (Thorleifson et al. 1998; The Partners for the Saskatchewan River Basin 2009). Fine-grained sediments (sand) deposited in glacial Lake Agassiz rest directly on bedrock over most of the nearshore habitat (Figure 6.6-1), while clay/silt mud dominates the offshore sediments (Thorleifson et al. 1998; EC and MWS 2011).

A limited amount of depth information provided along a narrow transportation corridor from the north basin of Lake Winnipeg into Dauphin River (by the Canadian Hydrographic Service; mapped by the Manitoba Geological Society) suggests a maximum depth of about 10.4 m at the northern end of the bay (EC and MWS 2011). Wind-driven sediment re-suspension (through wave action) in Sturgeon Bay results in turbidity levels that are generally higher than in other areas of the north basin of Lake Winnipeg (McCullough et al. 2001).

Median flow on the Dauphin River increased from 58 m^3/s during Pre-flood to 527 m^3/s during 2011 Flood (Table 6.6-1), resulting in an increase in water depth and higher water velocity conditions at the Dauphin River mouth (Figure 6.6-2; Appendix 6A). Although water velocity within the majority of the area modeled was less than 0.5 m/s, a small portion of the area (< 0.5%) was characterized by water velocity greater than 1.5 m/s, a condition that would not have occurred under median flow conditions prior to the flood (Table 6.6-1; Figure 6.6-2).

Pre-Operation substrate conditions in Sturgeon Bay were mapped during fall 2011 (Flood 2011), but high winds occurring through much of the fall greatly restricted the extent of the survey to a small area (1.33 km^2) in the vicinity of the Dauphin River mouth. Substrate in the area was primarily cobble/boulder and gravel (Table 6.6-1; Figure 6.6-3).

Although wind conditions prevented extensive substrate mapping from being conducted, ponar grabs were collected over a broad area in fall 2011 (Figure 6.6-4). Results indicated that substrates in a band along the southwest shore of Sturgeon Bay between the Dauphin River outflow and Willow Point were generally comprised of either rock or a mixture of rock and fines (Figure 6.6-4). Areas farther offshore were entirely comprised of fines (clay, silt and/or sand), with rock and/or cobble substrates occurring infrequently in small isolated locations.

Laboratory analysis of sediment samples revealed that along each transect the proportion of sand in samples generally decreased as distance from shore increased (Table 6.6-2), while the reverse was true for silt and clay. Samples from the offshore extensive zone were predominantly clay. Total organic carbon ranged from 0.2-3.91%, and the relative proportion of organic carbon increased with distance offshore (Table 6.6-2).

6.6.2 2011/2012 Operation

Modeling conducted by Manitoba Hydro prior to operation of Reach 1 indicated that the volume of water flowing out of Reach 1 would have a negligible effect on water level in Lake Winnipeg (contributing less than 2.5 cm to water level on the lake; KGS and AECOM 2011). Water level during operation (measured by Water Survey of Canada at gauge 05RD005; Berens River) ranged from 217.4 to 218.0 mASL.

Median flow on the lower Dauphin River during the 2011/2012 Operation was 343 m^3/s (Table 6.6-1). MIKE 21 modeling indicated that maximum water velocity at the Dauphin River mouth (and extending into Sturgeon Bay) during 2011/2012 Operation was lower than it had been during 2011 Flood (Figure 6.6-2). Mean water velocity within the area modeled was characterized by low velocity conditions (< 0.5 m/s; Table 6.6-1).

An empirical model used to estimate the amount of suspended sediment mobilized as a result of Reach 1 operation indicated that between November 2011 and November 2011, an additional 8,900 m^3 of suspended sediment entered Sturgeon Bay as a result of 2011/2012 Operation, most of which entered during the first month of operation (PESV Section 4.6.2). Further discussion regarding suspended sediment introduction into Sturgeon Bay is provided in the following section.

Ice processes on Lake Winnipeg do not appear to have been affected by Project operation.

6.6.3 2011/2012 Closure

Water level on Lake Winnipeg ranged from 217.3 to 218.2 mASL and median discharge on the lower Dauphin River was 212 m^3/s during the 2011/2012 Closure period (Table 6.6-1). MIKE 21 modeling indicated that water velocities at the mouth of the Dauphin River decreased in response to lower flow on the Dauphin River, but remained higher than those estimated for historical Pre-flood conditions (Table 6.6-1; Figure 6.6-2).

It is estimated that an additional 2,200 m^3 of suspended sediment from Buffalo Creek was introduced into Sturgeon Bay during 2011/2012 Closure. Conservatively, assuming that flows in Buffalo creek would have been negligible without operation of Reach 1, the residual effects of 2011/2012 Operation contributed 2,200 m^3 of suspended sediment to the Dauphin River and, ultimately, Sturgeon Bay.

In general, the introduction of suspended sediments from the Dauphin River is a naturally occurring process. During the high flow conditions that occurred during 2011/2012 Operation and 2011/2012 Closure, approximately 11,100 m^3 of the 157,000 m^3 of suspended sediments that were introduced into Sturgeon Bay from the Dauphin River were attributed to the operation of Reach 1 (Table 6.6-3), representing a 7.6% increase in suspended sediment introduction attributed to Reach 1 operation. As would be expected, a higher percent increase (12.1%) of suspended sediment was contributed during 2011/2012 Operation.

The extent and locations where introduced suspended sediments may have deposited were examined by comparing mapped distributions of substrate types (sonar mapping), substrate composition

(qualitative assessment of substrate grabs together with particle size and total organic carbon analysis of fine sediments), and sedimentation rates between years and locations within southern Sturgeon Bay.

Substrate distributions were mapped during Pre-Operation (fall 2011) and 2011/2012 Closure (fall 2013 and spring 2014). Mapping was greatly restricted in fall 2011 because of inclement weather and, consequently, only a small area to the immediate north of the Dauphin River inflow was mapped. A considerably larger portion of Sturgeon Bay was mapped during fall 2013, but only a small area near the mouth of the Dauphin River was mapped during spring 2014 as part of Dauphin River habitat mapping.

In the small area near the Dauphin River outflow where the 2011, 2013 and 2014 sonar surveys overlap, changes in substrate composition are apparent between 2011 and 2013 (Figure 6.6-3; Table 6.6-1). In 2013, substrates directly east of the river mouth did not change, but fine materials appear to have deposited over much of the coarser substrate that occurred to the north of the river mouth. Gravel and boulder/cobble persisted in the portion of the survey area to the northeast of the river mouth, but their distribution changed somewhat and the proportion of gravel increased slightly. Substrate conditions remained consistent between 2013 and 2014.

Substrate distribution was characterized over approximately 62 km^2 of Sturgeon Bay during the fall 2013 sonar survey. The survey area began at Hay Point and followed the southwest shoreline to a point about 3.5 km beyond Willow Point, extending approximately 4 km out into Sturgeon Bay along its entire length. The survey area had a maximum depth of 8 m, with shoreline water depths increasing fairly rapidly to 3 m in the vicinity of Halfway Point and Willow Point, and a more gradual gradient in areas south of Hay Point and Willow Point (Figure 6.6-5). Nearshore substrate was dominated by fines which, at a water depth of approximately 2 m, transitioned into a band of boulder/cobble that was approximately 1 km wide and ran the entire length of the survey area, except for in the vicinity of the Dauphin River mouth, where gravel replaced boulder/cobble (Figure 6.6-6). Farther offshore (> 5 m depth), fine substrates became dominant once again. Results from substrate grabs indicated that the nearshore fines were primarily sand, while the fines at offshore sites were primarily clay and silt (Table 6.6-2).

Substrate composition was examined during Pre-Operation (fall 2011) and 2011/2012 Closure (fall 2013 and spring 2014). Substrate samples were collected along pre-established transects in Sturgeon Bay were used to assess potential changes to substrate over a large area of southern Sturgeon Bay (Figures 6.6-6 to 6.6-8). Results indicated that substrate composition at sites greater than 3 km offshore was consistent between sampling seasons (i.e., years and Project phases), while sites closer to shore occasionally exhibited changes in substrate between years. Sites near to the Dauphin River outflow were no more or less likely to experience these changes, and the majority of the observed shifts in substrate composition were from fine sediments to mixed gravels and cobbles or rock.

Despite the small, dynamic changes that were seen between years, the general trends in substrate composition along each transect endured, indicating that the habitat features identified during the 2013 sonar survey (fine sediments nearshore, a strip of boulder/cobble that follows the shoreline profile, and fines again farther offshore) persisted throughout the monitoring period. Results of laboratory analyses

performed on the grab samples indicated that silt content at most sites increased between the 2011 and 2013 samples (Table 6.6-2). These increases were uniform across all areas and transects sampled, and did not indicate a particular pattern of sedimentation. A small additional, and similarly uniform, increase in silt content was also detected at most sites between 2013 and 2014.

Sedimentation rates were generally uniform across Sturgeon Bay. Substantial changes in the rate of sedimentation were observed between periods of open water and when competent ice cover was formed (PESV Section 4.6.2). In general, sedimentation during periods of open water was much greater than when Sturgeon Bay was ice covered. McCullough et al (2001) reported that wind and wave driven sediment re-suspension was generally higher in Sturgeon Bay than other, deeper areas of Lake Winnipeg. Satellite imagery of Sturgeon Bay under different wind conditions, in different seasons and Dauphin River flow conditions, illustrates the extent to which wind plays a dominant role in sediment re-suspension within this part of the lake. A selection of Landsat satellite images were used to examine the re-suspension of sediments and resulting turbidity in Sturgeon Bay prior to and during operation of Reach 1 (Figure 6.6-9). For example, a wind driven event on 30 September 2011 (Figure 6.6-9, panel B) appears to have caused considerable re-suspension of nearshore sediments, visible as bright plumes oriented in the north and west directions, driven by a mid-day wind of 20 km/h out of the east-southeast direction. Re-suspension under lower wind speeds of 7km/h out of the same direction (Figure 6.6-9, panel A) do not appear to cause the same amount of nearshore sediment re-suspension. Although visually less prominent in June 2014, due to reduced contrast created by cloud cover, high wind conditions again out of the east-southeast direction appear to re-suspend sediment in the water column uniformly across the width of Sturgeon Bay (Figure 6.6-9, panel C). During 2014/2015 Operation, another Landsat image (Figure 6.6-9, panel D) shows the re-suspension of nearshore and offshore sediments aligned with the predominant west wind under moderate wind speeds.

The spatial extent over which suspended sediments from the Dauphin River may have deposited within Sturgeon Bay during the 2011/2012 Operation and Closure periods could not be determined. However, substrate sampling suggests that no large scale and apparent change occurred to substrate conditions over most of southern Sturgeon Bay. A small increase in the silt proportion of fine grained sediments (sands, silts, and clays) was noted at most locations and, in a small number of locations, substrate composition changed from predominantly fine-grained to coarser grained materials (gravel/cobbles).

6.6.4 2014/2015 Operation – Effects to December 2014

Field studies to monitor aquatic habitat in Sturgeon Bay have not been conducted since the initiation of 2014/2015 Operation. Based on monitoring during the first sixteen weeks of 2014/2015 Operation (July to October 2014), the Dauphin River outflow has been estimated at 430 m^3/s. While this value is higher than the average outflow for 2011/2012 Operation (343 m^3/s), it is likely to change after flows from October 2014 until closure are taken into consideration.

Empirical modeling estimates that 25,400 m^3 of suspended was transported into Sturgeon Bay via the Dauphin River during the first sixteen weeks of 2014/2015 Operation. This volume has not been adjusted to take into account background levels of suspended sediment in the Dauphin River because background levels are calculated based on average background over the entire 2014/2015 Operation

phase. When compared to the unadjusted amount of suspended sediment that entered Sturgeon Bay during the year-long 2011/2012 Operation (82,222 m^3), the volume of sediment being transported into Sturgeon Bay appears similar between the two rounds of operation.

Table 6.6-1. Aquatic habitat parameters used for assessment of effects in Sturgeon Bay.

Habitat Parameters	Units	*Measured Values/Observations*				
		Pre-Operation (Pre-flood)	Pre-Operation (2011 Flood)	2011/2012 Operation	2011/2012 Closure [1]	2014/2015 Operation [2]
Effect to habitat as a result of the Project?		-	-	*no*	*no*	
Water Surface Elevation Range [3]	mASL	216.4-219.2	217.5-218.7	217.4-218.0	217.3-218.2	218.2-218.4
50th: Dauphin River Discharge	m^3/s	58	527	343	212	430
Water Depth – Dauphin River outlet [4]						
50th: mean depth	m	2.5	3.0	2.4	2.5	-
50th: max depth	m	4.2	4.9	4.2	4.2	-
Water Velocity – Dauphin River outlet [4]						
50th: 0 - 0.2 (Standing - Lentic)	ha	90.10	72.47	67.60	77.90	-
50th: 0.2 - 0.5 (Low)	ha	1.80	9.07	15.60	8.50	-
50th: 0.5 - 1.5 (Moderate)	ha	0.00	14.35	10.50	5.70	-
50th: >1.5 (High)	ha	0.00	0.40	0.00	0.00	-
50th: max velocity	m/s	0.30	1.80	1.20	1.00	-
50th: mean velocity	m/s	0.00	0.30	0.20	0.10	-
Substrate Composition - Dauphin River outlet [4]						
Boulder/Cobble	ha	-	42.33	-	17.18	-
Gravel	ha	-	28.84	-	23.78	-
Fines	ha	-	10.82	-	41.03	-

1 - 95^{th} percentile Pre-flood values were used as a proxy for 50^{th} percentile 2011/2012 Closure.
2 - Monitoring not yet completed for 2014/2015 operation, therefore all effects are predicted.
3 - Minimum and maximum water elevation on Lake Winnipeg at Berens River (Water Survey of Canada gauge 05RD005).
4 - MIKE 21 modeling results for a small area at the mouth of the Dauphin River (see Figure 6.6-2).

Table 6.6-2. Laboratory analysis of substrate samples collected from sites in Sturgeon Bay.

Site ID [1]	Laboratory Results						Site ID	Laboratory Results					
	Total Organic Carbon (%)			Particle Size (%) Sand/Silt/Clay				Total Organic Carbon (%)			Particle Size (%) Sand/Silt/Clay		
	2011	2013	2014	2011	2013	2014		2011	2013	2014	2011	2013	2014
T-1-1	2.89	1.62	2.39	38/49/13	39/52/9	26/62/12	T-9-1 R1	2.87	2.86	2.64	27/49/24	24/59/17	29/56/15
T-1-2	2.54	2.42	2.40	37/51/12	11/76/13	18/69/14	T-9-1 R2	-	-	2.67	-	-	19/62/18
T-1-4	0.49	-	-	20/28/52	-	-	T-9-1 R3	-	-	2.58	-	-	24/59/17
T-1-KN	-	0.98	0.26	-	55/38/7	91/8/1	T-9-2	0.73	-	0.64	9/65/26	-	17/31/51
							T-9-5	0.35	-	-	100/0/0	-	-
T-2-1	3.68	3.7	3.56	3/39/58	1/51/48	1/53/46	T-9-KN	-	-	0.25	-	-	95/4/1
T-2-2	3.79	4.17	3.27	6/45/49	1/60/39	2/61/37							
T-2-3 R1	1.07	1.74	1.46	64/28/8	33/57/10	45/45/10	T-10-1	3.12	3.51	3.52	4/59/37	2/60/38	2/67/32
T-2-3 R2	-	-	1.33	-	-	44/45/11	T-10-2	-	-	n.s.	-	-	n.s.
T-2-3 R3	-	-	1.64	-	-	43/46/11	T-10-3	-	-	n.s.	-	-	n.s.
T-2-4	0.51	-	-	87/7/6	-	-	T-10-4	0.49	-		55/11/34	-	-
T-2-KN	-	0.27	0.30	-	98/1.5/0.5	94/5/0.5	T-10-5	0.22	-	0.22	99/1/0	-	99/0.5/0.7
							T-10-KN	-	0.34	0.47	-	96/3.5/0.5	90/9/0.6
T-3-1	3.52	3.97	3.35	1/45/54	1/60/39	2/63/36							
T-3-2	0.35	-	-	-	-	-	T-11-2 R1	2.43	3.83	2.61	24/56/20	17/68/15	18/66/16
T-3-3	-	-	0.76	-	-	81/15/4	T-11-2 R2	-	-	2.83	-	-	14/67/19
T-3-KN	-	0.31	0.20	-	98.7/0.6/0.7	96/4/0.1	T-11-2 R3	-	-	2.5	-	-	17/68/15
							T-11-3	0.86	-	-	78/11/11	-	-
T-4-1	3.91	4.02	3.41	3/53/44	1/69/30	2/71/27	T-11-4	-	-	-	-	-	-
T-4-2	1.24	0.86	0.52	64/25/11	77/20/3	84/13/3	T-11-5	0.59	-	0.57	60/24/16	-	94/5/1
T-4-3	0.65	-	-	92/6/2	-	-	T-11-KN	-	0.88	0.37	-	98.5/0.5/1	95/5/0.3
T-4-KN	-	0.61	n.s.	-	35/17/48	n.s.							
							T-12-1	0.79	0.58	0.29	70/20/10	96/2/2	96/3/2
T-5-1	3.72	3.75	3.68	0/32/68	2/54/44	0.4/58/42	T-12-KN	-	0.71	n.s.	-	49/19/32	n.s.
T-5-2	2.55	2.62	2.36	36/39/25	27/58/15	37/51/13							
T-5-3	0.75	0.76	0.27	80/10/10	88/9/3	94/3/2	EZ-1 R1	2.87	2.78	2.65	1/29/70	3/42/55	2/42/56
T-5-4	0.54	0.35	<0.10	97/2/1	95/4/1	95/5/1	EZ-1 R2	-	-	2.85	-	-	1/40/59
T-5-5	0.2	0.36	-	99/0/1	97/2/1	-	EZ-1 R3	-	-	2.85	-	-	1/42/57
T-5-KN	-	0.47	0.18	-	38/44/18	84/8/8	EZ-2	3.02	3.25	2.93	3/30/67	2/39/59	5/43/51
							EZ-3	3.32	3.36	3.32	1/32/67	2/40/58	1/46/53
T-6-1	3.48	3.53	3.42	1/38/61	1/46/53	1/48/51							
T-6-2	3.74	3.81	3.47	0/38/62	0/51/49	3/57/40							
T-6-3	3.89	3.95	3.99	0/39/61	0/53/47	0.3/64/36							
T-6-4	0.57	-	-	88/9/3	-	-							

1 - See Figure 6.6-4 for site locations.

Table 6.6-3. Summary of suspended sediment introduction into Sturgeon Bay during 2011/2012 Operation and 2011/2012 Closure.

Suspended Sediment Contribution [1]	Units	2011/2012 Operation	2011/2012 Closure	Combined
Dauphin River Input including Reach 1 Operation	(m^3)	82,200	74,800	157,000
Dauphin River Input without Reach 1 Operation	(m^3)	73,300	72,600	145,900
Contribution Attributed to Reach 1 Operation	(m^3)	8,900	2,200	11,100
Percent increase in due to Reach 1 Operation	(%)	12.1	3.0	7.6

1 - Suspended sediment contributions based on empirical modeling results.



Figure 6.6-1. Shoreline of Sturgeon Bay in the vicinity of the Dauphin River, August 2011.

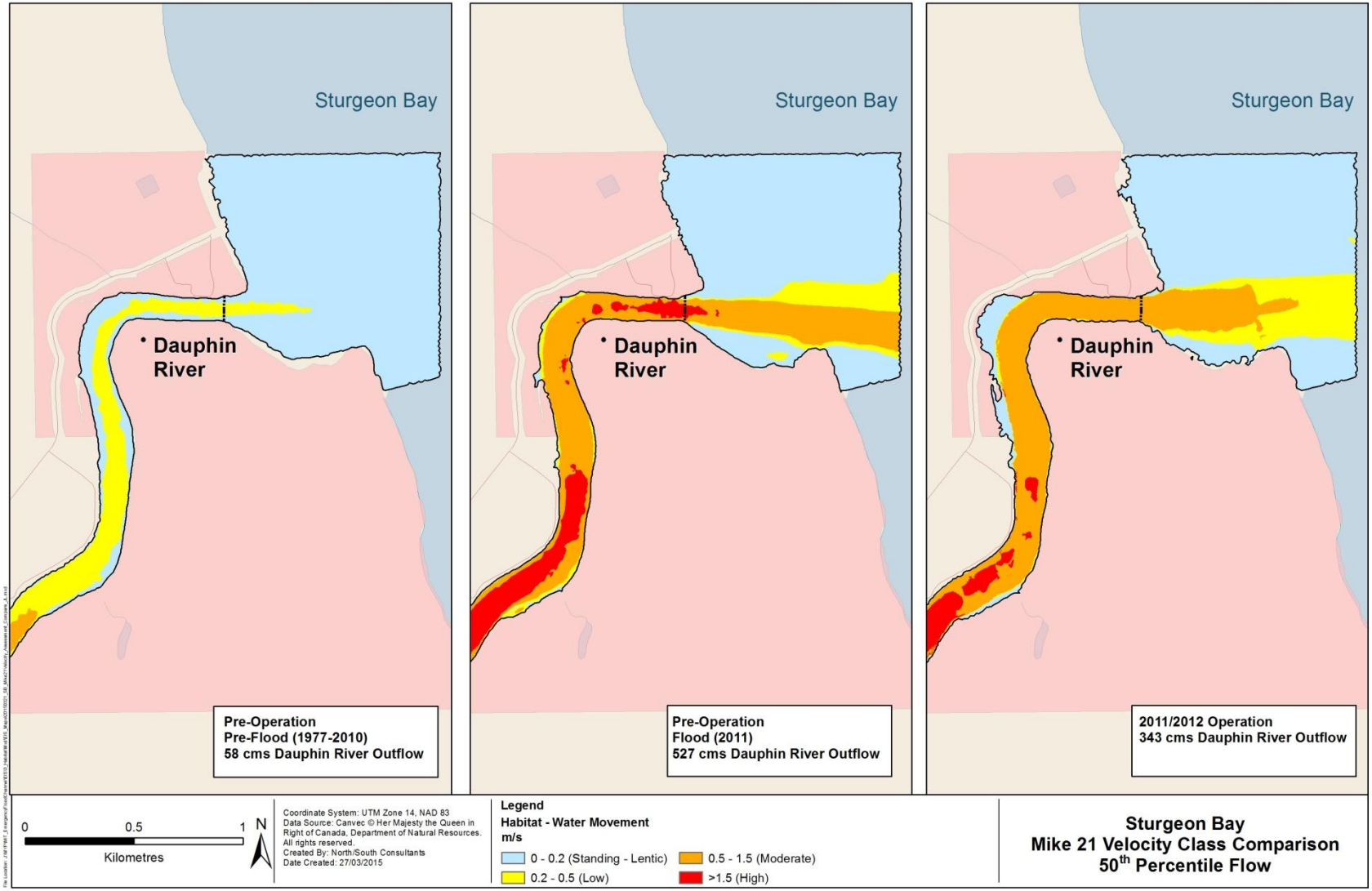


Figure 6.6-2. Comparison of 50th percentile Dauphin River outflow during the Pre-flood period, the 2011 Flood period, and 2011/2102 Operation.

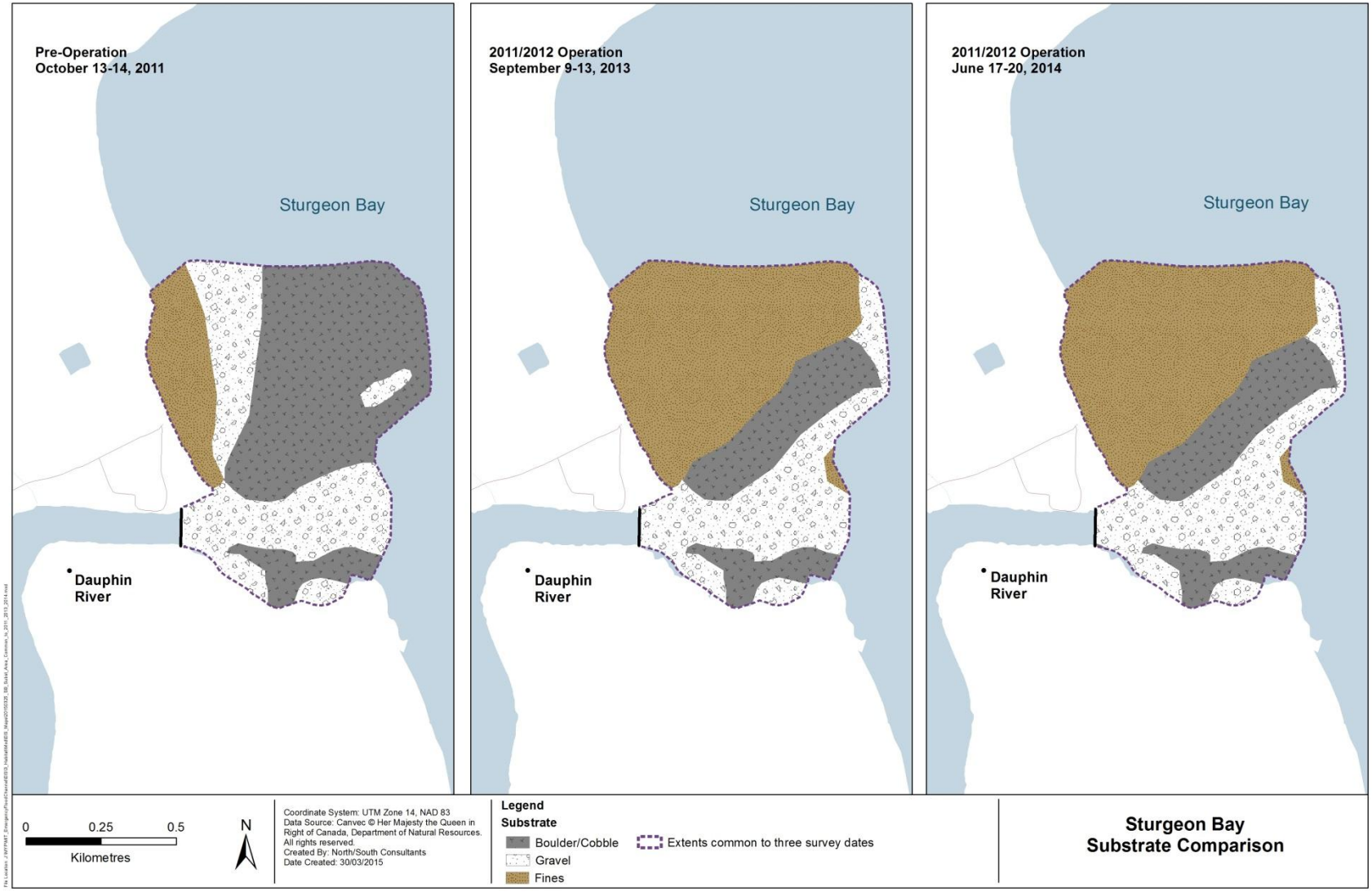


Figure 6.6-3. Comparison of Sturgeon Bay substrate near the Dauphin River outflow during Pre-Operation and Closure 2011/2012.

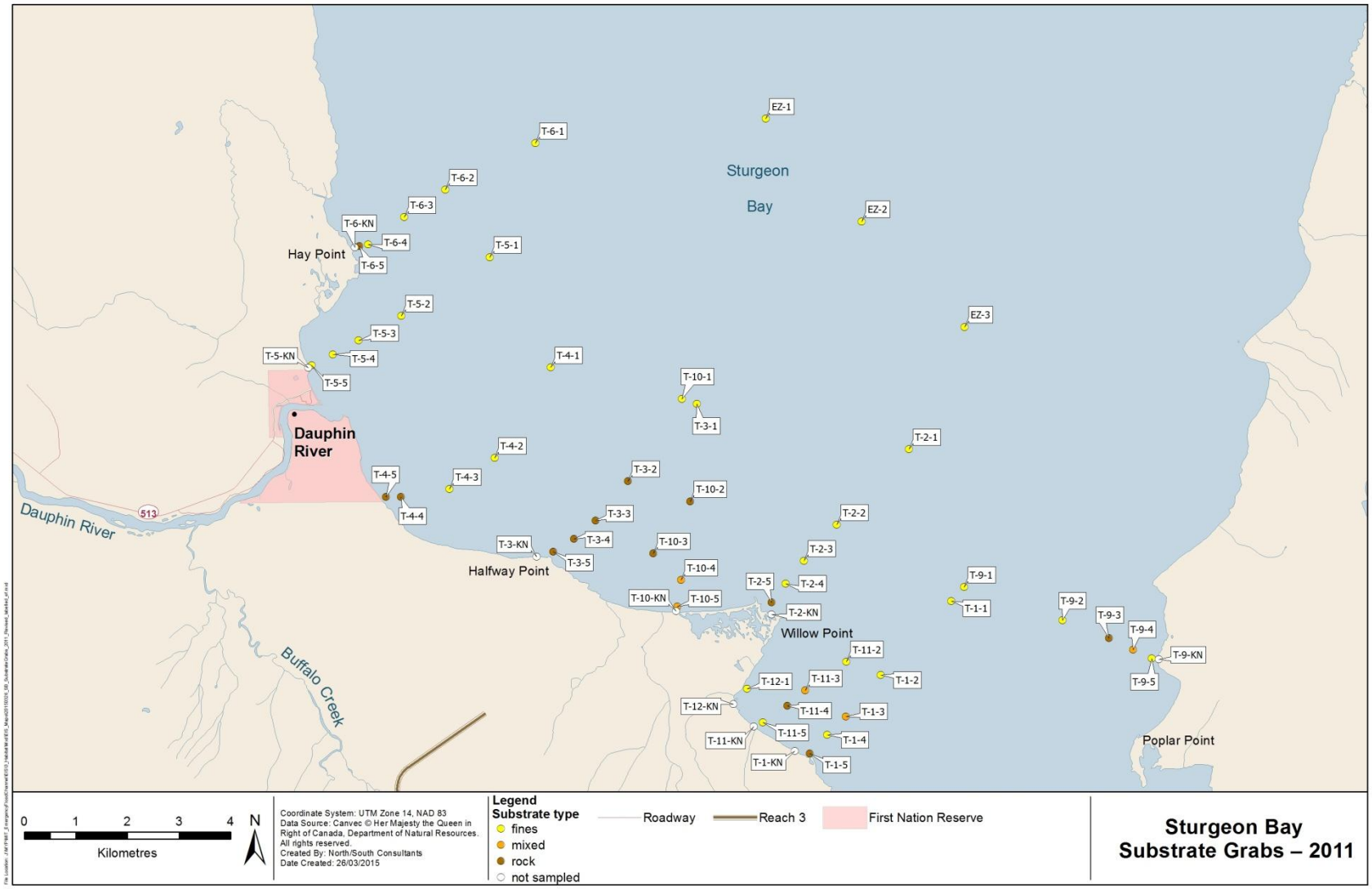


Figure 6.6-4. Substrate type classification from Ponar grab sampling conducted in Sturgeon Bay in fall 2011 (2011 Flood).

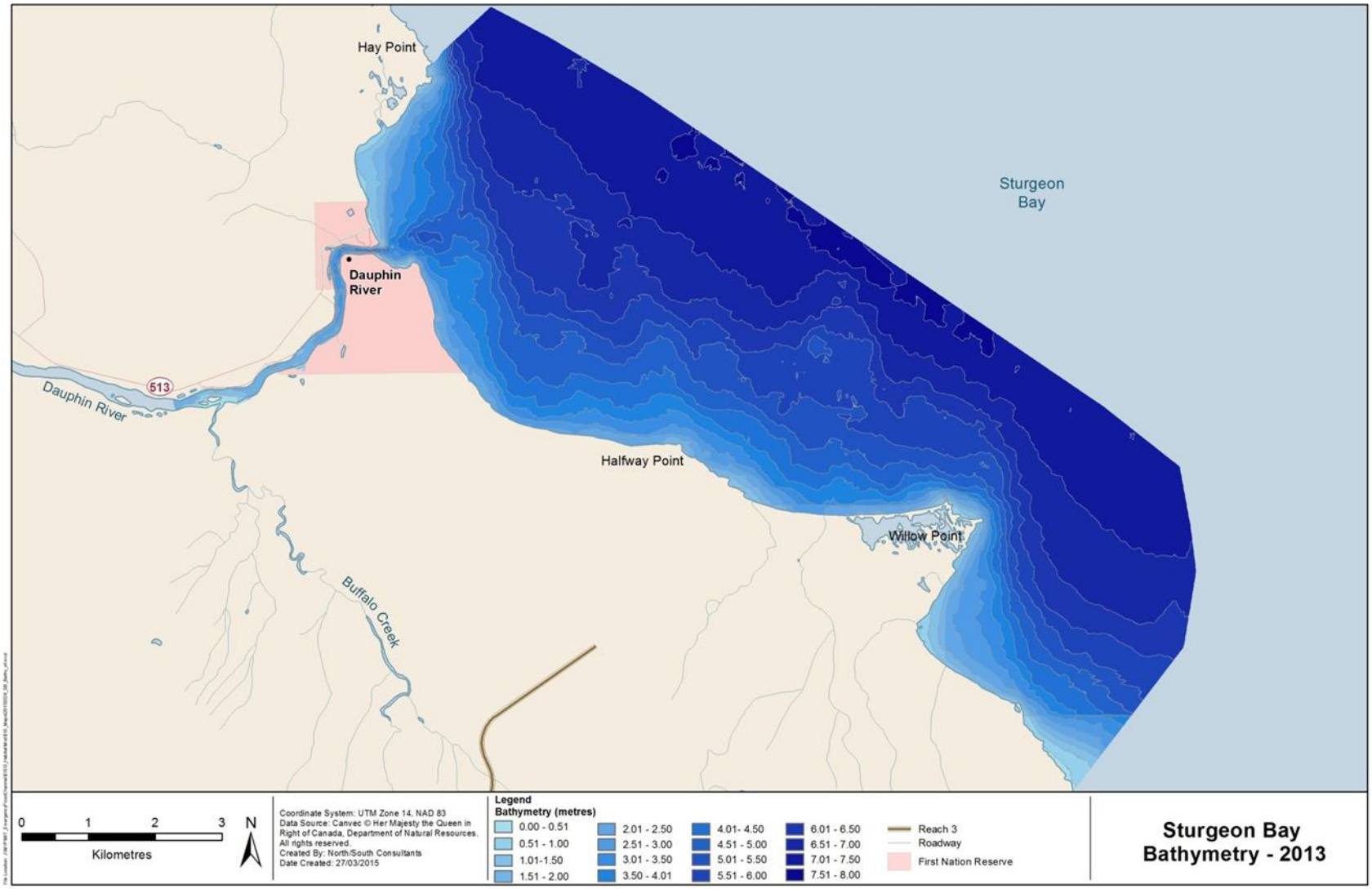


Figure 6.6-5. Results of the bathymetric survey conducted in Sturgeon Bay in fall 2013.

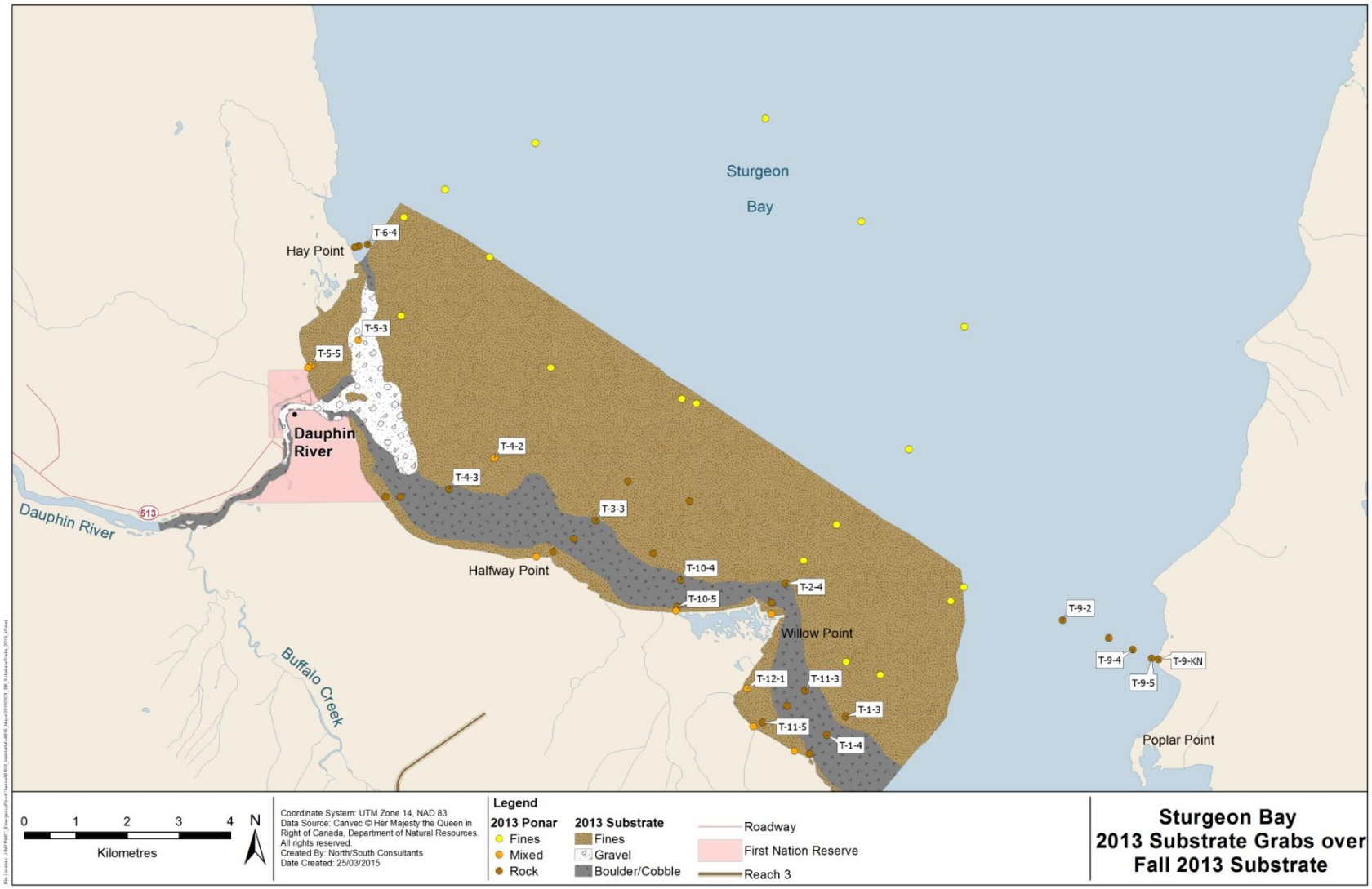


Figure 6.6-6. 2013 (2011/2012 Closure) Ponar grab sampling results superimposed on 2013 Sturgeon Bay substrate classification. Sites where Ponar grab results differ between years (2011, 2013, 2014) are marked with name labels.

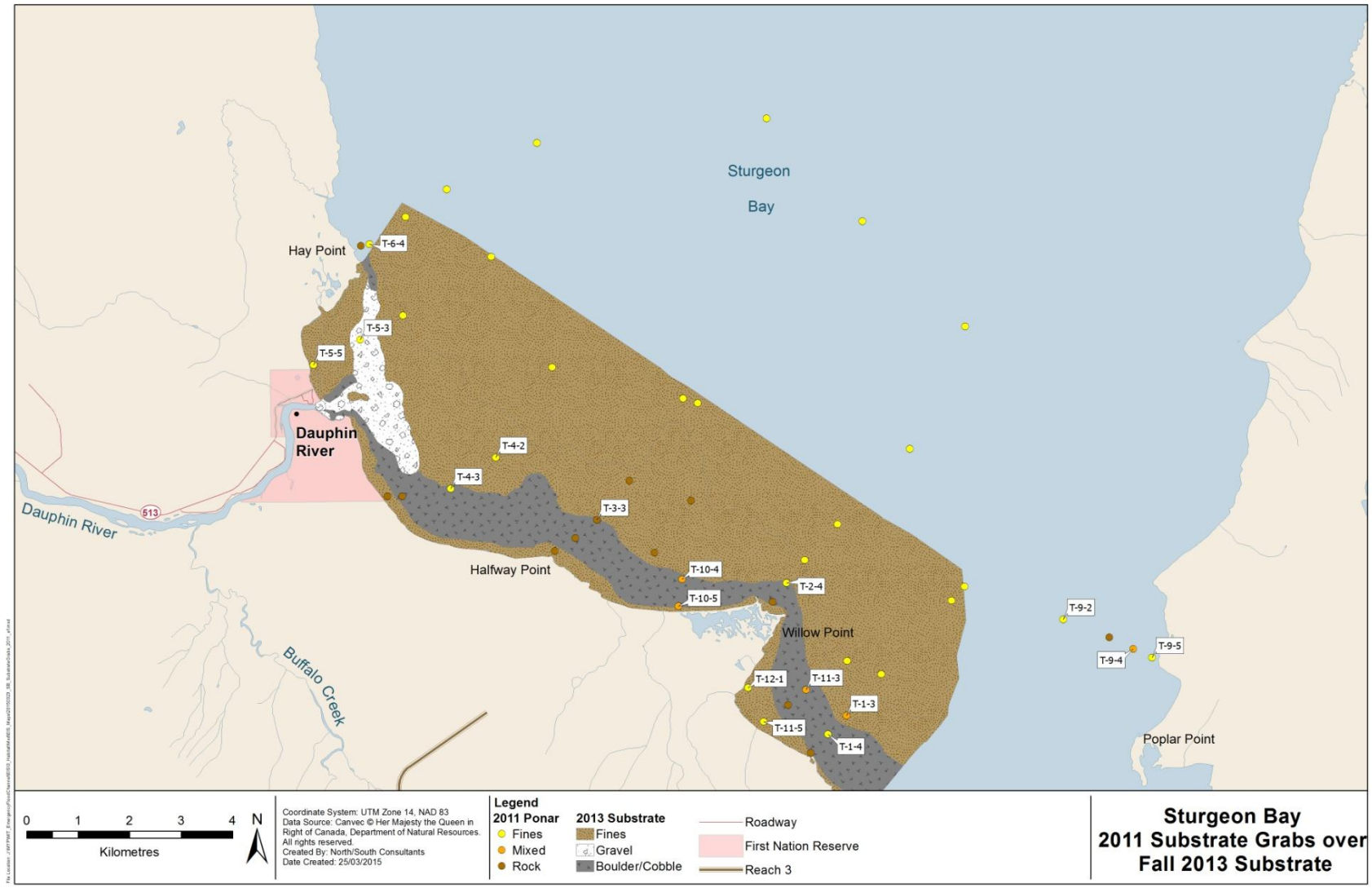


Figure 6.6-7. 2011 Flood Ponar grab sampling results superimposed on 2013 Sturgeon Bay substrate classification. Sites where Ponar grab results differ between years (2011, 2013, 2014) are marked with name labels.

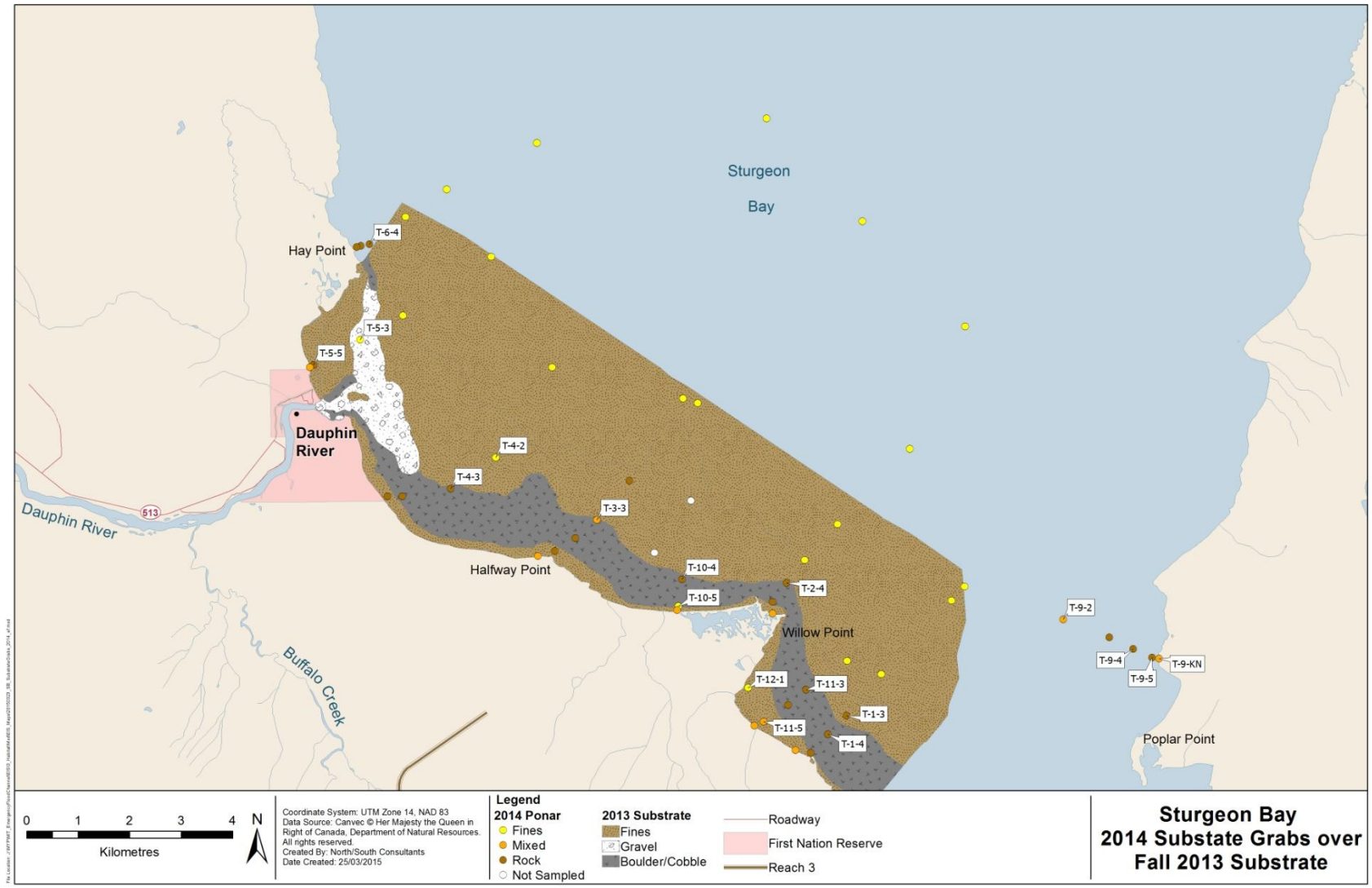


Figure 6.6-8. 2014 (2011/2012 Closure) Ponar grab sampling results superimposed on 2013 Sturgeon Bay substrate classification. Sites where Ponar grab results differ between years (2011, 2013, 2014) are marked with name labels.

A



B

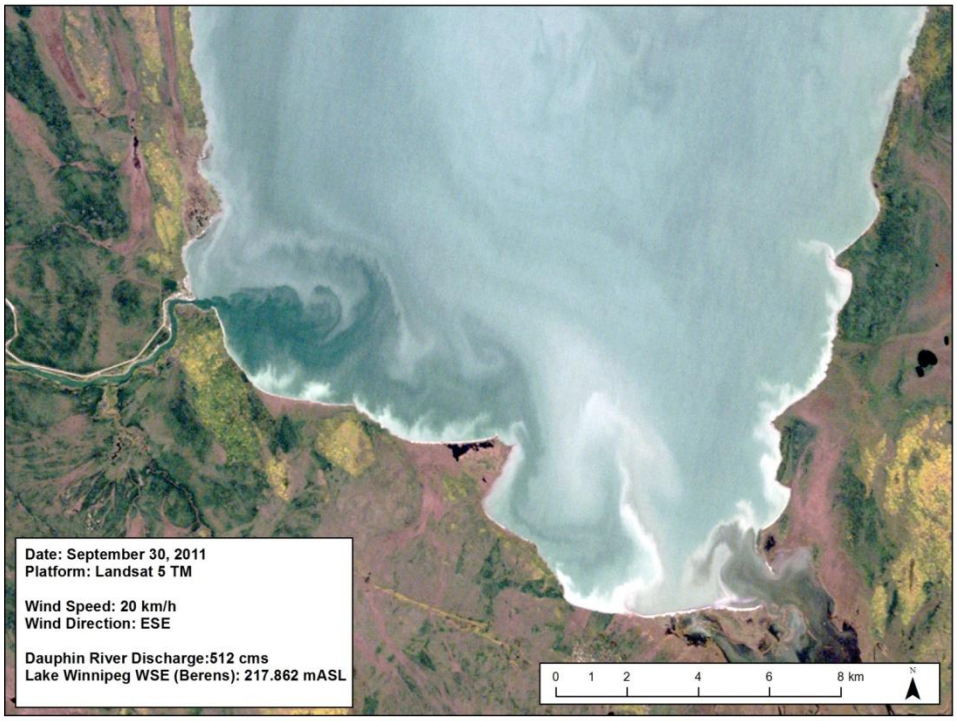
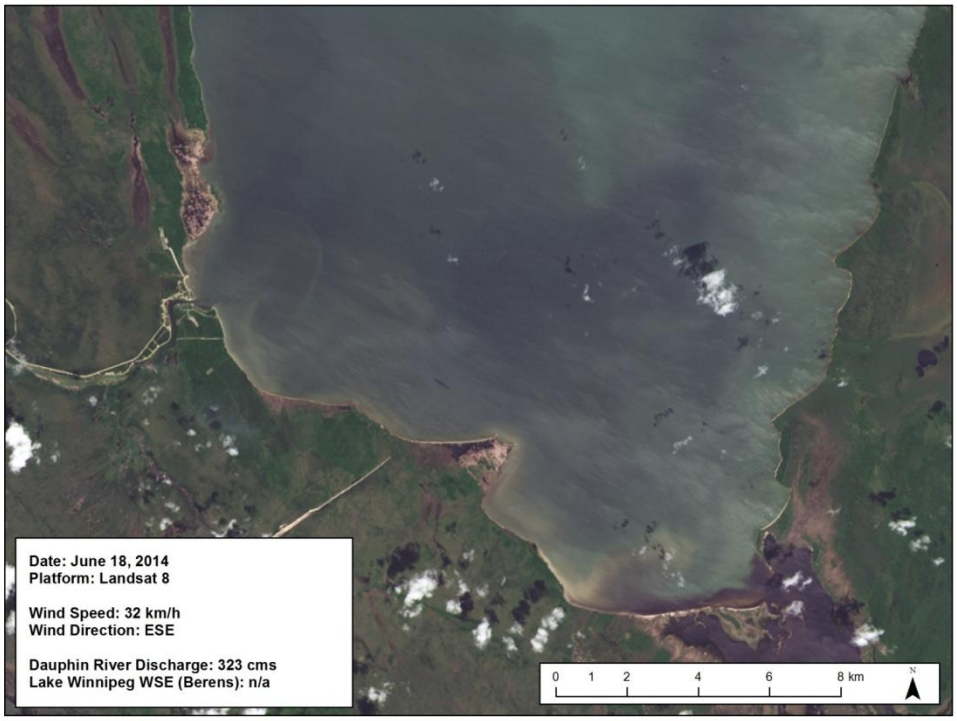


Figure 6.6-9. Satellite imagery of Sturgeon Bay under different wind conditions during the 2011 Flood period (A and B), 2011/2012 Closure (C), and 2014/2015 Operation (D).

C



D

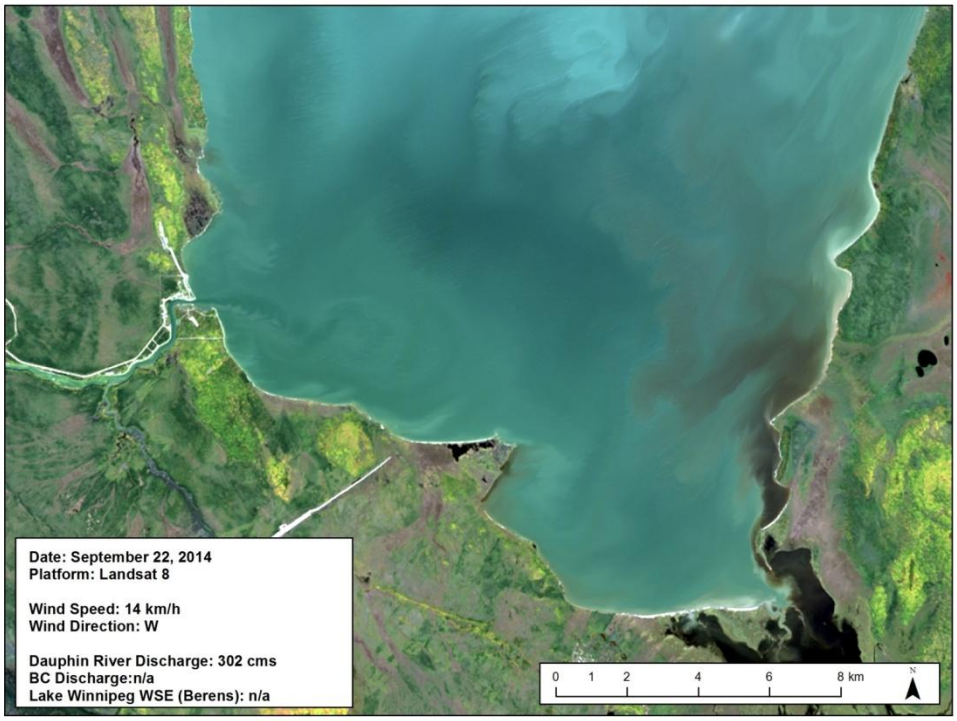


Figure 6.6-9. Continued.

6.7 REFERENCES

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low stream flow. Pages 62-73 IN: N. B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. American Fisheries Society, Western Division, Bethesda, Maryland.

Environment Canada and Manitoba Water Stewardship (EC and MWS). 2011. State of the Lake 1999 to 2007. Environment Canada Report. 222 p.

Keeyask Hydropower Limited Partnership. 2012. Keeyask Generation Project: Environmental impact statement, supporting volume: Aquatic environment. Keeyask Hydropower Limited Partnership, Winnipeg, MB

KGS and AECOM. 2011. Analysis of options for emergency reduction of Lake Manitoba and Lake St. Martin levels. A report for Manitoba Infrastructure and Transportation. 15 p.

Lake Manitoba Regulation Review Advisory Committee (LMRRAC). 2003. Regulation of water levels in Lake Manitoba and along the Fairford River, Pineimuta Lake, Lake St. Martin, and Dauphin River, and related issues. A report to the Manitoba Minister of Conservation. Volume 2: Main report. 99 p.

McCullough, G.K., K. Hocheim, and P.M. Cooley. 2001. Retrospective study of suspended sediment patterns on Lake Winnipeg using NOAA AVHRR Satellite Imagery. Report to the Department of Fisheries and Oceans, Winnipeg, Canada. v+72 pp.

McMahon, B.F. and R.M. Evans. 1992. Nocturnal foraging in the American white pelican. The Condor. 94: 101-109.

North/South Consultants Inc. 2013. Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels – Existing Aquatic Environment, Potential Impacts, and Work Plan. A draft report prepared for Manitoba Infrastructure and Transportation by North/South Consultants Inc. (November 2013). xiv + 87 p.

The Partners for the Saskatchewan River Basin. 2009. From the Mountains to the Sea. Summary of the State of the Saskatchewan River Basin. ISBN 978-0-9730693-7-2. 166 p.

Thorleifson, H., Anderson, T., Betcher, R., Bezys, R., Buhay, W., Burbidge, S., Cobb, D., Courtier, N., Doering, J., Fisher-Smith, G. Forbes, D., Franzin, W., Friesen, K., Frobel, D., Fuchs, D., Gibson, C., Henderson, P., Jarrett, K., James, T., King, J., Kling, H., Lambert, A., Last, W., Lewis, M., Lockhart, L., Matile, G., McKinnon, T., Moran, K., Nielsen, E., Pullan, S., Rack, F., Risberg, J., Rodrigues, C., Salki, A., Schröder-Adams, C., Stainton, M., Telka, A., Todd, B., Vance, R. and Weber, W. 1998: Status of the Lake Winnipeg Project (NTS 62I, 62P, 63A, 63B, 63G, and 63H). In: Manitoba Energy and Mines, Geological Services, Report of Activities, 1998: 196 – 209.

Traverse, M. J. 1999. Analyzing the effects of the Fairford Dam on Lake St. Martin First Nation. A thesis submitted to the Faculty of Graduate Studies in partial fulfillment of the requirements for the

Degree of Master of Science. Department of Native Studies. University of Manitoba. Winnipeg, Manitoba. 112 p.

Wardrop Enginneering Inc. 2001. Review of background information for the Fairford River Water Control Structure (FRWCS) Project. Little First Nation; structural microbiological and civil assessment – 114 homes and 8 community building, July 2001. 9 p.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. Journal of Geology 30: 377-392 pp.

Appendix 6A. Aquatic Habitat Assessment Analysis Results

Provided Within: Results of Aquatic Habitat Assessment Analysis

6A 1.1 MIKE 21 MODELING RESULTS

The tabular and graphical results of the MIKE 21 modeling data are presented below. Three water regime scenarios were provided: Pre-flood (1977 – 2010), 2011 Flood (based on data from 01 April to 01 November 2011), and 2011/2012 Operation, complete with simulated flows for low flow (5th percentile flow,) median flow (50th percentile flow), and high flow (95th percentile flow). The Pre-flood and 2011 Flood periods are two separate components of the Pre-Operation phase of the Project. The AHSV presents tabular and graphical data that are derived from these data sets.

6A 1.1.1 Total Habitat Area

Tables 6A.1 – 6A.3 present total habitat areas under 5th, 50th, and 95th percentile flow conditions for Buffalo Creek, Dauphin River, and Sturgeon Bay, respectively, for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation).

6A 1.1.2 Water Level Habitat Zones

Water level habitat zone areas for intermittently exposed habitats and predominantly wetted habitats for Buffalo Creek, the lower Dauphin River, and Sturgeon Bay for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation) are presented in Tables 6A-4 - 6A-6 and mapped in Figures 6A-1 - 6A-3.

6A 1.1.3 Water Depth and Water Velocity

Tables 6A-7 - 6A-9 present shallow and deep water depth zone areas for 5th, 50th, and 95th percentile flow conditions in Buffalo Creek, Dauphin River, and Sturgeon Bay, respectively, for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation).

Tables 6A-10 – 6A-12 present water velocity habitat class areas for 5th, 50th, and 95th percentile flow conditions in Buffalo Creek, the Lower Dauphin River, and Sturgeon Bay, respectively, for each of the Pre-Operation Pre-Flood (1977-2010), Pre-Operation Flood (2011), and 2011/2012 Operation project phases.

Table 6A-13 presents the mean and maximum depth statistics for 5th, 50th, and 95th percentile flow conditions in Buffalo Creek, the Lower Dauphin River, and Sturgeon Bay, respectively, for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation).

Table 6A-14 presents the mean and maximum velocity statistics for 5th, 50th, and 95th percentile flow conditions in Buffalo Creek, the Lower Dauphin River, and Sturgeon Bay, respectively, for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation).

Figures 6A-4 – 6A-12 present the water velocity classes and the shallow and deep water depth zone areas side by side for 5th, 50th, and 95th percentile flow conditions in Buffalo Creek, Dauphin River, and Sturgeon Bay, respectively, for all three water regime scenarios (Pre-flood, 2011 Flood, and 2011/2012 Operation).

6A 1.2 HEC-RAS MODELING RESULTS

The tabular and graphical results of the HEC-RAS modeling data are presented below. The AHSV presents tabular and graphical data that are derived from these data sets.

6A 1.2.1 Reach 1 Total Habitat Areas

Table 6A-15 presents the total wetted habitat area under 5th, 50th, and 95th percentile flow conditions for Reach 1 during 2011/2012 Operation. Table 6A-16 presents total habitat area for Reach 1 for 2011/2012 Closure.

6A 1.2.2 Reach 1 Habitat Variables

Wetted channel width, mean cross section velocity and maximum channel depth for 5th, 50th, and 95th percentile flows during 2011/2012 Operation are presented in Table 6A-17. The habitat variable ranges are presented graphically in Figure 6A-13. Wetted channel width, mean cross section velocity and maximum channel depth for 2011/2012 Closure are presented in Table 6A-18.

6A 1.2.3 Buffalo Creek Total Habitat Areas

Table 6A-19 presents the total wetted habitat area under 5th, 50th, and 95th percentile flow conditions for Buffalo Creek and the 95th percentile flow condition for Big Buffalo Lake bog during 2011/2012 Operation.

The total wetted area for Buffalo Creek includes the modeled data output from both HEC-RAS and MIKE 21. The overlapped area was removed from the MIKE 21 data set to show a complete extent of the wetted area under all flow conditions. This was completed within the GIS by clipping and deleting the overlapping section of the HEC-RAS Lidar data, and then recalculating the area.

6A 1.2.4 Buffalo Creek Habitat Variables

Wetted channel width, mean cross section velocity, and maximum channel depth for 5th, 50th, and 95th percentile flows for 2011 Flood, 2011/2012 Operation, and 2011/2012 Closure are presented in Tables 6A-20 - 6A-22, respectively. The habitat variable ranges are presented graphically in Figures 6A-14 - 6A-22.

Table 6A-1. Total habitat areas for the lower ~300 m of Buffalo Creek under 5th, 50th, and 95th percentile flow conditions during Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh.

Flow Percentile	Pre-Operation				2011/2012 Operation	
	Pre-flood		2011 Flood			
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
5th	5665	0.6	5609	0.6	13660	1.4
50th	5666	0.6	5952	0.6	25434	2.5
95th	5677	0.6	6283	0.6	25921	2.6

Table 6A-2. Total habitat areas for the Lower Dauphin River under 5th, 50th, and 95th percentile flow conditions during Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh.

Flow Percentile	Pre-Operation				2011/2012 Operation	
	Pre-flood		2011 Flood			
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
5th	499266	49.9	673766	67.4	645970	64.6
50th	610657	61.1	701336	70.1	754900	75.5
95th	647043	64.7	709347	70.9	764675	76.5

Table 6A-3. Total habitat areas for the area of Sturgeon Bay near the mouth of the Dauphin River under 5th, 50th, and 95th percentile flow conditions during Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh. (Note: These areas do not take into account water level fluctuations on Lake Winnipeg).

Flow Percentile	Pre-Operation				2011/2012 Operation	
	Pre-flood		2011 Flood			
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
5th	918607	91.9	963492	96.3	932676	93.3
50th	919059	91.9	963493	96.3	937850	93.8
95th	921709	92.2	963493	96.3	953182	95.3

Table 6A-4. Water level habitat zone areas for the lower ~300 m of Buffalo Creek during Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Habitat Zone	Pre-Operation				2011/2012 Operation	
	Pre-flood		2011 Flood			
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
Intermittently Exposed	12	0.0	674	0.1	12262	1.2
Predominantly Wetted	5665	0.6	5609	0.6	13660	1.4
Total	5677	0.6	6283	0.6	25921	2.6

Table 6A-5. Water level habitat zone areas for the Lower Dauphin River for Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Habitat Zone	Pre-Operation				2011/2012 Operation	
	Pre-flood		2011 Flood			
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
Intermittently Exposed	147777	14.8	35582	3.6	118705	11.9
Predominantly Wetted	499266	49.9	673766	67.4	645970	64.6
Total	647043	64.7	709347	70.9	764675	76.5

Table 6A-6. Water level habitat zone areas for Sturgeon Bay for Pre-Operation and 2011/2012 Operation. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Habitat	Pre-Operation				Operation	
	Pre-flood		2011 Flood		Operation I	
	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
Intermittently Exposed	3102	0.3	0	0.0	20506	2.1
Predominantly Wetted	918607	91.9	963492	96.3	932676	93.3
Total	921709	92.2	963493	96.3	953182	95.3

Table 6A-7. Depth zone habitat areas for the lower ~300 m of Buffalo Creek during the Pre-Operation and 2011/2012 Operation periods at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Depth Habitat Class (m)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	Deep (> 2 m)	0	0.0	0	0.0	0	0.0
	Shallow (< 2 m)	5598	0.6	5562	0.6	13680	1.4
50th	Deep (> 2 m)	0	0.0	0	0.0	0	0.0
	Shallow (< 2 m)	5625	0.6	5922	0.6	25416	2.5
95th	Deep (> 2 m)	0	0.0	0	0.0	9	0.0
	Shallow (< 2 m)	5634	0.6	6273	0.6	25929	2.6

Table 6A-8. Depth zone habitat areas for the Lower Dauphin River during Pre-Operation and 2011/2012 Operation at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Depth Habitat Class (m)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	Deep (> 2 m)	239841	24.0	239886	24.0	163485	16.3
	Shallow (< 2 m)	259551	26.0	434205	43.4	482544	48.3
50th	Deep (> 2 m)	136755	13.7	316035	31.6	173088	17.3
	Shallow (< 2 m)	473877	47.4	385587	38.6	581139	58.1
95th	Deep (> 2 m)	151605	15.2	348030	34.8	254583	25.5
	Shallow (< 2 m)	495468	49.5	361584	36.2	509697	51.0

Table 6A-9. Depth zone habitat areas for Sturgeon Bay during Pre-Operation and 2011/2012 Operation at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Depth Habitat Class (m)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	Deep (> 2 m)	767889	76.8	767889	76.8	664011	66.4
	Shallow (< 2 m)	150678	15.1	195417	19.5	268704	26.9
50th	Deep (> 2 m)	629325	62.9	769914	77.0	637740	63.8
	Shallow (< 2 m)	289656	29.0	193392	19.3	299718	30.0
95th	Deep (> 2 m)	629280	62.9	766521	76.7	677853	67.8
	Shallow (< 2 m)	292392	29.2	196785	19.7	275013	27.5

Table 6A-10. Velocity class habitat areas for the lower ~300 m of Buffalo Creek during Pre-Operation and 2011/2012 Operation at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Velocity Habitat Class (m/s)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	0 - 0.2 (Standing - Lentic)	2574	0.3	2457	0.2	972	0.1
	0.2 - 0.5 (Low)	2268	0.2	2340	0.2	594	0.1
	0.5 - 1.5 (Moderate)	828	0.1	756	0.1	6903	0.7
	>1.5 (High)	0	0.0	9	0.0	5031	0.5
50th	0 - 0.2 (Standing - Lentic)	2556	0.3	2700	0.3	8424	0.8
	0.2 - 0.5 (Low)	2340	0.2	2583	0.3	369	0.0
	0.5 - 1.5 (Moderate)	729	0.1	639	0.1	2295	0.2
	>1.5 (High)	0	0.0	0	0.0	14319	1.4
95th	0 - 0.2 (Standing - Lentic)	2574	0.3	2853	0.3	6570	0.7
	0.2 - 0.5 (Low)	2340	0.2	2925	0.3	1179	0.1
	0.5 - 1.5 (Moderate)	711	0.1	495	0.0	2844	0.3
	>1.5 (High)	9	0.0	0	0.0	15345	1.5

Table 6A-11. Velocity class habitat areas for the Lower Dauphin River during the Pre-Operation and 2011/2012 Operation periods at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Velocity Habitat Class (m/s)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	0 - 0.2 (Standing - Lentic)	417879	41.8	23229	2.3	26082	2.6
	0.2 - 0.5 (Low)	49689	5.0	54054	5.4	73287	7.3
	0.5 - 1.5 (Moderate)	30105	3.0	404802	40.5	439551	44.0
	>1.5 (High)	153	0.0	192006	19.2	105120	10.5
50th	0 - 0.2 (Standing - Lentic)	133263	13.3	18261	1.8	76023	7.6
	0.2 - 0.5 (Low)	243558	24.4	29448	2.9	18459	1.8
	0.5 - 1.5 (Moderate)	222309	22.2	259146	25.9	416169	41.6
	>1.5 (High)	11502	1.2	394785	39.5	243954	24.4
95th	0 - 0.2 (Standing - Lentic)	19854	2.0	18675	1.9	64926	6.5
	0.2 - 0.5 (Low)	52434	5.2	27999	2.8	12267	1.2
	0.5 - 1.5 (Moderate)	416673	41.7	204795	20.5	248841	24.9
	>1.5 (High)	158103	15.8	458145	45.8	438516	43.9

Table 6A-12. Velocity class habitat areas for Sturgeon Bay during Pre-Operation and 2011/2012 Operation at a 5th, 50th, and 95th percentile flows. Areas are derived from the spatial analysis of the MIKE 21 hydraulic model computational mesh outputs.

Flow Percentile	Velocity Habitat Class (m/s)	Pre-Operation				2011/2012 Operation	
		Pre-flood		2011 Flood			
		Area (m^2)	Area (ha)	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
05th	0 - 0.2 (Standing - Lentic)	918468	91.8	805554	80.6	793170	79.3
	0.2 - 0.5 (Low)	0	0.0	80703	8.1	98847	9.9
	0.5 - 1.5 (Moderate)	0	0.0	77049	7.7	36252	3.6
	>1.5 (High)	0	0.0	0	0.0	0	0.0
50th	0 - 0.2 (Standing - Lentic)	901143	90.1	507555	50.8	676233	67.6
	0.2 - 0.5 (Low)	17838	1.8	271899	27.2	156312	15.6
	0.5 - 1.5 (Moderate)	0	0.0	179460	17.9	105237	10.5
	>1.5 (High)	0	0.0	4392	0.4	0	0.0
95th	0 - 0.2 (Standing - Lentic)	779031	77.9	742023	74.2	666972	66.7
	0.2 - 0.5 (Low)	85410	8.5	68652	6.9	93582	9.4
	0.5 - 1.5 (Moderate)	57231	5.7	138645	13.9	189423	18.9
	>1.5 (High)	0	0.0	13986	1.4	3231	0.3

Table 6A-13. Mean and maximum depth statistics for the lower ~300 m of Buffalo Creek, the Lower Dauphin River and the immediate area of Sturgeon Bay resulting from the analysis of MIKE 21 hydraulic model derived depth rasters.

Reach	Water Regime	Percentile	Maximum Depth (m)	Mean Depth (m)
Buffalo Creek	Pre-Operation Pre-flood	5th	0.5	0.2
		50th	0.4	0.2
		95th	0.4	0.2
	Pre-Operation 2011 Flood	5th	0.5	0.2
		50th	0.9	0.2
		95th	1.0	0.2
	2011/2012 Operation	5th	1.3	0.7
		50th	1.8	0.6
		95th	2.0	0.7
Dauphin River	Pre-Operation Pre-flood	5th	4.9	2.2
		50th	4.2	1.2
		95th	4.2	1.4
	Pre-Operation 2011 Flood	5th	4.9	1.8
		50th	4.9	2.0
		95th	4.9	2.1
	2011/2012 Operation	5th	4.3	1.4
		50th	4.5	1.4
		95th	4.5	1.7
Sturgeon Bay	Pre-Operation Pre-flood	5th	4.9	3.2
		50th	4.2	2.5
		95th	4.2	2.5
	Pre-Operation 2011 Flood	5th	4.9	3.0
		50th	4.9	3.0
		95th	4.8	3.0
	2011/2012 Operation	5th	4.3	2.5
		50th	4.2	2.4
		95th	4.3	2.5

Table 6A-14. Mean and maximum velocity statistics for the lower ~300 m of Buffalo Creek, the Lower Dauphin River and the immediate area of Sturgeon Bay resulting from the analysis of MIKE 21 hydraulic model derived velocity rasters.

Reach	Water Regime	Percentile	Maximum Velocity (m/s)	Mean Velocity (m/s)
Buffalo Creek	Pre-Operation Pre-flood	5th	1.5	0.3
		50th	1.5	0.3
		95th	1.5	0.3
	Pre-Operation 2011 Flood	5th	1.5	0.3
		50th	1.2	0.3
		95th	1.2	0.2
	2011/2012 Operation	5th	4.5	1.5
		50th	7.6	1.6
		95th	5.1	1.7
Dauphin River	Pre-Operation Pre-flood	5th	1.6	0.1
		50th	2.7	0.5
		95th	3.0	1.1
	Pre-Operation 2011 Flood	5th	2.8	1.2
		50th	4.4	1.6
		95th	4.4	1.7
	2011/2012 Operation	5th	4.9	1.0
		50th	3.8	1.2
		95th	5.7	1.5
Sturgeon Bay	Pre-Operation Pre-flood	5th	0.1	0.0
		50th	0.3	0.0
		95th	1.0	0.1
	Pre-Operation 2011 Flood	5th	0.9	0.1
		50th	1.8	0.3
		95th	2.1	0.3
	2011/2012 Operation	5th	0.8	0.1
		50th	1.2	0.2
		95th	1.8	0.2

Table 6A-15. Total wetted habitat areas of Reach 1 under 5th, 50th, and 95th percentile flows during 2011/2012 Operation.

Period	Flow Percentile	Total Wetted Area (m^2)	Total Wetted Area (ha)
2011/2012 Operation	5^{th}	336877	33.7
	50^{th}	354824	35.5
	95^{th}	374299	37.4

Table 6A-16. Total wetted habitat area of Reach 1 during 2011/2012 Closure.

Period	Flow Percentile	Total Wetted Area (m^2)	Total Wetted Area (ha)
2011/2012 Closure	n/a	305416	30.5

Table 6A-17. Reach 1 modeled HEC-RAS cross-section habitat variables for 5th, 50th, and 95th percentile flows during 2011/2012 Operation.

	5% Q = 44 m^3/s				50% Q = 125 m^3/s				95% Q = 196 m^3/s			
Cross Section Station	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Max Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Max Depth (m/s)
625	242.79	57.43	0.57	1.69	243.56	63.90	1.00	2.46	244.14	68.67	1.21	3.04
1000	242.75	57.94	0.54	1.75	243.48	64.06	0.99	2.48	244.04	68.74	1.20	3.04
1300	242.73	68.27	0.44	1.68	243.44	72.74	0.83	2.39	243.99	86.04	1.02	2.94
2000	242.67	55.74	0.53	1.82	243.29	59.93	1.05	2.44	243.79	63.32	1.30	2.94
3000	242.60	58.10	0.47	1.90	243.06	61.79	1.04	2.36	243.49	65.25	1.33	2.79
4000	242.55	62.06	0.42	2.05	242.82	64.65	1.02	2.32	243.15	67.67	1.36	2.64
5000	242.52	63.87	0.35	2.36	242.62	64.73	0.96	2.47	242.77	66.03	1.40	2.62
6000	242.50	109.65	0.27	2.80	242.50	109.65	0.77	2.80	242.50	109.65	1.22	2.80

Table 6A-18. Reach 1 modeled HEC-RAS cross section habitat variables during 2011/2012 Closure.

Cross Section Station	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)
625	241.61	47.6	0.0	0.5
1000	241.61	48.4	0.0	0.6
1300	241.61	61.2	0.0	0.6
2000	241.61	48.5	0.0	0.8
3000	241.61	50.1	0.0	0.9
4000	241.61	53.2	0.0	1.1
5000	241.61	56.1	0.0	1.5
6000	241.61	90.7	0.0	1.9

Table 6A-19. Total wetted habitat areas of Buffalo Creek under 5th, 50th, and 95th percentile flows and Big Buffalo Lake bog under 95th percentile flows during 2011/2012 Operation.

	Buffalo Creek		Big Buffalo Lake Bog	
Flow Percentile	Area (m^2)	Area (ha)	Area (m^2)	Area (ha)
5th	567077	56.7	-	-
50th	1285961	128.6	-	-
95th	2022011	202.2	17720084	1772.0

Table 6A-20. Buffalo Creek modeled HEC-RAS cross-section habitat variables for 5th, 50th, and 95th percentile flows during 2011 Flood.

Cross Section Station	5% Q = 0.5 cms				50% Q = 3.9 cms				95% Q = 6.9 cms			
	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)
13474	237.20	6.92	0.31	0.33	237.71	9.76	0.68	0.84	237.99	32.24	0.70	1.12
13984	236.87	6.57	0.48	0.23	237.25	10.39	0.93	0.61	237.43	12.14	1.10	0.79
14457	235.94	5.21	0.46	0.30	236.42	11.63	0.79	0.78	236.61	13.53	0.92	0.98
14958	235.24	4.92	0.55	0.24	235.67	9.97	0.99	0.67	235.88	18.23	0.99	0.88
15468	234.20	10.67	0.28	0.21	234.58	11.77	0.66	0.60	234.79	13.83	0.80	0.80
15984	233.71	8.22	0.33	0.32	234.15	11.61	0.68	0.76	234.38	22.45	0.73	0.98
16476	233.20	7.47	0.46	0.25	233.51	8.06	1.14	0.57	233.67	8.35	1.46	0.72
16996	232.05	7.57	0.47	0.22	232.40	8.81	1.03	0.56	232.68	23.13	0.95	0.85
17488	231.04	8.63	0.37	0.26	231.40	14.11	0.70	0.62	231.57	15.12	0.83	0.80
18005	230.44	6.91	0.43	0.23	230.81	10.57	0.87	0.60	231.00	11.46	1.05	0.79
18505	229.72	7.46	0.47	0.22	230.04	12.88	0.90	0.53	230.18	14.23	1.09	0.68
19023	228.62	9.87	0.39	0.22	228.94	15.54	0.70	0.55	229.10	17.36	0.84	0.71
19562	227.72	8.69	0.35	0.20	228.07	15.45	0.68	0.55	228.23	16.68	0.82	0.71
20127	227.16	12.90	0.31	0.22	227.45	18.32	0.63	0.52	227.61	23.54	0.73	0.68
20590	226.61	9.67	0.30	0.28	226.98	23.68	0.48	0.66	227.18	25.54	0.53	0.85
21084	226.26	7.65	0.34	0.24	226.69	10.44	0.73	0.67	226.91	11.65	0.88	0.90
21560	225.91	10.06	0.29	0.22	226.38	13.30	0.53	0.69	226.62	13.91	0.65	0.93
22048	225.62	5.68	0.38	0.31	226.09	10.73	0.73	0.78	226.29	11.38	0.91	0.98
22642	225.15	7.96	0.39	0.25	225.51	12.35	0.80	0.61	225.66	14.00	0.99	0.76
23073	224.46	7.60	0.43	0.23	224.82	13.17	0.77	0.59	224.99	16.12	0.91	0.76
23666	223.55	12.05	0.18	0.30	223.99	15.74	0.45	0.75	224.20	18.68	0.56	0.95
24203	223.37	10.23	0.38	0.19	223.69	14.52	0.74	0.51	223.85	16.08	0.88	0.67
24677	222.60	7.52	0.34	0.23	223.01	9.50	0.81	0.64	223.21	11.08	0.99	0.84
25209	222.07	7.92	0.39	0.27	222.45	13.20	0.71	0.64	222.64	14.38	0.84	0.84
25683	221.47	6.01	0.51	0.22	221.85	10.14	0.98	0.59	222.03	24.91	1.01	0.77
26281	220.39	8.98	0.20	0.43	220.87	13.30	0.52	0.90	221.07	14.72	0.66	1.10
26743	220.29	13.58	0.27	0.27	220.68	16.75	0.52	0.65	220.84	18.10	0.66	0.81
27254	219.97	8.25	0.32	0.30	220.36	21.05	0.55	0.69	220.53	25.34	0.62	0.86
27802	219.49	7.22	0.33	0.23	219.91	9.61	0.80	0.65	220.11	11.21	0.98	0.85
28282	219.03	9.70	0.36	0.25	219.36	12.59	0.76	0.59	219.54	13.64	0.92	0.76

Table 6A-21. Buffalo Creek modeled HEC-RAS cross-section habitat variables for 5th, 50th, and 95th percentile flows during 2011/2012 Operation.

Cross Section Station	5% Q = 44 cms				50% Q = 125 cms				95% Q = 196 cms			
	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)
13474	238.80	60.29	0.82	2.05	240.06	136.82	0.64	3.31	240.81	136.82	0.66	4.07
13984	238.25	32.47	1.23	1.89	239.33	39.20	1.68	2.96	240.01	46.24	1.91	3.65
14457	237.60	35.14	1.31	2.06	238.65	42.82	1.65	3.11	239.35	45.65	1.84	3.81
14958	236.55	27.88	1.43	1.75	237.60	52.83	1.70	2.80	238.28	63.85	1.71	3.48
15468	235.66	31.53	1.08	2.06	236.79	38.36	1.56	3.19	237.50	40.97	1.81	3.90
15984	235.06	41.96	1.08	1.74	236.13	54.75	1.34	2.80	236.78	59.38	1.50	3.45
16476	234.15	32.74	1.57	1.66	235.06	85.13	1.54	2.58	235.70	94.50	1.40	3.21
16996	233.09	47.73	0.77	2.06	234.26	57.98	1.05	3.23	234.97	61.09	1.21	3.94
17488	232.72	47.89	0.92	2.19	233.77	93.17	1.02	3.24	234.42	116.60	1.01	3.90
18005	232.11	53.79	1.13	2.13	233.01	64.23	1.35	3.03	233.59	94.80	1.48	3.60
18505	230.88	34.70	1.46	1.61	231.82	88.51	1.41	2.55	232.41	138.79	1.28	3.15
19023	229.89	61.34	1.10	2.01	230.93	91.44	0.98	3.05	231.50	179.80	0.97	3.61
19562	229.21	42.36	1.16	1.75	230.32	198.70	0.73	2.86	230.95	198.79	0.66	3.49
20127	228.73	74.05	0.74	2.34	229.95	204.85	0.59	3.56	230.62	204.85	0.56	4.23
20590	228.54	73.36	0.57	2.61	229.76	205.60	0.50	3.83	230.44	205.60	0.50	4.50
21084	228.24	77.59	0.78	2.32	229.47	150.82	0.63	3.55	230.15	197.66	0.61	4.24
21560	227.88	54.60	0.73	2.66	229.12	150.62	0.72	3.90	229.82	174.20	0.67	4.60
22048	227.39	32.21	1.31	2.10	228.51	96.29	1.26	3.21	229.18	152.06	1.09	3.88
22642	226.61	47.79	0.84	1.72	227.71	79.69	1.04	2.83	228.39	127.59	1.04	3.51
23073	226.02	56.69	0.83	1.97	227.24	129.37	0.75	3.18	227.96	182.80	0.69	3.90
23666	225.48	78.52	0.68	2.51	226.76	128.86	0.66	3.78	227.50	191.71	0.62	4.52
24203	224.91	42.08	1.16	1.84	226.01	51.34	1.41	2.94	226.64	60.51	1.56	3.58
24677	224.27	36.80	1.08	2.23	225.33	84.51	1.21	3.29	225.98	113.19	1.18	3.93
25209	223.76	90.72	0.78	2.40	224.78	108.98	0.77	3.42	225.46	112.20	0.83	4.10
25683	223.16	98.06	0.61	2.15	224.29	107.74	0.66	3.29	225.01	108.90	0.73	4.01
26281	222.13	70.41	0.94	2.56	223.47	81.63	0.82	3.89	224.32	142.33	0.69	4.75
26743	221.82	32.81	1.03	2.26	223.14	73.75	1.01	3.57	223.99	82.92	1.03	4.42
27254	221.50	57.64	0.80	2.02	222.90	75.30	0.87	3.43	223.77	130.91	0.85	4.30
27802	221.00	28.92	1.38	2.33	222.35	63.26	1.27	3.68	223.20	79.96	1.22	4.52
28282	220.39	29.25	1.24	1.97	221.66	64.14	1.34	3.24	222.44	87.45	1.32	4.03

Table 6A-22. Buffalo Creek modeled HEC-RAS cross-section habitat variables for 5th, 50th, and 95th percentile flows during 2011/2012 Closure.

Cross Section Station	5% Q = 0.5 cms				50% Q = 3.9 cms				95% Q = 6.9 cms			
	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)	Water Surface Elevation (m ASL)	Wetted Width (m)	Mean Velocity (m/s)	Maximum Depth (m)
13474	237.07	8.82	0.27	0.32	237.57	19.76	0.47	0.82	237.73	24.69	0.57	0.98
13984	236.63	7.73	0.34	0.27	237.06	20.41	0.55	0.70	237.24	21.27	0.62	0.88
14457	235.85	7.22	0.34	0.31	236.31	13.11	0.64	0.78	236.52	16.83	0.74	0.98
14958	235.13	9.08	0.34	0.33	235.52	16.70	0.64	0.71	235.66	18.43	0.79	0.86
15468	234.02	10.40	0.22	0.41	234.43	20.10	0.45	0.83	234.60	21.49	0.55	1.00
15984	233.63	17.43	0.25	0.30	233.93	20.27	0.51	0.61	234.09	21.64	0.62	0.77
16476	232.76	9.47	0.38	0.27	233.07	16.97	0.70	0.58	233.21	17.55	0.86	0.72
16996	231.38	6.73	0.33	0.35	231.82	27.03	0.46	0.79	231.97	32.24	0.52	0.94
17488	230.86	10.91	0.23	0.34	231.35	17.97	0.43	0.82	231.57	19.49	0.52	1.05
18005	230.35	6.50	0.36	0.37	230.82	11.13	0.68	0.83	231.04	13.35	0.81	1.06
18505	229.53	8.14	0.40	0.26	229.86	17.71	0.68	0.59	230.01	19.27	0.81	0.73
19023	228.19	9.78	0.23	0.30	228.61	16.64	0.49	0.73	228.80	17.69	0.62	0.91
19562	227.75	12.98	0.30	0.29	228.05	20.88	0.55	0.59	228.19	21.55	0.67	0.73
20127	226.76	4.79	0.37	0.37	227.38	23.25	0.51	0.99	227.55	26.51	0.57	1.16
20590	226.45	8.45	0.20	0.52	227.00	23.01	0.31	1.07	227.24	24.43	0.38	1.30
21084	226.19	8.02	0.30	0.27	226.68	11.95	0.59	0.76	226.92	12.45	0.72	1.00
21560	225.80	11.83	0.19	0.59	226.32	19.00	0.38	1.10	226.55	19.85	0.46	1.33
22048	225.61	10.33	0.23	0.31	226.05	13.85	0.54	0.75	226.26	15.45	0.66	0.96
22642	225.17	14.43	0.27	0.29	225.49	22.83	0.50	0.60	225.65	29.79	0.57	0.77
23073	224.36	9.04	0.34	0.31	224.69	15.70	0.64	0.63	224.87	17.31	0.76	0.81
23666	223.51	15.60	0.11	0.52	223.99	17.22	0.32	1.01	224.22	19.23	0.42	1.24
24203	223.36	12.05	0.31	0.30	223.69	14.68	0.67	0.62	223.85	15.43	0.83	0.79
24677	222.41	9.31	0.26	0.37	222.83	17.15	0.51	0.79	223.03	17.80	0.62	0.98
25209	221.82	11.73	0.22	0.46	222.35	16.18	0.40	0.98	222.58	16.52	0.50	1.21
25683	221.39	4.01	0.51	0.39	221.93	12.00	0.82	0.93	222.10	13.46	0.98	1.10
26281	220.15	13.03	0.10	0.58	220.64	14.98	0.34	1.07	220.87	15.31	0.45	1.29
26743	220.09	17.81	0.16	0.52	220.54	21.72	0.33	0.97	220.73	22.06	0.42	1.16
27254	219.88	8.92	0.34	0.41	220.25	18.56	0.61	0.78	220.44	22.41	0.66	0.97
27802	219.02	8.36	0.26	0.34	219.48	11.73	0.59	0.81	219.70	12.67	0.74	1.03
28282	218.62	11.59	0.27	0.20	219.01	17.08	0.55	0.59	219.18	17.74	0.68	0.77

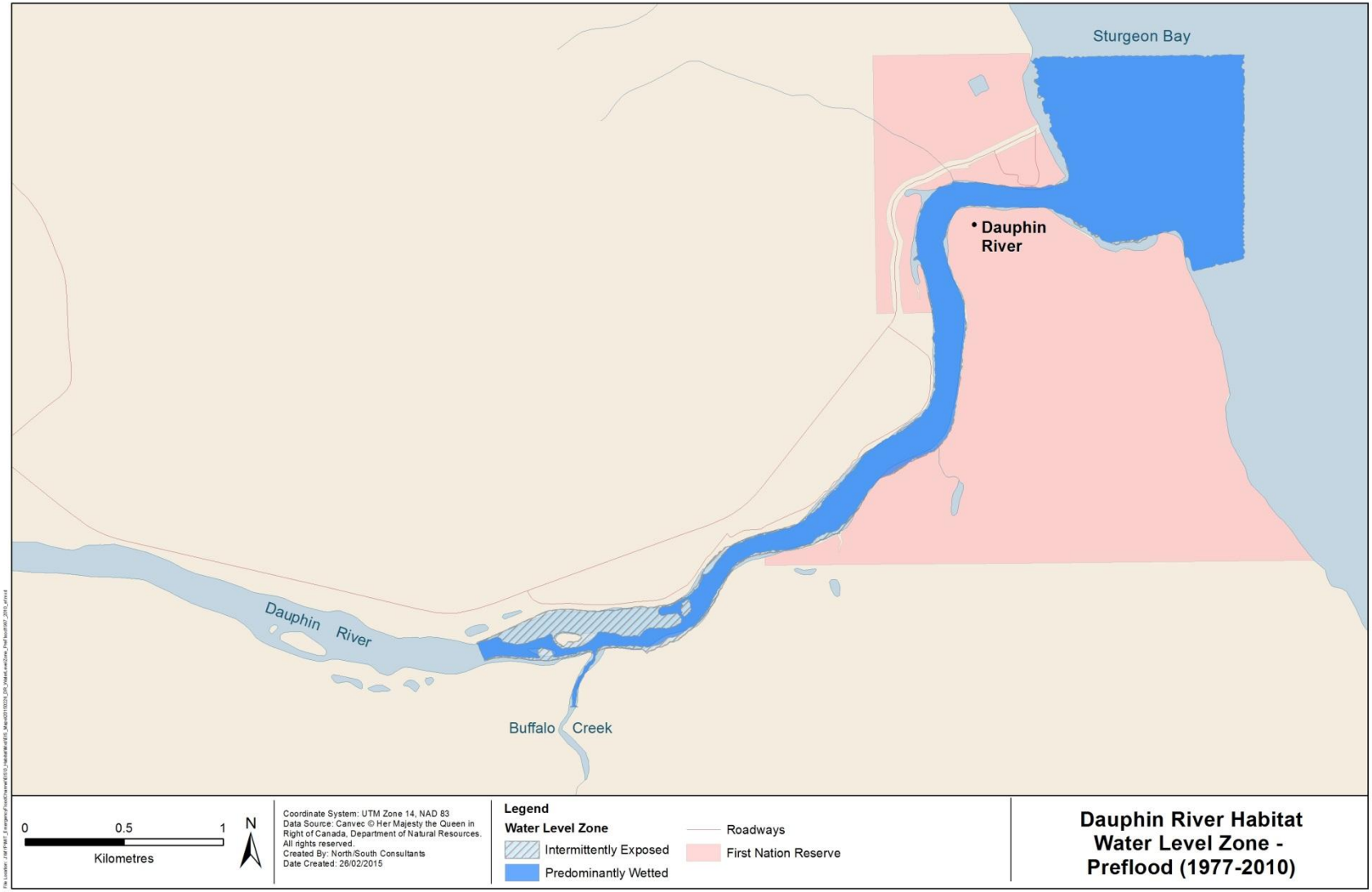


Figure 6A-1. Map showing the distribution of intermittently exposed and predominantly wetted habitat zones during the historic (Pre-flood) water regime period.

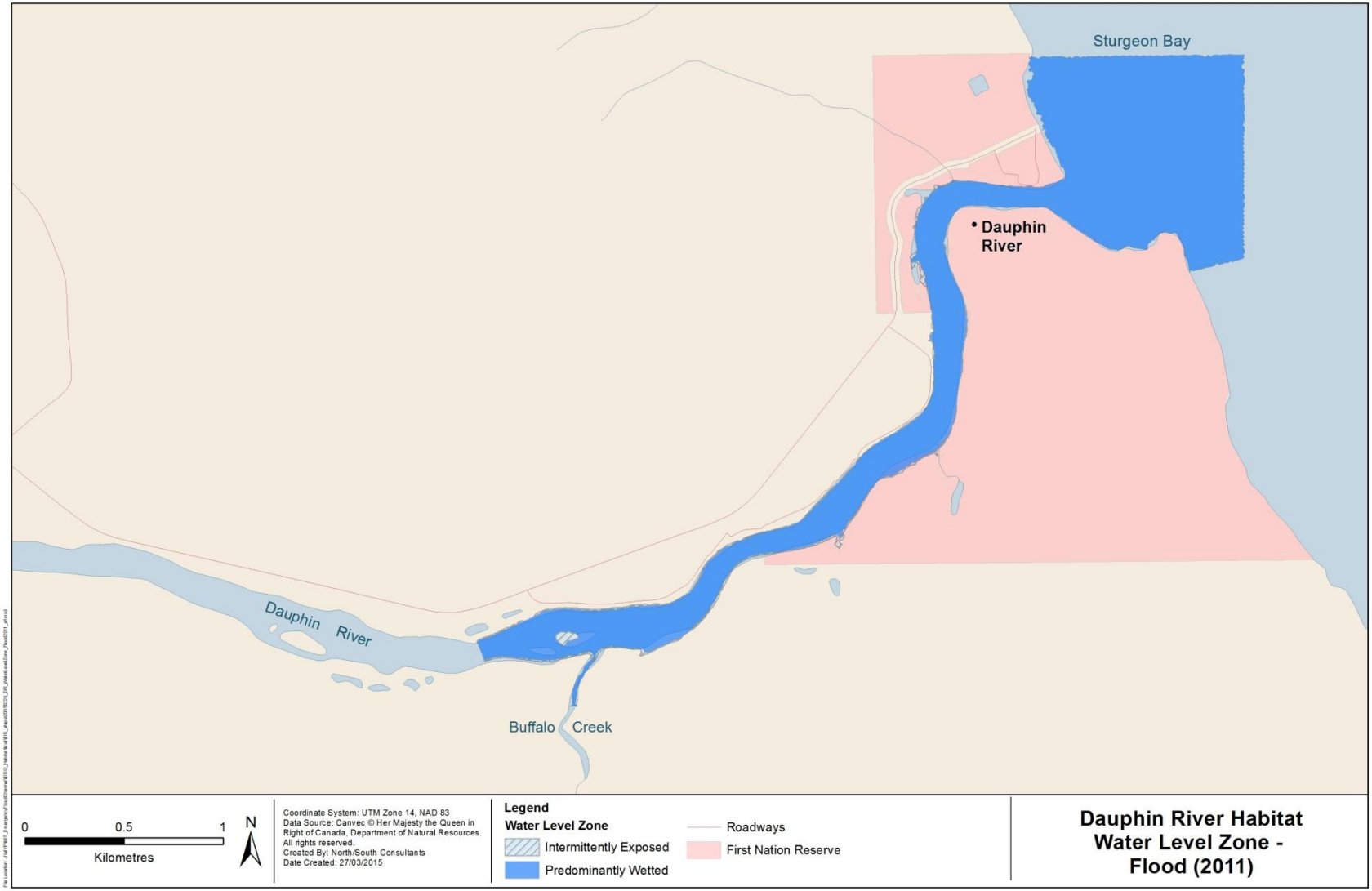


Figure 6A-2. Map showing the distribution of intermittently exposed and predominantly wetted habitat zones during the 2011 Flood water regime period.

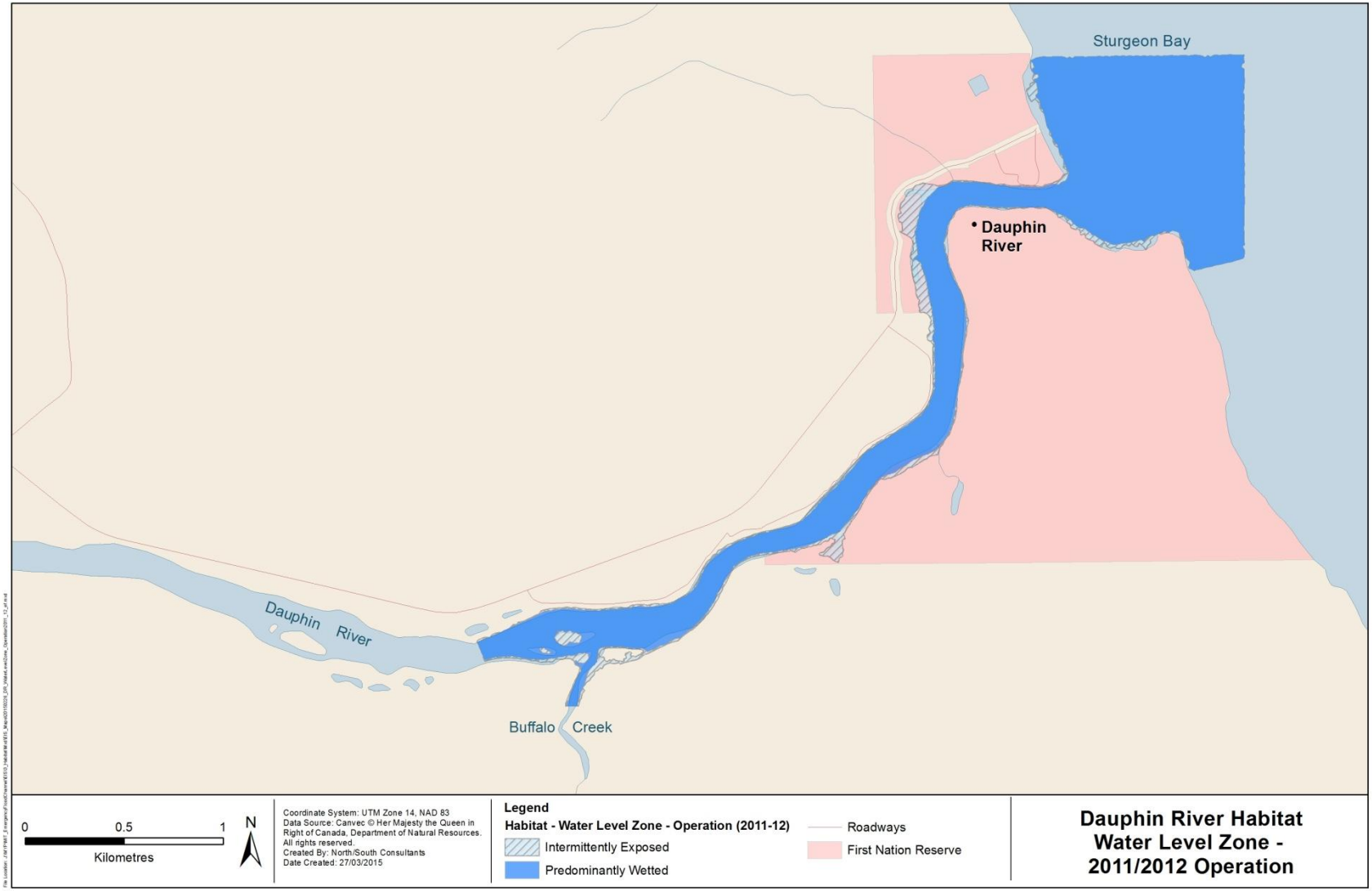


Figure 6A-3. Map showing the distribution of intermittently exposed and predominantly wetted habitat zones during the 2011/2012 Operation water regime period.

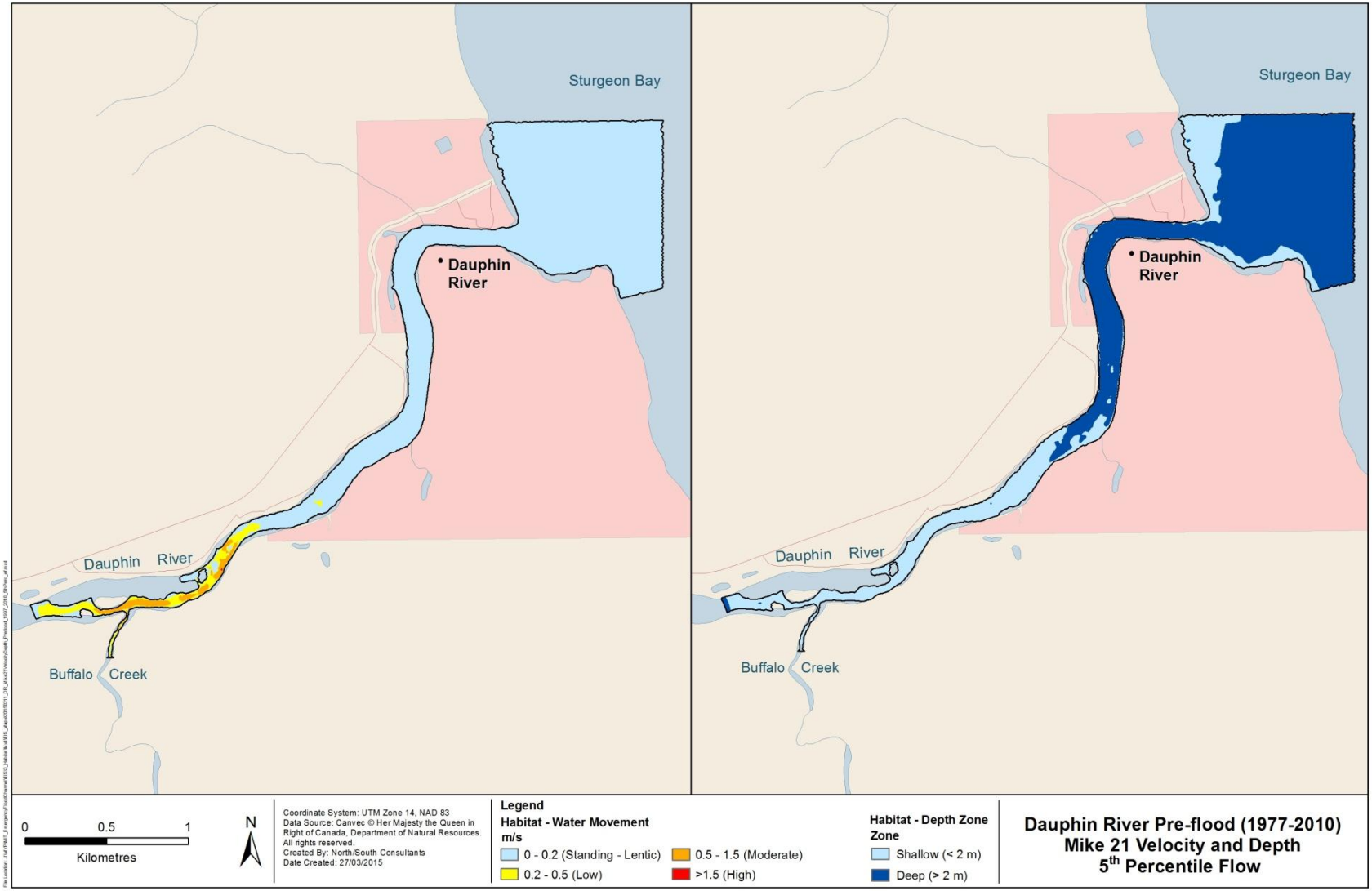


Figure 6A-4. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the historic (Pre-flood) 5th percentile (8 m^3/s) combined outflow condition.

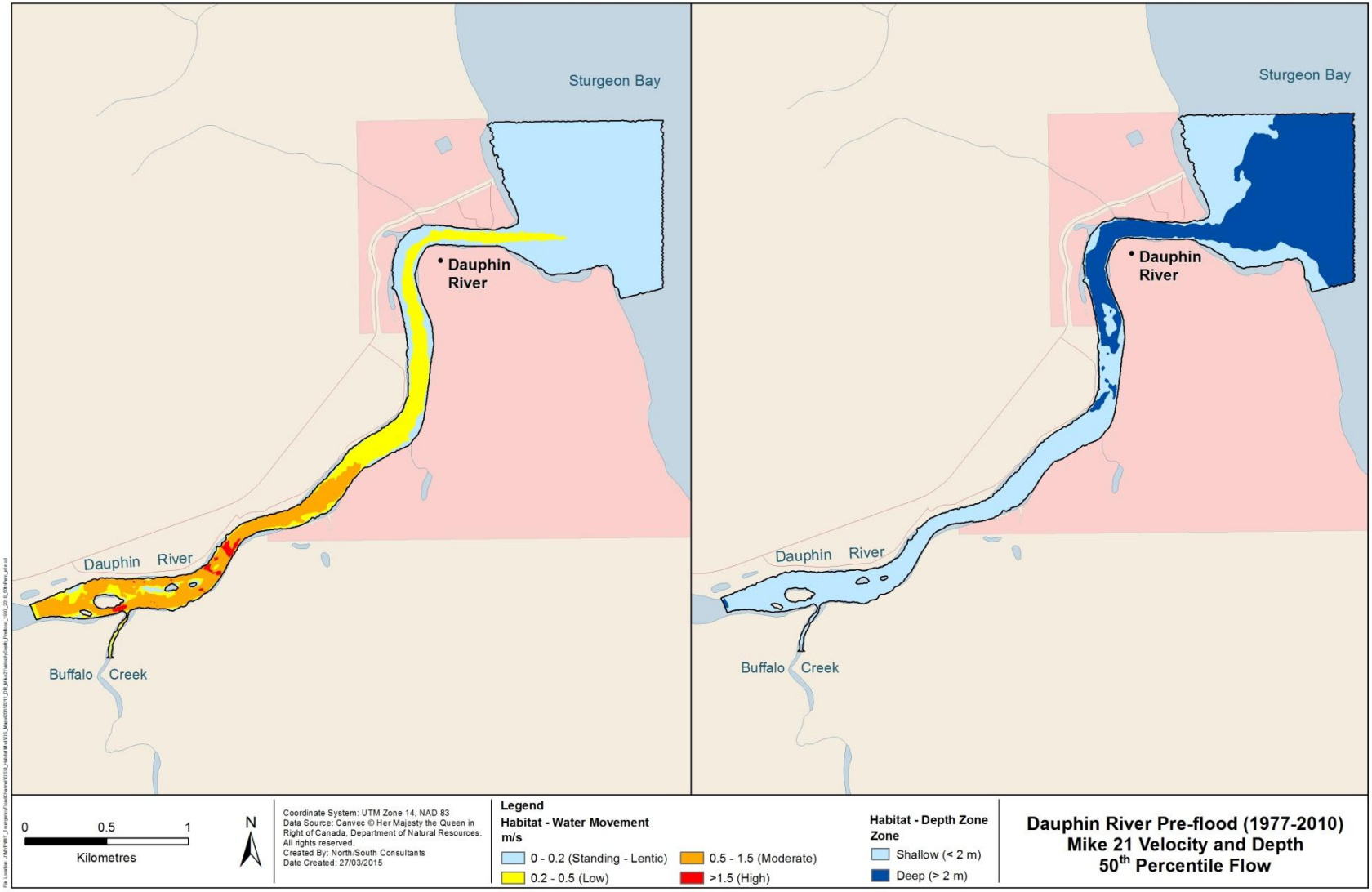


Figure 6A-5. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the historic (Pre-flood) 50th percentile (58 m^3/s) combined outflow condition.

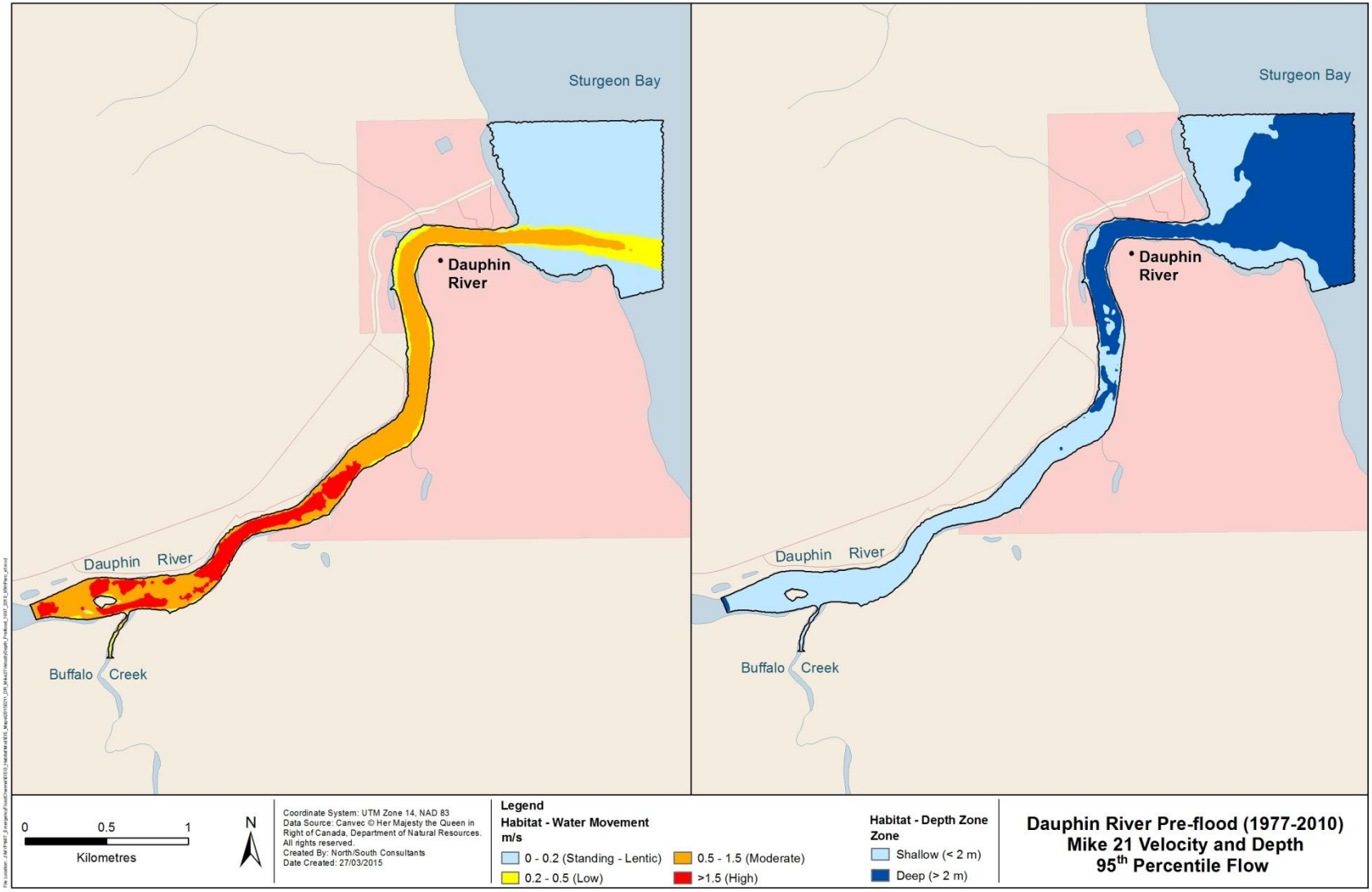


Figure 6A-6. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the historic (Pre-flood) 95th percentile (212 m^3/s) combined outflow condition.

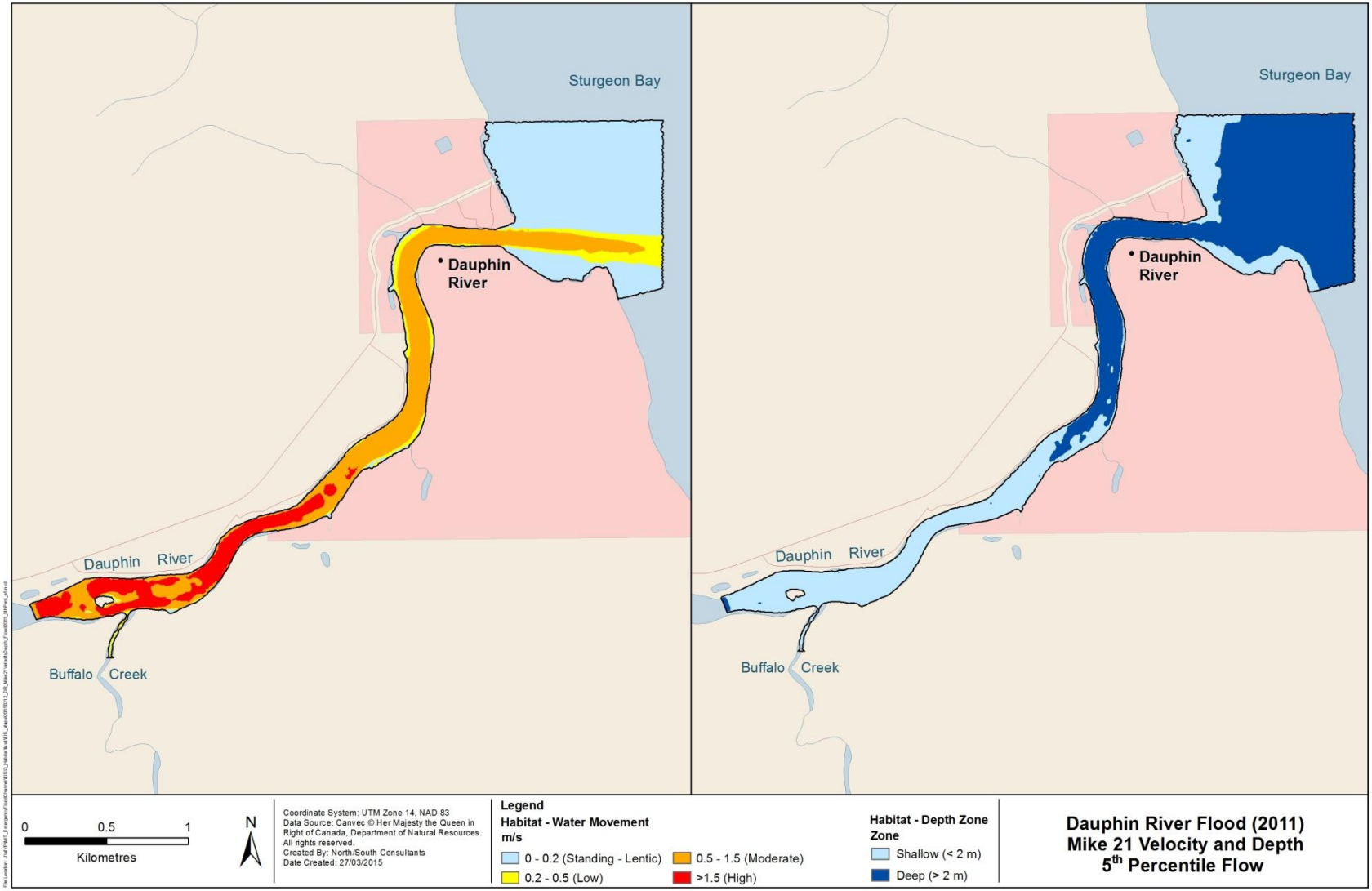


Figure 6A-7. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the2011 Flood 5th percentile (292 m^3/s) combined outflow condition.

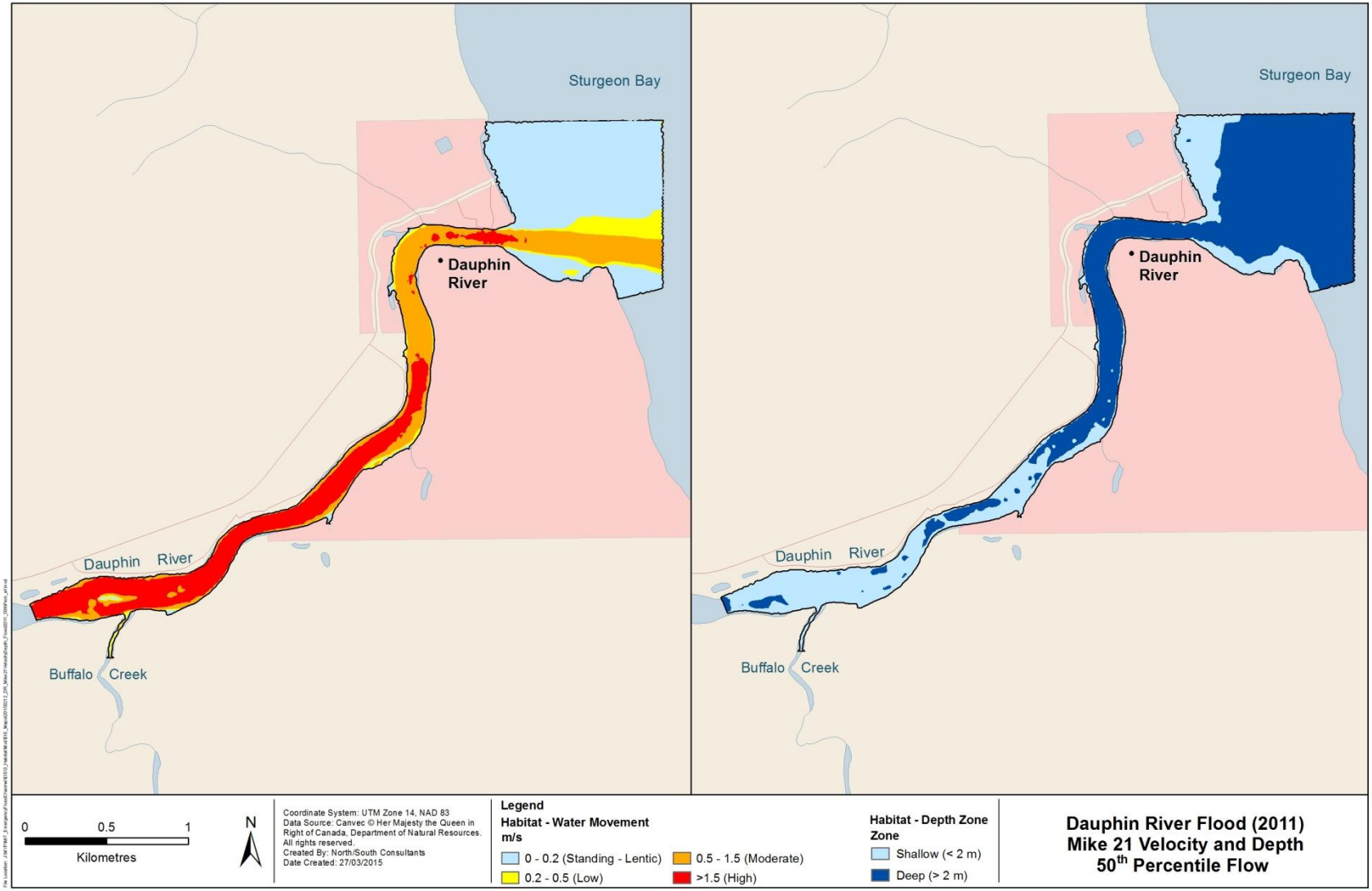


Figure 6A-8. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the 2011 Flood 50th percentile (527 m^3/s) combined outflow condition.

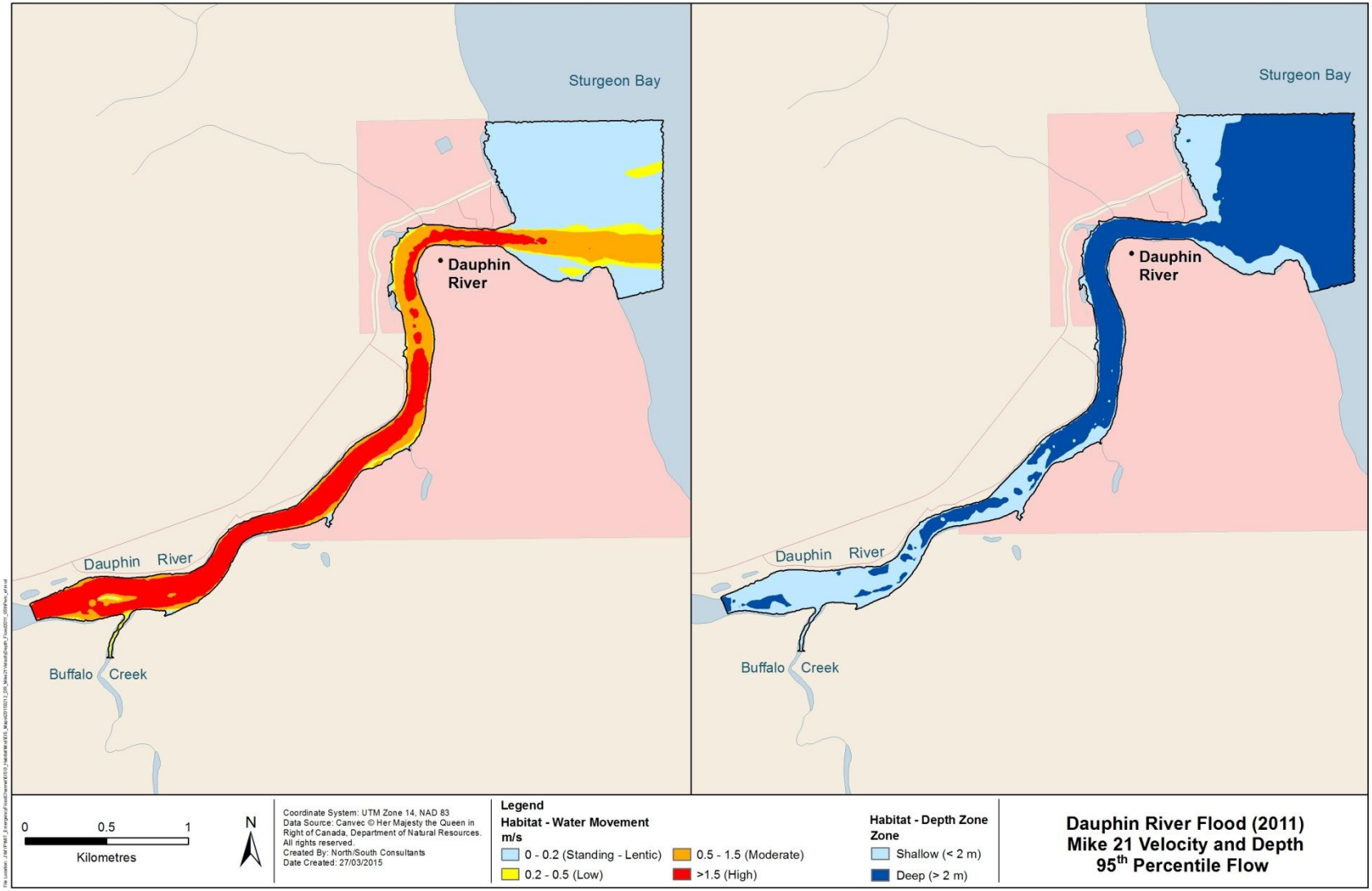


Figure 6A-9. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs under the 2011 Flood 95th percentile (589 m^3/s) combined outflow condition.

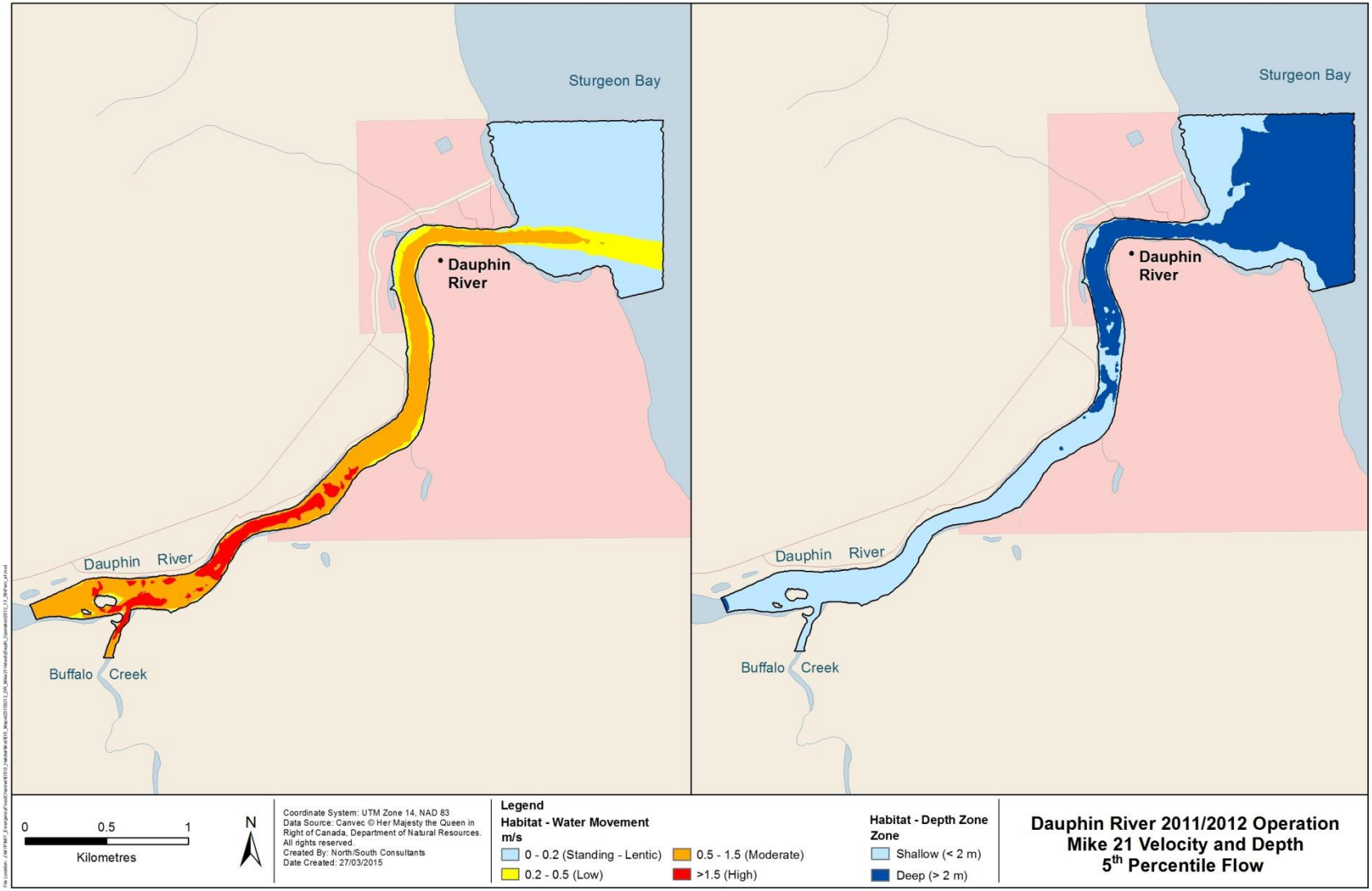


Figure 6A-10. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs during the 2011/2012 Operation 5th percentile (188 m^3/s) combined outflow condition.

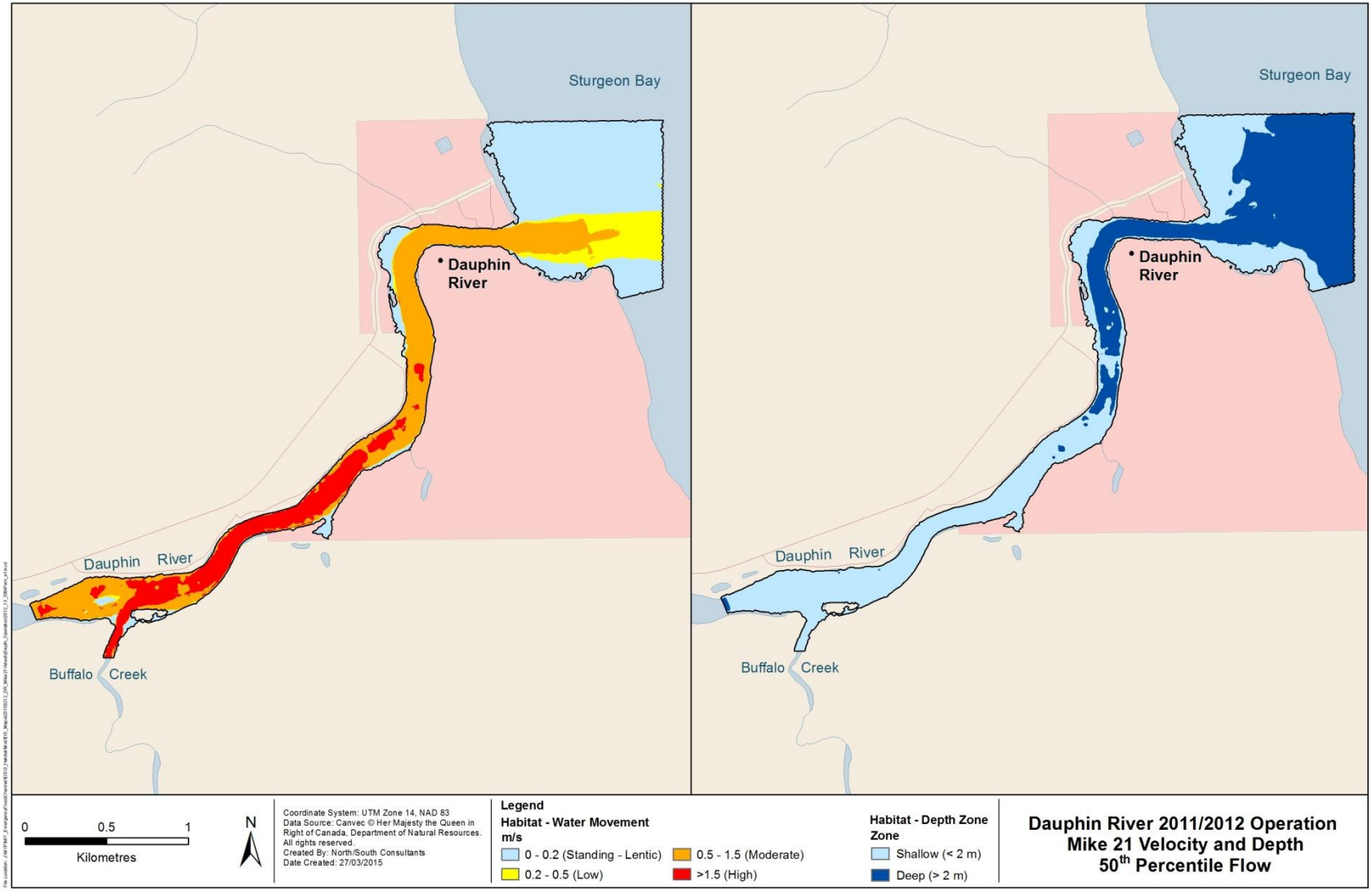


Figure 6A-11. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs during the 2011/2012 Operation 50th percentile (343 m^3/s) combined outflow condition.

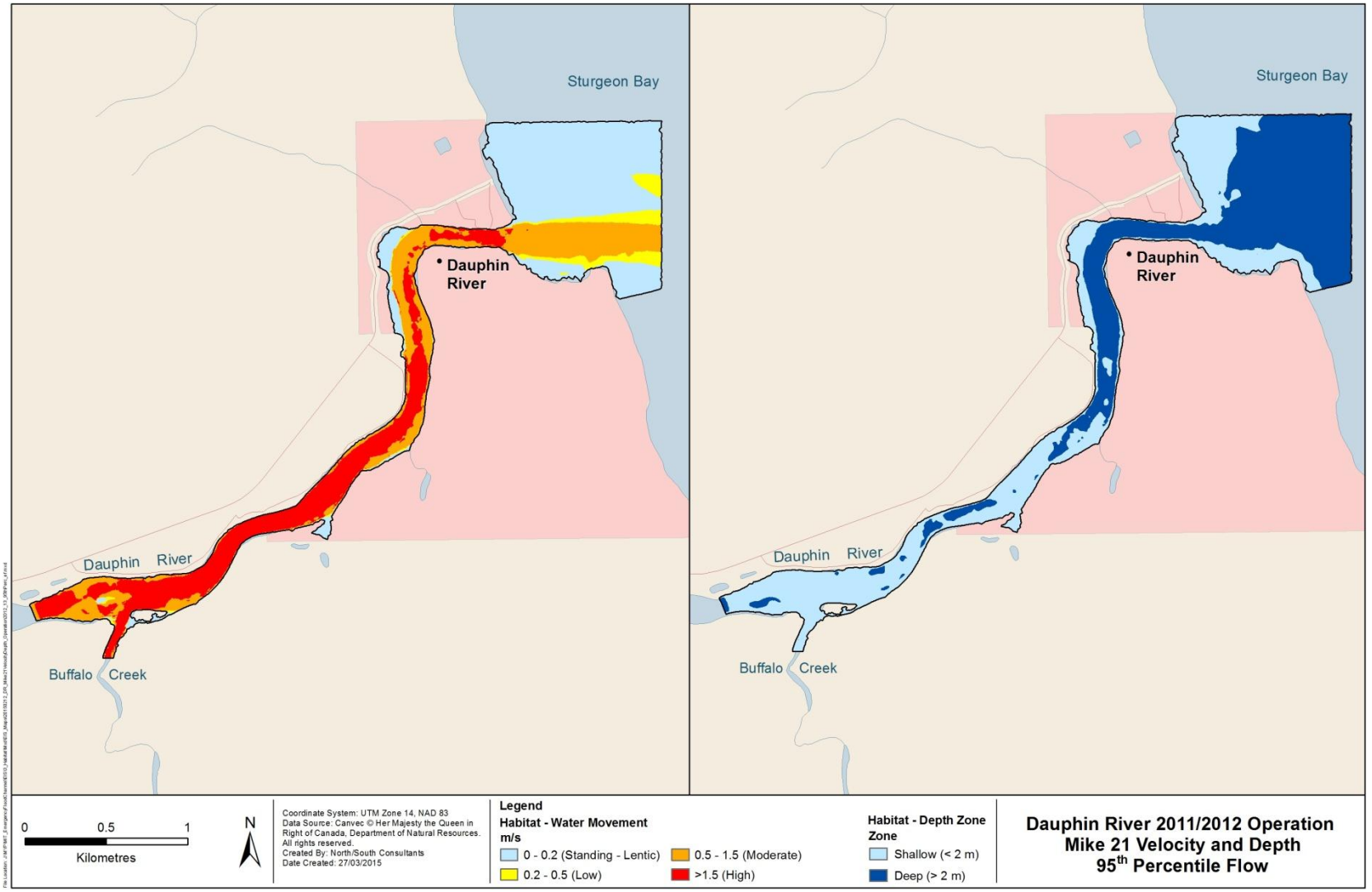


Figure 6A-12. Maps showing the distribution of velocity and depth habitat classes resulting from the spatial analysis of the MIKE 21 computational mesh outputs during the 2011/2012 Operation 95th percentile (521 m^3/s) combined outflow condition

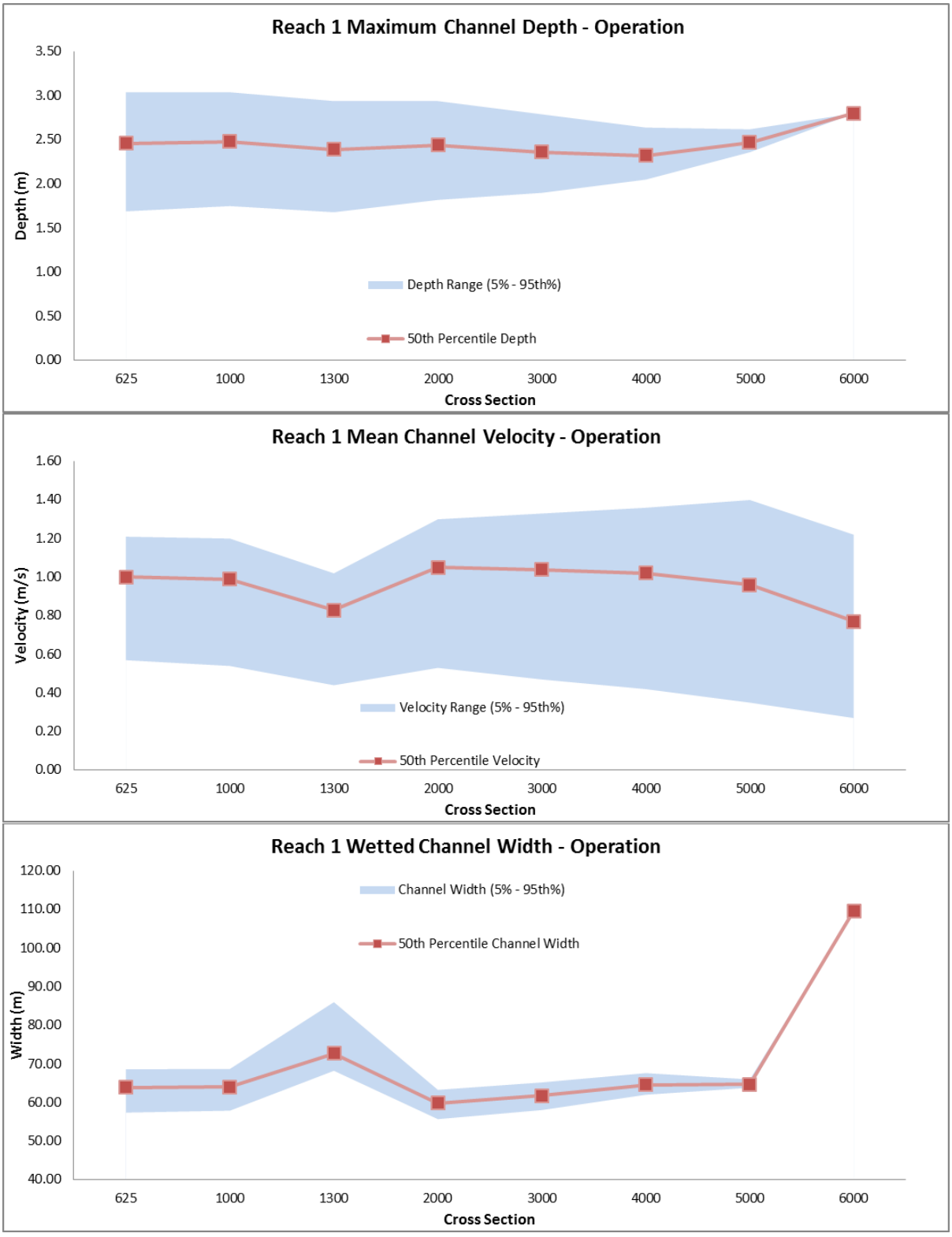


Figure 6A-13. Reach 1HEC-RAS hydraulic habitat variables showing ranges of maximum channel depth (top), mean velocity (middle), and wetted channel width (bottom) during 2011/2012 Operation.

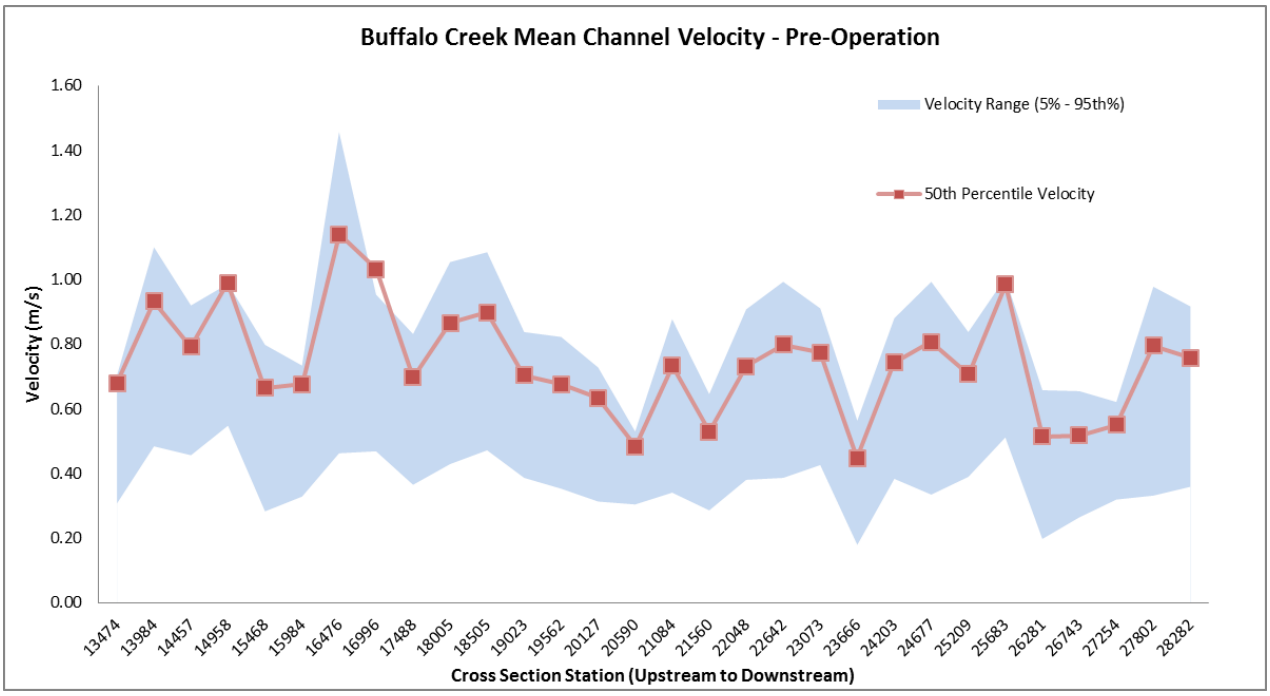


Figure 6A-14. Buffalo Creek HEC-RAS modeled Pre-Operation mean channel velocity at 30 cross section stations under simulated 5th, 50th and 95th percentile flows during.

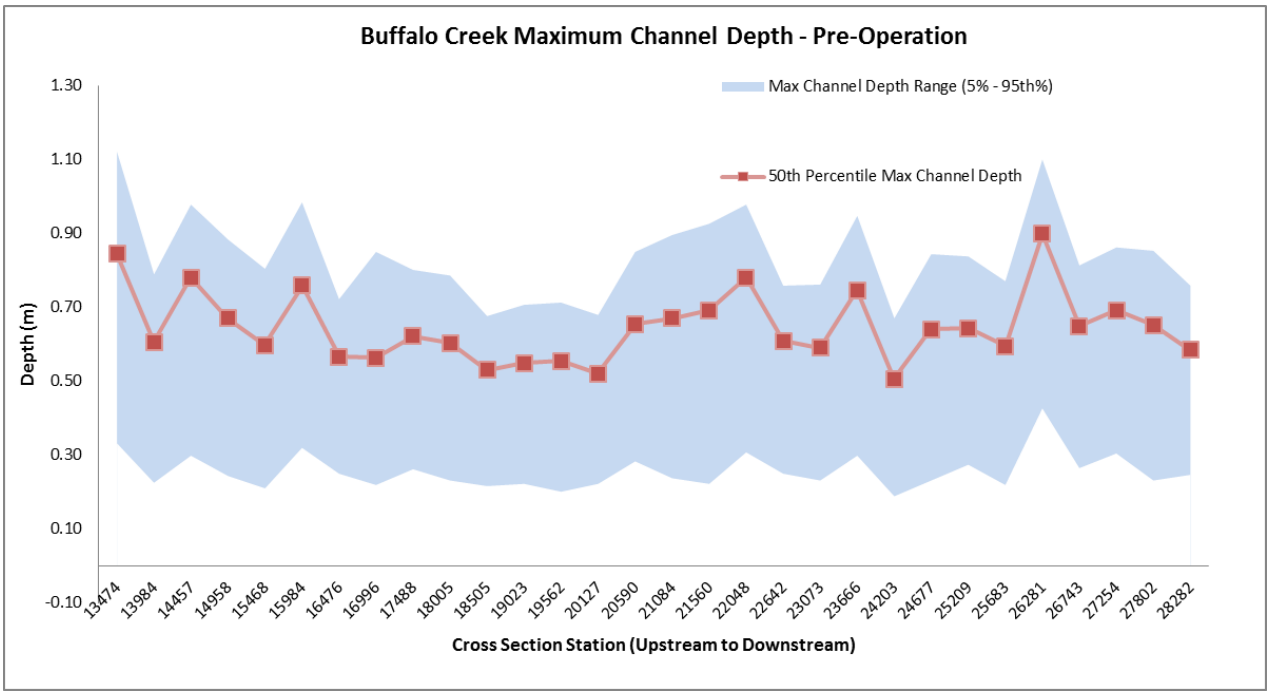


Figure 6A-15. Buffalo Creek HEC-RAS modeled Pre-Operation maximum channel depth at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

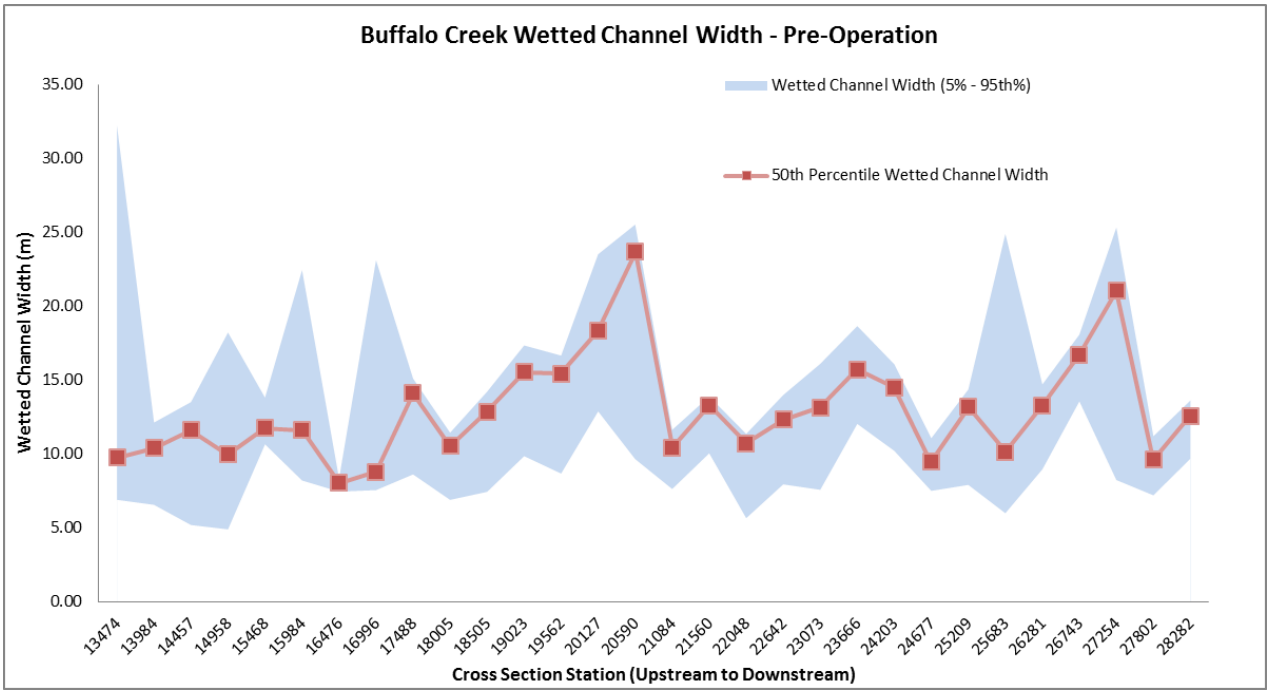


Figure 6A-16. Buffalo Creek HEC-RAS modeled Pre-Operation wetted channel width at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

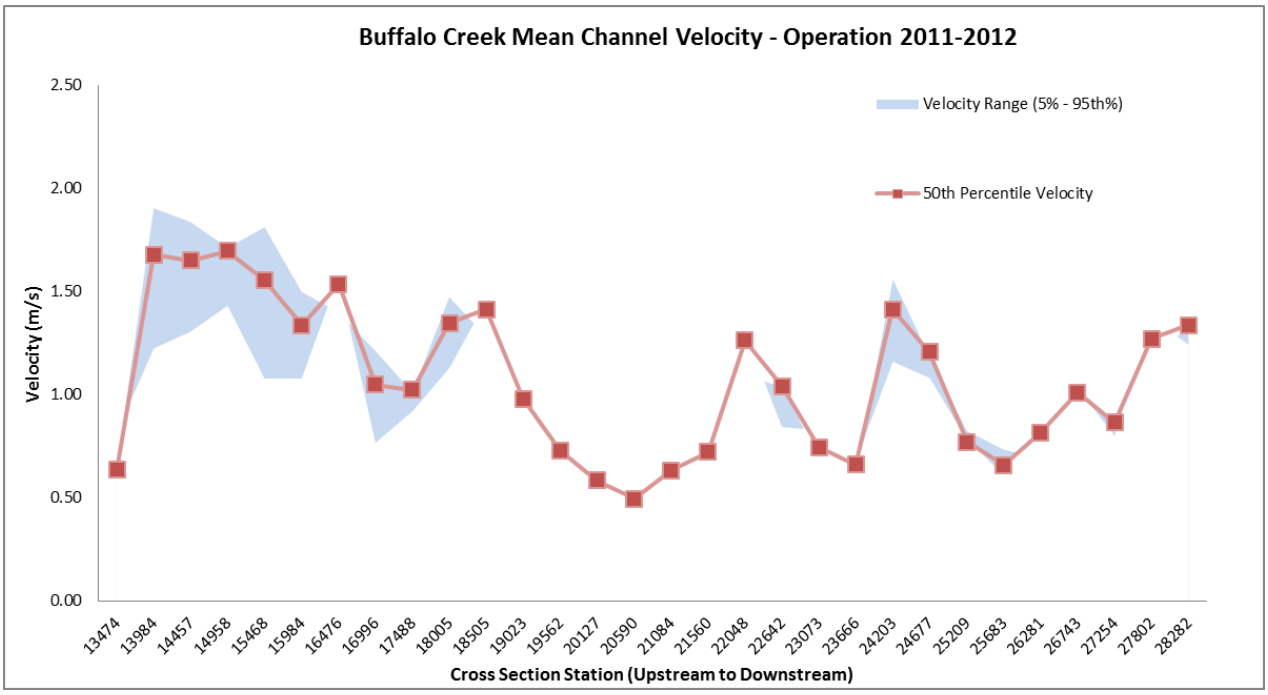


Figure 6A-17. Buffalo Creek HEC-RAS modeled 2011/2012 Operation mean channel velocity at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

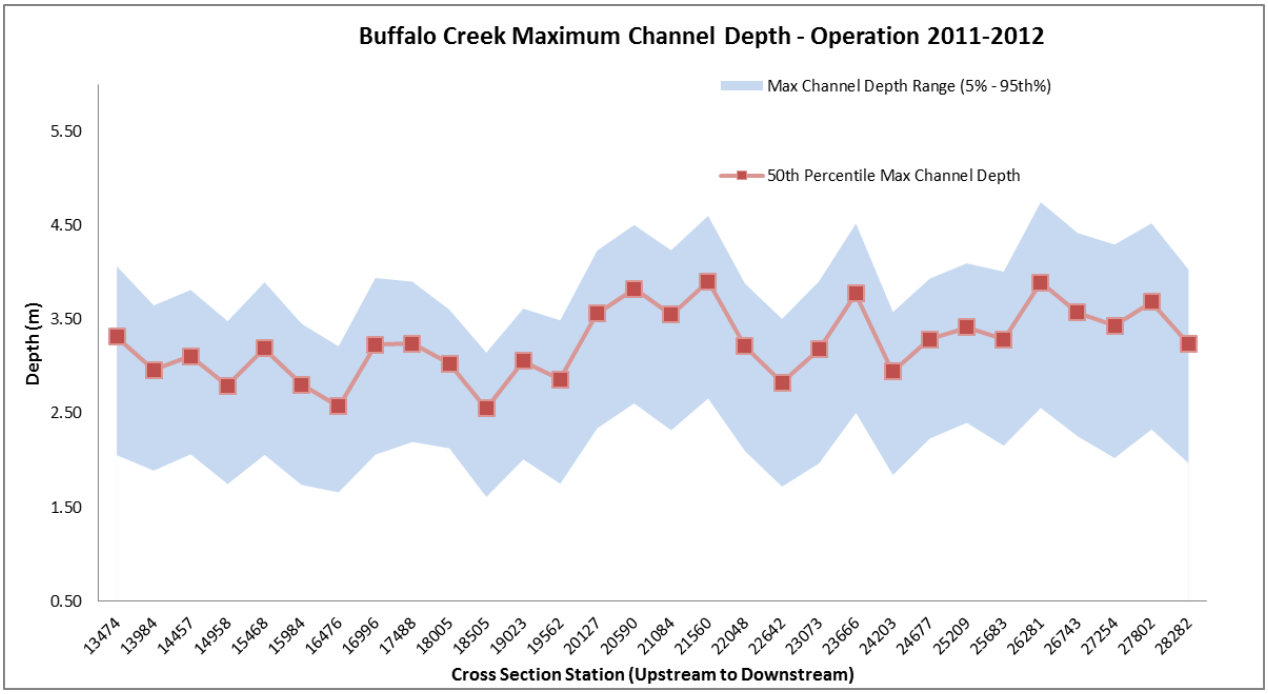


Figure 6A-18. Buffalo Creek HEC-RAS modeled 2011/2012 Operation maximum channel depth at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

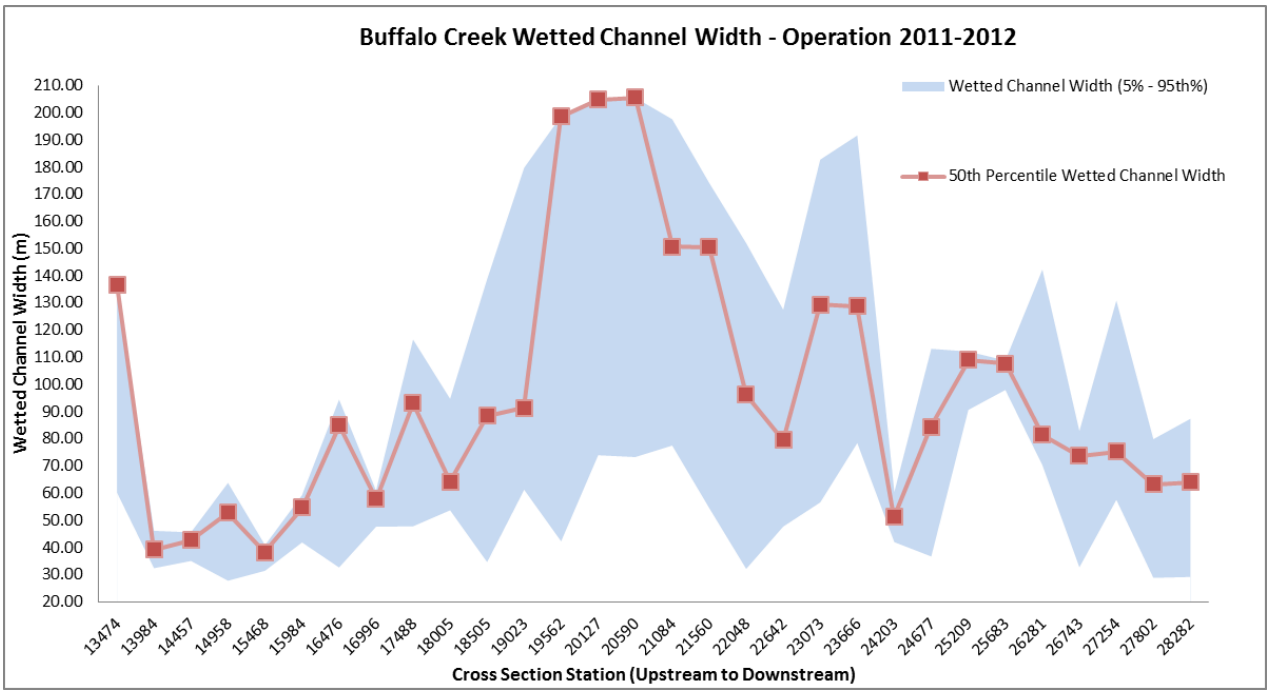


Figure 6A-19. Buffalo Creek HEC-RAS modeled 2011/2012 Operation wetted channel width at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

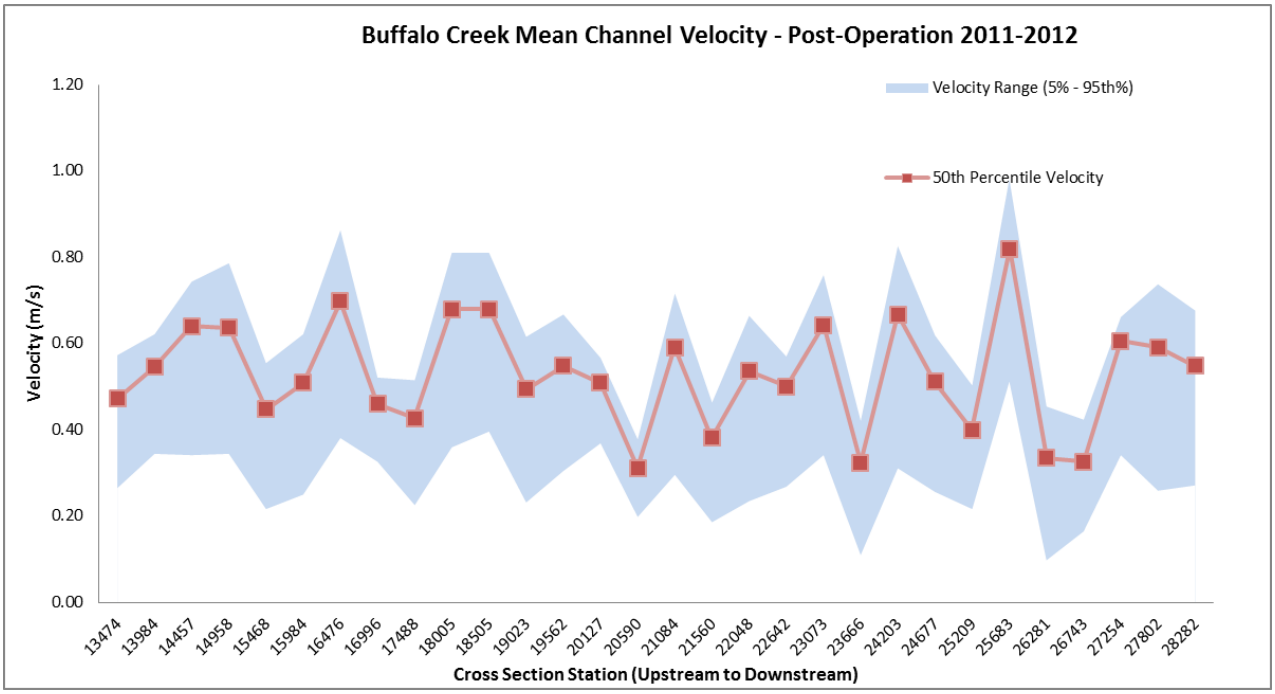


Figure 6A-20. Buffalo Creek HEC-RAS modeled 2011/2012 Closure mean channel velocity at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

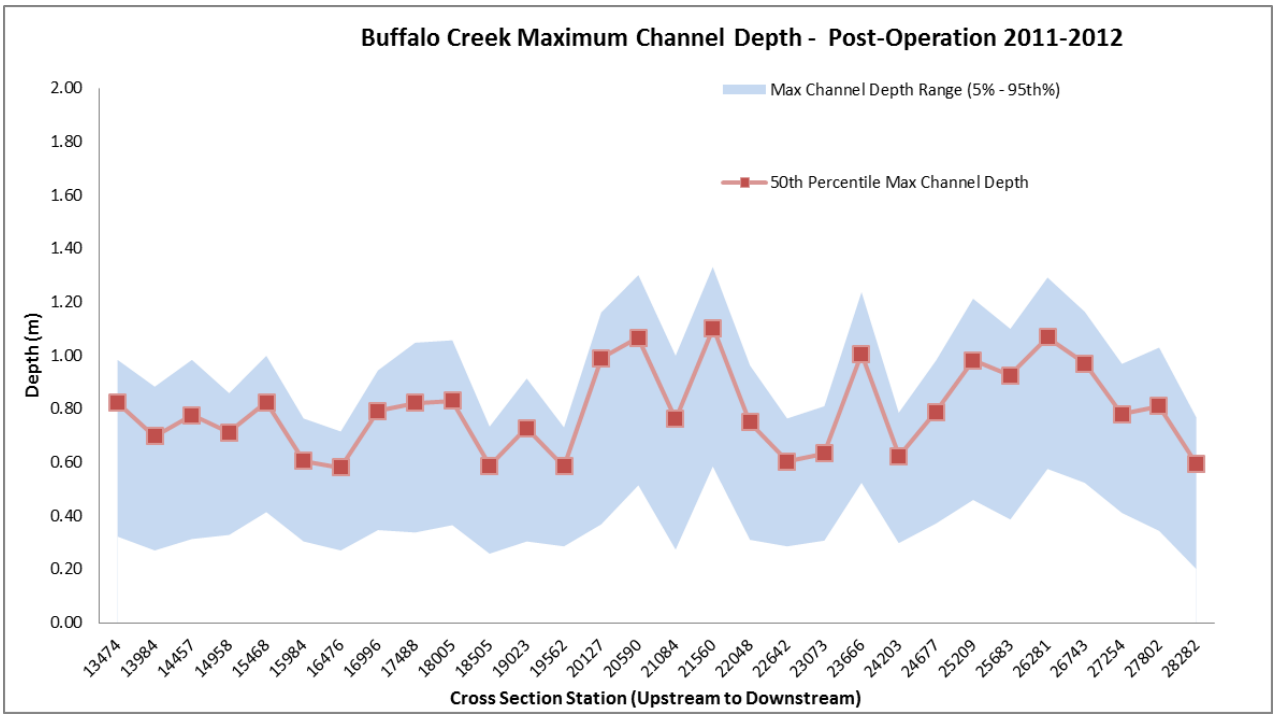


Figure 6A-21. Buffalo Creek HEC-RAS modeled 2011/2012 Closure maximum channel depth at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

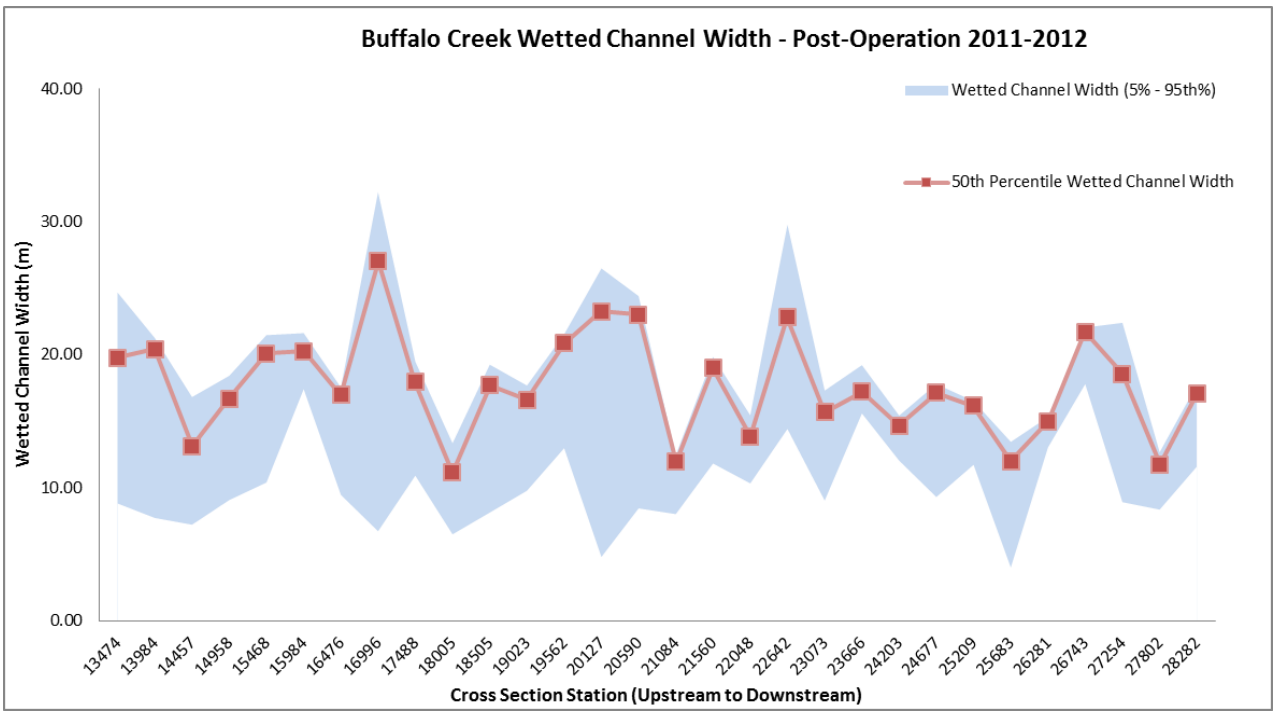


Figure 6A-22. Buffalo Creek HEC-RAS modeled 2011/2012 Closure wetted channel width at 30 cross section stations under simulated 5th, 50th and 95th percentile flows.

6A 4.0 REFERENCES

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low stream flow. Pages 62-73 IN: N. B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. American Fisheries Society, Western Division, Bethesda, Maryland.

North/South Consultants Inc. 2013. Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation: Volume 4 Fish Habitat. A draft report prepared for Manitoba Infrastructure and Transportation. xxii + xx pp. in prep

Appendix 6B. Geo-Referenced Aerial Imagery (GAIM™)

Provided Within: Details of the GAIM™ imagery used.

Geo-Referenced Aerial Imaging and Mapping (GAIM) is a system, used by Taiga Air Services LTD., that can collect geo-referenced high resolution imagery and video concurrently using a helicopter mounted sensor. The imagery captured for the Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation project (Table 6B-1) was acquired at an altitude of between 200 and 300 metres above ground level depending on the specific flight and tasks required. The helicopter imagery was captured at a speed of approximately 80 kilometers per hour as a requirement to provide clear and high resolution imagery. Typical resolution of the imagery is 7 cm to 10 cm ground pixel resolution.

GAIM data, specifically high resolution imagery, were collected in 2011 and 2012 as part of the Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels Project, which was the precursor to the current project (Figures 6B-1 and 6B-2). The imagery was initially requested by MIT for the purpose of documenting conditions at the site prior to and after construction of the emergency outlet channels. KGS Group and NSC repurposed the data to use support routing, biological surveys, sediment transport analysis, habitat assessments, etc. As part of the on-going monitoring in the project study area, MIT requested the GAIM be included in the current project. GAIM flights were conducted in July 2013 and June 2014 (Figures 6B-3 and 6B-4). Once again, the project team repurposed the imagery captured to support studies required to determine potential impacts from the development, operation, and post-operation of the LSMEOC system.

Three types of imagery products were captured for the project as follows:

- Hyperlinked geo-centered imagery;
- Georeferenced individual images placed; and
- Strip mosaicked Digital Ortho Imagery (DOI).

The imagery captured using GAIM are available as hyperlinked geo-centered imagery. The 2013 imagery was also produced as individual image georeferenced, and ortho strip imagery has been completed in select areas along Buffalo Creek and Reach 3. The complete 2014 imagery has been mosaicked into an ortho-strip.

Table 6B-1. GAIM Flight Data for Lake St. Martin Area Captured For KGS Group 2011–2014.

Year	Month	Area of Cover	Status	Submitted
2011	June	See image F01	Processed	Yes
2011	July	See image F01	Processed	Yes
2012	January	See image F02	Processed	Yes
2013	July	See image F03	Processed	Yes
2014	June	See image F04	In Progress	No



Figure 6B-1. Flight path for June/July 2011 GAIM data collection.



Figure 6B-2. Flight path for January 2012 GAIM data collection.



Figure 6B-3. Flight path for July 2013 GAIM data collection.



Figure 6B-4. Flight path for June 2014 GAIM data collection.

Appendix 6C. Water Temperature Logger Data by Year

Provided Within: Graphs summarizing annual water temperature data

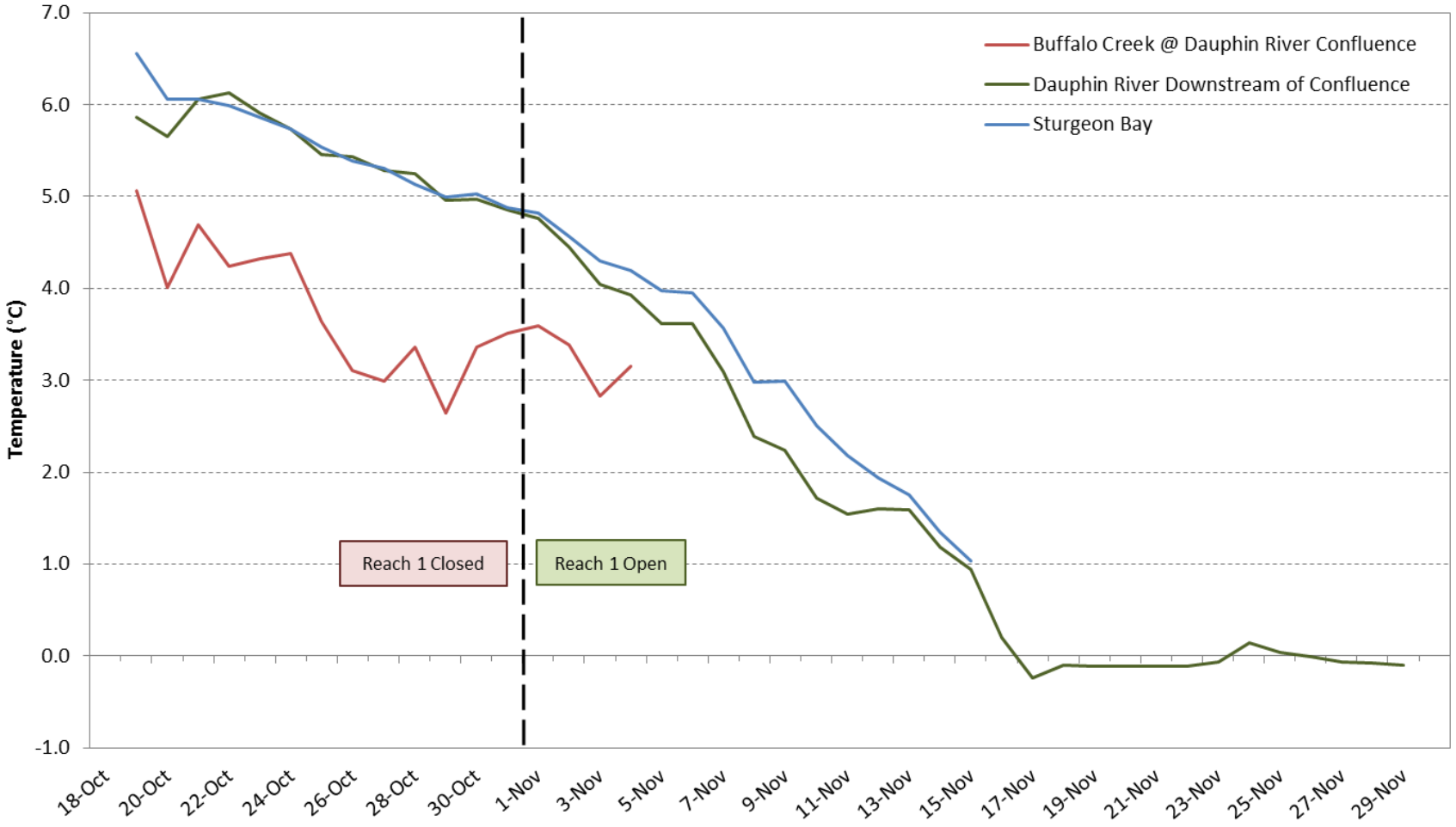


Figure 6C-1. Daily mean water temperature in Project waterbodies during fall 2011.



Figure 6C-2. Daily mean water temperature in Project waterbodies during the 2012 open water season.

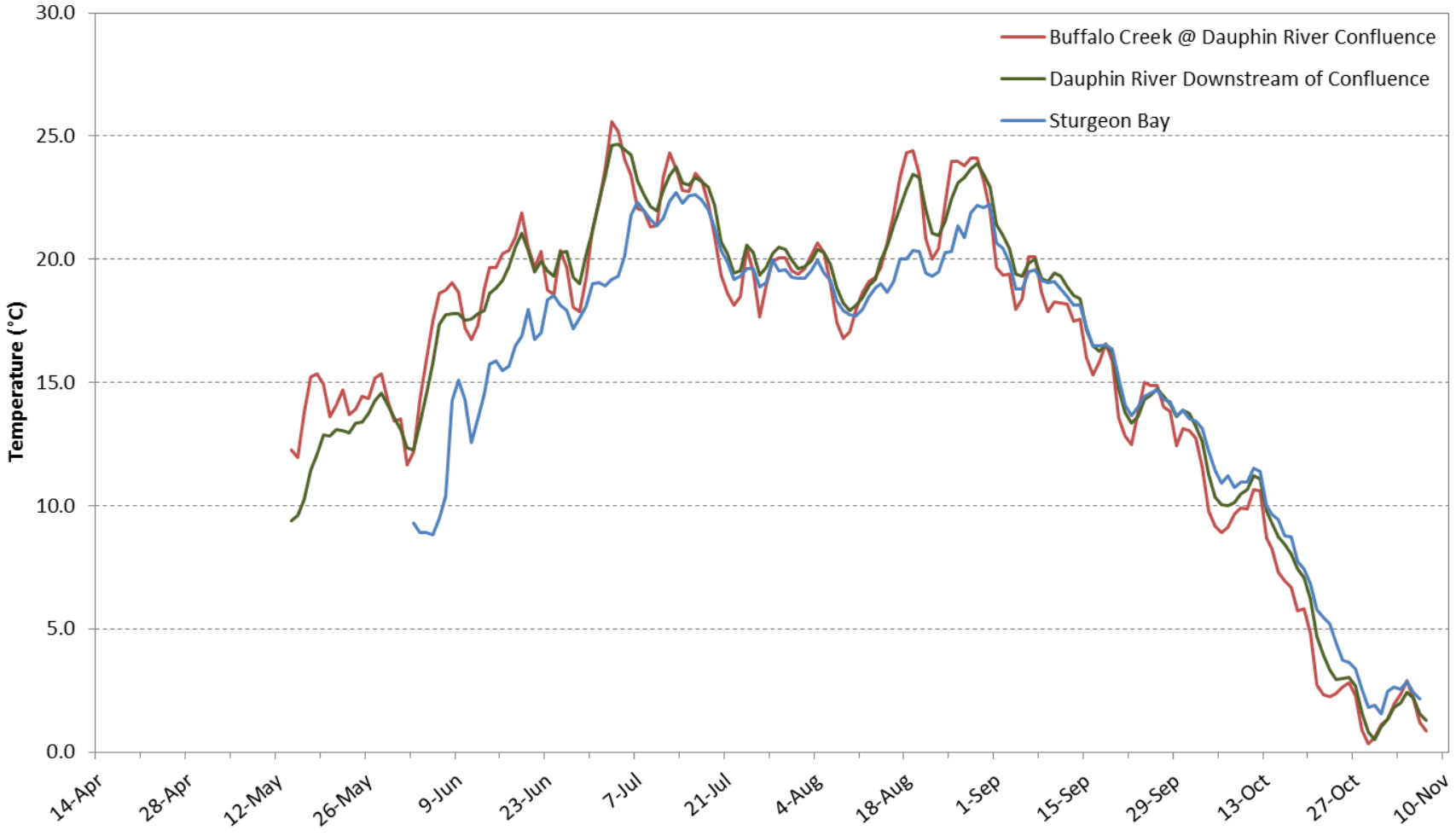


Figure 6C-3. Daily mean water temperature in Project waterbodies during the 2013 open water season.

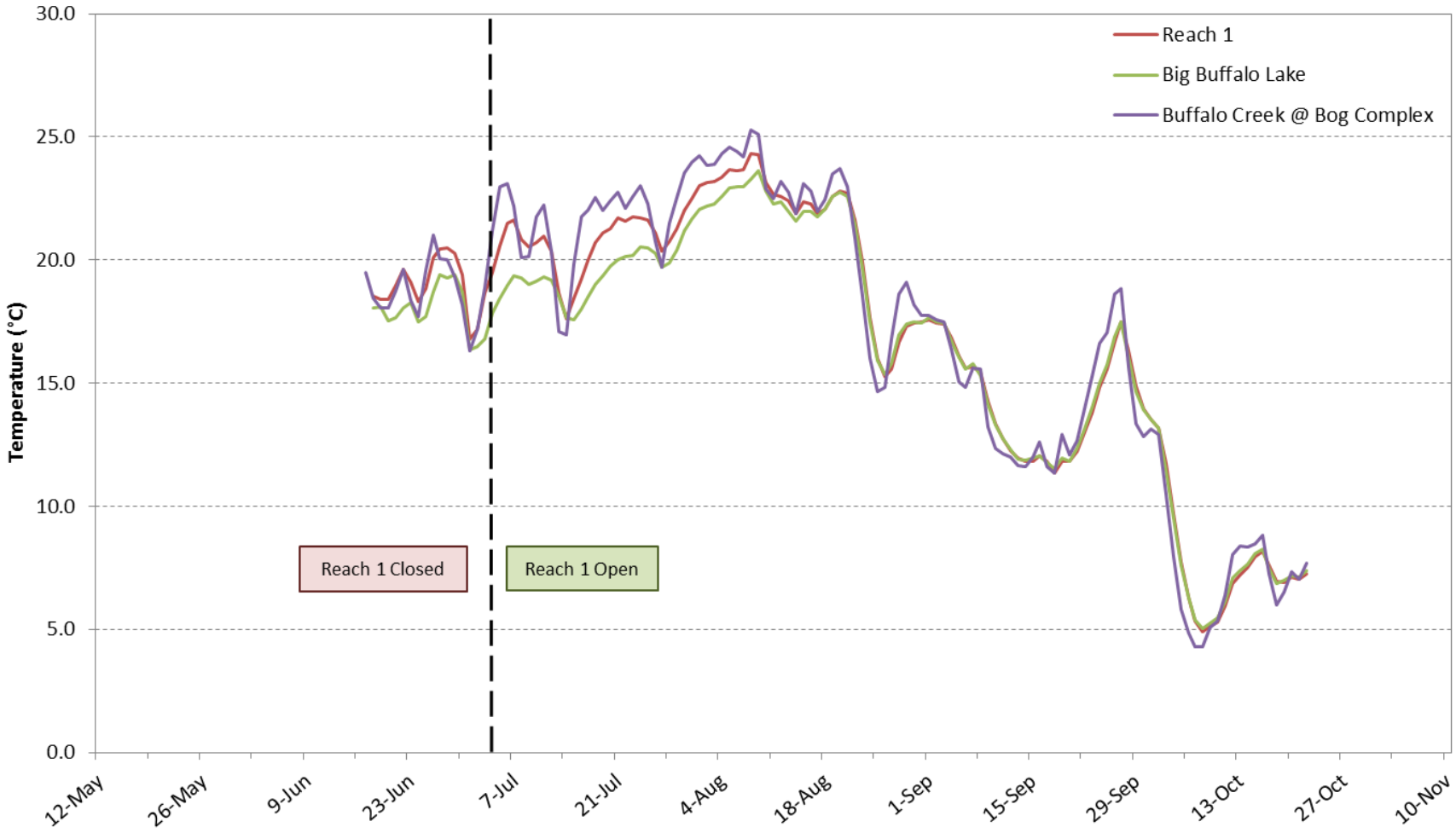


Figure 6C-4. Daily mean water temperature in Project waterbodies from Reach 1 downstream to the upper end of Buffalo Creek, 2014 open water season.

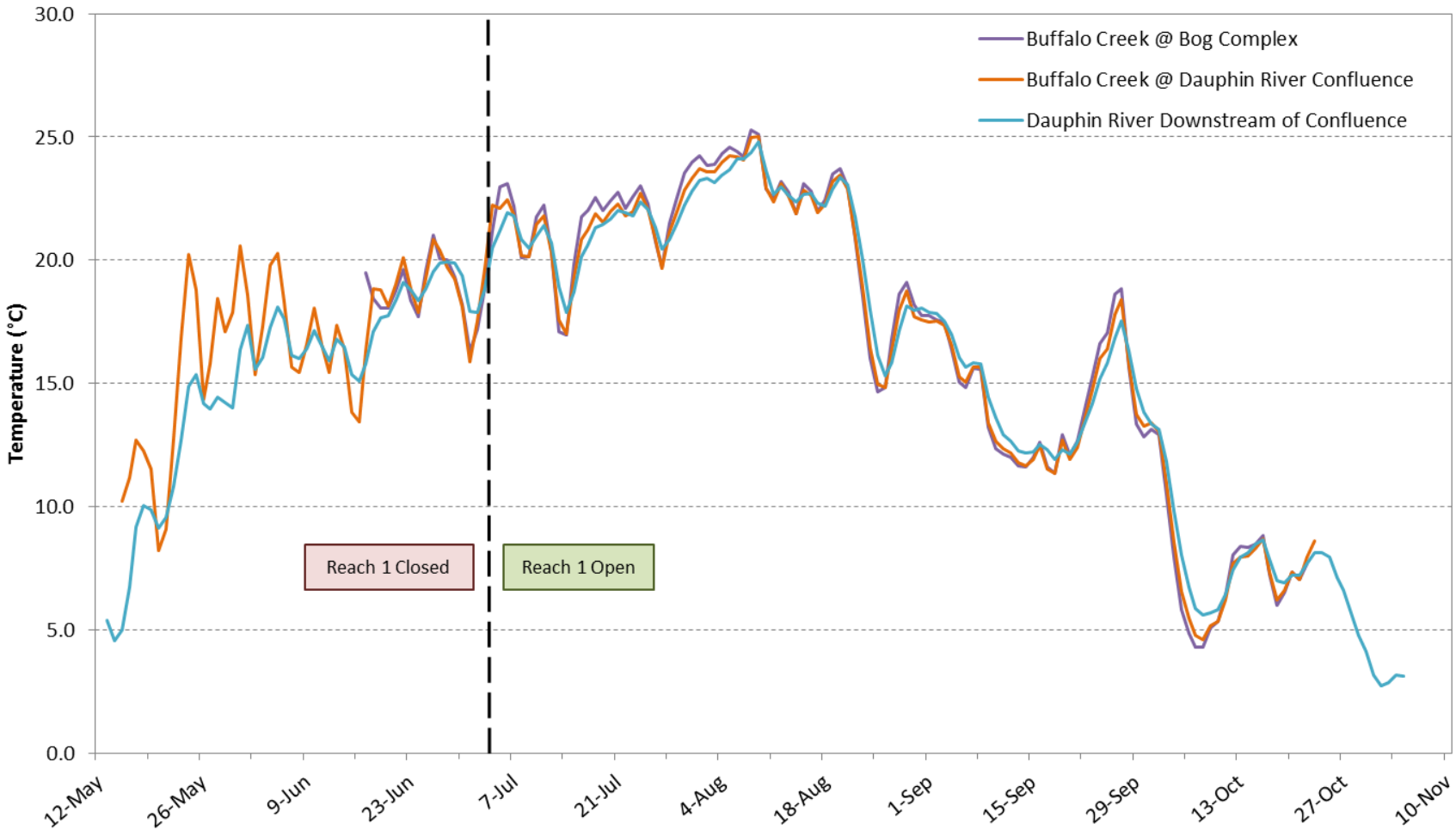


Figure 6C-5. Daily mean water temperature in Project waterbodies from the upper end of Buffalo Creek to the lower Dauphin River, 2014 open water season.

APPENDIX IAAC-13B1: RAW BASELINE SURFACE WATER QUALITY DATA

(see excel file)

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-13B1: Raw Baseline Surface Water Quality Data
May 31, 2022

Manitoba
Transportation and Infrastructure

Stantec

Manitoba
Environment, Climate and Parks

Water Science & Watershed Management Branch
Box 14, 200 Saulteaux Cres., Winnipeg, Manitoba, Canada R3J 3W3
T 204-793-7921 **F** 204-948-2357
https://www.gov.mb.ca/water/

April 13, 2022

Impact Assessment Agency of Canada
Government of Canada

Please note that this data was compiled on behalf of Manitoba Transportation and Infrastructure's Environmental Impact Statement process related to the Lake Manitoba – Lake St. Martin Outlet Channels Project.

WATER QUALITY DATA:
Lake Manitoba and Lake St. Martin Watershed, Sturgeon Bay – Lake Winnipeg /
Metals, Nutrients, General Chemistry, Microbiology and Pesticides

In accordance with your request, please find attached water quality data for the above mentioned watersheds. Should these data be used in a report, technical manuscript, presentation, or other document, would you please reference as follows:

Water Quality Management Section
Manitoba Environment, Climate and Parks
Box 14, 200 Saulteaux Crescent
Winnipeg MB R3J 3W3

Manitoba recommends that total phosphorus (TP) and particulate phosphorus (PP) values from Lake Winnipeg, for the period between April 1, 2001 – March 31, 2009, be adjusted as per McCullough 2015 (attached). Raw, unadjusted TP and PP values have been reported in your data request. We recommend that these reported TP values be multiplied by a factor of 0.89, and that PP be recalculated as the difference between adjusted TP and reported total dissolved phosphorus (TDP). A detailed review of the rationale for this adjustment can be found in McCullough 2015. We do not recommend applying this adjustment to phosphorus data from other water bodies than Lake Winnipeg.

Although we have taken all reasonable measures to ensure that the enclosed data are correct and free of errors, it is recommended that you review these data carefully in the context of your intended application. Please note that concentrations preceded by an "L" were measured as less than the method detection limit.

Please provide a copy of any report or manuscript arising from the use of these data to the undersigned. *Any requests for these data from a third party must be directed to the undersigned.*

Should you have any questions with regard to this information, or identify data that may be anomalous, please do not hesitate to contact our section at the above address, or by e-mail at Daniel.Rheault@gov.mb.ca.

Sincerely,

Daniel Rheault
Water Quality Specialist
Manitoba Environment, Climate and Parks

APPENDIX IAAC-13B2: BASELINE SURFACE WATER QUALITY DATA REPORT

Manitoba Transportation and Infrastructure

Stantec

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS, ROUND 3

Appendix IAAC-13B2: Baseline Surface Water Quality Data Report
May 31, 2022

Manitoba
Transportation and Infrastructure

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KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D3
ANNUAL MONITORING REPORT TO JULY 1, 2018

FINAL– REV 0

KGS Group 16-0300-006
August 2018

PREPARED BY:

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August 23, 2018 File No. 16-0300-006

Manitoba Infrastructure
Water Management and Structures
2nd Floor 280 Broadway
Winnipeg, Manitoba
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ATTENTION: Mr. Jared Baldwin, P.Eng.
Project Manager

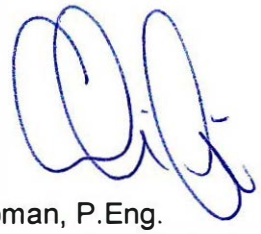
RE: Investigations & Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D Deliverable D3, Final – Rev 0

Dear Mr. Baldwin:

KGS Group is pleased to submit an electronic copy on the FTP site of our Final Report Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C and D Deliverable D3-Final Rev. 0. Three hard copies of the report will follow by courier.

We appreciate the opportunity to provide engineering services to Manitoba Infrastructure.

Sincerely,



Colin Siepman, P.Eng.
Senior Infrastructure/Project Engineer

MFH/jr
Enclosure

cc: Mr. Mark Allard, P.Eng. Project Director (MI)
Mr. Dave MacMillan, P.Eng. (KGS Group)
Mr. J. Bert Smith, P.Eng. (KGS Group)
Mr. Patrice Leclercq, P.Eng. (KGS Group)
Ms. Marci Friedman Hamm, P.Geo. (KGS Group)
Mr. Jason Mann, P.Geo. (KGS Group)
Mr. David Anderson, P.Eng. (KGS Group)
Mr. Steve Offman, M.Sc. (KGS Group)

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1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

Manitoba Infrastructure retained KGS Group to complete Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C and D. The "Summary Report" for the project was issued in May 2017[1]. Annual monitoring of groundwater and surface water is included in the project as required under Work Breakdown Structure (WBS) 1010.04 and WBS 1010.05 monitoring plan described in the memo Deliverable D1 Groundwater Level Monitoring and Quarterly Water Quality Sampling. The first annual monitoring report was issued on July 1, 2017 (Deliverable D2 Annual Monitoring Report to July 1, 2017). This report is the second annual monitoring report.

This annual monitoring report summarizes groundwater and surface water monitoring activities from July 1, 2017 through July 1, 2018. The report documents seasonal data collection activities and provides comments regarding surface and groundwater conditions, building on Deliverable D6 Groundwater Study (included as Appendix C of the May 2017 Summary Report) and Deliverable D2 Annual Monitoring Report to July 1, 2017[2]. Both of these reports contain background information on the project that should be used for reference. Manitoba Infrastructure directed that no further monitoring on Route C be conducted, with the exception of transducer downloads at Route C, beginning in May 2017. Downloads of transducers at Route C were not conducted in fall 2017 or May 2018 with Manitoba Infrastructure's agreement. Download of these instruments was deferred to the next stage of the project. A general site plan showing the location of Route C can be found in Appendix D3-A Plate D4-1. Detailed plans of Route C can be found in the May 2017 Summary Report.

[1] Investigations and Preliminary Engineering for LMB Outlet Channels Options C and D Summary Report, May 2017, Prepared by KGS Group.
[2] Investigations and Preliminary Engineering for LMB Channels Options C and D Deliverable D2, Annual Monitoring Report to July 1, 2017. Final Rev 0, Prepared by KGS Group.

1.2 SCOPE OF WORK

The Scope of Work for Deliverable D3 includes the following:

1. Route D Field Programs:
   - Groundwater Elevation, Sampling and Transducer Download; Summer - August 2017; Fall October 2017; and Spring - May 2018
   - Surface Water Sampling and Transducer Download Summer - August 2017; Fall - October 2017; and Spring - May 2018

2. Summary comments and conclusions relating to seasonal changes in groundwater and surface water levels and quality.

In addition to the original scope of work, a summary of recommended instrumentation maintenance repairs is included in Appendix D3-D. Drilling logs for 15-RD-04A, 15-RD-04B and 15-RD-PW-1 (2016) are included in this report in Appendix D3-E for completeness as they were not included in the 2016 Geotechnical report submission.

An additional scope of work was approved to report metals analysis for groundwater and surface water samples. Deliverable D1 (Groundwater, Surface Water and Geotechnical Investigations Program) included a one-time analysis of metals for groundwater and a one-time analysis for surface water. Upon review of the deliverable, Manitoba Infrastructure (MI) decided that additional analysis of metals would be beneficial towards generating additional data useful for the future Environmental Impact Statement for the project. KGS Group determined that further analysis of metals could be retrieved from data already collected by the lab from 2017 and 2018 sample events. KGS Group requested the metals data from the laboratory and incorporated it into existing tables as shown in this report. The laboratory certificates of analysis are contained in Appendix D-3-F.

The retrieved metals analyses for the **surface water can be relied upon** since samples were acidified in the field using standard procedures.

The retrieved metals analyses for the **groundwater should be used for reference only**, and not relied upon as the samples were not required to be analysed for extended metals at the time of sampling, and therefore were not filtered and preserved in the field. The groundwater samples were filtered and preserved in the laboratory. This means that there was opportunity for potential precipitation of metals during sample transit and potential removal of this precipitate when the samples were filtered in the laboratory.

2.0 ROUTE D

2.1 WATER ELEVATION, TEMPERATURE AND TRANSDUCER DOWNLOADS

2.1.1 Field Program Activities

The locations of instruments are shown on the plan set in Appendix D3-A, and on Table D3-1. The transducer at 15-RD-PW1 was replaced in October 2017. Installation methodology was as described in the Deliverable D2 report for other instruments.

The elevations of the packers and transducers have been updated in Appendix Table D3-B-4. The transducer for TH-ED-01 was installed 24 m above the open bedrock zone. The transducer for 15-RD-PW1 was re-installed with a longer cable to the bottom of the casing, immediately above the top of the open bedrock monitoring zone.

Foam inserts were installed in all other flowing wells to prevent water from rising above ground surface in the casing and freezing in winter, which would cause the casing to break and result in uncontrolled groundwater flow. Foam inserts consisted of an aluminum rod surrounded by a foam packer. These inserts were installed after the October 2017 monitoring and were removed during the May 2018 monitoring. Because the May 2018 monitoring was the last under this contract, the foam packers were re-installed. Vibrating wire piezometers were read in August 2017, October 2017 and May 2018.

Transducers were re-installed at two surface water locations: Reed Lake (D3) and Clear Lake (D4), in May 2018 to replace damaged instruments.

Repairs and maintenance are required at several instruments as summarized in Appendix D3-D.

2.1.2 Results

Results of the groundwater monitoring program on Route D are shown on Table D3-1 showing all instrumentation monitored, instrument details and depth to groundwater level, pressure or vibrating wire readings and appropriate conversions to geodetic elevations. Transducer

hydrographs are shown in Appendix D3-B. A summary of mechanical packer and transducer installation is shown in Table D3-B-1.

Well TH-ED-01W

Well TH-ED-01W (Figure D3-B-1) is confined and flowing artesian and has a deep overburden till cover of 25 m. In 2016 to 2017, groundwater elevations decreased slightly through the winter from elevation (El.) 254 m on December 8, 2016 to El. 253.5 m on March 28, 2017 when they began to rise through April 27, 2017 to 254.2 m, decreasing slightly through the end of May 2017. Although groundwater elevations showed a slight seasonal increase in April 2017, they were only 0.2 m higher than elevations in December 2016. The water elevation rise is attributed to a piezometric response to the regional groundwater system and may include a response to Lake Manitoba water levels (Appendix D3-C), which began to rise on April 1, 2017, as well as transmission of the piezometric response from a regional recharge in upland areas. At Well TH-ED-01W, groundwater elevation declined between May 2017 and April 2018 to a low of El. 252.5 m on April 14, 2018. The groundwater elevation then increased to El. 253.40 m on May 26, 2018. Regional lake levels at Lake Manitoba and Lake St. Martin also declined between May 2017 and April 2018 (Appendix D3-C). Well TH-ED-01W is located in the deep bedrock valley that is beneath most of the channel alignment. Regional recharge occurs at a distance from the valley in upland bedrock areas, and not through the local 25 m till to the bedrock.

Declining temperature was recorded at well TH-ED-01W throughout the 2016 to 2017 winter, from 6 °C to 4°C. A steeper decrease occurred in early March 2017 to 1°C and remained low through late May 2017. The temperature increased to 10.7°C on September 15, 2017 then decreased gradually to 4° C on February 17, 2018 before dropping steeply to 1°C or less. The temperature began to rise on May 18, 2018 and was 3.2°C by May 29, 2018. The timing of the temperature decrease in both years was well before the groundwater elevation increase in early April. The transducer in well TH-ED-01W is 24 m above the bedrock open hole, so is not in contact with aquifer groundwater, therefore temperature results are not considered to be representative of true aquifer response and appear to be influenced by surrounding ground temperatures. A longer cable is required on the transducer to place it closer to the bedrock

monitoring zone. This will require opening and re-installing the packer assembly in the artesian well.

A comparison of water quality results from October 2016 and May 2017 and July 2017, October 2017, and May 2018, as discussed in Section 2.2 (Table D-3-3), does not show any changes in water quality with seasonal recharge events. This indicates that the bedrock beneath the buried valley is isolated from local recharge.

Well 15-RD-PW-1

Groundwater elevation at Well 15-RD-PW-1 (Figure D3-B-2) is confined and flowing and has a deep overburden till cover of 16.3 m. In 2016 and 2017, groundwater elevations decreased slightly throughout the winter from El. 254.4 m on December 8, 2016 to El. 253.6 m on March 11, 2017, and then began to rise through early April 2018. These temperature variations appear to be influenced by surrounding ground temperatures. There was a sharp drop in elevation of 0.29 m on April 20, 2018 with a corresponding increase on May 24, 2018. The transducer did not connect in the field for the May 2017 download. It was removed during the August 2017 sampling event and a new transducer was installed with a longer cable during the October 2017 sampling event. Groundwater elevations continued to drop to 254.1 m on April 21, 2018 and rose with the spring melt to 254.2 m.

Temperature readings in 2016 at 15-RD-PW-1 followed a pattern similar to well TH-ED-01W, with a slow decrease in the winter to 4°C; however, a further drop occurred in late April 2017 followed by a rise to 11.6°C on August 1, 2018. The new transducer was installed in October 2017 just above the bedrock and has registered a constant temperature of approximately 6.5°C since that time. The stable temperature data at well 15-RD-PW-1 following transducer lowering provides clear evidence of the separation of the groundwater system beneath the buried valley and the surface water system.

Reed Lake (D3)

At Reed Lake (Appendix D3-B-3), water elevation remained constant through the spring 2017 melt. A very slight elevation increase was seen beginning in late March 2017 from El. 248.60 m on March 29 to El. 248.80 m on April 6, 2017. The water elevation increase began at the same time air temperatures rose above zero and water temperature fluctuations began, coincident with the spring melt. Elevations declined slightly to El. 248.31 m on November 11, 2017, when the transducer stopped working due to freeze up. The initial reading on May 25, 2018 was El. 248.17 m; however, this reading may have been influenced by freeze up and should be re-confirmed with a re-survey of the transducer tip elevation. Water temperatures rose from 3°C in mid-April 2017 to 12°C by the end of May 2017, peaking at 20.65 °C on August 2, 2017, and then declining through the fall to 4.4°C on November 11, 2017.

Clear Lake (D4)

At Clear Lake (Appendix D3-B-4), the transducer was frozen in the ice in January 2017 as shown by the sub-zero temperatures. This affected the elevation readings, which are not considered representative until early April 2017. An increase in elevation was seen in late July 2017 during the two high precipitation events shown on the top of the graph. The transducer malfunctioned in November 2017 at freeze-up when the temperature decreased to 0°C. The new transducer installed in May 2018 recorded an elevation of El. 248.17 m at the time of installation; however, this should be confirmed with a re-survey of the transducer tip elevation. Temperature increased from 0°C in early April 2017, to 15°C in late May 2017. A maximum temperature of 21°C was measured in August 2017, dropping to 0°C at freeze-up in November 2017.

2.2 GROUNDWATER AND SURFACE WATER QUALITY

2.2.1 Field Program Methodology

Nine sites were sampled for surface water along Route D on May 25, 2017; August 3, 2017; October 5, 2017; and May 30, 2018. Locations and site descriptions are as follows:

Site	Name	Zone	Easting	Northing
D1	L. Manitoba	14U	530539.95 m E	5680326.47 m N
D2	Watchorn Cr.	14U	531563.42 m E	5683591.34 m N
D3	Reed L.	14U	531162.00 m E	5687747.00 m N
D4	Clear L.	14U	530962.69 m E	5690166.46 m N
D5	Clark's Drain	14U	533740.43 m E	5697563.34 m N
D6	Birch Cr.	14U	532476.89 m E	5698322.06 m N
D7	Woodale Drain	14U	531665.45 m E	5699876.73 m N
D8	Birch Cr.	14U	533225.95 m E	5702310.91 m N
D9	L. St. Martin	14U	532723.36 m E	5706356.42 m N

- ***D1 (Lake Manitoba)* –** end of the mile road near the entrance to Watchorn Provincial Park with sampling occurring approximately 200 m into lake to reduce the shoreline effect.
- ***D2 (Watchorn Creek)* –** along P.R. 237.
- ***D3 (Reed Lake)* –** accessed by walking approximately 700 m from a gravel road through a pasture and was sampled on the west side of the lake.
- ***D4 (Clear Lake)* –** accessed by walking approximately 500 m along an old road allowance. The sample was collected on the west side of the lake.
- ***D5 (Clark's Drain)* –** sampled where the drain crossed the road.
- ***D6 (Birch Creek at PTH6)* –** upstream of Highway 6.
- ***D7 (Woodale Drain)* –** sampled approximately 150 m west of Highway 6.
- ***D8 (Birch Creek)* –** sampled upstream side of the road.
- ***D9 (Lake St. Martin)* –** Sampled at location of hydrometric station (at the end of Hilbre Rd.). Location is between Route C and Route D outlets.

Sites were all sampled on upstream side of roads (where roads were present). A reacher pole with disposable surface water sampling cup was used to collect water from most sampling sites to minimize shore effects and any disturbance from sampling activities. At a few locations samples were collected directly into the sample bottle.

Groundwater

Groundwater samples along Route D were taken at six locations on May 23 to 24, 2017; August 1 to 2, 2017; October 3 to 4, 2017; and May 28 to 30, 2018:

- 15-RD-PW1
- TH-ED-01W
- TH-ED-01P
- TH-ED-03
- TH-GD-02
- TH-GD-07

Sampling tubing was opened and groundwater was allowed to purge from the well under artesian conditions until groundwater parameters (conductivity and temperature) stabilized. Stable groundwater parameters were achieved at all sample locations within 20 minutes.

Field measurements for pH, conductivity and dissolved oxygen were taken for each sample. A flow through cell was used for groundwater samples. Groundwater and surface water samples were stored in a cooler chest at 4°C for transport to the laboratory. Samples for metals analysis (calcium, magnesium, potassium, and sodium) were filtered and preserved in the laboratory since extended metals analysis were not required for the 2017 and 2018 samples at the time they were collected. The samples were analyzed at ALS Laboratory in Winnipeg, Manitoba. Samples for isotope analysis were collected in clean 40 ml glass vials and shipped to the Environmental Isotope Laboratory at the University of Waterloo in Waterloo, Ontario.

A quality control/quality assurance assessment of all groundwater data was performed, including review of laboratory QA/QC, replicate samples and any trip or field blanks.

Quality Assurance/Quality Control

Standardized sampling procedures and protocols were used during the sampling events to ensure representative samples were collected in a controlled manner so that scientifically defendable comparisons can be made.

Chain of Custody – KGS Group ensured all Chain-of-Custody procedures were properly undertaken and holding times were not exceeded.

Sample Collection – Samples were collected directly from the pump outlet. Disposable latex gloves were worn when handling each piece of equipment and groundwater sample, using a new pair for each sample collection. Samples were collected in clean containers (supplied by the lab) and stored at the appropriate temperature using the proper preservatives.

Laboratory Qualification – ALS Environmental of Winnipeg, Manitoba, is a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited analytical testing laboratory. Criteria and guidelines used for assessment of analytical data were clearly established with the laboratory to ensure the appropriate detection limits were used. The University of Waterloo Environmental Isotope Laboratory is a modern research facility with an international client base encompassing universities, government agencies, consulting firms and other mainstream institutions.

Duplicate Samples – Duplicate samples were submitted at a frequency of 10% for the total samples submitted to assess the quality of the laboratory analysis. The field duplicates were labelled such that the laboratory did not know the samples were duplicates. Laboratory standards and duplicates are run regularly by ALS and are on file. One duplicate sample was collected for QA/QC as shown on the data summary tables. Laboratory duplicate samples for stable isotope analysis by the University of Waterloo Environmental Isotope Laboratory are shown on Table D3-8.

Field Equipment – Field equipment such as field chemistry meters were calibrated prior to use or installation.

2.2.2 Results

Groundwater

All groundwater samples were taken from bedrock monitoring wells with sampling zones found on Table D3-1, except TH-ED-03, which was completed in the till. Field chemistry from the groundwater program is shown in Table D3-2. General groundwater quality is shown on Table D3-3, with metals shown on Table D3-4. Results were compared against Canadian Drinking Water Quality Guidelines, since the aquifer is potable and is the sole source of drinking water in the region. Results exceeding the applicable guidelines were highlighted. The Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life was shown on the tables for reference.

Water type – Water type analysis was presented when sampled in November 2016 and May 2017 as discussed in Deliverable D6 and D4 submitted previously.

Water Quality Criteria November 2016 to May 2018 – The groundwater samples collected exceeded the drinking water criterion for turbidity; however, these samples are from monitoring wells and are not used for drinking water. All samples exceeded the criterion for hardness (359 to 420 mg/L; criterion 80 to 100 mg/L), typical of the carbonate aquifer and the till unit. All

sulphate samples were below the criterion of 500 mg/L. The sample at till well TH-ED-03 had much lower sulphate (22 – 58 mg/L) and lower conductivity (489 – 616 µS/cm) and hardness values (125 – 319 mg/L) than the bedrock samples. Nitrate values were below detection (generally <0.0051 mg/L), or at very low concentrations (TH-ED-01P) at all samples except the initial November 2016 sample of the till well TH-ED-03, which may not have been purged adequately due to low sample recovery. Boron, calcium, potassium and strontium values in November 2016 were also noticeably lower in the till well. Manganese, molybdenum, nickel, tungsten, uranium, and vanadium were found at low concentrations in the till well in November 2016, but were higher than in the bedrock samples.

Bacteria Sampling - Bacteria sampling was not conducted in groundwater in 2017 or 2018.

Metals - Metals analyses from October 2016 through May 2018 were all below the Health Canada Canadian Drinking Water Guidelines and the Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life Criteria, except manganese in August 2017 and October 2017 in TH-ED-3, a till well which typically had higher levels of turbidity.

Surface Water

Field chemistry from the surface water program November 2016 through May 2018 is shown in Table D3-5. Dissolved oxygen in samples ranged from 1.6 to 12.7 mg/L with lower values generally in August 2017, with a few in May 2018. Turbidity values were 4 to 11 NTU at the Inlet (D1 Lake Manitoba), 5 to 11 NTU at the Outlet (D9 Lake St. Martin), and were less than 5 NTU in the remainder of the samples except for: D5 Clarks Drain in October 2017 (11 NTU); D6 Birch Creek in October 2017 (5.6 NTU); D7 Woodale Drain in August 2017 (7.7 NTU); and D8 Birch Creek in May 2017 (5 NTU), October 2017 (10.5 NTU) and May 2018 (16.3 NTU). General surface water quality is shown on Table D3-6, with metals shown on Table D3-7. The Manitoba Water Quality Standards, Objectives and Guidelines MWQSOG November 28, 2011 were used where available for parameters analyzed. The CCME criteria for Freshwater Aquatic life are also shown and were used where MWQSOG were not listed. Results exceeding the applicable guidelines were highlighted.

Lake St. Martin sample D9 and Lake Manitoba sample D1 have a distinct geochemical composition that is different from the other surface water points due to their elevated sodium and chloride. Within the buried bedrock valley, groundwater quality was generally stable over the 2016 to 2018 monitoring period except for a slow increase in conductivity, hardness, and sulphate in bedrock well TH-ED-01P. Seasonal variations are not evident in the wells sampled, further supporting the relative isolation of the groundwater system below the buried bedrock valley from the surface water system.

Minor seasonal changes were noted in most surface water samples including an increase or decrease in sulphate, alkalinity, hardness, and conductivity. Watchorn Creek samples increased in conductivity, bicarbonate, hardness, and chloride over the 2016 to 2018 sampling period. The sample at Woodale Drain in October 2017 was taken during a dry period with very little flow and showed increased conductivity, alkalinity, hardness, choride, sulphate, and total phosphorous.

Water Type – Water type analysis was presented in Deliverable D6 and D2 and can be referenced.

Water Quality Criteria – All of the samples from Lake St. Martin (D9) exceed the CCME criterion for chloride for long term exposure (value 130 mg/L, criterion 120 mg/L). The sodium concentrations in Lake Manitoba and Lake St. Martin reflect the contribution of saline groundwater on the west side of Lake Manitoba. The Birch Creek drainage is isolated from this system, and drains into Lake St. Martin. All samples except Reed Lake (D3) and Woodale Drain (D7) in November 2016 and May 2017 exceed the CCME long-term criterion for fluoride (values 0.13 to 0.37 mg/L, criterion 0.12 mg/L).

All samples exceeded the MWQSOG for phosphorous of 0.025 mg/L for streams entering lakes except: D1 Lake Manitoba in May 2017 and May 2018; D3 Reed Lake in August 2017, October 2017, and May 2018; D5 North Clark's Drain in November 2016; D6 South Birch Creek in November 2016 and May 2017; D7 Woodale Drain in November 2016; and D9 Lake St. Martin in November 2016, August 2017, and October 2017. Clear Lake and Reed Lake were evaluated with these aquatic life criteria because of the interconnected nature of the Birch Creek drainage system. Considering the sampling record through May 2018, the Birch Creek sample D8 has

similar values of phosphorous (0.02 mg/L) to Reed Lake (D3) and Clear Lake (D4). Surface water samples exceeded the various CCME trigger ranges for phosphorous as follows:

- Mesotrophic (0.010 to 0.020 mg/L)
  - D1 Lake Manitoba: 1 of 5 dates
  - D5 North Clark's Drain: 1 of 5 dates
  - D6 South Birch Creek: 2 of 5 dates

- Meso-eutrophic (0.020 to 0.035 mg/L)
  - D1 Lake Manitoba: 3 of 5 dates
  - D2 Watchorn Creek: 1 of 5 dates
  - D3 Reed Lake: 4 of 5 dates
  - D4 Clear Lake: 3 of 5 dates
  - D5 North Clark's Drain: 2 of 5 dates
  - D6 South Birch Creek: 2 of 5 dates
  - D7 Woodale Drain: 1 of 5 dates
  - D8 Birch Creek: 2 of 5 dates
  - D9 Lake St. Martin: 5 of 5 dates

- Eutrophic (0.035 to 0.1 mg/L)
  - D1 Lake Manitoba: 1 of 5 dates
  - D2 Watchorn Creek: 4 of 5 dates
  - D3 Reed Lake: 1 of 5 dates
  - D4 Clear Lake: 2 of 5 dates
  - D5 North Clark's Drain: 2 of 5 dates
  - D6 South Birch Creek: 1 of 5 dates
  - D7 Woodale Drain: 3 of 5 dates
  - D8 Birch Creek: 3 of 5 dates
- Hyper-eutrophic (> 0.1 mg/L)
  - D7 Woodale Drain: 1 of 5 dates (this sample was taken during very low flow conditions)

Unionized ammonia values were calculated by KGS Group based on field pH and temperature as shown Table D3-6 with all samples below the CCME criterion of 0.019 mg/L.

Bacteria Sampling – Ranges of Total Coliform and *E. coli* at the various sampling locations were as follows:

Sampling Location	Total Coliform (MPN/100 mL)	E. coli (MPN/100 mL)
D1 Lake Manitoba	74 to 5,380	<1 to 114
D2 Watchorn Creek	860 to 2,420	20 to 70
D3 Reed Lake	300 to 3,270	19 to 33
D4 Clear Lake	38 to 2,420	1 to 281
D5 North Clarks Drain	750 to 4,480	18 to 64
D6 South Birch Creek	100 to 2,420	<2 to 3.8
D7 Woodale Drain	231 to 2,130	<1 to 122
D8 Birch Creek	230 to 2,420	39 to 249
D9 Lake St. Martin	100 to 1,990	1 to 613

Metals - Metals analyses from November 2016 through May 2018 were all below the MWQSOG (Tier III Freshwater Aquatic Life) and the CCME Freshwater Aquatic Life Criteria, except for the following samples:

- D-1 Lake Manitoba November 2016 - Aluminum
- D-8 Birch Creek May 2018 - Iron
- D-2 Watchorn Creek August 2017 and May 2018 Phosphorous
- D-7 Woodale Drain August 2017, October 2017 and May 2018 Phosphorous
- D-8 Birch Creek May 2018 Phosphorous
- D-7 Woodale Drain October 2017 – Uranium

Quality Assurance/Quality Control Evaluation

For groundwater from November 2016 through May 2018, relative percent difference (RPD) on Table D3-3 of duplicate samples were all below 5%. The RPD target (10% for all parameters where the analysis value was more than 5 times the detection limit) was met at all samples except for fluoride at GD-02 in November 2016, where the RPD was 17%.

For surface water, the RPDs on Table D3-6 were below the RPD target (10% for samples where the analysis values were more than 5 times the detection limit) except at D4 Clear Lake in May 2017 (total nitrogen and total Kjeldahl nitrogen were 19%) and at D4 Clear Lake in May 2018 (total dissolved phosphorous and total phosphorous were 25% and 18% respectively and total suspended solids were 62%).

A field blank was taken for each surface water sampling event. All parameters analyzed in the field blank were below detection except total dissolved phosphorous and total phosphorous (in November 2016 only), and antimony, calcium, magnesium and manganese in August 2016, all detected at very low concentrations that do not affect the interpretation of the analytical results. For metals analyses, the RPD target of 10% (for samples where the analysis values were more than 5 times the detection limit) was exceeded for the following samples:

- aluminum (16.5%) D9 Lake St. Martin November 2016, (102%) D-4 Clear Lake October 2017; and
- manganese (36%) D-4 Clear Lake October 2017

These variations can be present in surface water since they are not filtered and varying levels of sediment may be present even with standard sampling procedures.

Stable Isotopes

The stable isotopes Oxygen 18 (^{18}O) and deuterium (^{2}H) are used as surface water tracers in water quality studies. These isotopes are conservative tracers, reflecting the origin of the water. Surface water containing fresh snowmelt during a spring runoff or flood would typically have more negative ^{18}O values, in comparison to other times of the year. Less negative ^{18}O values would be expected later in the season, particularly in lakes where evaporation occurs. Groundwater in areas of recent recharge has less negative ^{18}O values, while more negative values can indicate older water.

Isotope samples were collected for the ^{18}O and ^{2}H for wells TH-ED-01W, 15-RD-PW1, as well as Lake Manitoba (D1), Clear Lake (D4), and at Lake St. Martin (D9). Sample results are shown on Table D3-8 and are plotted on Plate D3-1. The Global meteoric water line and the Gimli, Manitoba meteoric water line are plotted as reference. Surface water samples that plot to the right of these lines can indicate evaporation.

Groundwater samples for August 2017, October 2017, and May 2018 are in a similar position to the November 2016 samples (as shown in Deliverable D6 Plate D6-10), and May 2017 samples

(plotted in Deliverable D2 Plate D2-2). Sample TH GD-08 was sampled prior to sealing in 2016 and data is plotted in Deliverable 06 Plate D6-10.

The sample for Lake Saint Martin (D9) plots far to the right of the meteoric water lines and had an ^{18}O value of -8.1 to -8.6 VSMOW. The Lake Manitoba sample had a slightly less negative ^{18}O value of -8.1 to -8.3 VSMOW. The least negative values in both lakes in October 2017 and May 2018 are indicative of these surface waters having undergone a summer season (2017) of evaporation from the lakes, followed by a spring (2018) with low runoff and low lake levels.

The groundwater samples in August 2017 through May 2018 are very stable, with little seasonal variation, ranging from an ^{18}O of -15.3 at Well 15-RD-PW-1 to an ^{18}O of -14.9 at Well TH-ED-01W. These results suggest that this groundwater is reflective of relatively recent recharge from meteoric precipitation (rain and snow) with a relatively low residence time in the subsurface. This is expected since groundwater aquifer recharge in the region is known to be via rain and snowmelt within high elevation bedrock areas with thin overburden cover.

From August 2017 through May 2018 the surface water sample at Clear Lake (D-4) ranged from an ^{18}O of -10.3 in May 2018 to an ^{18}O of -7.19 in October 2017. These values are distinct from the groundwater samples. The Clear Lake samples exhibited a wider range of values from August 2017 to May 2018 than in the previous sampling. The May 2018 value was more similar to the May 2017 value (Table D-3-8) while the August and October values showed increasing depletion of ^{18}O. All surface water ^{18}O isotope values are consistently less negative than the groundwater values, indicating a distinct surface water source characterized by seasonal evaporative processes. The large variation in isotope concentrations is likely related to seasonal precipitation and evaporation rates.

3.0 CONCLUSIONS

The following conclusions regarding trends and seasonal effects can be made from the data collected over the 2016 to 2018 sampling period to July 1, 2018:

1. Minor water elevation changes at well TH-ED-01 and well 15-RD-PW-1 were observed and may be related to a combination of lake level rise and aquifer piezometric response, in combination with regional recharge from upland areas outside of the Route D buried bedrock valley area.

2. Temperature at well 15-RD-PW-1 was a constant 6.5 °C after a longer transducer cable was installed, enabling the transducer to measure groundwater temperature more closely to the bedrock surface. Previous temperature variations in the transducer readings at Routes D and C are not representative of bedrock aquifer conditions due to the shallow placement of the transducer in the well and groundwater temperature variability.

3. The constant groundwater temperature at well 15-RD-PW-1 (following transducer depth relocation) indicates the isolation of groundwater beneath the buried valley, from the surface water system or any other groundwater temperature effects,

4. Seasonal differences in groundwater quality on Route D were not observed between November 2016 and May 2018 in the wells sampled. Increasing parameters were observed at well TH-ED-01P.

5. Minor seasonal differences in surface water quality (e.g. sulphate, alkalinity, hardness, conductivity) between November 2016 and May 2018 were observed at most locations in the Birch Creek watershed. Increasing parameters were observed at D2 Watchorn Creek.

6. The water type and isotopic signatures for samples from Lake Manitoba and Lake St. Martin differ from the rest of the surface water (Clear Lake) and groundwater samples.

7. The stable isotope signature for bedrock groundwater (TH-ED-01W and 15-RD-PW1) and surface water (Clear Lake) samples is widely different and suggests negligible, if any, contribution of groundwater discharge to Clear Lake.

8. The water type signature for the groundwater samples differs from surface water samples along most locations sampled along the Birch Creek drainage, as shown in the Deliverable D6 and D2 reports; however, the sample from Watchorn Creek is more similar to the groundwater samples, due to a higher chloride contribution.

4.0 RECOMMENDATIONS

1. A longer cable should be installed for the transducer at well TH-ED-01W so that the instrument tip is placed closer to the bottom of the casing. This extension is required to obtain accurate temperature measurements of the active groundwater aquifer system.

2. The following repairs and actions are needed for the maintenance of the monitoring system and should be carried out during the next monitoring event:
    - Repair and re-survey staff gauges at D3 Reed Lake and D4 Clear Lake;
    - Re-survey transducer tips at Reed Lake and Clear Lake;
    - Protect cable at D3 Reed Lake with an animal-resistant protective sleeve;
    - Install a new Heron cable at D4 Clear Lake on the transducer with animal-resistant protective sleeve; and
    - Conduct repairs listed in Appendix D3-D at:
        - TH-GD-05
        - 15-RD-05
        - 15-RD-02
        - 15-RD-01
        - BH-D109

3. Transducers on Route C should be downloaded during the next sampling event. The functionality of the equipment should be checked and longer cables should be installed so that the transducer tip is near the bottom of the casing. These instruments on Route C provide valuable baseline regional monitoring for future works on Route D.

4. Baseline monitoring data should be set up in a project database. A series of interpretive plots such as time concentration plots, geochemical plots, and statistical analysis should be created during the next stage of the project for data interpretation and as necessary for environmental licensing compliance.

5. Expanded isotope monitoring at more surface water locations is recommended for future phases, as results have proven useful to differentiate groundwater and surface water sources.

5.0 STATEMENT OF LIMITATIONS AND CONDITIONS

5.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

5.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this report in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

TABLES

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GD-02	Left on road #237 (Township Line) just north of Moosehorn	5683632.07	531290.40		till	VW #1602935		248.625	6.91	241.715	-	-	9-Nov-16	-	-	-	2887.4	249.17	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	30-Mar-17	-	-	-	2874.3	250.16	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	24-May-17	-	-	-	2869.8	250.48	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	2-Aug-17	-	-	-	2870.6	250.42	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	4-Oct-17	-	-	-	2877.1	249.97	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	29-May-18	-	-	-	2883.5	249.27	yes	
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	9-Nov-16	-	>-0.85	>250.33	-	-	yes	Flowing at TOC; used bailer as extension to measure GW elevation.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	24-May-17	4.6	-3.24	252.72	-	-	yes	Removed foam insert - ice on foam 2 m down from top of rod to end of rod; sampled; pressure reading is approx.- seal not tight. Flow rate approx. 6.7 L/min.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	2-Aug-17	3.6	-2.53	252.01	-	-	yes	Sampled; flow rate approx. 10.5 L/min.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	4-Oct-17	3.1	-2.18	251.66	-	-	yes	Sampled; foam insert placed in STP for winter.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	29-May-18	2.5	-1.76	251.24	-	-	yes	Foam insert removed and reinstalled after sampling.
TH-GD-05	Carne Ridge Road	5693350.95	530617.18		till	VW #1602924		248.66	6.71	241.95	-	-	9-Nov-16	-	-	-	2772.2	249.83	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	30-Mar-17	-	-	-	2749.6	251.29	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	24-May-17	-	-	-	2751.2	251.18	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	1-Aug-17	-	-	-	2771.4	249.87	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	3-Oct-17	-	-	-	2767.2	250.14	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	28-May-18	-	-	-	2745.8	251.53	yes	
					till	STP	20	248.66	16.92	231.74	0.80	249.461	9-Nov-16	-	>-0.8	>250.26	-	-	yes	Flowing at TOC; no extension available
					till	STP	20	248.66	16.92	231.74	0.80	249.461	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	20	248.66	16.92	231.74	0.80	249.461	24-May-17	-	>-1.05	>249.71	-	-	yes	Used bailer as extension for GW elevation measurement. Removed foam insert; STP loose - pulls up while removing foam.
					till	STP	20	248.66	16.92	231.74	0.80	249.461	1-Aug-17	-	-	>249.46	-	-	yes	Stabilized STP; water flowing out of TOC
					till	STP	20	248.66	16.92	231.74	0.80	249.461	3-Oct-17	2.5	-1.76	251.22	-	-	yes	Water flowing out of STP; foam insert placed in STP for winter; plug placed on top of foam insert and then slip cap taped on to prevent leakage.
					till	STP	20	248.66	16.92	231.74	0.80	249.461	28-May-18	3.1	-2.18	251.64	-	-	yes	STP lifted; had to raise casing to open lid. Crack in casing (0.3 m long); water flowing out of STP once foam removed; foam reinstalled. Stick up now 1.08 m.
TH-GD-06	On left side of road #239 to Steep Rock	5697400.98	531025.08		till	VW #1602923		251.918	10.67	241.248	-	-	10-Nov-16	-	-	-	2738.5	251.56	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	30-Mar-17	-	-	-	2744.1	251.19	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	24-May-17	-	-	-	2740.2	251.45	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	1-Aug-17	-	-	-	2738.9	251.53	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	3-Oct-17	-	-	-	2751.1	250.71	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	28-May-18	-	-	-	2747.2	250.97	no	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	10-Nov-16	-	0.02	252.79	-	-	yes	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	30-Mar-17	-	0.02	252.79	-	-	yes	Foam insert frozen; could not remove.
					till	STP	25	251.918	21.34	230.578	0.89	252.809	24-May-17	-	1.495*	251.31*	-	-	no	Water was near TOC before removing foam insert; was still rising slowly after monitoring. Reading may still be depressed.
					till	STP	25	251.918	21.34	230.578	0.89	252.809	1-Aug-17	-	0.505	252.30	-	-	yes	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	3-Oct-17	-	0.565	252.24	-	-	yes	Foam insert placed in STP for winter
					till	STP	25	251.918	21.34	230.578	0.89	252.809	28-May-18	-	1.596	251.21	-	-	no	Foam insert removed and then reinstalled.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GD-07	Cluster of wells on west side of Hwy 6 (heading north)	5699453.66	531900.65		till	VW #1602937		252.045	12.19	239.855	-	-	9-Nov-16	-	-	-	2726.0	253.08	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	31-Mar-17	-	-	-	2720.0	253.48	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	24-May-17	-	-	-	2715.4	253.79	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	1-Aug-17	-	-	-	2723.6	253.24	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	3-Oct-17	-	-	-	2728.7	252.90	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	28-May-18	-	-	-	2726.6	253.04	yes	
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	9-Nov-16	-	>-0.79	>253.63	-	-	yes	Flowing at TOC; no extension available >1.6m ags
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	24-May-17	1.8	-1.27	254.10	-	-	yes	Removed foam insert; sampled. Flow rate approx. 0.8 L/min.
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	1-Aug-17	1.8	-1.27	254.10	-	-	yes	sampled
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	3-Oct-17	1.2	-0.84	253.68	-	-	yes	Sampled; foam insert placed in STP for winter
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	28-May-17	1.25	-0.88	253.72	-	-	yes	Foam insert removed and reinstalled after sampling.
TH-GD-08	Intersection of Iverson Road and Birch Bay Loop	5701521.62	532917.21		till	VW #1602938		246.807	7.32	239.487	-	-	9-Nov-16	-	-	-	2721.1	250.41	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	30-Mar-17	-	-	-	2689.4	252.03	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	24-May-17	-	-	-	2681.6	252.54	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	1-Aug-17	-	-	-	2684.9	252.31	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	3-Oct-17	-	-	-	2697.5	251.49	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	28-May-18	-	-	-	2697.8	251.45	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	9-Nov-16	-	-	-	2590.2	251.97	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	30-Mar-17	-	-	-	2587.5	252.15	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	24-May-17	-	-	-	2579.2	252.67	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	1-Aug-17	-	-	-	2582.7	252.45	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	3-Oct-17	-	-	-	2595.8	251.61	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	28-May-18	-	-	-	2597.7	251.49	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	9-Nov-16	-	>-7.92	>254.75	-	-	yes	Flowing at TOC; only able to extend by 7.92 m safely >7.9m ags. Installed pressure gauge.
					till	STP	25	246.807	17.07	229.737	0.91	247.717	30-Mar-17	5.2	-3.66	251.38	-	-	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	24-May-17	4.2	-2.96	250.67	-	-	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	1-Aug-17	3	-2.11	249.83	-	-	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	3-Oct-17	4.5	-3.17	250.88	-	-	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	28-May-18	0.5*	#VALUE!	#VALUE!	-	-	#VALUE!	Gauge may not be working correctly - reading is much lower than previous, and needle is sitting at lowest value (o.5). Well is under extreme pressure and field repair of gauge was not possible.
TH-ED-01P	Farm off Werster Road (off Carne Ridge Road)	5692376.38	530502.82	11+625	till	VW #1602932		249.431	6.10	243.331	-	-	9-Nov-16	-	-	-	2830.4	249.47	yes	
					till	VW #1602932		249.431	6.10	243.331	-	-	30-Mar-17	-	-	-	2841.9	248.61	no	
					till	VW #1602932		249.431	6.10	243.331	-	-	23-May-17	-	-	-	2830.7	249.42	no	
					till	VW #1602932		249.431	6.10	243.331	-	-	2-Aug-17	-	-	-	2835.9	249.04	no	
					till	VW #1602932		249.431	6.10	243.331	-	-	4-Oct-17	-	-	-	2846.5	248.29	no	
					till	VW #1602932		249.431	6.10	243.331	-	-	29-May-18	-	-	-	2851.8	247.87	no	
					till	VW #1602939		249.431	10.67	238.761	-	-	9-Nov-16	-	-	-	2771.9	250.36	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	30-Mar-17	-	-	-	2788.6	249.18	no	
					till	VW #1602939		249.431	10.67	238.761	-	-	23-May-17	-	-	-	2778.9	249.86	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	2-Aug-17	-	-	-	2784.7	249.44	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	4-Oct-17	-	-	-	2796.2	248.62	no	
					till	VW #1602939		249.431	10.67	238.761	-	-	29-May-18	-	-	-	2803.4	248.11	no	
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	9-Nov-16	-	-	>251.16	-	-	yes	Flowing at TOC; used bailer as extension to measure GW elevation.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	23-May-17	3.9	-2.74	253.09	-	-	yes	Removed foam insert; sampled. Flow rate approx. 4 L/min.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	2-Aug-17	4.3	-3.03	253.37	-	-	yes	Sampled; flow rate approx. 5.6 L/min.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	4-Oct-17	3.6	-2.53	252.88	-	-	yes	Sampled; flow rate approx. 5.3 L/min; foam insert placed in STP for winter.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	29-May-18	3.7	-2.60	252.95	-	-	yes	Foam insert removed and reinstalled after sampling.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-ED-01W	Farm off Werster Road (off Carne Ridge Road)	5692378.37	530495.27	11+625	bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	9-Nov-16	-	-4.57	255.10	-	-	yes	Artesian at 5.6 m above ground surface.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	30-May-17	-	-	-	-	-	yes	Mechanical packer installed in December, 2016. Sampling port frozen. Downloaded transducer.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	23-May-17	-	-	-	-	-	yes	Downloaded transducer and sampled. Flow rate from well sampling tube approx. 2 L/min.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	2-Aug-17	-	-	-	-	-	yes	Downloaded transducer and sampled. Flow rate from well sampling tube approx. 2 L/min.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	4-Oct-17	-	-	-	-	-	yes	Downloaded transducer and sampled. Packer was leaking so removed and cleaned; reinstalled. Flow rate from well sampling tube approx. 2 L/min.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	29-May-18	-	-	-	-	-	yes	Downloaded transducer and sampled.
TH-ED-01PP1	Farm off Werster Road (off Carne Ridge Road)	5692378.65	530536.08		till	STP	25	248.717	1.22	247.497	0.97	249.688	9-Nov-16	-	1.130	248.56	-	-	no	
					till	STP	25	248.717	1.22	247.497	0.97	249.688	30-Mar-17	-	1.855	247.83	-	-	no	Foam insert removed and then reinstalled.
					till	STP	25	248.717	1.22	247.497	0.97	249.688	23-May-17	-	1.470	248.22	-	-	no	Foam insert removed.
					till	STP	25	248.717	1.22	247.497	0.97	249.688	2-Aug-17	-	1.910	247.78	-	-	no	Transducer for atmospheric pressure was installed in casing above water.
					till	STP	25	248.717	1.22	247.497	0.97	249.688	4-Oct-17	-	2.095	247.59	-	-	no	Foam insert placed in STP for winter
					till	STP	25	248.717	1.22	247.497	0.97	249.688	29-May-18	-	1.831	247.86	-	-	no	Foam insert removed; bar logger downloaded; foam insert reinstalled.
TH-ED-01PP2	Farm off Werster Road (off Carne Ridge Road)	5692380.13	530549.75		till	STP	25	248.456	1.22	247.236	1.06	249.519	9-Nov-16	-	1.03	248.49	-	-	yes	
					till	STP	25	248.456	1.22	247.236	1.06	249.519	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	248.456	1.22	247.236	1.06	249.519	23-May-17	-	1.47	248.05	-	-	no	Foam insert removed.
					till	STP	25	248.456	1.22	247.236	1.06	249.519	2-Aug-17	-	1.81	247.71	-	-	no	
					till	STP	25	248.456	1.22	247.236	1.06	249.519	4-Oct-17	-	1.81	247.71	-	-	no	Foam insert placed in STP for winter
					till	STP	25	248.456	1.22	247.236	1.06	249.519	29-May-18	-	1.70	247.82	-	-	no	Foam insert removed and reinstalled.
TH-ED-03	Carne Ridge Road	5693404.42	529670.69		till	VW #1602931		252.218	6.10	246.118	-	-	9-Nov-16	-	-	-	2854.2	251.54	no	
					till	VW #1602931		252.218	6.10	246.118	-	-	30-Mar-17	-	-	-	-	-	-	VW reading error.
					till	VW #1602931		252.218	6.10	246.118	-	-	23-May-17	-	-	-	-	-	-	VW reading error.
					till	VW #1602931		252.218	6.10	246.118	-	-	1-Aug-17	-	-	-	-	-	-	VW reading error.
					till	VW #1602931		252.218	6.10	246.118	-	-	3-Oct-17	-	-	-	-	-	-	Cut VW wire down as far as possible and tried reading - still error
					till	STP	25	252.218	13.41	238.808	0.86	253.076	9-Nov-16	-	0.580	252.50	-	-	yes	
					till	STP	25	252.218	13.41	238.808	0.86	253.076	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	252.218	13.41	238.808	0.86	253.076	23-May-17	-	1.915	251.16	-	-	no	Foam insert removed; sampled.
					till	STP	25	252.218	13.41	238.808	0.86	253.076	1-Aug-17	-	0.465	252.61	-	-	yes	sampled
					till	STP	25	252.218	13.41	238.808	0.86	253.076	3-Oct-17	-	-	-	-	-	-	Waterra left in STP in August, so no water depth taken; sampled; waterra left in STP, no foam insert.
					till	STP	25	252.218	13.41	238.808	0.86	253.076	28-May-18	-	-	-	-	-	-	Waterra left in STP in October, so no water depth taken; sampled; waterra left in STP, no foam insert. Watera should be removed between samping periods to enable getting a water level prior to sampling.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-D109	Walk south on farmer's field from Township Line	5682844.41	530474.731		till	STP	20	249.716	12.85	236.866	0.96	250.676	21-Jul-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	29-Aug-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	9-Nov-16	-	1.11	249.57	-	-	no	
					till	STP	20	249.716	12.85	236.866	0.96	250.676	30-Mar-17	3	-2.11	252.79	-	-	yes	Foam insert removed and then reinstalled.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	23-May-17	-	-	>250.68	-	-	yes	Foam insert removed; water rose to TOC within a few minutes.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	2-Aug-17	-	-	>250.68	-	-	yes	Flow very slow - too little to measure with gauge.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	4-Oct-17	-	-	>250.68	-	-	yes	Flow very slow - too little to measure with gauge; foam insert placed in STP for winter.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	29-May-18	-	-	-	-	-	-	Ice in borehole and on bottom of foam insert. Did not thaw after 9 hours; reinstalled foam insert. Lock would not close on well casing.
15-RD-01	Beside TH-GD-02	5683639	531292	2+672	Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	16-Jul-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	4-Aug-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	9-Nov-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	9-Nov-16	1.1	-0.77	250.07	-	-	yes	Pressure gauge installed - not fitted tightly, so removed and replaced with j-plug.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	24-May-17	-	1.080	248.22	-	-	no	Removed foam insert; possibly artesian - water level may be low because foam was just removed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	2-Aug-17	-	0.055	249.25	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	4-Oct-17	-	0.050	249.25	-	-	yes	Foam insert placed in STP for winter
					Silty Clay	STP	25	248.3	10.4	237.9	0.9575	249.2575	28-May-18	-	0.450	248.81	-	-	yes	STP top broken off; obstruction at 1.5 m but got past it; reinstalled foam insert. New TOC is 0.0425 m lower than original.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	16-Jul-15	3.5	-2.46	251.73	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	4-Aug-15	2.9	-2.04	251.31	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	9-Nov-15	3	-2.11	251.38	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	9-Nov-16	3.8	-2.67	251.94	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	30-Mar-17	1	-0.70	249.97	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	24-May-17	3.9	-2.74	252.01	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	2-Aug-17	3.4	-2.39	251.66	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	4-Oct-17	2.9	-2.04	251.31	-	-	yes	Pressure gauge installed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	29-May-18	3	-2.11	251.38	-	-	yes	Pressure gauge installed.
BH-D101	East side of Bayton Road	5684505.014	530628.736		till	STP	25	249.251	8.94	240.311	1.12	250.371	21-Jul-12	-	-	248.09	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	29-Aug-12	-	-	247.69	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	9-Nov-16	-	1.33	249.04	-	-	no	
					till	STP	25	249.251	8.94	240.311	1.12	250.371	23-May-17	-	-	-	-	-	-	Foam remained stuck in STP; could not remove; could not monitor.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	1-Aug-17	-	2.02	248.36	-	-	no	Removed foam insert.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	4-Oct-17	-	2.82	247.55	-	-	no	Foam insert placed in STP for winter
					till	STP	25	249.251	8.94	240.311	1.12	250.371	29-May-18	-	1.83	248.55	-	-	no	Removed foam insert and reinstalled.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-D106	East side of Bayton Road	5682844.413	530474.731		till	STP	50	249.917	11.23	238.687	0.89	250.807	21-Jul-12	-	-	248.06	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	29-Aug-12	-	-	247.58	-	-	no	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	9-Nov-16	-	0.86	249.95	-	-	yes	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	30-Mar-17	-	2.56	248.25	-	-	no	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	23-May-17	-	1.31	approx 249.50	-	-	yes	STP rose or casing fell approx. 5 cm while monitoring water level; needs to be resurveyed.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	1-Aug-17	-	1.72	249.09	-	-	no	Lifted outer casing to appropriate height and poured bentonite inside casing and at base. Inside casing (STP) is stable.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	4-Oct-17	-	2.15	248.66	-	-	no	Outer well casing remained in place - very stable. No foam insert - 50 mm STP.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	29-May-18	-	2.19	248.62	-	-	no	No foam insert - 50 mm STP.
BH-D107	Access by quad from TH-ED-01 farm	5691570.348	530533.122		till	STP	50	249.81	8.69	241.12	0.86	250.67	21-Jul-12	-	-	248.97	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	29-Aug-12	-	-	248.65	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	9-Nov-16	-	-	-	-	-	-	No permission for access
					till	STP	50	249.81	8.69	241.12	0.86	250.67	23-May-17	-	1.137	249.53	-	-	no	Pressure gauge installed.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	2-Aug-17	-	1.490	249.18	-	-	no	Pressure gauge installed.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	4-Oct-17	-	2.079	248.59	-	-	no	No foam insert - 50 mm STP.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	28-May-18	-	-	-	-	-	-	No permission for access
15-RD-02	Corner of Burnett and Carne Ridge Road	5693417	530519	12+776	Silty Clay Til	STP	25	248.65	14.9	233.75	0.8	249.45	16-Jul-15	7.1	-5.00	254.45	-	-	yes	Pressure gauge installed.
					Silty Clay Til	STP	25	248.65	14.9	233.75	0.8	249.45	4-Aug-15	7.1	-5.00	254.45	-	-	yes	Pressure gauge installed.
					Silty Clay Til	STP	25	248.65	14.9	233.75	0.8	249.45	9-Nov-15	7.7	-5.42	254.87	-	-	yes	Pressure gauge installed.
					Silty Clay Til	STP	25	248.65	14.9	233.75	0.8	249.45	9-Nov-16	7.4	-5.21	254.66	-	-	yes	Pressure gauge installed.
					Silty Clay Til	STP	25	248.65	14.9	233.75	0.8	249.45	30-Mar-17	2.0	-1.41	250.86	-	-	yes	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	24-May-17	2.0	-1.41	250.86	-	-	yes	Pressure gauge installed; leaking a bit around pressure gauge.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	1-Aug-17	1.9	-1.34	250.79	-	-	yes	Leaking a bit around pressure gauge.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	3-Oct-17	1.4	-0.99	250.44	-	-	yes	Leaking around pressure gauge; could not seal.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	28-May-18	1.0	-0.70	250.15	-	-	yes	Pressure gauge reading is at lowest reading (1 psi), so could be less than 1; lots of water leaking from casing.
15-RD-02A	Corner of Burnett and Carne Ridge Road	5693419	530519	12+776	Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	16-Jul-15	-	0.91	248.39	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	4-Aug-15	-	0.98	248.33	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	9-Nov-15	-	0.65	248.65	-	-	yes	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	9-Nov-16	-	>-0.67	>249.97	-	-	yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	24-May-17	-	1.91	247.39	-	-	no	Removed foam insert.
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	1-Aug-17	-	0.69	248.62	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	3-Oct-17	-	0.89	248.41	-	-	no	Foam insert placed in STP for winter
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	28-May-18	-	0.81	248.49	-	-	no	Foam insert removed and then reinstalled.
BH-D9	East side of Burnett, walk from road	5693949.149	530788.559		till	STP	25	249.495	12.376	237.119	0.90	250.395	21-Jul-12	-	-	248.96	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	29-Aug-12	-	-	248.77	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	9-Nov-16	-	1.23	249.16	-	-	no	
					till	STP	25	249.495	12.376	237.119	0.90	250.395	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	24-May-17	-	2.12	248.28	-	-	no	
					till	STP	25	249.495	12.376	237.119	0.90	250.395	1-Aug-17	-	1.30	249.10	-	-	no	
					till	STP	25	249.495	12.376	237.119	0.90	250.395	3-Oct-17	-	2.10	248.30	-	-	no	Foam insert placed in STP for winter
					till	STP	25	249.495	12.376	237.119	0.90	250.395	28-May-18	-	2.32	248.08	-	-	no	Foam insert removed and then reinstalled.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
15-RD-03	On trail in woods across ditch on road #239, opposite side from TH-GD-06	5697485	530996	17+032	Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	16-Jul-15	-	1.75	250.99	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	4-Aug-15	-	1.68	251.06	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	9-Nov-15	-	1.30	251.44	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Til	STP	25	251.84	7.6	244.24	0.9	252.74	9-Nov-16	-	1.238	251.50	-	-	no	
					Silty Clay Til	STP	25	251.84	7.6	244.24	0.9	252.74	30-Mar-17	-	2.150	250.59	-	-	no	
					Silty Clay Til	STP	25	251.84	7.6	244.24	0.9	252.74	24-May-17	-	2.090	250.65	-	-	no	
					Silty Clay Til	STP	25	251.84	7.6	244.24	0.9	252.74	1-Aug-17	-	1.540	251.20	-	-	no	
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	3-Oct-17	-	2.360	250.38	-	-	no	Foam insert placed in STP for winter
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	28-May-18	-	2.219	250.52	-	-	no	Foam insert removed and then reinstalled.
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	16-Jul-15	-	0.36	252.39	-	-	yes	Water level 0.9 m below grade upon completion of drilling
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	4-Aug-15	-	0.32	252.42	-	-	yes	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	9-Nov-15	-	0.00	252.74	-	-	yes	Water level at Top Of Casing (TOC)
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	9-Nov-16	-	>-0.9	>253.64	-	-	yes	Flowing at TOC; no extension available
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	24-May-17	-	0.852	251.89	-	-	yes	Removed foam insert; water still rising after monitoring.
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	1-Aug-17	-	0.020	252.72	-	-	yes	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	3-Oct-17	-	0.774	251.97	-	-	yes	Foam insert placed in STP for winter
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	28-May-18	-	0.671	252.07	-	-	yes	Foam insert removed and then reinstalled.
15-RD-03A	On trail in woods across ditch on road #239, opposite side from TH-GD-06	5697489	530991	17+032	Sand	VW #1403291		251.86	10.4	241.46	-	-	16-Jul-15	-	-	250.52	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	4-Aug-15	-	-	251.18	-	-	no	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	9-Nov-15	-	-	251.94	-	-	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	9-Nov-16	-	-	-	2816.1	251.93	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	30-Mar-17	-	-	-	2823.9	251.44	no	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	24-May-17	-	-	-	2818.4	251.78	no	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	1-Aug-17	-	-	-	2814.2	252.04	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	3-Oct-17	-	-	-	2828.1	251.16	no	No foam insert due to VW wire.
					Sand	VW #1403291		251.86	10.4	241.46	-	-	28-May-18	-	-	-	2825.2	251.35	no	No foam insert due to VW wire.
15-RD-04	Cluster of wells on west side of Hwy 6 (heading north)	5699450	531894	19+256	Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	16-Jul-15	-	1.03	251.73	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	4-Aug-15	-	2.51	250.26	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	9-Nov-15	-	0.75	252.01	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	9-Nov-16	-	0.54	252.22	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	24-May-17	-	1.92	250.84	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	1-Aug-17	-	1.50	251.26	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	3-Oct-17	-	1.67	251.09			no	Foam insert placed in STP for winter
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	28-May-18	-	1.15	251.61			no	Foam insert removed and then reinstalled.
					Silty Clay Til	STP	25	251.76	14.5	237.26	1	252.76	16-Jul-15	1.6	-1.13	253.89	-	-	yes	
					Silty Clay Til	STP	25	251.76	14.5	237.26	1	252.76	4-Aug-15	1.1	-0.77	253.53	-	-	yes	
					Silty Clay Til	STP	25	251.76	14.5	237.26	1	252.76	9-Nov-15	2.5	-1.76	254.52	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	9-Nov-16	-	>-1	>253.76	-	-	yes	Flowing at TOC; no extension available
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	24-May-17	1	-0.70	253.46	-	-	yes	Flowing at TOC; no extension available
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	1-Aug-17	0.5	-0.35	253.11	-	-	yes	Flowing at TOC; 0.3 m head measured above TOC with bailer
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	3-Oct-17	-	-	>252.76	-	-	yes	Flowing at TOC too slowly to measure P with gauge; foam insert placed in STP for winter
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	28-May-18	-	-	>252.76	-	-	yes	Flowing at TOC; too tight against casing to measure P with gauge; foam insert removed and then reinstalled.

TABLE D3-1
TESTHOLE AND GROUNDWATER DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading* (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
15-RD-PW1	Cluster of wells on west side of Hwy 6 (heading north)	5699447	531897	19+256	bedrock	STP	125	251.76	23.16	228.6	0.94	252.70	9-Nov-16	-	-	-	-	-	yes	Conducted pump test (flow rate approx. 9.5 L/min); sampled; installed packer with transducer.
					bedrock	STP	125	251.76	23.16	228.6	1.94	253.70	31-Mar-17	-	-	-	-	-	yes	Transducer would not connect.
					bedrock	STP	125	251.76	23.16	228.6	2.94	254.70	24-May-17	-	-	-	-	-	yes	Transducer would not connect; sampled. Flow rate from well sampling tube approx. 1.3 L/min.
					bedrock	STP	125	251.76	23.16	228.6	2.94	254.70	1-Aug-17	-	-	-	-	-	yes	Transducer would not connect; transducer and packer removed. Connection successful in office. Cable being replaced.
					bedrock	STP	125	251.76	23.16	228.6	2.94	254.70	3-Oct-17	-	-	-	-	-	yes	Reinstalled packer and transducer; sampled
					bedrock	STP	125	251.76	23.16	228.6	2.94	254.70	28-May-18	-	-	-	-	-	yes	Downloaded logger; sampled.
15-RD-10A	Use quad from old house on Burnett - watch for ditch in middle of field	5698130	531200	17+800	Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	16-Jul-15	-	-	-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	4-Aug-15	-		-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	9-Nov-15	-	-	-	-	-	-	Was not read
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	9-Nov-16	-	-	-	2727.5	249.60	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	31-Mar-17	-	-	-	2732.3	249.29	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	24-May-17	-	-	-	2728.0	249.54	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	1-Aug-17	-	-	-	2725.9	249.67	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	3-Oct-17	-	-	-	2731.0	249.36	yes	No foam insert due to VW wire.
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	28-May-18	-	-	-	2733.2	249.22	yes	No foam insert due to VW wire.
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	16-Jul-15	-	-	-	-	-	-	Water level at bottom of hole upon completion of drilling
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	4-Aug-15	-	-	-	-	-	-	No Access
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	9-Nov-15	-	0.1	249.77	-	-	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	9-Nov-16	-	>-1	>250.87	-	-	yes	Flowing at TOC; no extension available
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	24-May-17	-	1.613	248.26	-	-	no	Removed foam insert. Possibly artesian; water still rising after monitoring.
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	1-Aug-17	-	0.03	249.84	-	-	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	3-Oct-17	-	0.35	249.52	-	-	yes	Foam insert placed in STP for winter
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	28-May-18	-	0.407	249.46	-	-	yes	Foam insert removed and then reinstalled.
15-RD-05	Across road from TH-GD-08	5701483	532787	21+464	Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	16-Jul-15	-	1.90	246.14			no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	4-Aug-15	-	1.89	246.15			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	9-Nov-15	-	1.37	246.67			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	9-Nov-16	-	-	-	-	-	-	Blocked at 0.61 m. Could not install foam insert.
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	30-Mar-17	-	-	-	-	-	-	Blocked at 0.46 m.
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	24-May-17	-	-	-	-	-	-	Blocked at 0.46 m.
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	1-Aug-17	-	-	-	-	-	-	Blocked at 0.46 m.
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	16-Jul-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	4-Aug-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	9-Nov-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	9-Nov-16	-	0.23	247.79			yes	
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	30-Mar-17	-	-	-			-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	24-May-17	-	0.15	247.87			yes	Removed foam insert; water still rising after monitoring (rose 1 m in 20 min).
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	1-Aug-17	-	0.00	248.02			yes	flowing
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	3-Oct-17	0.5	-0.35	248.37			yes	Flowing; foam insert placed in STP for winter
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	3-Oct-17	-	-	-			yes	Flowing; could not remove foam insert as STP is bent at about 0.25 m below TOC.

VW = Vibrating Wire
STP = Standpipe
* Pressure gauges were installed on standpipes at: TH-GD-08; 15-RD-01 (10.4 m STP); and 15-RD-02. Pressure readings at other standpipes were taken with a handheld gauge.

Notes:
1. BH-BC series drilled and surveyed in 2011.
2. 15-RC series drilled in 2015. Ground elevations were estimated using LiDAR.
3. TH-GC and TH-EC series drilled and surveyed in 2016.
4. Transducers were installed December 8, 2016 in wells TH-ED-01W and 15-RD-PW1.

TABLE D3-2
GROUNDWATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (°C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
TH-ED-01W	26-Oct-16	6.5	793	6.4	174.9	NA	none to very low	none	none	start of pump test
	26-Oct-16	-	901	6.3	399.7	NA	none to very low	none	none	end of pump test - not sure if YSI was working properly
	23-May-17	7.4	813	4.7	133.2	3.07	none	none	none	purged 60 L; flow rate approx. 2 L/min.
	2-Aug-17	7.2	810	6.6	6.7	2.83	none	none	none	purged 95 L; flow rate approx. 2 L/min.
	4-Oct-17	7.7	844	6.7	-4.2	0.43	none	none	none	purged 140 L; flow rate approx. 1.7 L/min.
	29-May-18	9.0	811	5.5	-42.3	0.04	very low	none	none	purged 80 L; flow rate approx. 1.7 L/min.
TH-ED-01P	9-Nov-16	-	868	9.1	-185.1	1.21	none to very low	none	none	pH not calibrating
	23-May-17	7.3	818	7.0	122.2	1.92	none	none	none	purged 40 L; flow rate approx. 4 L/min.
	2-Aug-17	7.1	832	6.1	-36.7	0.41	low	none	none	purged 95 L; flow rate approx. 5.6 L/min.
	4-Oct-17	7.7	848	6.1	-14.0	0.78	low	swampy	none	purged 150 L; flow rate approx. 5.3 L/min.
	29-May-18	9.1	813	6.0	-	1.15	low	none	none	purged 300 L; flow rate approx. 4.8 L/min.
TH-ED-03	9-Nov-16	-	616	9.7	-172.9	9.02	none to very low	none	none	pH not calibrating
	24-May-17	8.1	548	8.7	77.1	6.52	none	none	none	purged dry after 8 L; recharge after 28 hours - 1 L
	1-Aug-17	7.2	518	10.2	-15.5	1.06	low	none	silty	purged dry after 4 L; sampled; sampled again after 30 hours - clearer water
	4-Oct-17	8.2	561	11.8	-5.4	3.58	moderate	none	silty	purged dry after 4 L; sampled after recharging for 28.5 hours
	28-May-18	6.8	562	12.4	-37.2	1.35	low	rotten eggs	silty	purged dry after 5 L; used this water for sample
TH-GD-02	9-Nov-16	-	796	5.7	-24.6	1.54	none to very low	none	none	pH not calibrating
	24-May-17	7.4	815	5.8	153.0	0.97	none	none	none	purged 150 L; flow rate approx. 6.7 L/min.
	2-Aug-17	7.2	797	6.0	-5.9	0.64	none	none	none	purged 210 L; flow rate approx. 10.5 L/min.
	4-Oct-17	7.3	814	5.9	-203.7	1.17	very low	none	silty	purged 270 L; flow rate approx. 9.4 L/min.
	29-May-18	8.2	782	5.9	-33.7	0.04	very low	none	none	purged 240 L; flow rate approx. 8.5 L/min.
TH-GD-07	9-Nov-16	-	782	7.4	-296.5	1.15	none to very low	none	none	pH not calibrating
	24-May-17	7.2	813	7.3	112.3	1.46	none	none	none	purged 30 L; flow rate approx. 0.8 L/min.
	1-Aug-17	7.1	796	8.9	-28.2	1.27	none	none	none	purged 15 L; flow rate approx. 0.7 L/min.
	3-Oct-17	7.5	807	8.3	-31.9	1.26	very low	sulfur	none	purged 18 L; flow rate approx. 0.3 L/min.
	28-May-18	8.9	767	6.7	-56.0	0.01	low	none	none	purged 12 L; flow rate approx. 0.3 L/min.
15-RD-PW1	24-May-17	7.3	817	6.3	97.0	1.24	none	none	none	purged 40 L; flow rate approx. 1.3 L/min.
	1-Aug-17	7.3	792	6.8	-6.0	0.78	yes	none	none	purged 70 L; flow rate approx. 3.4 L/min.
	3-Oct-17	7.7	808	9.4	-42.5	0.77	very low	none	none	purged 35 L; flow rate approx. 0.5 L/min.
	28-May-18	8.9	767	6.7	-56.0	0.01	none	none	none	purged 600 L; flow rate approx. 0.6 L/min.

Notes:
1. Mechanical packers installed in wells TH-ED-01W and 15-RD-PW1 in December, 2016.
2. Mechanical packer and transducer were removed from well 15-RD-PW1 in August, 2017, as the transducer was not functioning properly.
3. Mechanical packer and transducer were reinstalled in well 15-RD-PW1 in October, 2017.
4. pH readings for May 28, 2018 are generally higher than laboratory readings and may indicate pH probe malfunction.

"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D3-3
GROUNDWATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Field / Lab Dup. Info	Parameter [1]																						
			Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [5]	Fluoride	Sulphate	Ammonia (as N)	Un-ionized Ammonia	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Iron	Manganese	Free Cyanide	Total Phosphorus	T.D.S.	T.K.N.	E. Coli (MPN/100 mL)	Total Coliform (MPN/100mL)
EQL			*0.2*	*0.01*	*1*	*1*	*1*	*1 / 0.60*	*1 / 0.34*	*1*	*0.5*	*0.02*	*0.5*	*0.01*	*0.03*	*0.01 / 0.0051*	*0.01 / 0.005*	*0.01/0.02/0 .001*	*0.03*	*0.005*	*0.001*	*0.05*	*2 / 5*	*0.03*	*1*	*1*
TH-ED-01W TEST START	26-Oct-16		17.6	7.7	741	321	392	<0.60	<0.34	374	6.09	0.757	149	0.247	-	<0.010	<0.010	<0.0100	-	-	-	0.025	513	0.26	<1	24
TH-ED-01W TEST STOP	26-Oct-16		-	7.7	744	339	413	<0.60	<0.34	375	6	-	148	0.246	-	<0.070	<0.040	<0.020	-	-	-	0.0129	521	0.28	<1	2
TH-ED-01W	23-May-17		-	7.71	768	328	400	<0.60	<0.34	398	5.76	-	142	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	514	-	-	-
TH-ED-01W	2-Aug-17		-	7.61	783	321	392	<0.60	<0.34	397	5.84	-	143	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	511	-	-	-
TH-ED-01W	4-Oct-17		-	7.53	754	316	386	<0.60	<0.34	402	5.8	-	143	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	508	-	-	-
TH-ED-01W	29-May-18		-	7.86	820	323	395	<0.60	<0.34	420	5.98	-	147	-	-	<0.010	<0.010	<0.0020	-	-	-	-	528	-	-	-
TH-ED-01P	9-Nov-16		1.41	7.72	776	301	368	<0.60	<0.34	398	6.18	0.821	149	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	508	-	-	-
TH-ED-01P	23-May-17		-	7.71	771	319	390	<0.60	<0.34	390	6.12	-	148	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	518	-	-	-
TH-ED-01P	2-Aug-17		-	7.62	786	315	384	<0.60	<0.34	392	6.18	-	149	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	515	-	-	-
TH-ED-01P	4-Oct-17		-	7.54	809	316	385	<0.60	<0.34	396	6.21	-	149	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	517	-	-	-
TH-ED-01P	29-May-18		-	7.59	827	315	384	<0.60	<0.34	414	6.33	-	153	-	-	<0.010	<0.010	<0.0020	-	-	-	-	532	-	-	-
TH-ED-03	9-Nov-16		694	8.11	616	377	460	<0.60	<0.34	319	14.6	0.466	21.6	-	-	0.23	0.211	0.0191	-	-	-	-	390	-	-	-
TH-ED-03	25-May-17		-	8.34	514	332	399	2.88	<0.34	162	17	-	43.2	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	372	-	-	-
TH-ED-03	2-Aug-17		-	8.23	520	221	270	<0.60	<0.34	134	17.6	-	53.6	-	-	0.0139	0.0139	<0.0010	-	-	-	-	320	-	-	-
TH-ED-03	4-Oct-17		-	8.07	508	247	301	<0.60	<0.34	138	17.8	-	57.4	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	338	-	-	-
TH-ED-03	28-May-18		-	8.46	489	218	253	6	<0.34	125	17.7	-	33.7	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	295	-	-	-
TH-GD-02	9-Nov-16		0.67	7.83	760	266	324	<0.60	<0.34	369	13.6	0.483	159	-	-	0.0063	0.0063	<0.0010	-	-	-	-	498	-	-	-
TH-GD-02	9-Nov-16	Dup	1.44	7.85	757	267	326	<0.60	<0.34	382	14	0.573	165	-	-	0.007	0.007	<0.0010	-	-	-	-	508	-	-	-
		RPD	-	*0.3%*	*0.4%*	*0.4%*	*0.6%*	-	-	*3.5%*	*2.9%*	*17.0%*	*3.7%*	-	-	-	-	-	-	-	-	-	*2.0%*	-	-	-
TH-GD-02	23-May-17		-	7.84	744	276	336	<0.60	<0.34	359	12.9	-	156	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	496	-	-	-
TH-GD-02	2-Aug-17		-	7.78	758	271	330	<0.60	<0.34	362	13	-	156	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	494	-	-	-
TH-GD-02	4-Oct-17		-	7.72	749	272	331	<0.60	<0.34	362	13.1	-	156	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	494	-	-	-
TH-GD-02	29-May-18		-	7.7	799	274	334	<0.60	<0.34	369	13	-	157	-	-	<0.0051	<0.0050	0.001	-	-	-	-	502	-	-	-
TH-GD-07	9-Nov-16		2.96	7.7	751	320	391	<0.60	<0.34	391	5.62	0.765	120	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	482	-	-	-
TH-GD-07	23-May-17		-	7.74	739	334	407	<0.60	<0.34	384	5.3	-	117	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	487	-	-	-
TH-GD-07	1-Aug-17		-	7.63	747	332	404	<0.60	<0.34	379	5.3	-	116	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	482	-	-	-
TH-GD-07	2-Aug-17	Field Dup. (MW100)	-	7.68	746	330	402	<0.60	<0.34	379	5.28	-	116	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	480	-	-	-
		RPD	-	*0.7%*	*0.1%*	*0.6%*	*0.5%*	-	-	*0.0%*	*0.4%*	-	*0.0%*	-	-	-	-	-	-	-	-	-	*0.4%*	-	-	-
TH-GD-07	3-Oct-17		-	7.59	719	329	401	<0.60	<0.34	387	5.35	-	115	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	481	-	-	-
TH-GD-07	3-Oct-17	Dup	-	7.63	733	332	405	<0.60	<0.34	390	5.31	-	115	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	485	-	-	-
		RPD	-	*0.5%*	*1.9%*	*0.9%*	*1.0%*	-	-	*0.8%*	*0.8%*	-	*0.0%*	-	-	-	-	-	-	-	-	-	*0.8%*	-	-	-
TH-GD-07	28-May-18		-	7.93	782	335	408	<0.60	<0.34	397	5.34	-	117	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	493	-	-	-
TH-GD-07	28-May-18	Dup	-	7.69	788	332	405	<0.60	<0.34	403	5.33	-	116	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	494	-	-	-
		RPD	-	*3.1%*	*0.8%*	*0.9%*	*0.7%*	-	-	*1.5%*	*0.2%*	-	*0.9%*	-	-	-	-	-	-	-	-	-	*0.2%*	-	-	-
TH-GD-08	29-Oct-16		-	7.79	732	324	395	<0.60	<0.34	384	6.26	-	115	0.17	-	<0.010	<0.010	<0.0020	-	-	-	0.081	-	0.26	-	-

TABLE D3-3
GROUNDWATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Field / Lab Dup. Info	Parameter [1]																					
			Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [5]	Fluoride	Sulphate	Ammonia (as N)	Un-ionized Ammonia	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Iron	Manganese	Free Cyanide	Total Phosphorus	T.D.S.	T.K.N.	E. Coli (MPN/100 mL)	Total Coliform (MPN/100mL)
EQL			*0.2*	*0.01*	*1*	*1*	*1*	*1 / 0.60*	*1 / 0.34*	*1*	*0.5*	*0.02*	*0.5*	*0.01*	*0.03*	*0.01 / 0.0051*	*0.01 / 0.005*	*0.01/0.02/0 .001*	*0.03*	*0.005*	*0.001*	*0.05*	*2 / 5*	*0.03*	*1*	*1*
15-RD-PW1	9-Nov-16		8.91	7.78	745	320	390	<0.60	<0.34	388	5.65	0.697	121	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	483	-	-	-
15-RD-PW1	23-May-17		-	7.75	736	339	414	<0.60	<0.34	371	5.29	-	115	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	483	-	-	-
15-RD-PW-1	1-Aug-17		-	7.65	773	338	413	<0.60	<0.34	383	5.39	-	118	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	489	-	-	-
15-RD-PW-1	3-Oct-17		-	7.53	723	324	396	<0.60	<0.34	388	5.44	-	118	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	482	-	-	-
15-RD-PW1	28-May-18		-	7.84	788	334	407	<0.60	<0.34	389	5.38	-	118	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	490	-	-	-
HC-CDWQ [2]																										
Drinking Water			0.3/1.0/0.1 (MAC)[8]	6.5 - 8.5 (AO)	-	-	-	-	-	[9]	≤250 (AO)	1.5 (MAC)	500 (AO)	-	-	-	10 [4] (MAC)	1.0 [4] (MAC)	0.3 (AO)	0.05 (AO)	0.2 (MAC)	-	500 (AO)	-	None Detectable per 100 mL (MAC)	None Detectable per 100 mL (MAC)
CCME[3] (Shown for Reference Only)																										
Freshwater Aquatic Life			Narrative [7]	6.5 - 9.0	-	-	-	-	-	-	120[5a]/640 [5b]	0.12	-	-	0.019 [6]	-	3[12]/ 124[11]	0.06	0.3	-	0.005	[10]	-	-	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.K.N. = Total Kjeldahl Nitrogen
T.D.S. = Total Dissolved Solids
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L, which is equivalent to 1 mg/L nitrite-nitrogen.
5. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
   b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function.
   but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information
   c. Guideline is dependant on type of plant. See CCME summary table for details.
   Foliar damage
   = 100-178 mg/L for almond apricots and plums
   = 178-355 mg/L for grapes, peppers, potatoes and tomatoes
   = 355-710 mg/L for alfalfa, barley, corn, and cucumbers
   >710 mg/L for cauliflower, cotton, safflower, sesame, sorghum, sugar beets, and sunflowers
   Rootstocks
   = 180-600 mg/L for stone fruit (peaches, plums, etc.)
   = 710-900 mg/L for grapes
   Cultivars
   = 110-180 mg/L for strawberries
   = 230-460 mg/L for grapes
   = 250 mg/L for boysenberries, blackberries, and raspberries
6. Guideline for total ammonia is pH and Temperature dependent. See Factsheet for details.
7. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
8. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
   a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
   b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
   c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
   Turbidity values greater than 1 NTU are shaded.
9. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as $CaCO_3$) , provide acceptable balance between corrosion and incrustation; where a water softener is used, a separate unsoftened supply for cooking and drinking purposes is recommended.
10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

11. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
    These are NOT protective guidelines.
12. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).

- Exceedance of HC-CDWQ Guidelines

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																		
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
TH-ED-01W TEST START	26-Oct-16	<0.0020	<0.00020	0.00063	0.015	<0.00020	<0.00020	0.529	<0.000010	77.4	<0.00010	<0.0010	0.00025	0.00024	0.125	0.000108	0.0281	44	0.0144	0.00037
TH-ED-01W TEST STOP	26-Oct-16	-	-	-	-	-	-	-	-	78.1	-	-	-	-	-	-	-	43.6	-	-
TH-ED-01W	4-Oct-17	<0.0010	<0.00010	0.00039	0.0138	<0.00010	<0.000050	0.623	<0.0000050	79.8	0.000043	<0.00010	0.00018	<0.00020	<0.010	<0.000050	0.0344	49.3	0.00873	0.000307
TH-ED-01W	23-May-17	<0.0020	<0.00020	0.00043	0.0136	<0.00020	<0.00020	0.614	<0.000010	81.5	<0.00010	<0.0010	0.0002	<0.00020	<0.010	<0.000090	0.0367	47.2	0.00923	0.00028
TH-ED-01W	2-Aug-17	<0.0010	<0.00010	0.00043	0.0139	<0.00010	<0.000050	0.547	<0.0000050	78.6	0.000047	<0.00010	0.00016	<0.00020	<0.010	<0.000050	0.0307	48.7	0.00908	0.000243
TH-ED-01W	29-May-18	<0.0010	<0.00010	0.00033	0.0144	<0.00010	<0.000050	0.639	<0.0000050	86.3	0.000045	<0.00010	0.00019	<0.00020	<0.010	<0.000050	0.038	49.7	0.00927	0.000257
TH-ED-01P	9-Nov-16	<0.0020	<0.00020	0.00071	0.0156	<0.00020	<0.00020	0.645	<0.000010	79.5	<0.00010	<0.0010	0.00026	<0.00020	0.154	<0.000090	0.0326	48.5	0.0153	0.00029
TH-ED-01P	23-May-17	<0.0020	<0.00020	0.00046	0.0142	<0.00020	<0.00020	0.652	<0.000010	79.5	<0.00010	<0.0010	0.00023	<0.00020	<0.010	<0.000090	0.0355	46.5	0.0137	0.00028
TH-ED-01P	2-Aug-17	<0.0010	<0.00010	0.0005	0.0145	<0.00010	<0.000050	0.559	<0.0000050	78	0.000042	<0.00010	0.00025	<0.00020	<0.010	<0.000050	0.0301	47.8	0.0141	0.000262
TH-ED-01P	4-Oct-17	<0.0010	<0.00010	0.00044	0.0145	<0.00010	<0.000050	0.675	<0.0000050	78.5	0.000041	<0.00010	0.00023	<0.00020	<0.010	<0.000050	0.0348	48.6	0.0141	0.000294
TH-ED-01P	29-May-18	<0.0010	<0.00010	0.00049	0.0154	<0.00010	<0.000050	0.668	<0.0000050	83.2	0.000035	<0.00010	0.00024	<0.00020	<0.010	<0.000050	0.0379	50.1	0.015	0.000282
TH-ED-03	9-Nov-16	0.0035	0.00021	0.00034	0.0275	<0.00020	<0.00020	0.184	<0.000010	38.8	<0.00010	<0.0010	0.00048	0.00146	0.01	<0.000090	0.0193	53.8	0.0321	0.0148
TH-ED-03	25-May-17	0.0072	0.00074	0.00061	0.0223	<0.00020	<0.00020	0.174	<0.000010	20.8	<0.00010	<0.0010	0.00035	0.00084	<0.010	<0.000090	0.0146	26.8	0.0482	0.0315
TH-ED-03	2-Aug-17	0.0128	0.00046	0.00066	0.0192	<0.00010	<0.000050	0.187	0.0000123	18	0.000012	<0.00010	0.00049	0.00097	0.01	<0.000050	0.0104	21.7	0.103	0.0392
TH-ED-03	4-Oct-17	0.0043	0.00024	0.00103	0.0179	<0.00010	<0.000050	0.199	0.0000058	17.9	<0.000010	<0.00010	0.0003	0.00039	<0.010	<0.000050	0.0103	22.5	0.0813	0.0271
TH-ED-03	28-May-18	0.0189	0.00029	0.00072	0.023	<0.00010	<0.000050	0.168	0.0000056	16.5	<0.000010	<0.00010	0.00022	0.00046	0.012	<0.000050	0.0112	20.3	0.0421	0.0224
TH-GD-02	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0212	<0.00020	<0.00020	0.709	<0.000010	67.5	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0377	48.8	0.0121	0.00041
TH-GD-02 Dup	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0203	<0.00020	<0.00020	0.65	<0.000010	66.5	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0364	52.3	0.0123	0.00042
RPD		-	-	-	*4.34%*	-	-	*8.68%*	-	*1.49%*	-	-	-	-	-	-	*3.51%*	*6.92%*	*1.64%*	*2.41%*
TH-GD-02	23-May-17	<0.0020	<0.00020	<0.00020	0.0201	<0.00020	<0.00020	0.692	<0.000010	68	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0402	45.9	0.012	0.00044
TH-GD-02	2-Aug-17	0.0011	<0.00010	<0.00010	0.0204	<0.00010	<0.000050	0.606	<0.0000050	66.9	0.000035	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0345	47.2	0.0122	0.0003
TH-GD-02	4-Oct-17	<0.0010	<0.00010	<0.00010	0.0204	<0.00010	<0.000050	0.732	<0.0000050	67.3	0.000032	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0406	47	0.0123	0.000324
TH-GD-02	29-May-18	0.0019	<0.00010	<0.00010	0.0202	<0.00010	<0.000050	0.7	<0.0000050	70.5	0.000034	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0435	46.9	0.0118	0.000307
TH-GD-07	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0211	<0.00020	<0.00020	0.579	<0.000010	74.4	<0.00010	<0.0010	<0.00020	0.00023	<0.010	<0.000090	0.0323	49.8	0.00827	0.00022
TH-GD-07	23-May-17	<0.0020	<0.00020	<0.00020	0.0187	<0.00020	<0.00020	0.566	<0.000010	75.2	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.035	47.8	0.00768	0.00023
TH-GD-07	1-Aug-17	0.0015	<0.00010	0.00013	0.0195	<0.00010	<0.000050	0.481	<0.0000050	70.8	0.000036	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0296	49.2	0.01	0.000273
TH-GD-07 Field Dup. (MW100)	2-Aug-17	0.0013	<0.00010	0.00013	0.0195	<0.00010	<0.000050	0.485	<0.0000050	71.4	0.000034	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0294	48.8	0.0101	0.000209
RPD		-	-	*0.00%*	*0.00%*	-	-	*0.83%*	-	*0.84%*	*5.71%*	-	-	-	-	-	*0.68%*	*0.82%*	*1.00%*	-
TH-GD-07	3-Oct-17	0.0019	<0.00010	0.00013	0.0193	<0.00010	<0.000050	0.548	<0.0000050	73.1	0.00003	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0336	49.7	0.00963	0.000259
TH-GD-07 Dup	3-Oct-17	0.0021	<0.00010	0.00013	0.0203	<0.00010	<0.000050	0.585	<0.0000050	74.2	0.00003	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0341	49.8	0.00939	0.000263
RPD		*10.00%*	-	*0.00%*	*5.05%*	-	-	*6.53%*	-	*1.49%*	*0.00%*	-	-	-	-	-	*1.48%*	*0.20%*	*2.52%*	*1.53%*
TH-GD-07	28-May-18	0.0018	<0.00010	0.0001	0.0199	<0.00010	<0.000050	0.548	<0.0000050	76.6	0.000032	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0371	50.1	0.00962	0.000263
TH-GD-07 Dup	28-May-18	0.0013	<0.00010	<0.00010	0.0197	<0.00010	<0.000050	0.553	<0.0000050	78.2	0.000027	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0367	50.5	0.0093	0.000195
RPD		*32.26%*	-	-	*1.01%*	-	-	*0.91%*	-	*2.07%*	-	-	-	-	-	-	*1.08%*	*0.80%*	*3.38%*	-
TH-GD-08	29-Oct-16	-	-	-	-	-	-	-	-	74.3	-	-	-	-	-	-	-	48.3	-	-

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																		
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
15-RD-PW1	9-Nov-16	<0.0020	<0.00020	0.00089	0.0201	<0.00020	<0.00020	0.594	<0.000010	72.4	<0.00010	<0.0010	<0.00020	<0.00020	0.028	<0.000090	0.0326	50.3	0.0056	0.00018
15-RD-PW1	23-May-17	<0.0020	<0.00020	<0.00020	0.0183	<0.00020	<0.00020	0.55	<0.000010	70.9	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0351	47.2	0.00871	0.00017
15-RD-PW1	1-Aug-17	<0.0010	<0.00010	0.0002	0.0207	<0.00010	<0.000050	0.486	0.0000066	69.5	0.000047	0.00069	<0.00010	<0.00020	<0.010	<0.000050	0.0299	51	0.00413	0.000203
15-RD-PW1	3-Oct-17	<0.0010	<0.00010	0.0001	0.0195	<0.00010	<0.000050	0.568	0.0000061	73.1	0.000036	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	0.0345	50	0.00511	0.000232
15-RD-PW1	28-May-18	<0.0010	<0.00010	<0.00010	0.0178	<0.00010	<0.000050	0.573	<0.0000050	77.4	0.000034	<0.00010	<0.00010	0.00027	<0.010	0.000093	0.038	47.4	0.00873	0.000181
EQL		*0.002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.05*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0001*	*0.001*
HC-CDWQ [2]																				
Drinking Water		0.1- 0.2 [4] (OG)	0.006 (MAC)	0.010 (MAC)	1.0 (MAC)	-	-	5.0 (MAC)	0.005 (MAC)	-	-	0.05 (MAC)	-	1.0 (AO)	0.3 (AO)	0.010 (MAC)	-	-	0.05 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		0.005 - 0.1 [5]	-	0.005	-	-	-	(29 [6]) 1.5 [7]	0.09 µg/L [9a] 1.0 µg/L [9b]	-	-	0.0089 (III), 0.001 (VI)	-	[9c]	0.3	[9d]	-	-	-	0.073

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																	
		Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
TH-ED-01W TEST START	26-Oct-16	<0.0010	<0.030	9.2	0.00629	<0.0010	5.31	<0.00010	34.9	0.574	<0.00020	<0.00010	<0.00010	0.00135	<0.00050	0.00015	0.0012	<0.00020	<0.0020	<0.00040
TH-ED-01W TEST STOP	26-Oct-16	-	-	9.18	-	-	-	-	32.9	-	-	-	-	-	-	-	-	-	-	-
TH-ED-01W	4-Oct-17	<0.00050	<0.050	9.57	0.00663	<0.000050	5.01	<0.000010	31.5	0.58	<0.00020	0.000021	<0.00010	<0.00010	<0.00030	<0.00010	0.00123	<0.00050	<0.0010	<0.000060
TH-ED-01W	23-May-17	<0.0010	<0.030	9.65	0.00643	<0.0010	5.28	<0.00010	31.5	0.542	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00121	<0.00020	<0.0020	<0.00040
TH-ED-01W	2-Aug-17	0.0007	<0.050	9.77	0.00681	<0.000050	4.99	<0.000010	31.6	0.538	<0.00020	0.00002	<0.00010	<0.00010	<0.00030	<0.00010	0.00118	<0.00050	0.0017	<0.000060
TH-ED-01W	29-May-18	0.00063	<0.050	11	0.00705	<0.000050	5.29	<0.000010	33.9	0.587	<0.00020	0.000024	<0.00010	<0.00010	<0.00030	<0.00010	0.00135	<0.00050	<0.0010	<0.000060
TH-ED-01P	9-Nov-16	<0.0010	<0.030	10	0.00606	<0.0010	5.54	<0.00010	33.8	0.546	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00114	<0.00020	<0.0020	<0.00040
TH-ED-01P	23-May-17	<0.0010	<0.030	9.82	0.00633	<0.0010	5.43	<0.00010	36	0.535	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.0012	<0.00020	<0.0020	<0.00040
TH-ED-01P	2-Aug-17	0.00075	<0.050	9.64	0.00636	<0.000050	5.27	<0.000010	35.8	0.528	<0.00020	0.00002	<0.00010	<0.00010	<0.00030	<0.00010	0.00118	<0.00050	<0.0010	<0.000060
TH-ED-01P	4-Oct-17	0.00066	<0.050	9.52	0.00638	<0.000050	5.3	<0.000010	35.7	0.566	<0.00020	0.000021	<0.00010	<0.00010	<0.00030	<0.00010	0.00118	<0.00050	<0.0010	<0.000060
TH-ED-01P	29-May-18	0.00074	<0.050	10.4	0.00674	<0.000050	5.48	<0.000010	39.8	0.577	<0.00020	0.00002	<0.00010	<0.00010	<0.00030	<0.00010	0.00127	<0.00050	0.0013	<0.000060
TH-ED-03	9-Nov-16	0.0019	<0.030	3.11	0.00164	<0.0010	4.56	<0.00010	30.9	0.131	<0.00020	<0.00010	<0.00010	0.00029	<0.00050	0.00133	0.00376	0.00048	<0.0020	<0.00040
TH-ED-03	25-May-17	0.0029	<0.030	2.43	0.00118	<0.0010	3.14	<0.00010	62.1	0.105	<0.00020	<0.00010	<0.00010	0.0004	<0.00050	0.00148	0.0049	0.0029	<0.0020	<0.00040
TH-ED-03	2-Aug-17	0.00454	<0.050	2.17	0.00086	0.000167	4.12	<0.000010	74.1	0.08	<0.00020	<0.000010	<0.00010	0.00089	0.00143	0.013	0.00474	0.00244	<0.0010	0.000129
TH-ED-03	4-Oct-17	0.00236	<0.050	1.83	0.00048	0.000124	4.66	<0.000010	72.7	0.0928	<0.00020	<0.000010	<0.00010	0.00126	<0.00030	0.00662	0.00238	0.0022	<0.0010	0.000109
TH-ED-03	28-May-18	0.00224	<0.050	2.64	0.00082	0.000061	3.35	<0.000010	73	0.103	<0.00020	<0.000010	<0.00010	0.00064	0.00118	0.00117	0.00322	0.00411	<0.0010	0.000158
TH-GD-02	9-Nov-16	<0.0010	<0.030	10.3	0.007	<0.0010	4.45	<0.00010	38.6	0.53	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00173	<0.00020	<0.0020	<0.00040
TH-GD-02 Dup	9-Nov-16	<0.0010	<0.030	10.5	0.00727	<0.0010	4.65	<0.00010	39.9	0.521	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00164	<0.00020	<0.0020	<0.00040
RPD		-	-	*1.92%*	*3.78%*	-	*4.40%*	-	*3.31%*	*1.71%*	-	-	-	-	-	-	*5.34%*	-	-	-
TH-GD-02	23-May-17	<0.0010	<0.030	9.88	0.00683	<0.0010	4.62	<0.00010	37.5	0.527	<0.00020	<0.00010	<0.00010	0.00022	<0.00050	<0.00010	0.00159	<0.00020	<0.0020	<0.00040
TH-GD-02	2-Aug-17	<0.00050	<0.050	9.85	0.00705	<0.000050	4.52	<0.000010	38	0.519	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00153	<0.00050	<0.0010	<0.000060
TH-GD-02	4-Oct-17	<0.00050	<0.050	9.92	0.00697	<0.000050	4.5	<0.000010	37.8	0.547	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00157	<0.00050	<0.0010	<0.000060
TH-GD-02	29-May-18	<0.00050	<0.050	9.86	0.00678	<0.000050	4.56	<0.000010	39.7	0.546	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00168	<0.00050	<0.0010	<0.000060
TH-GD-07	9-Nov-16	<0.0010	<0.030	10.7	0.0062	<0.0010	5.04	<0.00010	30.4	0.532	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00064	<0.00020	0.0049	<0.00040
TH-GD-07	23-May-17	<0.0010	<0.030	10.2	0.0059	<0.0010	5.28	<0.00010	31.4	0.536	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00066	<0.00020	<0.0020	<0.00040
TH-GD-07	1-Aug-17	<0.00050	<0.050	10.2	0.00594	<0.000050	5.03	<0.000010	31.7	0.51	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00061	<0.00050	<0.0010	<0.000060
TH-GD-07 Field Dup. (MW100)	2-Aug-17	<0.00050	<0.050	10	0.00606	<0.000050	5.06	<0.000010	31.1	0.512	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000631	<0.00050	<0.0010	<0.000060
RPD		-	-	*1.98%*	*2.00%*	-	0.59%	-	*1.91%*	0.39%	-	-	-	-	-	-	*3.38%*	-	-	-
TH-GD-07	3-Oct-17	<0.00050	<0.050	10.1	0.00604	<0.000050	5.07	<0.000010	30.3	0.553	<0.00020	<0.000010	<0.00010	0.00013	<0.00030	<0.00010	0.000593	<0.00050	<0.0010	<0.000060
TH-GD-07 Dup	3-Oct-17	<0.00050	<0.050	10.2	0.00605	<0.000050	5.11	<0.000010	30.8	0.563	<0.00020	<0.000010	<0.00010	0.00021	<0.00030	<0.00010	0.000618	<0.00050	0.0018	<0.000060
RPD		-	-	*0.99%*	*0.17%*	-	0.79%	-	*1.64%*	1.79%	-	-	-	-	-	-	*4.13%*	-	-	-
TH-GD-07	28-May-18	<0.00050	<0.050	10.6	0.00625	<0.000050	5.27	<0.000010	33.3	0.561	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000656	<0.00050	<0.0010	<0.000060
TH-GD-07 Dup	28-May-18	<0.00050	<0.050	11.1	0.00619	<0.000050	5.33	<0.000010	33.1	0.566	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000654	<0.00050	<0.0010	<0.000060
RPD		-	-	*4.61%*	-	-	-	-	*0.60%*	-	-	-	-	-	-	-	-	-	-	-
TH-GD-08	29-Oct-16	-	-	10	-	-	-	-	35.4	-	-	-	-	-	-	-	-	-	-	-

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																		
		Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
15-RD-PW1	9-Nov-16	<0.0010	<0.030	10.1	0.00586	<0.0010	5.55	<0.00010	31.1	0.54	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00094	<0.00020	<0.0020	<0.00040
15-RD-PW1	23-May-17	<0.0010	<0.030	10	0.00544	<0.0010	5.51	<0.00010	30.3	0.521	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00103	<0.00020	<0.0020	<0.00040
15-RD-PW1	1-Aug-17	<0.00050	<0.050	10.3	0.00579	<0.000050	5.12	<0.000010	32.1	0.508	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000819	<0.00050	0.0012	<0.000060
15-RD-PW1	3-Oct-17	0.0018	<0.050	10.1	0.00559	<0.000050	5.07	<0.000010	30.9	0.547	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000764	<0.00050	0.0054	<0.000060
15-RD-PW1	28-May-18	0.00082	<0.050	10.2	0.00574	<0.000050	5.15	<0.000010	31.9	0.562	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000904	<0.00050	0.0049	<0.000060
EQL		*0.03*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.02*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
HC-CDWQ [2]																				
Drinking Water		-	-	-	-	0.05 (MAC)	-	-	200 (AO)	-	-	-		-	-	-	0.02 (MAC)	-	5 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		(8e)	(9,10)	-	-	0.001	-	0.00025	-	-	-	0.0008		-	-	-	(0.033[6]) 0.015 [7]	-	0.03	-

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
   OG = Operational Guideline
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Guidelines for Canadian Drinking Water Quality.
   Community Water Supplies (Health Canada - Canadian Drinking Water Quality Guidelines)
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
   Canadian Water Quality Guidelines for the Protection of Agriculture Water Uses
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5.
   The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater or equal to 6.5.
6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
   These are NOT protective guidelines.
7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L.
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <17 mg/L, CWQG is 0.04 µg/L. At other hardness values, the CWQG can be calculated with the equation CWQG = 10^{0.83[log(hardness)] - 3.2} µg/L
   valid for hardness between 17 and 280 mg $CaCO_3$/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <5.3 mg/L,
   CWQG is 0.11 µg/L. At other hardness values, the benmark can be calculated with the equation Benchmark - 10^{1.016(log[hardness])-1.71},
   valid for hardness between 5.3 and 360 mg CaCO3/L.
   c. **Copper** Guideline = e^(0.8545[ln(hardness)]-1.465) * 0.2 µg/L;
   d. **Lead** Guideline = e^(1.273[ln(hardness)]-4.705) µg/L;
   e. **Nickel** Guideline = e^(0.76[ln(hardness)]+1.06) µg/L

Well No. (November 2016)	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W TEST START	374	0.000086	0.008017	0.007	0.017	0.260
TH-ED-01W TEST STOP	375	0.000086	0.008039	0.007	0.017	0.261
TH-GD-08	384	0.000088	0.008235	0.007	0.018	0.266
TH-ED-01P	398	0.000091	0.008540	0.008	0.018	0.273
TH-ED-03	319	0.000076	0.006821	0.006	0.014	0.231
TH-GD-02	369	0.000085	0.007909	0.007	0.017	0.258
TH-GD-02 Dup	382	0.000088	0.008192	0.007	0.018	0.265
TH-GD-07	391	0.000089	0.008388	0.008	0.018	0.269
15-RD-PW1	388	0.000089	0.008322	0.008	0.018	0.268

Well No. (May 2017)	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W	398	0.000091	0.008540	0.008	0.018	0.273
TH-ED-01P	390	0.000089	0.008366	0.008	0.018	0.269
TH-ED-03	162	0.000043	0.003427	0.004	0.006	0.138
TH-GD-02	359	0.000083	0.007691	0.007	0.016	0.252
TH-GD-07	384	0.000088	0.008235	0.007	0.018	0.266
15-RD-PW1	371	0.000086	0.007952	0.007	0.017	0.259

TABLE D3-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No. (August 2017)	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W	397	0.000091	0.008519	0.008	0.018	0.273
TH-ED-01P	392	0.000090	0.008410	0.008	0.018	0.270
TH-ED-03	134	0.000037	0.002826	0.003	0.005	0.119
TH-GD-02	362	0.000084	0.007756	0.007	0.016	0.254
TH-GD-07	379	0.000087	0.008126	0.007	0.017	0.263
TH-GD-07 (DUP)	379	0.000087	0.008126	0.007	0.017	0.263
15-RD-PW-1	383	0.000088	0.008214	0.007	0.018	0.265

Well No. (October 2017)	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W	402	0.000092	0.008628	0.008	0.019	0.275
TH-ED-01P	396	0.000090	0.008497	0.008	0.018	0.272
TH-ED-03	138	0.000038	0.002912	0.003	0.005	0.122
TH-GD-02	362	0.000084	0.007756	0.007	0.016	0.254
TH-GD-07	387	0.000089	0.008301	0.008	0.018	0.267
TH-GD-07 (DUP)	390	0.000089	0.008366	0.008	0.018	0.269
15-RD-PW-1	388	0.000089	0.008322	0.008	0.018	0.268

Well No. (May 2018)	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W	420	0.000095	0.009020	0.008	0.020	0.284
TH-ED-01P	414	0.000094	0.008889	0.008	0.019	0.281
TH-ED-03	125	0.000035	0.002633	0.003	0.004	0.113
TH-GD-02	369	0.000085	0.007909	0.007	0.017	0.258
TH-GD-07	397	0.000091	0.008519	0.008	0.018	0.273
TH-GD-07 (DUP)	403	0.000092	0.008649	0.008	0.019	0.276
15-RD-PW1	389	0.000089	0.008344	0.008	0.018	0.268

9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):				
	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

10. Low level phosphorous was not analyzed for groundwater samples. Phosphorous values in Table D3-4 analyzed by ICP are at detection limits higher than some trigger values shown in Note 9.

- Exceedance of HC-CDWQ Criteria

TABLE D3-5
SURFACE WATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (°C)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Odour	Colour	Comments
D1 - Lake MB	7-Nov-16	8.1	492	4.6	35.9	12.68	9.17	none	slightly cloudy	sampled adjacent to Watchorn Prov. Park
	25-May-17	8.3	936	14.1	205.5	7.33	5.04	none	none	sampled adjacent to Watchorn Prov. Park approx. 75 m from shoreline at depth of 0.1 m; very windy; light rair
	3-Aug-17	8.0	932	25.2	-25.0	5.22	11.24	none	none	sampled adjacent to Watchorn Prov. Park approx. 40 m from shoreline at depth of 1 m; calm; small waves
	5-Oct-17	6.9	945	11.6	-69.0	8.28	24.7	none	grey/cloudy	sampled adjacent to Watchorn Prov. Park approx. 40 m from shoreline at depth of 1 m; calm; small waves
	30-May-18	7.2	849	21.0	-15.7	6.96	3.73	none	grey/cloudy	sampled adjacent to Watchorn Prov. Park approx. 100 m from shoreline at depth of 0.8 m; calm; water appears clear and is low compared to previous visits
D2 - Watchorn Creek	7-Nov-16	7.8	485	4.5	31.8	8.31	0.79	none	none	sampled from side road off gravel road
	25-May-17	7.4	603	13.8	175.6	3.59	1.59	none	none	sampled approx. 40 m south of PR 237 from side road using reacher pole; very windy; light rair
	3-Aug-17	6.9	629	21.5	-22.1	1.60	2.76	none	none	sampled approx. 40 m south of PR 237 from side road using reacher pole; lots of vegetation; calm; slow flow
	5-Oct-17	6.6	869	10.4	-68.5	4.85	1.06	none	none	sampled approx. 40 m south of PR 237 from side road using reacher pole; lots of vegetation; calm; slow flow
	30-May-18	7.5	853	21.1	-6.3	7.18	1.15	none	none	sampled approx. 40 m south of PR 237 from side road using reacher pole at approx. 0.5 m depth; visible flow;
D3 - Reed Lake	7-Nov-16	7.5	469	6.2	-24.4	7.77	1.32	none	none	sampled at 3.5' depth beyond logger
	25-May-17	7.7	540	14.1	152.0	6.16	2.70	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; windy; light rair
	3-Aug-17	7.9	502	25.1	-22.1	4.66	1.85	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; lots of vegetation; calm
	5-Oct-17	6.3	572	12.2	-70.5	6.32	1.01	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; lots of vegetation; cows may have been here - lots of cattails knocked down; calm; water appears clear
	30-May-18	6.9	583	21.9	-38.0	3.39	1.43	none	none	sampled approx. 3 m beyond staff gauge/edge of reeds using reacher pole at approx. 0.5 m depth; water appears clear
D4 - Clear Lake	7-Nov-16	7.8	532	6.6	34.2	10.96	4.01	none	none	sampled approximately 5 m beyond reeds in open water
	25-May-17	8.3	696	12.8	131.4	5.63	1.09	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; windy; light rair
	3-Aug-17	7.0	655	23.2	-20.4	4.52	0.89	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; calm
	5-Oct-17	6.9	731	10.0	-72.7	6.82	6.51	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; calm; water low; sediment disturbed while sampling; lots of geese and swans on lake
	30-May-18	7.2	789	19.9	-25.2	2.39	4.2	none	none	sampled beyond staff gauge/edge of reeds using reacher pole at approx. 0.5 m depth; calm; water low; recent muskrat pushup approx. 30 m north of staff gauge; tracks (snowmobile?) coming right up to gauge; lots of copepods in water
D5 - Clark's Drain	7-Nov-16	8.2	481.5	4.1	-32.8	10.63	0.96	none	none	sampled on E side of road
	25-May-17	8.1	622.5	14.4	118.0	7.07	3.21	none	none	sampled on E side of road in front of middle culvert; water approx. 0.2 m deep; windy
	4-Aug-17	7.2	675	18.1	-13.6	2.44	2.16	none	none	sampled on E side of road in front of middle culvert with reacher pole; water approx. 0.3 m deep; calm; water
	5-Oct-17	6.6	791	9.2	-74.3	5.51	10.99	none	none	sampled on E side of road standing in front of middle culvert;calm; water below bottom of culvert

TABLE D3-5
SURFACE WATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (°C)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Odour	Colour	Comments
	30-May-18	7.2	742	17.8	-23.5	3.05	1.09	none	brownish	sampled on E side of road standing in front of southern most culvert; two culverts were blocked with mud and sticks; water flowing slowly through northern most culvert

TABLE D3-5
SURFACE WATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (°C)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Odour	Colour	Comments
D6 - Birch Creek	7-Nov-16	8.1	584	5.4	-48.3	7.64	0.89	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek
	25-May-17	8.0	876	14.0	133.9	6.42	3.37	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek using reacher pole; water approx. 0.35 m
	3-Aug-17	7.2	848	18.9	-13.4	3.54	1.4	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek using reacher pole; water approx. 0.8 m
	5-Oct-17	6.7	943	8.2	-77.4	7.06	5.55	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek using reacher pole; water approx. 0.3 m deep; calm; water flowing slowly
	30-May-18	7.2	867	19.6	-26.7	3.11	4.29	none	slightly brown	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek using reacher pole; water approx. 0.3 m deep; calm; water low; good flow
D7 - Woodale Drain	7-Nov-16	8.2	477	5.6	-51.0	8.68	1.08	none	none	sampled on N side of #167N, 75 m from Hwy 6
	25-May-17	7.7	541	13.2	125.2	5.21	0.97	none	none	sampled on N side of Ira Pontius Rd., 100 m west of Hwy 6; water approx. 0.15 m deep; windy
	3-Aug-17	6.8	706	18.9	-10.6	7.30	7.74	none	none	sampled on N side of Ira Pontius Rd., 100 m west of Hwy 6; very little water, lots of vegetation; calm
	5-Oct-17	6.6	1746	5.9	-72.5	6.02	0.87	none	none	sampled on N side of Ira Pontius Rd., 100 m west of Hwy 6; very little water (deepest spot 0.05 m deep), lots of vegetation - some vegetation in sample; calm
	30-May-18	6.8	742	18.3	-16.6	3.29	1.15	none	none	sampled on N side of Ira Pontius Rd., 100 m west of Hwy 6; very little water (deepest spot 0.08 m deep); light drizzle
D8 - Birch Creek	7-Nov-16	8.3	567	5.5	-54.4	9.83	1.89	none	none	sampled upstream of bridge
	25-May-17	8.4	788	14.6	130.8	7.96	5.04	none	none	sampled upstream of bridge on Bittner Bay Rd. off end of culvert; water approx. 1 m deep; windy
	3-Aug-17	7.5	823	20.3	-14.9	3.70	2.97	none	none	sampled upstream of bridge on Bittner Bay Rd. off end of culvert; water >3 m deep (near top of culvert); calm
	5-Oct-17	6.4	952	9.9	-69.8	6.84	10.51	none	brownish	sampled upstream of bridge on Bittner Bay Rd. off end of culvert; very little flow; calm
	30-May-18	7.4	832	20.5	-20.5	3.57	16.3	none	brownish	sampled upstream of bridge on Bittner Bay Rd. off end of culvert; no visible flow; water level low
D9 - LSM	7-Nov-16	8.4	691	6.6	-26.1	10.58	5.15	none	none	sampled at prov. hydrometric station
	25-May-17	8.2	932	14.2	150.2	7.29	3.27	none	none	sampled south of prov. hydrometric station approx. 10 m from shoreline at depth of 1 m; windy; lake high - covering
	3-Aug-17	7.2	970	21.8	-21.6	5.37	9.42	none	none	sampled south of prov. hydrometric station at depth of 1 m; calm; lake high - covering approach road and most of
	5-Oct-17	6.4	959	10.5	-74.4	9.33	6.17	none	none	sampled south of prov. hydrometric station at depth of 0.6 m; calm, small waves; lake still high but lower than Augus - covering approach road approximately 0.1 m deep.
	30-May-18	6.5	960	19.2	-1.7	6.78	14.55	none	none	sampled south of prov. hydrometric station approx. 10 m off shore at depth of 0.35 m; calm, small waves; no standing water on approach road, although surface was too soft for driving

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D3-6
SURFACE WATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Location	Date	Field / Lab Dup. Info	Parameter (mg/L unless otherwise specified)																					
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [3]	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	TKN	Phos-phorous, Total Dissolved	Total Phosphorous	Phosphor-ous, Total Particulate	Ammonia, total as N	Calculated Unionized Ammonia	T.D.S.	T.S.S.	E. Coli	Total Coliform (MPN/100mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*0.2*	*0.2*	*0.001*	*0.001*		*0.01*	-	*5*	*2*	*1*	*1*
D-1	Lake Manitoba	8-Nov-16		5.91	8.35	604	260	310	3.72	<0.34	322	33.1	0.153	46.2	<0.0051	<0.0050	<0.0010	1.06	1.06	0.0111	**0.032**	-	0.042	0.0011036	373	8.8	<100	1350
D-1	Lake Manitoba	25-May-17		2.5	8.5	886	193	222	6.6	<0.34	250	141	0.148	82.7	<0.010	<0.010	<0.0020	0.87	0.87	0.0054	0.022	-	<0.010	0.0007	532	3.8	<1	74
D-1	Lake Manitoba	3-Aug-17		7.96	8.62	864	195	213	12.1	<0.34	249	134	0.153	80.6	<0.010	<0.010	<0.0020	1.13	1.13	0.0069	**0.027**	-	0.021	0.0040611	511	13.8	6	5380
D-1	Lake Manitoba	5-Oct-17		24.7	8.48	862	180	209	5.16	<0.34	245	149	0.143	77.6	<0.010	<0.010	<0.0020	1.23	1.23	0.0067	**0.04**	-	<0.010	0.000597	518	51	114	1050
D-1	Lake Manitoba	30-May-18		2.55	8.45	840	172	200	4.8	<0.34	229	134	0.149	85.1	<0.010	<0.010	<0.0020	1.01	1.01	0.0037	0.0123	-	<0.010	0.0010713	494	2.9	7	365
D-2	Watchorn Creek	8-Nov-16		0.63	7.94	582	229	279	<0.60	<0.34	321	10.1	0.138	95.6	0.0174	0.0162	0.0011	1.7	1.69	0.072	**0.082**	-	0.021	0.0002164	366	<2.0	<100	860
D-2	Watchorn Creek	25-May-17		1.2	7.82	561	272	332	<0.60	<0.34	329	13.3	0.221	129	<0.010	<0.010	<0.0020	1.51	1.51	0.037	**0.046**	-	<0.010	0.0002	426	<2.0	20	1990
D-2	Watchorn Creek	3-Aug-17		1.1	7.56	579	267	326	<0.60	<0.34	316	5.75	0.129	76.8	<0.0051	<0.0050	<0.0010	2.12	2.12	0.058	**0.067**	-	0.036	0.0005679	358	4	51	2410
D-2	Watchorn Creek	5-Oct-17		0.93	7.83	766	331	403	<0.60	<0.34	430	32.8	0.261	112	<0.0051	<0.0050	<0.0010	1.22	1.22	0.026	**0.032**	-	0.024	0.0003068	501	<2.0	37	2420
D-2	Watchorn Creek	30-May-18		1.03	8.22	841	421	514	<0.60	<0.34	476	23.5	0.286	62	<0.010	<0.010	0.002	1.75	1.75	0.0588	0.0717	-	0.023	0.0015281	511	2.4	70	1730
D-3	Reed Lake	7-Nov-16		1.15	7.88	564	240	293	<0.60	<0.34	335	4.78	0.113	85.6	0.0067	0.0051	0.0016	1.88	1.87	0.02	**0.031**	-	0.15	0.0015453	352	2.2	<100	300
D-3	Reed Lake	25-May-17		2	7.98	508	239	292	<0.60	<0.34	291	4.32	0.109	66.2	<0.0051	<0.0050	<0.0010	1.54	1.54	0.02	**0.042**	-	<0.010	0.0002	318	3.8	33	236
D-3	Reed Lake	3-Aug-17		1.5	8.84	435	213	221	19	<0.34	245	4.1	0.128	64.8	<0.0051	<0.0050	<0.0010	1.81	1.81	0.0113	0.024	-	0.027	0.0076464	284	6.8	19	3270
D-3	Reed Lake	5-Oct-17		1.01	8.14	448	231	282	<0.60	<0.34	275	4.52	0.142	66.8	<0.0051	<0.0050	<0.0010	1.54	1.54	0.0109	0.023	-	0.023	0.0006786	305	<2.0	23	613
D-3	Reed Lake	30-May-18		0.99	7.93	562	259	316	<0.60	<0.34	297	4.81	0.133	60.3	<0.0051	<0.0050	<0.0010	1.99	1.99	0.0055	0.0222	-	0.076	0.0028298	326	<2.0	31	866
D-4	Clear Lake	7-Nov-16		3.39	8.15	633	280	341	<0.60	<0.34	394	7.76	0.185	97	<0.0051	<0.0050	<0.0010	1.41	1.41	0.025	**0.04**	-	0.018	0.0003532	410	6	<100	<100
D-4	Clear Lake	25-May-17		0.9	8.45	645	337	393	8.88	<0.34	418	6.83	0.171	74	<0.0051	<0.0050	<0.0010	1.15	1.15	0.02	**0.028**	-	<0.010	0.0006	419	<2.0	2	42
D-4	Clear Lake	25-May-17	Dup	0.9	8.46	642	338	393	9.6	<0.34	405	6.81	0.178	73.9	<0.0051	<0.0050	<0.0010	1.39	1.39	0.02	**0.027**	-	<0.010	0.0006	416	<2.0	1	38
			RPD	*0.0%*	0.1%	*0.5%*	*0.3%*	*0.0%*	*7.8%*	-	*3.2%*	*0.3%*	*4.0%*	*0.1%*	-	-	-	*18.9%*	*18.9%*	*0.0%*	*3.6%*	-	-	-	*0.7%*	-	*66.7%*	*10.0%*
D-4	Clear Lake	3-Aug-17		0.91	8.28	589	286	349	<0.60	<0.34	333	8.84	0.215	66.9	<0.0051	<0.0050	<0.0010	1.77	1.77	0.02	**0.029**	-	0.024	0.0020834	363	<2.0	1	472
D-4	Clear Lake	3-Aug-17	Dup	1.06	8.27	590	290	354	<0.60	<0.34	338	8.88	0.215	67	<0.0051	<0.0050	<0.0010	1.89	1.89	0.021	**0.028**	-	0.026	0.0003926	367	<2.0	4	1410
			RPD	-	*0.1%*	0%	1%	1%	-	-	1%	0%	0%	0%	-	-	-	7%	7%	5%	4%	-	8%	-	1%	-	120%	100%
D-4	Clear Lake	5-Oct-17		60.4	7.88	653	332	406	<0.60	<0.34	353	11.6	0.24	73.5	<0.0051	<0.0050	<0.0010	2.17	2.17	0.021	**0.052**	-	0.092	0.0012773	407	120	260	2420
D-4	Clear Lake	5-Oct-17	*Dup*	32	7.91	647	335	409	<0.60	<0.34	339	11.5	0.24	73.4	<0.0051	<0.0050	<0.0010	2.19	2.19	0.0163	**0.062**	-	0.107	0.0015902	403	63	281	2420
			RPD	-	*0.4%*	1%	1%	1%	-	-	4%	1%	0%	0%	-	-	-	1%	1%	25%	18%	-	-	-	1%	62%	8%	0%
D-4	Clear Lake	30-May-18		1.96	7.94	782	364	444	<0.60	<0.34	433	14.4	0.309	76.8	<0.0051	<0.0050	0.0013	2.56	2.56	0.023	0.0334	-	0.261	0.0086358	467	<2.0	172	411
D-4	Clear Lake	30-May-18	*Dup*	1.87	7.99	782	368	449	<0.60	<0.34	438	14.4	0.312	76.8	<0.0051	<0.0050	0.0011	2.62	2.62	0.0226	0.0321	-	0.262	0.0096876	473	<2.0	178	461
			RPD	-	*0.6%*	0%	1%	1%	-	-	1%	0%	1%	0%	-	-	-	2%	2%	2%	4%	-	0%	-	1%	-	3%	11%
D-5	North Clarks Drain	8-Nov-16		0.77	8.27	574	322	393	<0.60	<0.34	362	1.68	0.234	32.9	<0.0051	<0.0050	<0.0010	1.06	1.06	0.0062	0.0109	-	0.012	0.0002531	346	<2.0	<100	750
D-5	North Clarks Drain	25-May-17		2.93	8.27	585	368	448	<0.60	<0.34	375	0.78	0.244	18.1	0.0346	0.0295	0.0051	0.92	0.89	0.021	**0.03**	**-**	0.05	0.0023	364	4	49	2420
D-5	North Clarks Drain	3-Aug-17		1.02	7.94	615	392	478	<0.60	<0.34	394	0.62	0.279	4.62	<0.0051	<0.0050	<0.0010	1.8	1.8	0.034	**0.038**	-	0.029	0.0008439	370	<2.0	64	4480
D-5	North Clarks Drain	5-Oct-17	no flow	9.02	8.06	691	386	471	<0.60	<0.34	386	2.66	0.357	72.9	<0.0051	<0.0050	<0.0010	1.62	1.62	0.034	**0.076**	**-**	0.049	0.016	439	10.4	18	2420
D-5	North Clarks Drain	30-May-18		1.05	*8*	740	426	520	<0.60	<0.34	462	1.39	0.374	30.2	<0.0051	<0.0050	<0.0010	2.11	2.11	0.0225	**0.0331**	-	0.019	0.016	445	<2.0	18	1020
D-6	South Birch Creek	8-Nov-16		0.76	8.05	683	295	359	<0.60	<0.34	424	8.45	0.235	112	0.0173	0.0173	<0.0010	1.75	1.74	0.017	0.0181	-	0.019	0.0002703	445	<2.0	<100	100
D-6	South Birch Creek	25-May-17		2.39	8.22	810	416	508	<0.60	<0.34	526	9.25	0.246	110	0.011	0.011	<0.0020	1.36	1.34	0.0102	0.0162	0.006	<0.010	0.0004	549	2.4	185	1730
D-6	South Birch Creek	3-Aug-17		0.95	8	764	343	419	<0.60	<0.34	447	5.87	0.272	141	<0.0051	<0.0050	<0.0010	2.55	2.55	0.033	**0.033**	-	0.023	0.0008101	502	<2.0	11	2420
D-6	South Birch Creek	5-Oct-17		3.7	8.06	817	390	476	<0.60	<0.34	419	10.1	0.239	157	<0.010	<0.010	<0.0020	1.93	1.93	0.026	**0.03**	-	0.018	0.0003267	544	3.8	27	1050
D-6	South Birch Creek	30-May-18		2.89	8.08	857	387	472	<0.60	<0.34	500	11.4	0.323	117	<0.010	<0.010	<0.0020	1.94	1.94	0.0301	**0.0437**	-	0.035	0.0015459	534	<2.0	52	1990
D-7	Woodale Drain	8-Nov-16		0.9	8.07	564	280	341	<0.60	<0.34	353	3.05	0.088	60.6	<0.0051	0.0051	<0.0010	1.41	1.41	0.0196	0.02	-	0.063	0.000953	353	<2.0	<100	410
D-7	Woodale Drain	25-May-17		0.79	7.99	511	303	370	<0.60	<0.34	311	0.8	0.08	20.7	<0.0051	<0.0050	<0.0010	1.29	1.29	0.04	**0.043**	**-**	<0.010	0.0002	308	<2.0	68	1550
D-7	Woodale Drain	3-Aug-17		0.91	8.07	628	361	441	<0.60	<0.34	398	0.45	0.136	45.6	<0.0051	<0.0050	<0.0010	2.39	2.39	0.048	**0.052**	-	0.081	0.0033314	391	<2.0	122	2130
D-7	Woodale Drain	5-Oct-17	very low flow	20.3	*7.75*	1430	425	518	<0.60	<0.34	1050	8.31	0.24	724	<0.025	<0.025	0.006	2.03	2.03	0.046	0.192	-	0.028	0.0002093	1330	76.6	<1	231
D-7	Woodale Drain	30-May-18		1.63	*7.77*	726	337	411	<0.60	<0.34	420	0.98	0.158	98.3	<0.0051	<0.0050	<0.0010	1.88	1.88	0.0386	**0.0475**	-	0.018	0.0003627	439	<2.0	4	960

TABLE D3-6
SURFACE WATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Location	Date	Field / Lab Dup. Info	Parameter (mg/L unless otherwise specified)																						
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [3]	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	TKN	Phos-phorous, Total Dissolved	Total Phosphorous	Phosphorous, Total Particulate	Ammonia, total as N	Calculated Unionized Ammonia	T.D.S.	T.S.S.	E. Coli	Total Coliform (MPN/100mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*0.2*	*0.2*	*0.001*	*0.001*		*0.01*	-	*5*	*2*	*1*	*1*
D-8	Birch Creek	8-Nov-16		1.31	8.18	667	308	376	<0.60	<0.34	430	7.07	0.231	96.1	0.0185	0.0185	<0.0010	1.55	1.53	0.0173	**0.029**	**-**	0.018	0.0003465	436	<2.0	<100	310
D-8	Birch Creek	25-May-17		3.43	8.49	720	396	455	13.4	<0.34	480	6.82	0.243	78.1	<0.0051	<0.0050	<0.0010	1.3	1.3	0.0134	**0.029**	**-**	<0.010	0.0008	485	3.2	39	1990
D-8	Birch Creek	3-Aug-17		1.57	8.17	737	352	429	<0.60	<0.34	448	5.7	0.269	117	<0.0051	<0.0050	<0.0010	2.19	2.19	0.038	**0.043**	-	0.032	0.0018067	484	<2.0	41	2420
D-8	Birch Creek	5-Oct-17		7.5	*8.2*	814	382	466	<0.60	<0.34	429	10.3	0.244	162	<0.010	<0.010	<0.0020	2.14	2.14	0.029	**0.039**	-	0.025	0.0007089	548	6.4	249	2420
D-8	Birch Creek	30-May-18		10.8	*8.29*	802	390	476	<0.60	<0.34	481	8.12	0.315	90.2	<0.010	<0.010	<0.0020	2.26	2.26	0.0502	**0.0725**	-	0.037	0.002742	498	15.1	49	230
D-9	Lake St. Martin	8-Nov-16		3.53	8.47	813	182	211	5.4	<0.34	261	130	0.239	77.5	0.117	0.103	0.0139	1.36	1.24	0.0116	0.021	-	0.014	0.000562	503	7	<100	<100
D-9	Lake St. Martin	8-Nov-16	Dup	3.72	8.48	814	185	214	5.76	<0.34	248	128	0.238	76.7	0.027	0.022	0.0051	1.3	1.27	0.0141	0.02	-	0.016	0.0006566	491	6.6	100	100
			RPD	*5.2%*	*0.1%*	*0.1%*	*1.6%*	*1.4%*	*6.5%*	-	*5.1%*	*1.6%*	-	*1.0%*	-	-	-	*4.5%*	*2.4%*	-	*4.9%*	-	-	-	*2.4%*	-	-	-
D-9	Lake St. Martin	25-May-17		2.41	8.24	864	208	253	<0.60	<0.34	270	142	0.125	64	0.011	0.011	<0.0020	0.82	0.81	0.0096	**0.027**	**-**	<0.010	0.0004	532	3.6	1	387
D-9	Lake St. Martin	3-Aug-17		3.6	8.61	874	189	207	11.3	<0.34	247	148	0.148	69.1	<0.010	<0.010	<0.0020	2.18	2.18	0.0057	0.02	-	0.03	0.0046573	519	6.6	29	1550
D-9	Lake St. Martin	5-Oct-17		4.4	*8.5*	845	189	215	7.44	<0.34	196	151	0.139	69.4	<0.010	<0.010	<0.0020	0.98	0.98	0.0052	0.024	-	0.017	0.0009779	488	8.2	20	74
D-9	Lake St. Martin	30-May-18		9.37	*8.41*	917	180	212	3.96	<0.34	244	147	0.146	77.6	<0.010	<0.010	<0.0020	0.82	0.82	0.0031	0.0136	-	0.01	0.0008754	516	10.4	613	1990
FB		8-Nov-16	Field Blank	<0.10	5.98	<1.0	<1.0	<1.2	<0.60	<0.34	0.25	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	0.0011	0.0045	-	<0.010	-	<5.0	<2.0	<100	<100
FB		25-May-17	Field Blank	<0.10	6.27	1	1.1	1.3	<0.60	<0.34	<0.25	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	<0.0010	<0.0010	<0.0028	<0.010	-	<5.0	<2.0	<1	<1
FB		3-Aug-17	Field Blank	<0.10	6.7	1	3.6	4.4	<0.60	<0.34	0.27	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	<0.0010	<0.0010	-	<0.010	-	<5.0	<2.0	<1	<1
FB		5-Oct-17	Field Blank	<0.10	*6.24*	1.1	<1.0	<1.2	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	<0.0010	<0.0010	-	<0.010	-	<5.0	<2.0	<1	<1
FB		30-May-18	Field Blank	<0.10	*6.08*	<1.0	<1.0	<1.2	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	<0.0010	<0.0010	-	<0.010	-	<5.0	<2.0	<1	<1
MWQSOG [1]																										
Surface Water - Tier III																										
Freshwater Aquatic Life				[2]	6.5 - 9.0	-	-	-	-	-	-	-	-	-	-	13	0.06	-	-	-	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [3]		[4]		-	[5]	-	-
CCME[6]																										
Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				Narrative [7]	6.5 - 9.0	-	-	-	-	-	-	120[8a]/640 [8b]	0.12	-	-	13[9]/ 330[10]	0.06	-	-	-	[11]		[12]	0.019	-	Narrative [13]	-	-

TABLE D3-6
SURFACE WATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids
T.S.S. = Total Suspended Solids
TKN = Total Kjeldahl Nitrogen
RPD = Relative Percent Difference

1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. MWQSOG Tier II Objective - Equivalent induced levels of change as calculated from site-specific or regional correlation between total suspended sediment and turbidity.
3. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
4. MWQSOG Tier II Objective - Cool Water, All Periods (Eq. 3). Manitoba Water Stewardship, November 2011.
5. Total Suspended Sediment Guidelines:
   5 mg/L Induced Change over 30 days from background TSS <= 25 mg/L
   25 mg/L Induced Change over 1 day from background TSS <= 250 mg/L
   10% Induced Change over 1 day from background TSS > 250 mg/L
6. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
7. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
8. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation.
   b. Short-term exposure - Derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
9. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).
10. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
    These are NOT protective guidelines.
11. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.
Trigger ranges (µg/L):

ultra-oligotrophic	<4	meso-eutrophic	20 - 35
oligotrophic	4 - 10	eutrophic	35 - 100
mesotrophic	10 - 20	hyper-eutrophic	>100

12. Guideline for total ammonia is pH and temperature dependent. See factsheet for details.
13. Total Suspended Solids:
    Clear flow - Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
    High flow - Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is ≥ 250 mg/L.

	- Exceedance of CCME Guidelines
BOLD	- Exceedance of MWQSOG Guidelines

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
D-1	Lake Manitoba	8-Nov-16	**0.111**	<0.00020	0.00087	0.0328	<0.00020	<0.00020	0.058	<0.000010	49	<0.00010	<0.0010	<0.00020	0.00059	0.126	0.000097	0.0172	48.6	0.00595	0.00069
D-1	Lake Manitoba	25-May-17	0.0299	0.00027	0.00159	0.0409	<0.00020	<0.00020	0.09	<0.000010	43.6	<0.00010	<0.0010	<0.00020	0.00053	0.025	<0.000090	0.0315	34.2	0.00461	0.00186
D-1	Lake Manitoba	3-Aug-17	0.0747	0.00033	0.00213	0.0437	<0.00010	<0.000050	0.1	0.0000053	43.4	0.000012	0.00019	0.00011	0.00064	0.083	0.000164	0.0328	34.2	0.011	0.00187
D-1	Lake Manitoba	5-Oct-17	0.0592	0.00014	0.00195	0.0423	<0.00010	<0.000050	0.101	<0.0000050	42.1	0.000012	0.00015	0.00012	0.00051	0.081	0.000242	0.0319	33.8	0.0103	0.00216
D-1	Lake Manitoba	30-May-18	0.0236	0.00015	0.00179	0.0451	<0.00010	<0.000050	0.09	<0.0000050	40.6	<0.000010	<0.00010	<0.00010	0.00056	0.025	0.000059	0.0315	30.9	0.00509	0.00183
D-2	Watchorn Creek	8-Nov-16	0.0098	<0.00020	0.00053	0.0235	<0.00020	<0.00020	0.05	<0.000010	41.6	<0.00010	<0.0010	<0.00020	0.00029	0.024	<0.000090	0.0154	52.9	0.00797	0.0003
D-2	Watchorn Creek	25-May-17	0.02	<0.00020	0.00065	0.0246	<0.00020	<0.00020	0.054	<0.000010	47.5	<0.00010	<0.0010	<0.00020	0.00027	0.037	<0.000090	0.0145	51	0.0446	0.00024
D-2	Watchorn Creek	3-Aug-17	0.0057	0.00025	0.00076	0.0325	<0.00010	<0.000050	0.079	<0.0000050	45.8	<0.000010	<0.00010	0.00012	<0.00050	0.07	<0.000050	0.0168	48.9	0.815	0.000079
D-2	Watchorn Creek	5-Oct-17	0.0158	<0.00010	0.00074	0.0406	<0.00010	<0.000050	0.102	<0.0000050	62.3	<0.000010	0.0001	<0.00010	<0.00050	0.023	<0.000050	0.0329	66.6	0.0288	0.000946
D-2	Watchorn Creek	30-May-18	0.0283	0.00012	0.00139	0.0394	<0.00010	<0.000050	0.114	<0.0000050	66.5	<0.000010	0.0002	0.00021	0.00069	0.111	<0.000050	0.0352	75.2	0.0323	0.000222
D-3	Reed Lake	7-Nov-16	0.0107	<0.00020	0.00057	0.0209	<0.00020	<0.00020	0.039	<0.000010	42.5	<0.00010	<0.0010	<0.00020	0.00038	0.021	<0.000090	0.0122	55.5	0.00874	0.00032
D-3	Reed Lake	25-May-17	0.0203	<0.00020	0.00054	0.0194	<0.00020	<0.00020	0.051	<0.000010	37	<0.00010	<0.0010	<0.00020	0.00023	0.025	<0.000090	0.0134	48.3	0.0146	0.00037
D-3	Reed Lake	3-Aug-17	<0.0030	0.00023	0.0007	0.013	<0.00010	<0.000050	0.072	<0.0000050	21.7	<0.000010	<0.00010	<0.00010	<0.00050	<0.010	<0.000050	0.0154	46.5	0.0306	0.000194
D-3	Reed Lake	5-Oct-17	*<0.0030*	*<0.00010*	*0.1%*	*1.2%*	*<0.00010*	*<0.000050*	*7.0%*	*<0.0000050*	22.4	*<0.000010*	*0.0%*	*<0.00010*	*<0.00050*	0.01	*<0.000050*	*1.7%*	53.1	0.0185	*0.0%*
D-3	Reed Lake	30-May-18	*1.0%*	*<0.00010*	*0.1%*	*2.1%*	*<0.00010*	*<0.000050*	*8.2%*	*<0.0000050*	36.6	*<0.000010*	*<0.00010*	*<0.00010*	*<0.00050*	0.016	*<0.000050*	*1.8%*	49.9	0.0522	*0.0%*
D-4	Clear Lake	7-Nov-16	0.0617	<0.00020	0.00077	0.0342	<0.00020	<0.00020	0.051	<0.000010	58.3	<0.00010	<0.0010	<0.00020	0.00085	0.069	<0.000090	0.0165	60.3	0.0108	0.00052
D-4	Clear Lake	25-May-17	0.0269	<0.00020	0.00074	0.0263	<0.00020	<0.00020	0.036	<0.000010	45.2	<0.00010	<0.0010	<0.00020	0.00117	0.021	<0.000090	0.0189	74	0.00546	0.00052
D-4 Dup	Clear Lake	25-May-17	0.0148	<0.00020	0.00069	0.0263	<0.00020	<0.00020	0.036	<0.000010	44.8	<0.00010	<0.0010	<0.00020	0.00053	0.014	<0.000090	0.0185	71.2	0.00514	0.00049
		RPD	-	-	*7.0%*	*0.0%*	-	-	*0.0%*	-	*0.9%*	-	-	-	-	-	-	*2.1%*	*3.9%*	*6.0%*	*5.9%*
D-4	Clear Lake	3-Aug-17	0.0035	0.00028	0.00094	0.0307	<0.00010	<0.000050	0.085	<0.0000050	44.3	<0.000010	0.00012	<0.00010	<0.00050	0.022	<0.000050	0.0193	53.9	0.0167	0.000378
D-4 Dup (SW100)	Clear Lake	3-Aug-17	0.0036	0.00027	0.00101	0.0311	<0.00010	<0.000050	0.089	<0.0000050	42.3	<0.000010	0.00011	<0.00010	<0.00050	0.019	<0.000050	0.0202	56.3	0.0171	0.000394
		RPD	*2.82%*	*3.64%*	*7.18%*	*1.29%*	-	-	*4.60%*	-	*4.6%*	-	*8.70%*	-	-	-	-	*4.56%*	*4.4%*	*2.4%*	*4.15%*
D-4	Clear Lake	5-Oct-17	0.103	<0.00010	0.001	0.0323	<0.00010	<0.000050	0.086	<0.0000050	42.1	0.000018	0.00032	0.00013	<0.00050	0.097	0.000165	0.0234	60.3	0.0256	0.000581
D-4 Dup (SW100)	Clear Lake	5-Oct-17	0.0336	<0.00010	0.00102	0.0304	<0.00010	<0.000050	0.089	<0.0000050	38.6	<0.000010	0.00018	<0.00010	<0.00050	0.03	0.00006	0.0235	59	0.0178	0.000578
		RPD	*101.61%*	-	*1.98%*	*6.06%*	-	-	*3.43%*	-	*8.7%*	-	-	-	-	-	-	*0.43%*	*2.2%*	*35.9%*	*0.52%*
D-4	Clear Lake	30-May-18	0.0461	0.00011	0.00133	0.0452	<0.00010	<0.000050	0.168	<0.0000050	62.4	<0.000010	0.00025	0.00013	<0.00050	0.049	0.000078	0.0269	67.2	0.0726	0.000481
D-4 Dup	Clear Lake	30-May-18	0.0433	0.00011	0.00125	0.0464	<0.00010	<0.000050	0.171	<0.0000050	66.8	<0.000010	0.0003	0.00013	<0.00050	0.051	0.00008	0.0271	65.9	0.0734	0.000486
		RPD	*6.26%*	*0.00%*	*6.20%*	*2.62%*	-	-	*1.77%*	-	*6.81%*	-	-	*0.00%*	-	*4.00%*	*2.53%*	*0.74%*	*1.95%*	*1.10%*	*1.03%*
D-5	North Clarks Drain	8-Nov-16	0.0179	<0.00020	0.00056	0.0285	<0.00020	<0.00020	0.043	<0.000010	56.5	<0.00010	<0.0010	<0.00020	0.00043	0.036	<0.000090	0.0121	53.6	0.00746	0.00028
D-5	North Clarks Drain	25-May-17	0.085	<0.00020	0.00079	0.0335	<0.00020	<0.00020	0.065	<0.000010	63.2	<0.00010	<0.0010	<0.00020	0.00057	0.116	<0.000090	0.0125	52.7	0.0318	0.00027
D-5	North Clarks Drain	3-Aug-17	0.017	0.00027	0.00139	0.039	<0.00010	<0.000050	0.086	0.0000097	70.3	<0.000010	0.00016	0.00015	<0.00050	0.154	<0.000050	0.0139	53.1	0.0542	0.000196
D-5	North Clarks Drain	5-Oct-17	0.0669	<0.00010	0.00145	0.0502	<0.00010	<0.000050	0.137	<0.0000050	65.1	<0.000010	0.0002	0.00014	0.00066	0.117	0.000105	0.0169	54.2	0.0501	0.000881
D-5	North Clarks Drain	30-May-18	*0.0146*	*0.00011*	*0.00236*	*0.0472*	*<0.00010*	*<0.000050*	*0.112*	*0.000007*	89	*<0.000010*	*0.00044*	*0.00035*	*0.00072*	0.2	*<0.000050*	*0.0177*	58.3	0.137	*0.000517*

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
D-6	South Birch Creek	8-Nov-16	0.0132	<0.00020	0.00064	0.0328	<0.00020	<0.00020	0.07	<0.000010	61.2	<0.00010	<0.0010	<0.00020	0.00053	0.031	<0.000090	0.0198	65.8	0.00491	0.0006
D-6	South Birch Creek	25-May-17	0.0514	<0.00020	0.00083	0.037	<0.00020	<0.00020	0.078	<0.000010	74.2	<0.00010	<0.0010	<0.00020	0.00034	0.073	<0.000090	0.0232	82.7	0.0308	0.00043
D-6	South Birch Creek	3-Aug-17	0.0179	0.00026	0.00088	0.0368	<0.00010	<0.000050	0.119	<0.0000050	58.9	<0.000010	0.0001	<0.00010	<0.00050	0.036	<0.000050	0.0251	72.8	0.0166	0.000181
D-6	South Birch Creek	5-Oct-17	0.0259	<0.00010	0.00095	0.0275	<0.00010	<0.000050	0.093	<0.0000050	45.6	<0.000010	0.00037	<0.00010	<0.00050	0.047	<0.000050	0.029	74.1	0.00705	0.000295
D-6	South Birch Creek	30-May-18	0.0951	<0.00010	0.00125	0.0441	<0.00010	<0.000050	0.124	<0.0000050	74.1	0.000011	0.0003	0.00017	<0.00050	0.135	0.000075	0.028	76.6	0.114	0.000419
D-7	Woodale Drain	8-Nov-16	0.025	<0.00020	0.00064	0.03	<0.00020	<0.00020	0.02	<0.000010	56.4	<0.00010	<0.0010	<0.00020	0.00043	0.059	<0.000090	0.0111	51.5	0.0108	0.00033
D-7	Woodale Drain	25-May-17	0.0208	<0.00020	0.00085	0.0241	<0.00020	<0.00020	0.017	<0.000010	46.7	<0.00010	<0.0010	<0.00020	0.00036	0.084	<0.000090	0.0115	47.2	0.0407	<0.00020
D-7	Woodale Drain	3-Aug-17	0.0145	0.00024	0.00154	0.024	<0.00010	<0.000050	0.012	<0.0000050	52	<0.000010	0.00019	0.00018	<0.00050	0.053	<0.000050	0.0225	65.1	0.0297	0.00024
D-7	Woodale Drain	5-Oct-17	0.109	*<0.00010*	0.0014	0.0931	*<0.00010*	*<0.000050*	0.037	0.0000064	131	0.000019	0.00058	0.00034	0.00164	0.201	0.000182	0.0555	176	0.756	0.00429
D-7	Woodale Drain	30-May-18	0.0097	<0.00010	0.00194	0.033	<0.00010	<0.000050	0.024	<0.0000050	50.8	<0.000010	0.00015	0.00023	<0.00050	0.088	<0.000050	0.0307	71.2	0.167	0.00161
D-8	Birch Creek	8-Nov-16	0.0357	<0.00020	0.00064	0.0327	<0.00020	<0.00020	0.064	<0.000010	63.2	<0.00010	<0.0010	<0.00020	0.0006	0.059	<0.000090	0.0179	66.1	0.00712	0.00054
D-8	Birch Creek	25-May-17	0.112	<0.00020	0.00093	0.0355	<0.00020	<0.00020	0.074	<0.000010	70.8	<0.00010	<0.0010	<0.00020	0.00065	0.11	<0.000090	0.0199	73.7	0.0438	0.00043
D-8	Birch Creek	3-Aug-17	0.0342	0.00027	0.00111	0.0385	<0.00010	<0.000050	0.121	<0.0000050	61.5	<0.000010	0.00012	0.00013	<0.00050	0.069	<0.000050	0.024	71.6	0.0142	0.000247
D-8	Birch Creek	5-Oct-17	0.0522	<0.00010	0.00103	0.029	<0.00010	<0.000050	0.099	<0.0000050	48	<0.000010	0.00017	0.00011	0.00052	0.085	0.000058	0.029	75.1	0.00749	0.000381
D-8	Birch Creek	30-May-18	0.283	<0.00010	0.00162	0.0425	<0.00010	<0.000050	0.126	0.000005	77.8	0.00003	0.0007	0.00031	0.00084	**0.305**	0.000176	0.0251	69.7	0.0688	0.000455
D-9	Lake St. Martin	8-Nov-16	0.0421	<0.00020	0.00172	0.0398	<0.00020	<0.00020	0.086	<0.000010	43.3	<0.00010	<0.0010	<0.00020	0.00043	0.037	0.000118	0.0283	37.1	0.00489	0.00203
D-9 Dup	Lake St. Martin	8-Nov-16	0.0357	<0.00020	0.00166	0.0396	<0.00020	<0.00020	0.083	<0.000010	40.4	<0.00010	<0.0010	<0.00020	0.00038	0.036	0.000113	0.0262	35.8	0.00476	0.00185
D-9		*RPD*	*16.5%*	-	*3.6%*	*0.5%*	-	-	*3.6%*	-	*6.9%*	-	-	-	-	-	-	*7.7%*	*3.6%*	*2.7%*	*9.3%*
D-9	Lake St. Martin	25-May-17	0.036	<0.00020	0.00132	0.0391	<0.00020	<0.00020	0.083	<0.000010	48.6	<0.00010	<0.0010	<0.00020	0.00048	0.031	<0.000090	0.0262	36.2	0.00518	0.00156
D-9	Lake St. Martin	3-Aug-17	0.0356	0.00033	0.00187	0.0424	<0.00010	<0.000050	0.096	0.0000101	46.6	<0.000010	<0.00010	<0.00010	<0.00050	0.036	0.000091	0.0311	31.7	0.0106	0.00177
D-9	Lake St. Martin	5-Oct-17	0.0092	0.00013	0.00167	0.0335	<0.00010	<0.000050	0.099	<0.0000050	34.1	<0.000010	<0.00010	<0.00010	<0.00050	0.011	0.000068	0.0268	26.9	0.00378	0.00193
D-9	Lake St. Martin	30-May-18	0.167	0.00014	0.00169	0.0425	<0.00010	<0.000050	0.102	<0.0000050	47.4	0.00002	0.00041	0.00014	0.00072	0.169	0.000153	0.0333	30.5	0.00804	0.00187
FB	Field Blank	8-Nov-16	<0.0050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.010	<0.000010	0.1	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	<0.0020	<0.010	<0.00030	<0.00020
FB	Field Blank	25-May-17	<0.0050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.010	<0.000010	<0.10	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	<0.0020	<0.010	<0.00030	<0.00020
FB	Field Blank	3-Aug-17	<0.0030	0.00018	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	0.096	<0.000010	<0.00010	<0.00010	<0.00050	<0.010	<0.000050	<0.0010	0.0068	0.00013	<0.000050
FB	Field Blank	5-Oct-17	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00050	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	<0.000050
FB	Field Blank	30-May-18	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00050	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	<0.000050
EQL			*0.005*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.1 / 0.050*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0003 / 0.0001*	*0.0002*
MWQSOG [(1)]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			0.005 - 0.1 [(3)]	-	0.15 - 0.34 [(4)]	-	-	-	-	[(7)]	-	-	[(7)]	-	[(7)]	0.3	[(7)]	-	-	-	0.073
CCME[(2)]																					
Freshwater Aquatic Life			0.005 - 0.1 [(3)]	-	0.005	-	-	-	(29 [(5)]) 1.5 [(6)]	0.09 µg/L [(8a)] 1.0 µg/L [(8b)]	-	-	0.0089 (III), 0.001 (VI)	-	[(8c)]	0.3	[(8d)]	-	-	-	0.073

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
D-1	Lake Manitoba	8-Nov-16	<0.0020	<0.10	7.98	0.00403	<0.0010	8.01	<0.00010	32.5	0.15	<0.00020	<0.00010	<0.00010	<0.00020	0.00472	<0.00010	0.00188	0.00094	0.0021	<0.00040
D-1	Lake Manitoba	25-May-17	<0.0020	<0.10	9.26	0.0032	<0.0010	4.18	<0.00010	106	0.234	<0.00020	<0.00010	<0.00010	<0.00020	0.00108	<0.00010	0.00164	0.00119	<0.0020	<0.00040
D-1	Lake Manitoba	3-Aug-17	0.00082	<0.050	9.3	0.00371	0.0001	5.44	<0.000010	92.8	0.237	<0.00020	<0.000010	<0.00010	<0.00010	0.00358	<0.00010	0.00159	0.00154	0.0049	0.000113
D-1	Lake Manitoba	5-Oct-17	0.00077	<0.050	8.27	0.00346	0.000076	5.87	<0.000010	99.4	0.248	<0.00020	<0.000010	<0.00010	<0.00010	0.00248	<0.00010	0.00165	0.00174	<0.0030	0.00011
D-1	Lake Manitoba	30-May-18	0.00072	<0.050	8.02	0.00301	0.000077	4.03	<0.000010	92.1	0.239	<0.00020	<0.000010	<0.00010	<0.00010	0.00092	<0.00010	0.00146	0.00125	<0.0030	0.000061
D-2	Watchorn Creek	8-Nov-16	<0.0020	<0.10	15.6	0.00724	<0.0010	7.84	<0.00010	12.6	0.108	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00104	<0.00020	<0.0020	<0.00040
D-2	Watchorn Creek	25-May-17	<0.0020	<0.10	10.2	0.00473	<0.0010	2.5	<0.00010	11.5	0.117	<0.00020	<0.00010	<0.00010	<0.00020	0.00067	<0.00010	0.00069	0.00027	<0.0020	<0.00040
D-2	Watchorn Creek	3-Aug-17	<0.00050	0.063	9.43	0.00517	0.000088	10.9	<0.000010	10.6	0.127	<0.00020	<0.000010	<0.00010	<0.00010	0.0003	<0.00010	0.000127	<0.00050	<0.0030	<0.000060
D-2	Watchorn Creek	5-Oct-17	0.00071	<0.050	7.17	0.00386	0.000087	6.99	<0.000010	21.1	0.196	<0.00020	<0.000010	<0.00010	<0.00010	0.00085	<0.00010	0.00367	0.00054	<0.0030	0.000107
D-2	Watchorn Creek	30-May-18	0.00131	0.089	6.46	0.00363	0.000171	3.27	<0.000010	25	0.222	<0.00020	<0.000010	<0.00010	<0.00010	0.00125	<0.00010	0.00176	0.00096	0.0049	0.000248
D-3	Reed Lake	7-Nov-16	<0.0020	<0.10	9.16	0.00467	<0.0010	9.2	<0.00010	10.9	0.0965	<0.00020	<0.00010	<0.00010	<0.00020	0.00053	<0.00010	0.00143	<0.00020	<0.0020	<0.00040
D-3	Reed Lake	25-May-17	<0.0020	<0.10	8.56	0.00399	<0.0010	2.78	<0.00010	9.88	0.0861	<0.00020	<0.00010	<0.00010	<0.00020	0.00073	<0.00010	0.00077	0.0003	<0.0020	<0.00040
D-3	Reed Lake	3-Aug-17	<0.00050	<0.050	9.45	0.00449	0.000068	2.15	<0.000010	9.33	0.0453	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000373	<0.00050	<0.0030	<0.000060
D-3	Reed Lake	5-Oct-17	<0.00050	<0.050	9.5	0.00437	0.00008	4.42	<0.000010	10.4	0.0506	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000405	<0.00050	<0.0030	<0.000060
D-3	Reed Lake	30-May-18	<0.00050	<0.050	8.92	0.0041	0.000064	3.01	<0.000010	9.96	0.0855	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.000316	<0.00050	<0.0030	<0.000060
D-4	Clear Lake	7-Nov-16	<0.0020	<0.10	8.33	0.00475	<0.0010	9.33	<0.00010	10.6	0.146	<0.00020	<0.00010	<0.00010	<0.00020	0.00231	<0.00010	0.0034	0.00076	<0.0020	<0.00040
D-4	Clear Lake	25-May-17	<0.0020	<0.10	3.27	0.00199	<0.0010	2.1	<0.00010	13.4	0.141	<0.00020	<0.00010	<0.00010	<0.00020	0.00086	<0.00010	0.00423	0.00115	<0.0020	<0.00040
D-4 Dup	Clear Lake	25-May-17	<0.0020	<0.10	3.23	0.0021	<0.0010	2.09	<0.00010	13	0.136	<0.00020	<0.00010	<0.00010	<0.00020	0.00056	<0.00010	0.00411	0.0011	<0.0020	<0.00040
		RPD	-	-	*1.2%*	*5.4%*	-	*0.5%*	-	*3.0%*	*3.6%*	-	-	-	-	-	-	*2.9%*	*4.4%*	-	-
D-4	Clear Lake	3-Aug-17	0.00076	<0.050	6.46	0.00437	0.000183	4.41	<0.000010	11.1	0.128	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00131	<0.00050	<0.0030	0.000844
D-4 Field Dup. (SW100)	Clear Lake	3-Aug-17	0.00074	<0.050	6.64	0.00454	0.00014	4.54	<0.000010	11.4	0.13	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00129	<0.00050	<0.0030	0.000125
		RPD	*2.67%*	-	*2.7%*	*3.82%*	-	*2.91%*	-	*2.7%*	*1.55%*	-	-	-	-	-	-	*1.54%*	-	-	-
D-4	Clear Lake	5-Oct-17	0.00073	<0.050	7.05	0.00394	0.000134	2.91	<0.000010	13	0.129	<0.00020	<0.000010	<0.00010	0.00011	0.005	<0.00010	0.00232	0.00069	0.0032	0.000152
D-4 Dup (SW100)	Clear Lake	5-Oct-17	0.0005	<0.050	6.98	0.00363	0.000113	2.77	<0.000010	12.7	0.131	<0.00020	<0.000010	<0.00010	<0.00010	0.0012	<0.00010	0.00231	0.00052	<0.0030	0.000113
		RPD	-	-	*1.0%*	*8.19%*	-	*4.93%*	-	*2.3%*	*1.54%*	-	-	-	-	-	-	*0.43%*	-	-	-
D-4	Clear Lake	30-May-18	0.00082	<0.050	12.1	0.00586	0.000169	5.31	<0.000010	15.5	0.202	<0.00020	<0.000010	<0.00010	<0.00010	0.00166	<0.00010	0.00118	<0.00050	<0.0030	0.000144
D-4 Dup	Clear Lake	30-May-18	0.00081	<0.050	12.3	0.00581	0.00016	5.65	<0.000010	15.4	0.199	<0.00020	<0.000010	<0.00010	<0.00010	0.00179	<0.00010	0.0012	<0.00050	<0.0030	0.000131
		RPD	-	-	*1.64%*	*0.86%*	*5.47%*	*6.20%*	-	*0.65%*	*1.50%*	-	-	-	-	*7.54%*	-	*1.68%*	-	-	*9.45%*
D-5	North Clarks Drain	8-Nov-16	<0.0020	<0.10	2.57	0.00253	<0.0010	7.23	<0.00010	5.75	0.114	<0.00020	<0.00010	<0.00010	<0.00020	0.00084	<0.00010	0.00201	0.00048	<0.0020	<0.00040
D-5	North Clarks Drain	25-May-17	<0.0020	<0.10	2.26	0.00219	<0.0010	4.1	<0.00010	5.77	0.127	<0.00020	<0.00010	<0.00010	<0.00020	0.00358	<0.00010	0.00146	0.00083	<0.0020	<0.00040
D-5	North Clarks Drain	3-Aug-17	0.00086	<0.050	1.67	0.00208	0.000186	11.2	<0.000010	4.67	0.147	<0.00020	<0.000010	<0.00010	<0.00010	0.00082	<0.00010	0.000702	<0.00050	<0.0030	0.000179
D-5	North Clarks Drain	5-Oct-17	0.00123	<0.050	5.02	0.00228	0.00016	3.79	<0.000010	7.16	0.186	<0.00020	<0.000010	<0.00010	<0.00010	0.00222	<0.00010	0.0025	0.00099	<0.0030	0.000249
D-5	North Clarks Drain	30-May-18	0.00182	<0.050	3.37	0.00353	0.00028	8.98	<0.000010	6.97	0.183	<0.00020	<0.000010	<0.00010	<0.00010	0.00099	<0.00010	0.00173	0.00068	0.0059	0.000426

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
D-6	South Birch Creek	8-Nov-16	<0.0020	<0.10	8.57	0.00425	<0.0010	9.89	<0.00010	12.3	0.17	<0.00020	<0.00010	<0.00010	<0.00020	0.00061	<0.00010	0.0038	0.00036	<0.0020	<0.00040
D-6	South Birch Creek	25-May-17	<0.0020	<0.10	6.66	0.00337	<0.0010	3.79	<0.00010	16.3	0.221	<0.00020	<0.00010	<0.00010	<0.00020	0.00247	<0.00010	0.00262	0.0005	<0.0020	<0.00040
D-6	South Birch Creek	3-Aug-17	<0.00050	<0.050	4.67	0.00257	0.000116	17.4	<0.000010	12.8	0.204	<0.00020	<0.000010	<0.00010	<0.00010	0.00071	<0.00010	0.000457	<0.00050	<0.0030	0.000071
D-6	South Birch Creek	5-Oct-17	<0.00050	<0.050	7.14	0.00294	0.000118	14.2	<0.000010	15.6	0.176	<0.00020	<0.000010	<0.00010	<0.00010	0.00143	<0.00010	0.00107	0.00058	<0.0030	0.000117
D-6	South Birch Creek	30-May-18	0.00074	<0.050	7.94	0.00429	0.000165	9.87	<0.000010	14.8	0.229	<0.00020	<0.000010	<0.00010	<0.00010	0.00411	<0.00010	0.00136	0.0008	<0.0030	0.000193
D-7	Woodale Drain	8-Nov-16	<0.0020	<0.10	6.78	0.00244	<0.0010	8.99	<0.00010	6.58	0.0966	<0.00020	<0.00010	<0.00010	<0.00020	0.00105	<0.00010	0.00352	0.00053	0.0029	<0.00040
D-7	Woodale Drain	25-May-17	<0.0020	<0.10	4.7	0.00162	<0.0010	3.95	<0.00010	6.06	0.0821	<0.00020	<0.00010	<0.00010	<0.00020	0.00067	<0.00010	0.00068	0.00038	0.0023	<0.00040
D-7	Woodale Drain	3-Aug-17	0.00104	0.062	2.49	0.0014	0.000174	6.27	<0.000010	8.89	0.131	<0.00020	<0.000010	<0.00010	<0.00010	0.00065	<0.00010	0.00127	0.00058	<0.0030	0.000194
D-7	Woodale Drain	5-Oct-17	0.00156	0.155	9.76	0.00367	0.000143	10.1	<0.000010	23.9	0.346	<0.00020	<0.000010	<0.00010	<0.00010	0.00628	<0.00010	0.0444	0.00141	0.0082	0.000241
D-7	Woodale Drain	30-May-18	0.00128	0.059	4.61	0.00184	0.000184	3.75	<0.000010	10.8	0.137	<0.00020	<0.000010	<0.00010	<0.00010	0.00058	<0.00010	0.00823	0.00062	<0.0030	0.000173
D-8	Birch Creek	8-Nov-16	<0.0020	<0.10	7.31	0.00376	<0.0010	9.25	<0.00010	11.5	0.166	<0.00020	<0.00010	<0.00010	<0.00020	0.00155	<0.00010	0.0038	0.0005	<0.0020	<0.00040
D-8	Birch Creek	25-May-17	<0.0020	<0.10	5.33	0.00306	<0.0010	2.9	<0.00010	13.2	0.185	<0.00020	<0.00010	<0.00010	<0.00020	0.00477	<0.00010	0.00255	0.00096	<0.0020	<0.00040
D-8	Birch Creek	3-Aug-17	0.00058	<0.050	4.41	0.00258	0.000147	14.6	<0.000010	12.2	0.193	<0.00020	<0.000010	<0.00010	<0.00010	0.00142	<0.00010	0.000821	0.0005	<0.0030	0.000134
D-8	Birch Creek	5-Oct-17	0.00052	<0.050	6.89	0.003	0.000131	13	<0.000010	15.9	0.183	<0.00020	<0.000010	<0.00010	<0.00010	0.00333	<0.00010	0.00157	0.00086	<0.0030	0.000216
D-8	Birch Creek	30-May-18	0.00127	0.086	6.45	0.0041	0.000184	5.3	<0.000010	11.6	0.223	<0.00020	<0.000010	<0.00010	<0.00010	0.0113	<0.00010	0.00188	0.00181	<0.0030	0.00045
D-9	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.74	0.00359	<0.0010	5.78	<0.00010	96.8	0.231	<0.00020	<0.00010	<0.00010	<0.00020	0.00138	<0.00010	0.00189	0.00152	<0.0020	<0.00040
D-9 Dup	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.34	0.00351	<0.0010	5.58	<0.00010	91	0.213	<0.00020	<0.00010	<0.00010	<0.00020	0.00126	<0.00010	0.0018	0.00145	<0.0020	<0.00040
		RPD	-	-	*4.7%*	*2.3%*	-	*3.5%*	-	*6.2%*	*8.1%*	-	-	-	-	-	-	*4.9%*	*4.7%*	-	-
D-9	Lake St. Martin	25-May-17	<0.0020	<0.10	8.57	0.00344	<0.0010	3.77	<0.00010	108	0.229	<0.00020	<0.00010	<0.00010	<0.00020	0.00105	<0.00010	0.00143	0.00099	<0.0020	<0.00040
D-9	Lake St. Martin	3-Aug-17	0.00069	<0.050	8.63	0.00382	0.000084	5.18	<0.000010	101	0.243	<0.00020	<0.000010	<0.00010	<0.00010	0.00149	<0.00010	0.00141	0.00115	<0.0030	<0.000060
D-9	Lake St. Martin	5-Oct-17	0.00051	<0.050	6.31	0.00273	0.000079	6.19	<0.000010	86.8	0.198	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	0.00131	0.00125	<0.0030	<0.000060
D-9	Lake St. Martin	30-May-18	0.001	<0.050	7.97	0.00362	0.000077	4.54	<0.000010	97.5	0.255	<0.00020	<0.000010	<0.00010	<0.00010	0.00735	<0.00010	0.00151	0.00156	<0.0030	0.000152
FB	Field Blank	8-Nov-16	<0.0020	<0.10	<0.020	<0.00020	<0.0010	<0.10	<0.00010	<0.030	0.00013	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	<0.00010	<0.00020	<0.0020	<0.00040
FB	Field Blank	25-May-17	<0.0020	<0.10	<0.020	<0.00020	<0.0010	<0.10	<0.00010	<0.030	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	<0.00010	<0.00020	<0.0020	<0.00040
FB	Field Blank	3-Aug-17	<0.00050	<0.050	<0.050	<0.00020	<0.000050	<0.10	<0.000010	<0.050	<0.00020	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0030	<0.000060
FB	Field Blank	5-Oct-17	<0.00050	<0.050	<0.050	<0.00020	<0.000050	<0.10	<0.000010	<0.050	<0.00020	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0030	<0.000060
FB	Field Blank	30-May-18	<0.00050	<0.050	<0.050	<0.00020	<0.000050	<0.10	<0.000010	<0.050	<0.00020	<0.00020	<0.000010	<0.00010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0030	<0.000060
EQL			*0.002*	*0.1*	*0.02 / 0.05*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.03 / 0.05*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
MWQSOG [1]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			[7]	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [9]	-	-	0.001	-	0.0001	-	-	-	0.0008	-	-	-	-	(0.033[5]) 0.015 [6]	-	[7]	-
CCME[2]																					
Freshwater Aquatic Life			[8e]	[10]	-	-	0.001	-	0.00025	-	-	-	0.0008	-	-	-	-	(0.033[5]) 0.015 [6]	-	0.03	-

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

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1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
3. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5. The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater than or equal to 6.5.
4. Short term duration (1 hour) should not exceed 0.34 mg/L long term duration (4 days) should not exceed 0.15 mg/L.
5. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.
6. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
7. The following table provides guidelines for parameters based on the sample's hardness and the toxicity of the metal.

Hardness (mg/L)	*Cadmium (mg/L)*		*Chromium (mg/L)*		*Copper (mg/L)*		*Lead (mg/L)*		*Nickel (mg/L)*		*Zinc (mg/L)*	
	Chronic	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*
245	0.00046	0.00481	0.15439	1.18692	0.01926	0.03126	0.00657	0.16872	0.11099	0.99931	0.25243	0.25038
270	0.00049	0.00528	0.16718	1.28523	0.02093	0.03426	0.00728	0.18684	0.1205	1.08492	0.27409	0.27186
295	0.00052	0.00576	0.17976	1.38191	0.02257	0.03724	0.00799	0.20496	0.12988	1.16932	0.29544	0.29305
320	0.00055	0.00623	0.19214	1.47711	0.0242	0.04021	0.00869	0.22307	0.13913	1.25263	0.31652	0.31396
345	0.00058	0.0067	0.20435	1.57097	0.0258	0.04316	0.0094	0.24116	0.14827	1.33493	0.33736	0.33462
370	0.00061	0.00717	0.2164	1.66361	0.02739	0.0461	0.0101	0.25922	0.15731	1.41633	0.35796	0.35505
400	0.00064	0.00774	0.02067	1.7733	0.02928	0.04962	0.01094	0.28025	0.16804	1.51289	0.3824	0.3793

8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is 0 to <17 mg/L, CWQG is 0.04µg/L.
   At hardness ≥ 17 to ≤ 280, the CWQG can be calculated with the equation CWQG (ug/L) = 10^{0.83[log(hardness (mg/L)] - 2.46}. At hardness >280 mg/L, the CWQG is 0.37 ug/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness.
   When water hardness is 0 to <5.3 mg/L, the short-term CWQG is 0.11 µg/L. At hardness≥5.3 to ≤360 mg/L, the short term bench mark is calculated using this equation CWQG (ug/L) = 10^{1.016(log[hardness (mg/L])-1.71}. At hardness >360 mg/L, the short term benchmark is 7.7 ug/L
   c. **Copper** Guideline = When the water hardness is 0 to <82 mg/L, the CWQG is 2 ug/L.
   At hardness ≥ 82 to ≤180 mg/L the CDWQ is calculated using this equation: CWQG (ug/L) = e^(0.8545[ln(hardness (mg/L)]-1.465) * 0.2;
   At hardness > 180 mg/L, the CWQG is 4 ug/L, if the hardness is not known, the CDQG is 2 ug/L.
   d. **Lead** Guideline =When the hardness is 0 to≤60 mg/L, the CWQG is 1 ug/L. At hardness >60 to≤180 mg/L the CWQG is calculated using: CWQG(ug/L) = e^(1.273[ln(hardness (mg/L))]-4.705) µg/L; At hardness >180 mg/L, the CWQG is 7 ug/L, If the hardness is unknown, the CWQG is 1 ug/L.
   e. **Nickel** Guideline = Whan water hardness is 0 to≤60 mg/L, the CWQG is 25 ug/L.
   At hardness >60 to ≤180 mg/L the CWQG is calculated using the following equation: CWQG (ug/L) = e^(0.76[ln(hardness)]+1.06). At hardness >180 mg/L, the CWQG is 150 ug/L. If the hardness is unknown, the CWQG is 25 ug/L.

Well No. (November 2016)	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	322	0.00042	0.00689	0.00642	0.01410	0.23245
D-2	321	0.00042	0.00686	0.00641	0.01404	0.23190
D-3	335	0.00043	0.00717	0.00664	0.01483	0.23954
D-4	394	0.00049	0.00845	0.00763	0.01823	0.27098
D-5	362	0.00046	0.00776	0.00710	0.01636	0.25408
D-6	424	0.00053	0.00911	0.00813	0.02001	0.28652
D-7	353	0.00045	0.00756	0.00695	0.01585	0.24926
D-8	430	0.00053	0.00924	0.00822	0.02037	0.28959
D-9	261	0.00035	0.00556	0.00537	0.01079	0.19815

TABLE D3-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No. (May 2017)	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	250	0.00034	0.00532	0.00517	0.01021	0.19177
D-2	329	0.00043	0.00704	0.00654	0.01449	0.23628
D-3	291	0.00038	0.00621	0.00589	0.01239	0.21523
D-4	418	0.00052	0.00898	0.00803	0.01965	0.28343
D-5	375	0.00047	0.00804	0.00732	0.01712	0.26099
D-6	526	0.00063	0.01134	0.00977	0.02633	0.33752
D-7	311	0.00041	0.00665	0.00624	0.01349	0.22639
D-8	480	0.00058	0.01033	0.00903	0.02343	0.31484
D-9	270	0.00036	0.00576	0.00553	0.01127	0.20332

Well No. (August 2017)	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	249	0.00034	0.00530	0.00516	0.01016	0.19119
D-2	316	0.00041	0.00676	0.00632	0.01376	0.22915
D-3	245	0.00033	0.00522	0.00509	0.00996	0.18885
D-4	338	0.00044	0.00723	0.00669	0.01500	0.24117
D-5	394	0.00049	0.00845	0.00763	0.01823	0.27098
D-6	447	0.00055	0.00961	0.00850	0.02140	0.29825
D-7	398	0.00050	0.00854	0.00770	0.01846	0.27306
D-8	448	0.00055	0.00963	0.00852	0.02146	0.29876
D-9	247	0.00034	0.00526	0.00512	0.01006	0.19002

Well No. (October 2017)	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	245	0.00033	0.00522	0.00509	0.00996	0.18885
D-2	430	0.00053	0.00924	0.00822	0.02037	0.28959
D-3	275	0.00037	0.00587	0.00561	0.01153	0.20618
D-4	353	0.00045	0.00756	0.00695	0.01585	0.24926
D-5	386	0.00049	0.00828	0.00750	0.01776	0.26678
D-6	419	0.00052	0.00900	0.00804	0.01971	0.28395
D-7	1050	0.00112	0.02288	0.01764	0.06348	0.57076
D-8	429	0.00053	0.00922	0.00821	0.02031	0.28908
D-9	196	0.00028	0.00416	0.00420	0.00749	0.15939

Well No. (May 2018)	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	229	0.00032	0.00487	0.00480	0.00914	0.17940
D-2	476	0.00058	0.01024	0.00897	0.02319	0.31285
D-3	297	0.00039	0.00634	0.00599	0.01272	0.21860
D-4	438	0.00054	0.00941	0.00835	0.02086	0.29368
D-5	462	0.00056	0.00994	0.00874	0.02232	0.30583
D-6	500	0.00060	0.01077	0.00936	0.02469	0.32477
D-7	420	0.00052	0.00902	0.00806	0.01977	0.28446
D-8	481	0.00058	0.01035	0.00905	0.02350	0.31534
D-9	244	0.00033	0.00520	0.00507	0.00990	0.18826

9. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

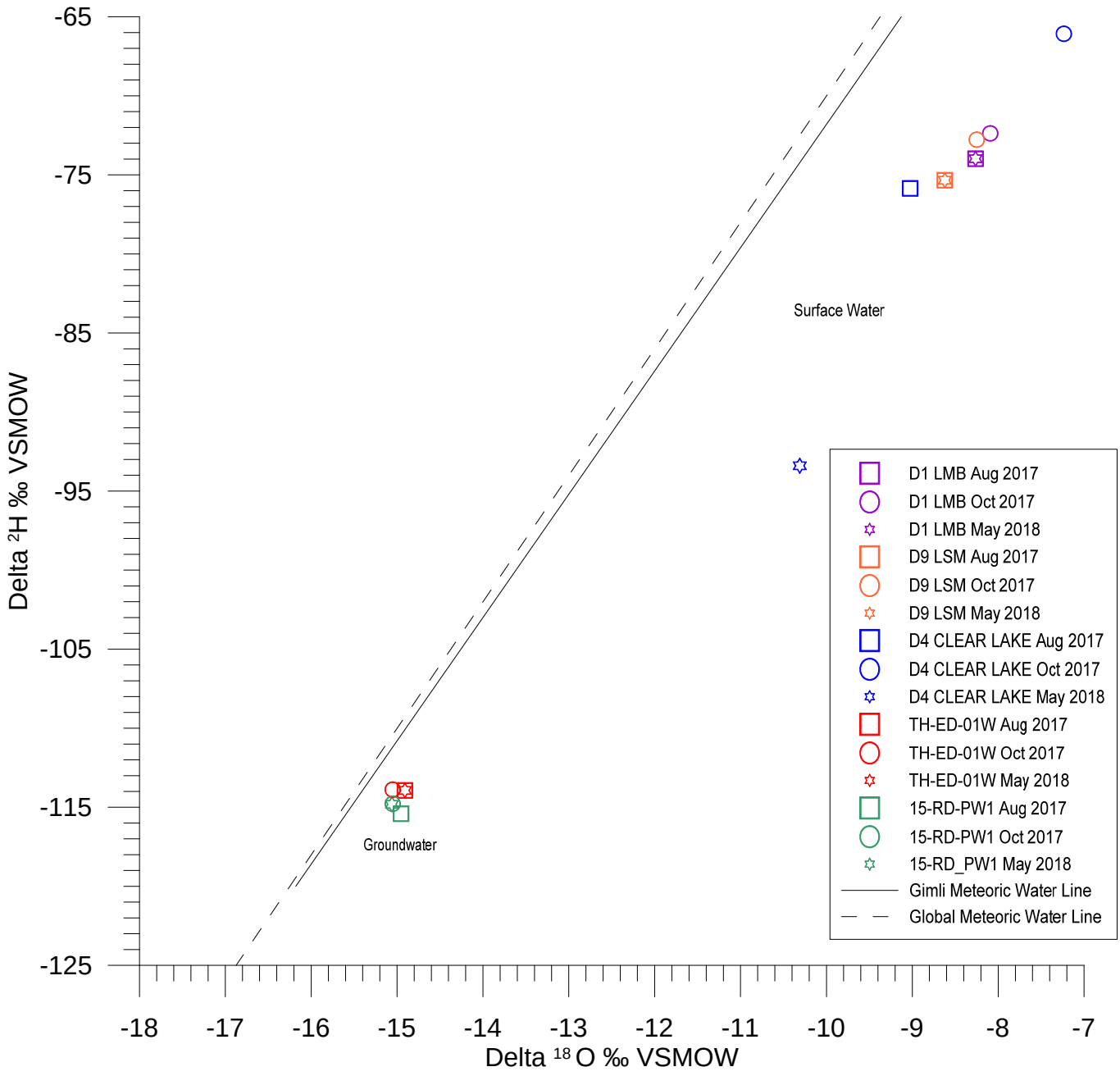
Trigger ranges (µg/L):	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

	- Exceedance of CCME Guidelines
BOLD	- Exceedance of MWQSOG Guidelines

TABLE D3-8
STABLE ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample	Date	Lab#	δ18O	Result	Repeat	δ^2H	Result	Repeat	pH	Conductivity
			H_2O	VSMOW		H_2O	VSMOW			µS/cm
Ground Water										
TH-ED-01W	26-Oct-16	373023	X	-14.72	-14.89	X	-113.02	-112.97	6.51	511
TH-ED-01W	23-May-17	381957	X	-15.14	-15.11	X	-114.18	-113.99	7.38	813
TH-ED-01W	2-Aug-17	384686	X	-14.91	-15.06	X	-113.94	-114.01	7.17	810
TH-ED-01W	4-Oct-17	386776	X	-15.05	-15.10	X	-113.88	-113.78	7.73	844
TH-ED-01W	29-May-18	403342	X	-14.88	-14.91	X	-113.74	-113.46	9.01	811
TH-GD-08	29-Oct-16	373025	X	-14.86	0.16	X	-113.64	-	-	*
15-RD-PW1	24-May-17	381958	X	-15.30	-	X	-115.05	-	7.33	817
15-RD-PW1	1-Aug-17	384687	X	-14.95	-	X	-115.42	-	7.32	792
15-RD-PW1	3-Oct-17	386777	X	-15.05	-	X	-114.78	-	7.71	808
15-RD-PW1	28-May-18	403343	X	-15.06	-	X	-114.82	-	8.94	767
Surface Water										
D-1 LMB	8-Nov-16	374371	X	-9.72	-	X	-75.68	-	8.05	492
D-1 LMB	25-May-17	381959	X	-8.83	-8.81	X	-75.80	-75.55	8.32	936
D-1 LMB	3-Aug-17	384688	X	-8.26	-8.42	X	-73.98	-73.79	8.01	932
D-1 LMB	5-Oct-17	386778	X	-8.09	-8.00	X	-72.38	-72.11	6.87	945
D-1 LMB	30-May-18	403344	X	-8.06	-8.01	X	-73.16	-72.56	7.15	849
D-4 Clear Lake	8-Nov-16	374374	X	-11.31	-11.29	X	-80.81	-80.67	8.84	532
D-4 Clear Lake	25-May-17	381960	X	-10.67	-	X	-90.14	-	8.33	696
D-4 Clear Lake DUP	25-May-17	381962	X	-10.68	-10.75	X	-89.83	-89.67	8.33	696
D-4 Clear Lake	3-Aug-17	384689	X	-9.02	-	X	-75.86	-	7.02	659
D-4 Clear Lake DUP	3-Aug-17	384691	X	-8.84	-9.06	X	-75.05	-75.18	7.02	659
D-4 Clear Lake	5-Oct-17	386779	X	-7.23	-	X	-66.07	-	6.93	731
D-4 Clear Lake DUP	5-Oct-17	386781	X	-7.19	-7.16	X	-65.85	-65.98	6.93	731
D-4 Clear Lake	30-May-18	403345	X	-10.31	-	X	-93.41	-	7.15	789
D-4 Clear Lake DUP	30-May-18	403347	X	-10.16	-10.20	X	-92.64	-92.86	7.15	789
D-9 LSM	8-Nov-16	374372	X	-8.46	-8	X	-72.86	-73.00	8.41	691
D-9 LSM-DUP	8-Nov-16	374373	X	-8.51	-	X	-72.83	-	8.41	691
D-9 LSM	25-May-17	381961	X	-9.00	-	X	-77.15	-	8.18	932
D-9 LSM	3-Aug-17	384690	X	-8.62	-	X	-75.34	-	7.2	970
D-9 LSM	5-Oct-17	386780	X	-8.25	-	X	-72.78	-	6.43	959
D-9 LSM	30-May-18	403346	X	-8.14	-	X	-73.23	-	6.48	960

PLATES



Gimli Meteoric Water Line

Delta $^{2}H = (7.8)$ Delta $^{18}O + 6.2$

Global Meteoric Water Line

Delta $^{2}H = (8)$ Delta $^{18}O + 10$

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/08/21	ISSUED WITH DELIVERABLE D3	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D

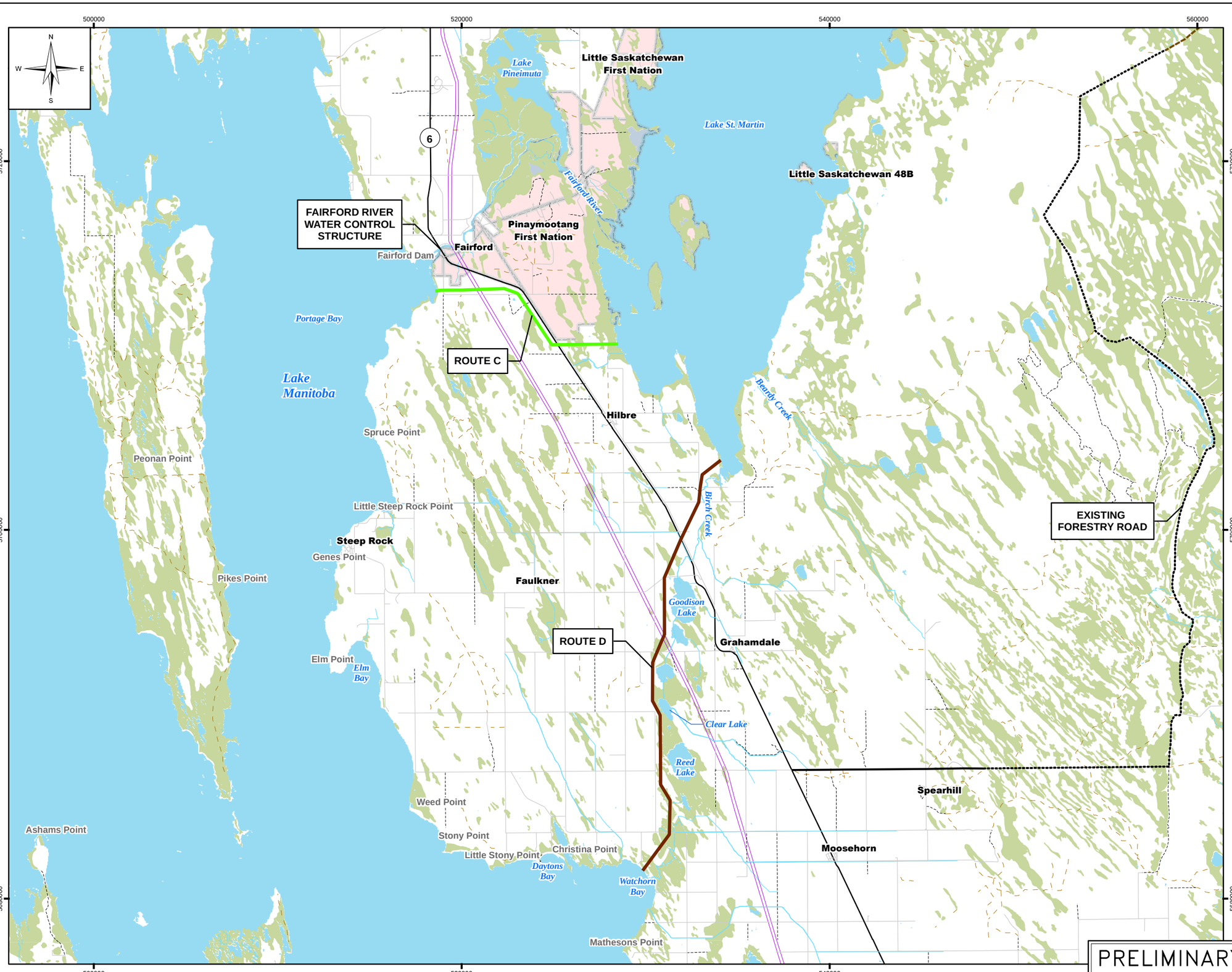
AUGUST 2018	PLATE D3-1	REV: 0

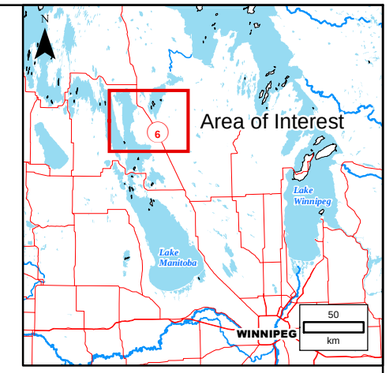
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APPENDIX D3-A

LOCATION PLANS FROM: INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNELS OPTIONS C AND D SUMMARY REPORT, MAY 2017. APPENDIX A, DELIVERABLE 4 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER – ROUTE D

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LEGEND:

- LMB Channel Option C
- LMB Channel Option D
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Wetlands
- Waterbody
- First Nation

NOTES:

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

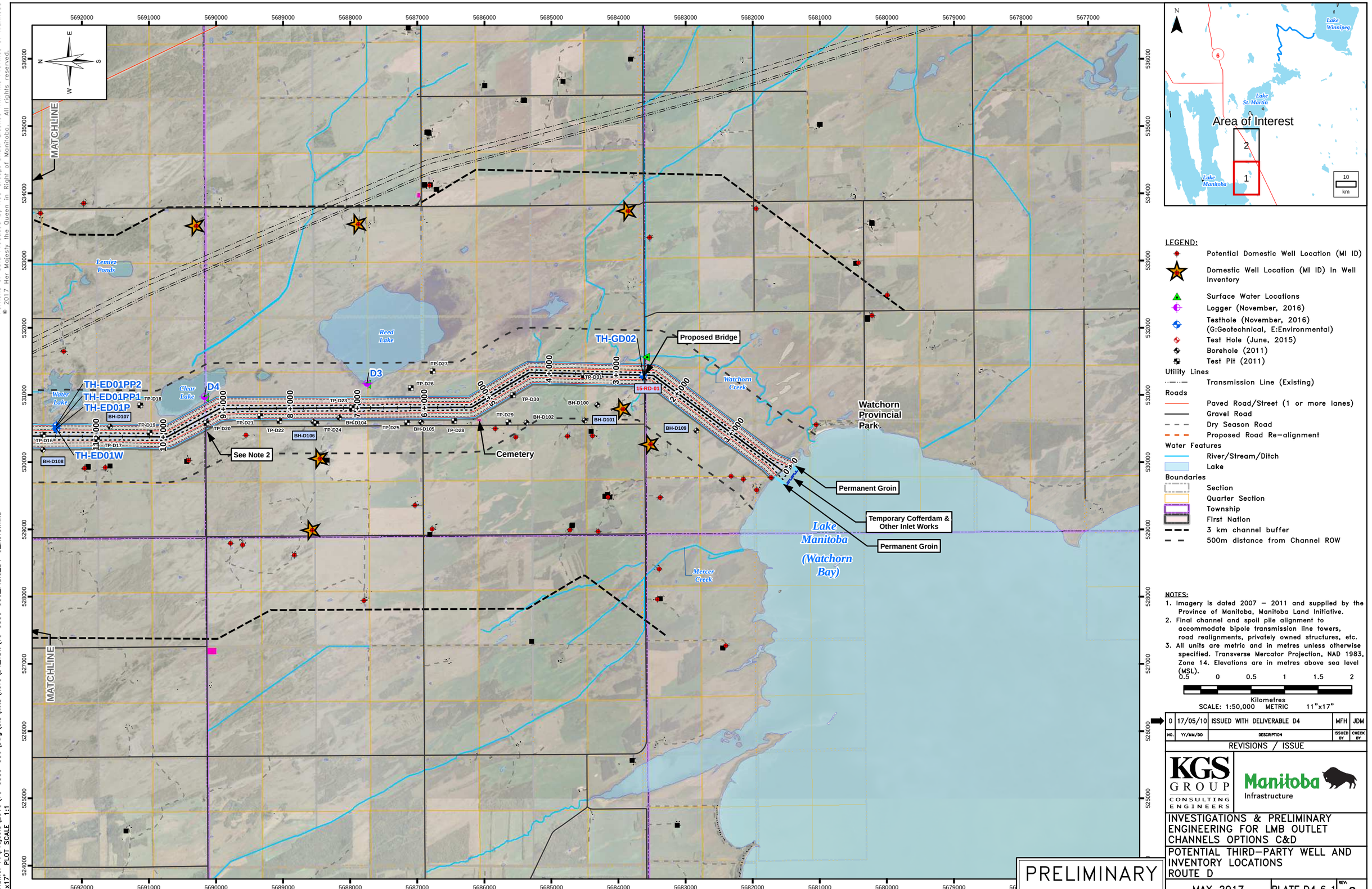
GENERAL SITE PLAN ROUTE C AND D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-1 | REV: 0

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11"x17" PLOT SCALE 1:1

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LEGEND:

- Potential Domestic Well Location (MI ID)
- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Logger (November, 2016)
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

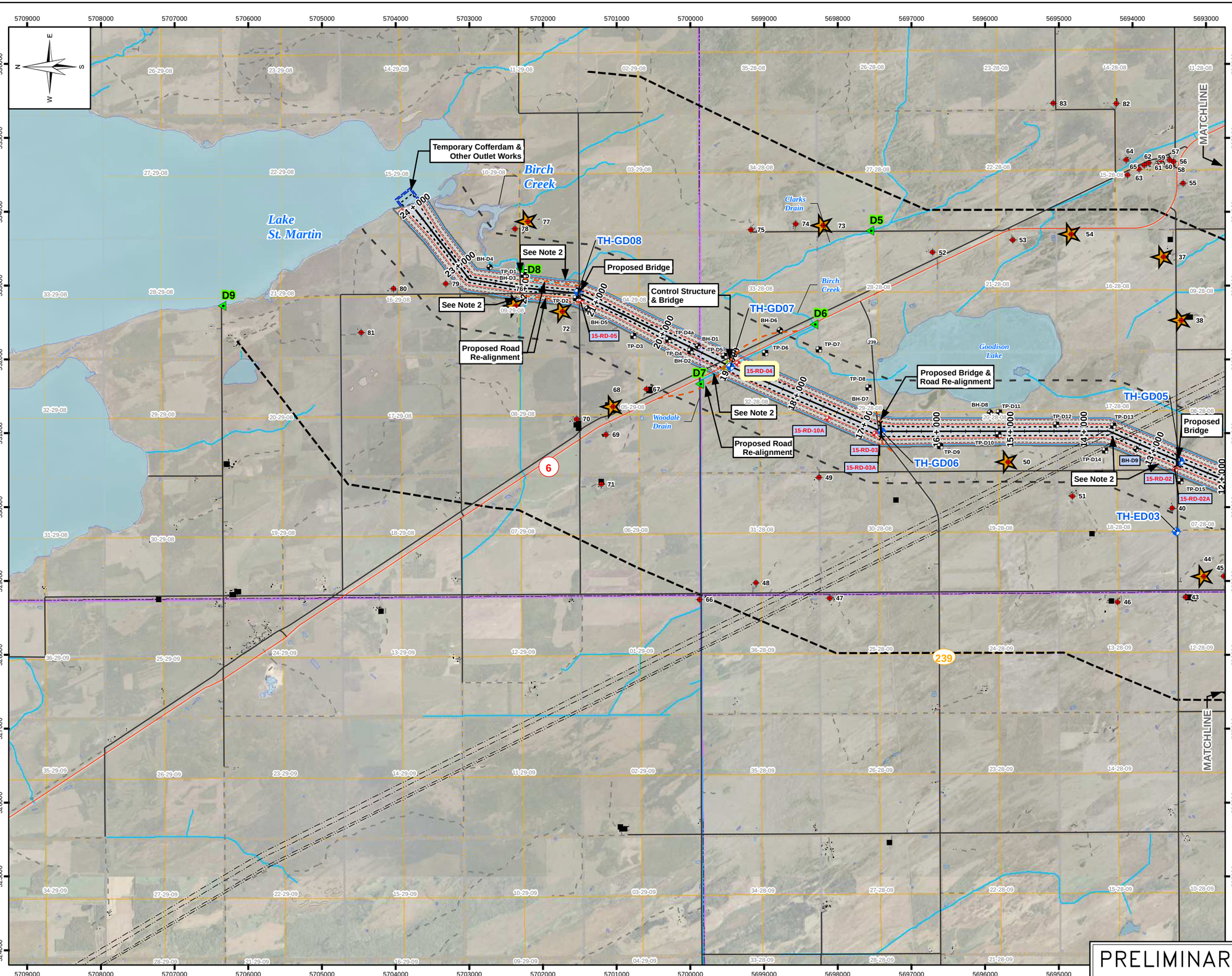
POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

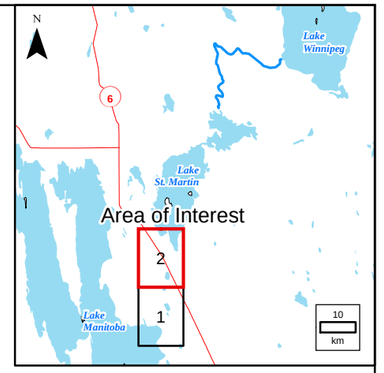
MAY 2017 | PLATE D4-6.1 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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LEGEND:

- Potential Domestic Well Location (MI ID)
- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

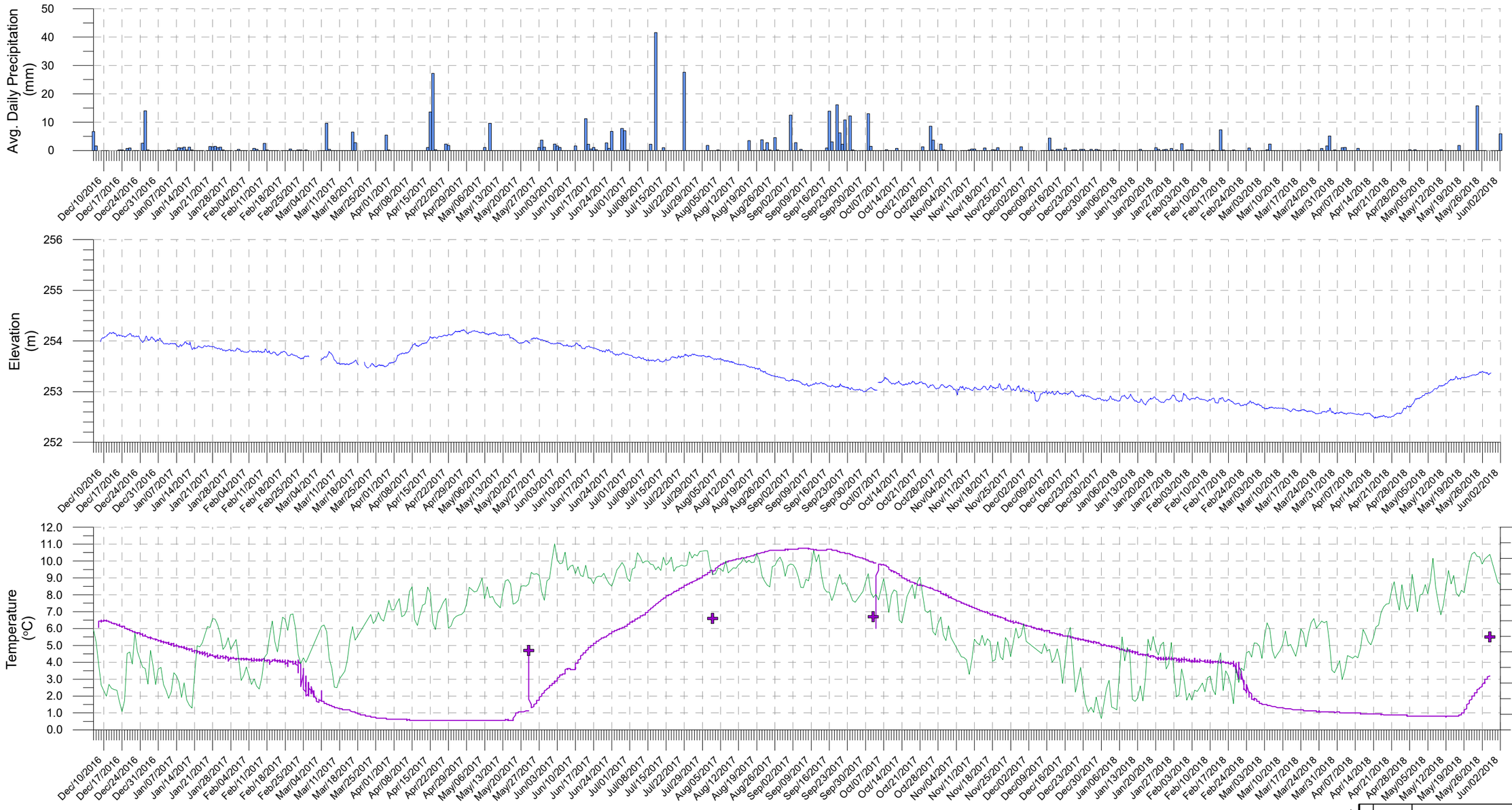
MAY 2017 | PLATE D4-6.2 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

APPENDIX D3-B

CONTINUOUS WATER ELEVATION AND TEMPERATURE DATA



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB (AUT) weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Daily Precipitation - Fisher Branch (AUT)
Groundwater Elevation

Temperature
Water Temperature (Transducer)
Field Measured Water Temperature (YSI)
Air Temperature - Fisher Branch (AUT)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/08/22	ISSUED WITH DELIVERABLE D3	PJL	MFH

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LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL TH-ED-01W

AUGUST 2018 | FIGURE D3-B-1 | REV: 0

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Avg. Daily Precipitation (mm)

Elevation (m)

Temperature (°C)

Avg. Daily Air Temperature (°C)

Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB (AUT) weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.
4. Transducer malfunctioned August 2017.
6. New transducer installed in October 2017.

Daily Precipitation - Fisher Branch (AUT)
GW Elevation

Temperature
Water Temperature (Transducer)
Field Measured Water Temperature (YSI)
Daily Air Temperature - Fisher Branch (AUT)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/08/22	ISSUED WITH DELIVERABLE D3	PJL	MFH

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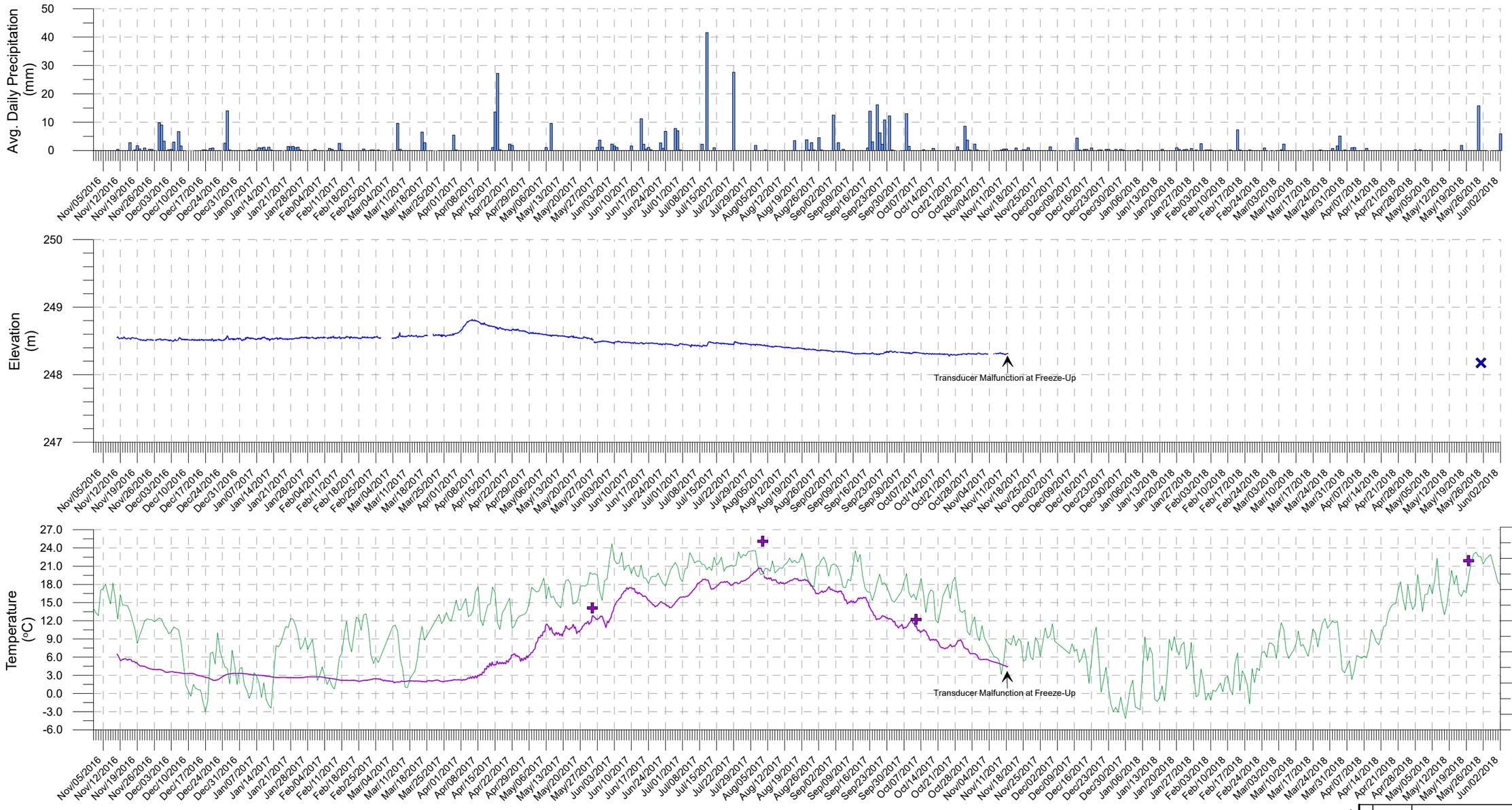
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LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL 15-RD-PW1

AUGUST 2018 | FIGURE D3-B-2 | REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Transducer Data\LMB_Dec 2016 to 2018_TD Data\D\15-RD-PW1_180821_Rev0_PJL.grf



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB (AUT) weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.
4. Transducer malfunctioned after November 11, 2017 likely due to freeze up in lake.
5. New transducer installed May 28, 2018.

Daily Mean Precipitation (mm) - Fisher Branch (AUT)
Surface Water Elevation
Surface Water Elevation

Temperature
Water Temperature (Transducer)
Field Measured Water Temperature (YSI)
Air Temperature (oC) - Fisher Branch (AUT)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/08/22	ISSUED WITH DELIVERABLE D3	PJL	MFH

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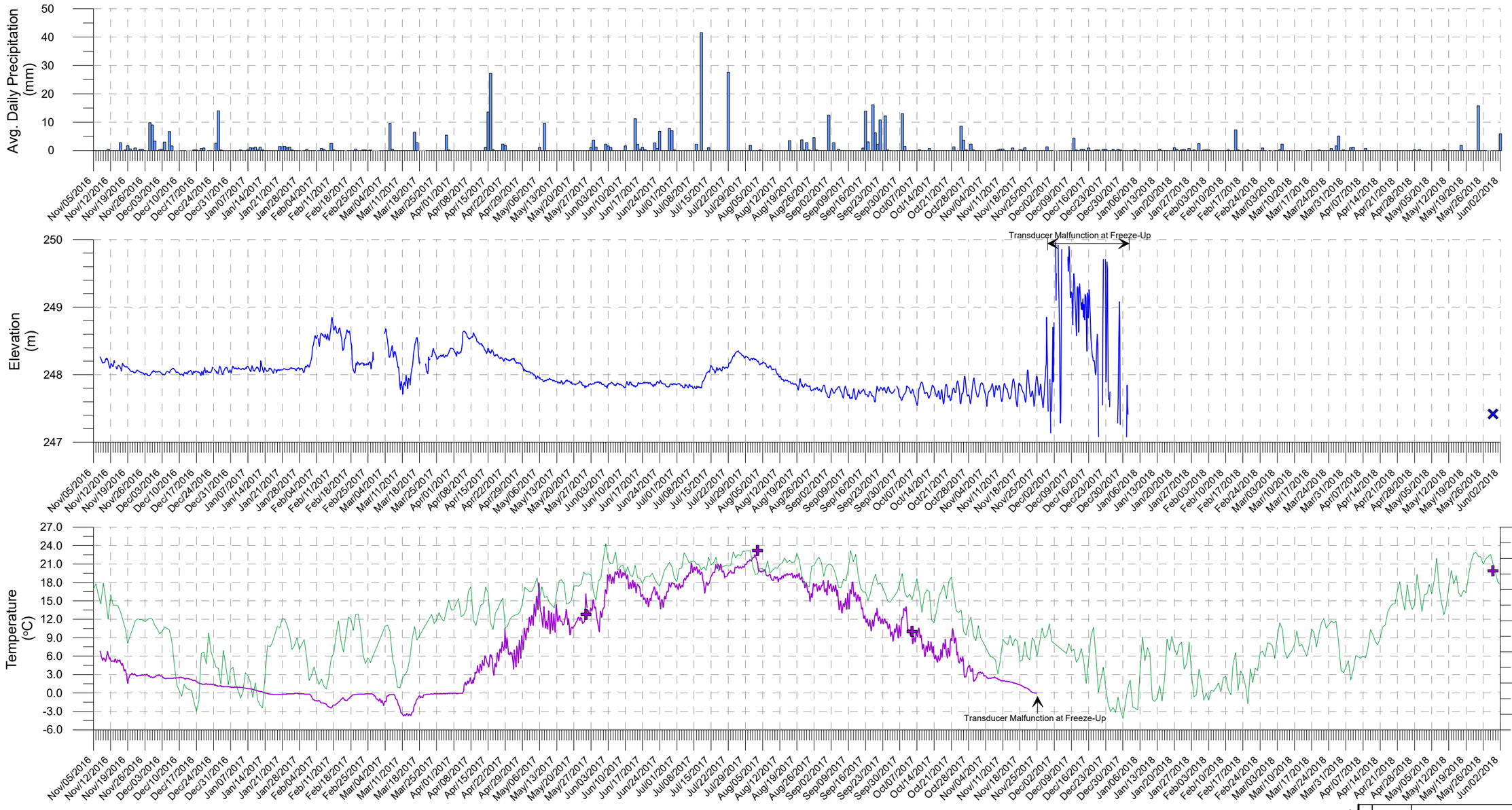
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LAKE MANITOBA CHANNEL D
SURFACE WATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT D3, REED LAKE

AUGUST 2018 | FIGURE D3-B-3 | REV: 0

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Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.
4. Transducer malfunctioned after November 25, 2017 likely due to freeze up in lake.
5. New transducer installed May 30, 2018.

Daily Precipitation - Fisher Branch (AUT)
Surface Water Elevation
Surface Water Elevation

Temperature
Water Temperature (Transducer)
Field Measured Water Temperature (YSI)
Air Temperature - Fisher Branch (AUT)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/08/22	ISSUED WITH DELIVERABLE D3	PJL	MFH

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LAKE MANITOBA CHANNEL D
SURFACE WATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT D4, CLEAR LAKE

AUGUST 2018 | FIGURE D3-B-4 | REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Transducer Data\LMB_Dec 2016 to 2018_TD Data\D\D4 Clear Lake_180821_Rev0_PJL.grf

TABLE D3-B-1
MECHANICAL PACKER AND TRANSDUCER INSTALLATION - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

ID	TOC El. (m)	Ground El. (m)	Packer El. (m)	Date	Transducer Tip El. (m)	Bedrock Open Zone Elevation
TH-ED-01W	250.53	249.49	248.65	Dec 8, 2016	247.89	223.89 m to 217.8 m
15-RD-PW1	252.67	251.76	250.79	Dec 8, 2016	250.06	234.96 m to 228.6 m
				Oct 3, 2017	235.02	
Reed Lake	-	-	-	Nov 7, 2016	247.619 (1)	-
				May 25, 2018	247.57	
Clear Lake	-	-	-	Nov 7, 2016	247.678 (1)	-
	-	-	-	May 25, 2018	247.68	-

Note:
1. Tip Elevation for transducer at Reed Lake and Clear Lake surveyed.

TABLE D3-B-5
MECHANICAL PACKER AND TRANSDUCER INSTALLATION - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

ID	TOC El. (m)	Ground El. (m)	Packer El. (m)	Date	Transducer Tip El. (m)	Bedrock Open Zone Elevation
TH-ED-01W	250.53	249.49	248.65	Dec 8, 2016	247.89	223.89 m to 217.8 m
15-RD-PW1	252.67	251.76	250.79	Dec 8, 2016	250.06	234.96 m to 228.6 m
				Oct 3, 2017	235.02	
Reed Lake	-	-	-	Nov 7, 2016	247.619 (1)	-
				May 25, 2018	247.57	
Clear Lake	-	-	-	Nov 7, 2016	247.678 (1)	-
	-	-	-	May 25, 2018	247.68	-

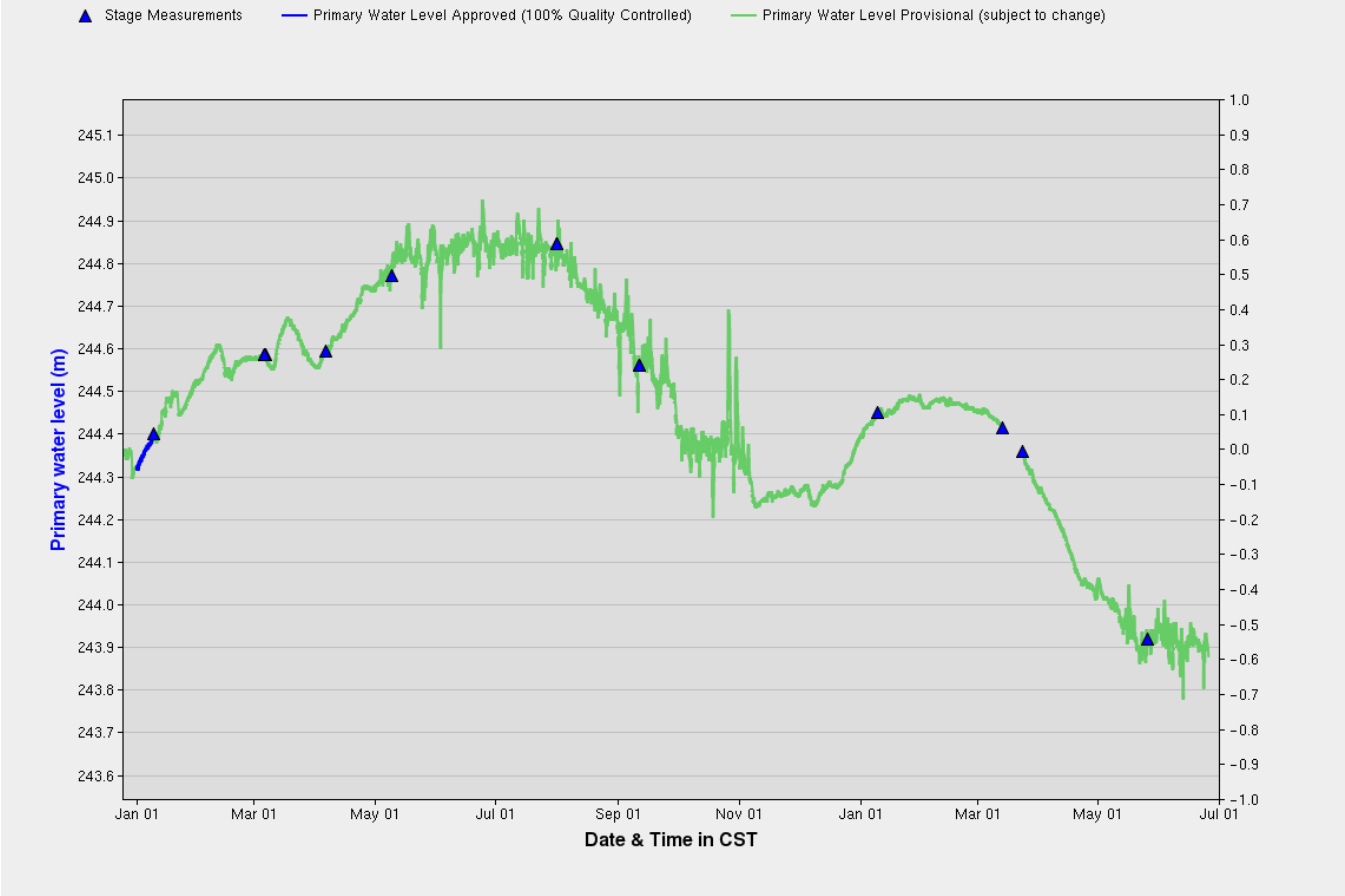
Note:
1. Tip Elevation for transducer at Reed Lake and Clear Lake surveyed.

APPENDIX D3-C

LAKE LEVEL HYDROGRAPHS – ENVIRONMENT CANADA
LAKE MANITOBA (STEEPROCK 05LK002)
LAKE ST. MARTIN (HILBRE05LM005)

Government of Canada Gouvernement du Canada

Real-Time Hydrometric Data Graph for LAKE ST. MARTIN NEAR HILBRE (05LM005) [MB]



Timeliness of the real-time data

Station Information

Active or discontinued:	Active
Province / Territory:	Manitoba
Latitude:	51° 30' 31" N
Longitude:	98° 31' 44" W
Gross drainage area:	82200 km^2
Effective drainage area:	N/A
Record length:	53 Years
Period of record:	1966 - 2018
Regulation type:	Regulated
Regulation length:	N/A

Real-time data available:	Yes
Sediment data available:	No
Type of water body:	Lake
RHBN:	No
EC Regional Office:	WINNIPEG
Data contributed by:	N/A
Datum of published data:	GEODETIC SURVEY OF CANADA DATUM (LOCAL 1964 ADJ.)

Data Collection History

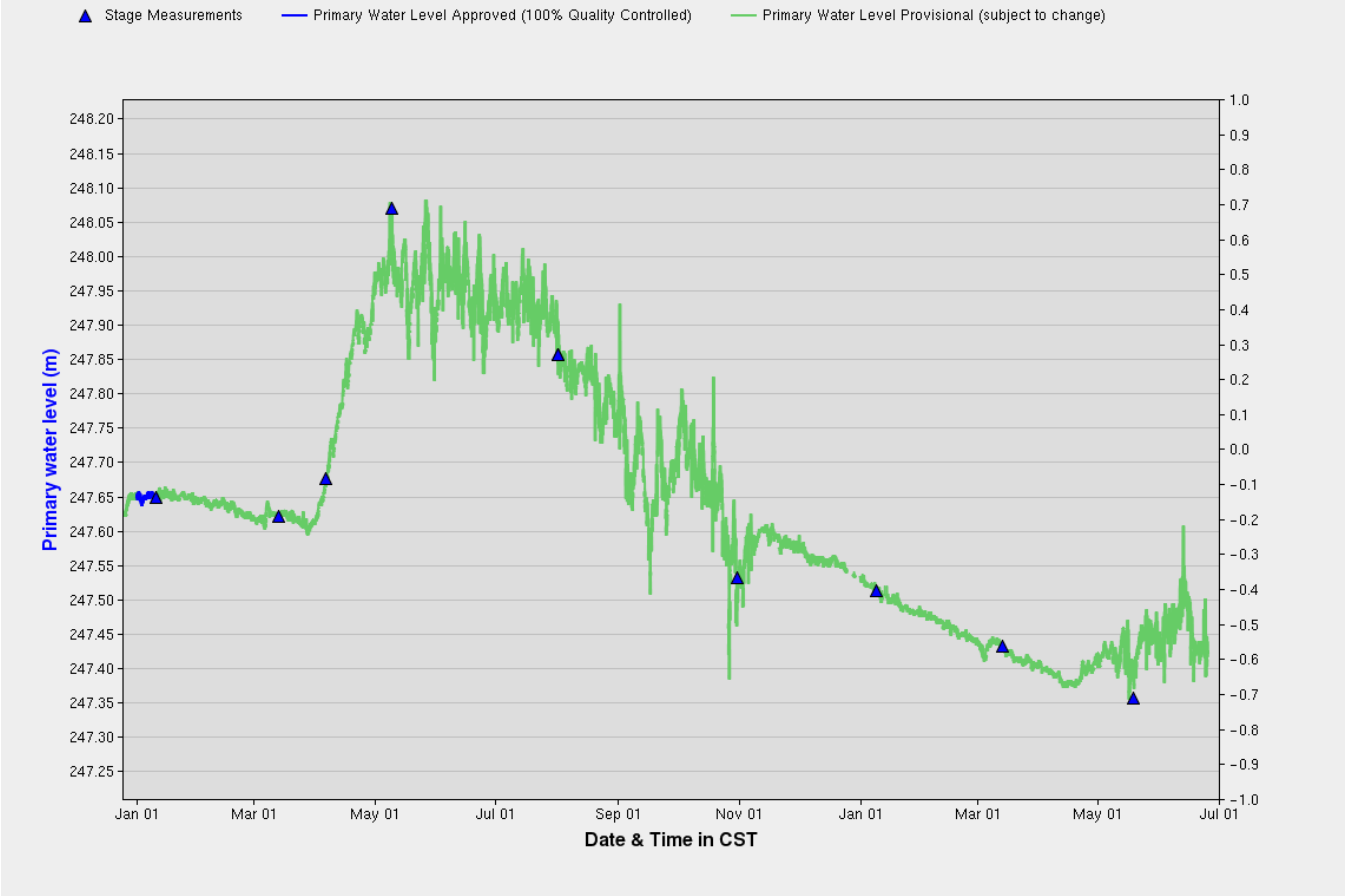
This table contains information pertaining to the historical changes of defined elements in the operation of a station.

Period of operation	Type	Operation schedule	Gauge type
1966 - 1970	Level	Continuous	Manual
1971 - 2018	Level	Continuous	Recorder

Date modified:
2018-03-14

Government of Canada Gouvernement du Canada

Real-Time Hydrometric Data Graph for LAKE MANITOBA AT STEEP ROCK (05LK002) [MB]



Timeliness of the real-time data

Station Information

Active or discontinued:	Active
Province / Territory:	Manitoba
Latitude:	51° 26' 38" N
Longitude:	98° 48' 11" W
Gross drainage area:	79800 km^2
Effective drainage area:	N/A
Record length:	96 Years
Period of record:	1923 - 2018
Regulation type:	Regulated
Regulation length:	N/A

Real-time data available:	Yes
Sediment data available:	No
Type of water body:	Lake
RHBN:	No
EC Regional Office:	WINNIPEG
Data contributed by:	N/A
Datum of published data:	GEODETIC SURVEY OF CANADA DATUM (LOCAL 1964 ADJ.)

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

Period of operation	Type	Operation schedule	Gauge type
1923 - 1960	Level	Continuous	Manual
1961 - 2018	Level	Continuous	Recorder

Date modified:
2018-03-14

APPENDIX D3-D

MAY 2018 FIELD PROGRAM AND REPAIRS NEEDED

KGS Group

Lake Manitoba Sampling

May 28-30, 2018

Please see the following details for the groundwater and surface water monitoring program:

The sampling program for the Lake Manitoba Outlet Channel occurred during the week of May 28, 2018. The call log and contact list was used to notify landowners and note any special access requirements. KGS Group Job Safety Analysis (JSA) sheets were updated for the project, and reviewed daily on-site.

Dan Leitch, Environmental Scientist was the field lead on the project with Luke McAllister, E.I.T. The work completed was as follows:

- Groundwater monitoring at all installations on Route D, except BH-D107 due to lack of access permission.
- Groundwater sampling at 6 wells on Route D, plus one field blank and one duplicate
- Surface water sampling at 9 locations on Route D, plus one field blank and one duplicate
- Download of logger at TH-ED-01W (#B10576), with real-time-readings before and after sampling. As noted last year, replacing the logger cable with a longer cable during the next stage of the project is recommended to get accurate temperature measurements.
- Download of barometric logger now at TH-ED-01-PP1 (#A10260)
- Download of logger at 15-RD-PW1 (#C11866)
- Re-installed foam inserts in all artesian monitoring (without packers) to facilitate transfer for next stage of the project.
- Download of loggers at Reed Lake D3 and Clear Lake D4
    - D3: Aqua troll Logger (owned by KGS Group) did not connect. Instrument was installed there since 2016 when initial MI owned Heron did not connect. Instrument was scheduled to be removed and replaced with MI owned Heron logger (#10580) and a cable. Replacement was done. The removed Aqua troll logger subsequently worked once back in the office however data did not record beyond Nov 11, 2017.
    - D4: Heron logger (#10577) would not connect. The cable and outer protective sleeve appeared to have been chewed through by an animal. The logger and cable removed and replaced with new Heron logger (#10584) (without attached cable). A new Heron cable is required to be installed with an animal proof protective sleeve to allow logger download without removal from the water. KGS Group will send the unit to the manufacturer to try to recover the data.
    - The two Herons that were used as replacements were purchased previously by MI as part of the drilling and instrumentation program.
- Transducer downloads did not occur at Route C. One of the two Route C wells was last downloaded in August 2017, while the other was last downloaded in May 2017.
- Data from the May 2018 field program will be added to the summary project tables in preparation for Deliverable D3, due July 1, 2018.
- Abnormal items/needing repair:

- TH-GD-05 – The metal casing is loose, with a 30 cm crack down one edge. PVC standpipe also moved up 4 mm during sampling. PVC standpipe and metal casing should be secured with bentonite. Very hard to get casing lid past the PVC standpipe.
- 15-RD-05 – PVC standpipe is bent inward 25cm below top, preventing removal of foam insert and sampling. Depending on depth of damage, top of PVC standpipe can be cut and a new stickup installed. Monitoring data was not able to be collected.
- 15-RD-02 – water is leaking from within the casing and pooling at the base. Repair of the casing is required.
- 15-RD-01 – top of PVC standpipe had broken off (reduced top of casing by 4.25 cm). An obstruction at 1.497 m from top of casing made it very difficult to place foam insert back in standpipe), but it was replaced. Repair of the casing would be required.
- BH-D109: Ice on bottom of 35cm of foam insert. The foam was left out for a day in attempt to allow it to thaw but it remained frozen at 2.510m, preventing depth to bottom reading; water above ice at 2.450m.
- Staff gauge boards at both D3 and D4 have shifted (possibly due to ice); should be re-secured and surveyed in.



Figure 1: Logger cable at D4, broken apart, with animal chew marks visible.



Figure 2: TH-GD-05 with a crack in the metal casing visible in the middle of the picture. Water leaked through after the PVC standpipe was opened, but stopped leaking after the PVC standpipe was re-sealed.



Figure 3: 15-RD-05, showing damaged lower standpipe. The foam insert could not be removed further due to damage to standpipe below.



Figure 4: 15-RD-02, showing leaking casing and wet ground around well.



Figure 5: 15-RD-01, showing broken standpipe; obstruction also present at 1.497 m.

APPENDIX D3-E

DRILLING LOGS (2016)
15-RD-04A
15-RD-04B
15-RD-PW-1

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE 2 km north of steep rock junction
LOCATION 5 m south of 15-RD-PW1
DRILLING METHOD Mud Rotary

JOB NO.	12-0300-011
GROUND ELEV.	251.76 m
TOP OF PVC ELEV.	252.62 m
WATER ELEV.	253.75 m
DATE DRILLED	7/30/2015
UTM (m)	N 5,699,450
	E 531,894

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
251	1	5		**SILTY CLAY TILL** - Light brown.
250	2			
249	3	10		
248	4			
247	5	15		
246				
245.7	6	20		**GRANITE BOULDERS**
244.9	7			**TILL** - Light grey/tan.
244		25		
243	8			
242	9	30		

PIEZ. LOG | DEPTH (m) | SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2012\12-0300-011\DESIGN\ENVLOGS\MIT_12-0300-011_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04A**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
241	11	35		
240	12	40		- Dense, with cobbles below 12.50 m.
239	13			
238	14	45		
237.1				
237	15	50		**CLAY TILL** - Medium dense.
236	16			
235.5				
235	17	55		**LIMESTONE** - White with yellow streaks.
234	18	60		- Softer below 18.29 m.
233				
232.6	19			**END OF HOLE AT 19.20 m.**
232	20	65		Notes: 1. Installed 50 mm diameter PVC casing with 0.86 m stickup and protective steel casing. 2. Installed pressure gauge at top of casing. 3. Flowing artesian conditions observed during drilling.
231	21			
230		70		

PIEZ. LOG: 15.5–15.8; 17.7–18.6; 19.2

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04B**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE 2 km north of steep rock junction
LOCATION 100 m south of 15-RD-PW1
DRILLING METHOD Mud Rotary

JOB NO. 12-0300-011
GROUND ELEV. 251.76 m
TOP OF PVC ELEV. 252.60 m
WATER ELEV. 573.78 m
DATE DRILLED 7/31/2015
UTM (m) N 5,699,354
E 531,943

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
251	1	5		TILL - Light brown, dry.						20 40 60	20 40 60 80
250	2										
249	3	10									
248	4										
247	5	15									
246.6				CLAY TILL - Grey/brown.							
246	6	20									
245	7										
244	8	25									
243.5				COBBLES							
243.3	9	30		TILL - Grey/brown.							
242.3				SAND - Fine grained.							
242											

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04B**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
241.7				**SAND/SILT** - Very fined grained sand.
241		35		
240.8	11			**SAND** - Fine to medium grained.
240				
239.9	12			**TILL** - Grey/brown.
239.6		40		**CLAY** - Light grey.
239	13			
238.3				**CLAY TILL** - Medium dense.
238		45		
	14			
237				
	15			
236.5		50		**LIMESTONE** - White.
236				
	16			
235		55		- Fractures at 16.61 m.
	17			
				- Softer below 17.37 m. - Fractures at 17.53 m.
234	18			
233.5		60		- Fractures at 18.14 m.
				END OF DRILLING 18.29 m.
233	19			Notes: 1. Installed 50 mm diameter PVC casing with 0.84 m stickup. 2. Installed pressure gauge at top of casing. 3. Flowing artesian conditions observed during drilling.
232		65		
	20			
231				
	21			
230		70		

PIEZ. LOG: 14.6, 14.9, 16.2, 17.1, 18.3

SAMPLE TYPE | SAMPLE NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-PW1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE 2 km north of steep rock junction
LOCATION 5 m west of 15-RD-04
DRILLING METHOD Mud Rotary

JOB NO. 12-0300-011
GROUND ELEV. 251.76 m
TOP OF PVC ELEV. 252.67 m
WATER ELEV. 253.68 m
DATE DRILLED 7/30/2015
UTM (m) N 5,699,447
E 531,897

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
251	1	5		**SILTY CLAY TILL** - Light brown.		0.3				20 40 60	20 40 60 80
250	2										
249	3	10									
248	4										
247	5	15		- Densed below 4.57 m.							
246	6	20									
245	7										
244	8	25		- Light grey/brown below 7.62 m.							
243	9	30									
242.0 242				**SAND** - Fine to medium grained sand.							

SAMPLE TYPE

CONTRACTOR Maple Leaf Enterprises
INSPECTOR A. SINCLAIR
APPROVED KDT
DATE 1/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. 15-RD-PW1

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
241		35								20 40 60	20 40 60 80
240.8	11			**TILL** - Light grey/brown.							
240	12	40		- Dense below 11.89 m.							
239	13										
238	14	45									
237	15										
236	16	50				15.7 16.0					
235.5				**LIMESTONE** - White, hard.		16.8					
235	17	55									
234	18			- Yellow, soft below 17.98 m. - White below 18.14 m.							
233		60		- Red shale and limestone between 18.44 and 21.34 m.							
232	19										
231	20	65		- Softer limestone at 19.81 m.							
230	21	70									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. 15-RD-PW1

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
229	22	75								20 40 60	20 40 60 80
228.6	23			END OF HOLE AT 23.16 m.		23.2					
228	24	80		Note: 1. Installed 125 mm diameter PVC casing with 0.94 m stickup and protective steel casing. 2. Flowing artesian conditions observed during drilling.							
227	25										
226	26	85									
225	27										
224	28	90									
223	29	95									
222	30										
221	31	100									
220	32	105									
219	33	110									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	A. SINCLAIR	KDT	1/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2012\12-0300-011\DESIGN\ENV\LOGS\MIT_12-0300-011_LOGS.GPJ

APPENDIX D3-F

LABORATORY REPORTS ROUTE D

D3-F-1 MAY 2017

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-1
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	222		mg/L			29-MAY-17
Carbonate (CO3)	6.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		29-MAY-17
pH						
pH	8.50		pH units			26-MAY-17
Turbidity						
*Turbidity	2.50		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0299		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	0.00027		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00159		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0409		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.090		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	43.6		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00053		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.025		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0315		mg/L			29-MAY-17
Magnesium (Mg)-Total	34.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00461		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00186		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	9.26		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00320		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	4.18		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	106		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.234		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00108		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-1
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00164		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00119		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	532		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	82.7		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	250	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.148		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	886		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	141		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	193		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0054		mg/L			01-JUN-17
Phosphorus (P)-Total	0.022		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.87		mg/L			02-JUN-17
Total Nitrogen	0.87		mg/L			02-JUN-17
Total Suspended Solids	3.8		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	74		MPN/100mL	0		26-MAY-17
Escherichia Coli	<1		MPN/100mL	0		26-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-1
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-2
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	332		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		29-MAY-17
pH						
pH	7.82		pH units			26-MAY-17
Turbidity						
*Turbidity	1.20		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0200		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00065		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0246		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.054		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	47.5		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00027		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.037		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0145		mg/L			29-MAY-17
Magnesium (Mg)-Total	51.0		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0446		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00024		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	10.2		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00473		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	2.50		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	11.5		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.117		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00067		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-2
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00069		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00027		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	426		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	129		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	329	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.221		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	561		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.3		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	272		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.037		mg/L			29-MAY-17
Phosphorus (P)-Total	0.046		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.51		mg/L			06-JUN-17
Total Nitrogen	1.51		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		26-MAY-17
Escherichia Coli	20		MPN/100mL	0		26-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-2
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-3
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	292		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.98		pH units			26-MAY-17
Turbidity						
*Turbidity	2.00		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0203		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00054		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0194		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.051		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	37.0		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00023		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.025		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0134		mg/L			29-MAY-17
Magnesium (Mg)-Total	48.3		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0146		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00037		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	8.56		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00399		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	2.78		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	9.88		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.0861		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00073		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-3
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00077		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00030		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	318		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	66.2		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	291	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.109		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	508		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.32		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	239		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17
Phosphorus (P)-Total	0.042		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.54		mg/L			06-JUN-17
Total Nitrogen	1.54		mg/L			06-JUN-17
Total Suspended Solids	3.8		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	236		MPN/100mL	0		26-MAY-17
Escherichia Coli	33		MPN/100mL	0		26-MAY-17

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Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-3
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-4
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	393		mg/L			29-MAY-17
Carbonate (CO3)	8.88		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.45		pH units			26-MAY-17
Turbidity						
*Turbidity	0.90		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0269		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00074		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0263		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.036		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	45.2		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00117		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.021		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0189		mg/L			29-MAY-17
Magnesium (Mg)-Total	74.0		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00546		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00052		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	3.27		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00199		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	2.10		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	13.4		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.141		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00086		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-4
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00423		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00115		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	419		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	74.0		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	418	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.171		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	645		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.83		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17
Phosphorus (P)-Total	0.028		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.15		mg/L			02-JUN-17
Total Nitrogen	1.15		mg/L			02-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	42		MPN/100mL	0		26-MAY-17
Escherichia Coli	2		MPN/100mL	0		26-MAY-17

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-4
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-5
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	448		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.0346		mg/L	10		29-MAY-17
pH						
pH	8.27		pH units			26-MAY-17
Turbidity						
*Turbidity	2.93		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0850		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00079		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0335		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.065		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	63.2		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00057		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.116		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0125		mg/L			29-MAY-17
Magnesium (Mg)-Total	52.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0318		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00027		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	2.26		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00219		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	4.10		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	5.77		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.127		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00358		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-5
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00146		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00083		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	364		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	18.1		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0051		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0295		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	375	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.244		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	585		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.78		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	368		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.021		mg/L			29-MAY-17
Phosphorus (P)-Total	0.030		mg/L			29-MAY-17
Ammonia, Total (as N)	0.050		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.89		mg/L			06-JUN-17
Total Nitrogen	0.92		mg/L			06-JUN-17
Total Suspended Solids	4.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		26-MAY-17
Escherichia Coli	49		MPN/100mL	0		26-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-5
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-6
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	508		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.011		mg/L	10		29-MAY-17
pH						
pH	8.22		pH units			26-MAY-17
Turbidity						
*Turbidity	2.39		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0514		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00083		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0370		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.078		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	74.2		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00034		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.073		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0232		mg/L			29-MAY-17
Magnesium (Mg)-Total	82.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0308		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00043		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	6.66		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00337		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	3.79		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	16.3		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.221		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00247		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

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Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-6
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00262		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00050		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	549		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	110		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.011	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	526	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.246		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	810		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.25		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	416		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0102		mg/L			01-JUN-17
Phosphorus (P)-Total	0.0162		mg/L			01-JUN-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Phosphorus (P)-Total Particulate	0.0060		mg/L			01-JUN-17
Total Kjeldahl Nitrogen	1.34		mg/L			02-JUN-17
Total Nitrogen	1.36		mg/L			02-JUN-17
Total Suspended Solids	2.4		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1730		MPN/100mL	0		26-MAY-17
Escherichia Coli	185		MPN/100mL	0		26-MAY-17

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ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-6
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-7
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	370		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.99		pH units			26-MAY-17
Turbidity						
*Turbidity	0.79		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0208		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00085		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0241		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.017		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	46.7		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00036		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.084		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0115		mg/L			29-MAY-17
Magnesium (Mg)-Total	47.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0407		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	<0.00020		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	4.70		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00162		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	3.95		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	6.06		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.0821		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00067		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-7
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00068		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00038		mg/L			29-MAY-17
Zinc (Zn)-Total	0.0023		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	308		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	20.7		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	311	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.080		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	511		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.80		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	303		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.040		mg/L			29-MAY-17
Phosphorus (P)-Total	0.043		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.29		mg/L			02-JUN-17
Total Nitrogen	1.29		mg/L			02-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1550		MPN/100mL	0		26-MAY-17
Escherichia Coli	68		MPN/100mL	0		26-MAY-17

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Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-7
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-8
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	455		mg/L			29-MAY-17
Carbonate (CO3)	13.4		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.49		pH units			26-MAY-17
Turbidity						
*Turbidity	3.43		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.112		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00093		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0355		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.074		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	70.8		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00065		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.110		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0199		mg/L			29-MAY-17
Magnesium (Mg)-Total	73.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0438		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00043		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	5.33		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00306		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	2.90		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	13.2		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.185		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00477		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-8
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00255		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00096		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	485		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	78.1		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	480	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.243		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	720		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.82		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	396		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0134		mg/L			01-JUN-17
Phosphorus (P)-Total	0.029		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.30		mg/L			06-JUN-17
Total Nitrogen	1.30		mg/L			06-JUN-17
Total Suspended Solids	3.2		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		26-MAY-17
Escherichia Coli	39		MPN/100mL	0		26-MAY-17

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-8
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-9
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	253		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.011		mg/L	10		29-MAY-17
pH						
pH	8.24		pH units			26-MAY-17
Turbidity						
*Turbidity	2.41		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0360		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00132		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0391		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.083		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	48.6		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00048		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.031		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0262		mg/L			29-MAY-17
Magnesium (Mg)-Total	36.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00518		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00156		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	8.57		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00344		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	3.77		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	108		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.229		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00105		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-9
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00143		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00099		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	532		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	64.0		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.011	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	270	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.125		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	864		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	142		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	208		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0096		mg/L			01-JUN-17
Phosphorus (P)-Total	0.027		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.81		mg/L			02-JUN-17
Total Nitrogen	0.82		mg/L			02-JUN-17
Total Suspended Solids	3.6		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	387		MPN/100mL	0		26-MAY-17
Escherichia Coli	1		MPN/100mL	0		26-MAY-17

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Lab Sample ID: L1931744-9
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Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	393		mg/L			29-MAY-17
Carbonate (CO3)	9.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.46		pH units			26-MAY-17
Turbidity						
*Turbidity	0.90		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0148		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	0.00069		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	0.0263		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	0.036		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	44.8		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	0.00053		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	0.014		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	0.0185		mg/L			29-MAY-17
Magnesium (Mg)-Total	71.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00514		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	0.00049		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	3.23		mg/L			29-MAY-17
Rubidium (Rb)-Total	0.00210		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	2.09		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	13.0		mg/L		200	29-MAY-17
Strontium (Sr)-Total	0.136		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	0.00056		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

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PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00411		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	0.00110		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	416		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	73.9		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	405	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.178		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	642		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.81		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	338		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17
Phosphorus (P)-Total	0.027		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.39		mg/L			06-JUN-17
Total Nitrogen	1.39		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	38		MPN/100mL	0		26-MAY-17
Escherichia Coli	1		MPN/100mL	0		26-MAY-17

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Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: FB
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	1.3		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	6.27		pH units			26-MAY-17
Turbidity						
*Turbidity	<0.10		NTU			26-MAY-17
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	29-MAY-17
Antimony (Sb)-Total	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Total	<0.00020		mg/L	0.01		29-MAY-17
Barium (Ba)-Total	<0.00020		mg/L	1		29-MAY-17
Beryllium (Be)-Total	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Total	<0.00020		mg/L			29-MAY-17
Boron (B)-Total	<0.010		mg/L	5		29-MAY-17
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Total	<0.10		mg/L			29-MAY-17
Cesium (Cs)-Total	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Total	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Total	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Total	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Total	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Total	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Total	<0.0020		mg/L			29-MAY-17
Magnesium (Mg)-Total	<0.010		mg/L			29-MAY-17
Manganese (Mn)-Total	<0.00030		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Total	<0.00020		mg/L			29-MAY-17
Nickel (Ni)-Total	<0.0020		mg/L			29-MAY-17
Phosphorus (P)-Total	<0.10		mg/L			29-MAY-17
Potassium (K)-Total	<0.020		mg/L			29-MAY-17
Rubidium (Rb)-Total	<0.00020		mg/L			29-MAY-17
Selenium (Se)-Total	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Total	<0.10		mg/L			29-MAY-17
Silver (Ag)-Total	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Total	<0.030		mg/L		200	29-MAY-17
Strontium (Sr)-Total	<0.00010		mg/L			29-MAY-17
Tellurium (Te)-Total	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Total	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Total	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Total	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Total	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Total	<0.00010		mg/L			29-MAY-17

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Date: 05-JUL-18
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: FB
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals by ICP-MS						
Uranium (U)-Total	<0.00010		mg/L	0.02		29-MAY-17
Vanadium (V)-Total	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Total	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Total	<0.00040		mg/L			29-MAY-17
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	<0.25	HTC	mg/L		500	05-JUL-18
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	1.0		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	1.1		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			01-JUN-17
Phosphorus (P)-Total	<0.0010		mg/L			01-JUN-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Phosphorus (P)-Total Particulate	<0.0028		mg/L			01-JUN-17
Total Kjeldahl Nitrogen	<0.20		mg/L			06-JUN-17
Total Nitrogen	<0.20		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	<1		MPN/100mL	0		26-MAY-17
Escherichia Coli	<1		MPN/100mL	0		26-MAY-17

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Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Judy Dalmaijer
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: STEVE OFFMAN

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3733144								
WG2536090-19 LCS								
Alkalinity, Total (as CaCO3)			103.5		%		85-115	26-MAY-17
WG2536090-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	26-MAY-17
CL-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Chloride (Cl)			99.3		%		90-110	26-MAY-17
WG2535719-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
EC-WP	**Water**							
Batch R3733144								
WG2536090-18 LCS								
Conductivity			99.1		%		90-110	26-MAY-17
WG2536090-16 MB								
Conductivity			<1.0		umhos/cm		1	26-MAY-17
F-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Fluoride (F)			100.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	26-MAY-17
MET-T-L-MS-WP	**Water**							
Batch R3735288								
WG2536780-2 LCS								
Aluminum (Al)-Total			103.2		%		80-120	29-MAY-17
Antimony (Sb)-Total			95.2		%		80-120	29-MAY-17
Arsenic (As)-Total			98.0		%		80-120	29-MAY-17
Barium (Ba)-Total			100.1		%		80-120	29-MAY-17
Beryllium (Be)-Total			100.9		%		80-120	29-MAY-17
Bismuth (Bi)-Total			99.9		%		80-120	29-MAY-17
Boron (B)-Total			102.6		%		80-120	29-MAY-17
Cadmium (Cd)-Total			98.5		%		80-120	29-MAY-17
Calcium (Ca)-Total			98.3		%		80-120	29-MAY-17
Cesium (Cs)-Total			99.7		%		80-120	29-MAY-17
Chromium (Cr)-Total			99.4		%		80-120	29-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3735288								
WG2536780-2 LCS								
Cobalt (Co)-Total			98.4		%		80-120	29-MAY-17
Copper (Cu)-Total			98.1		%		80-120	29-MAY-17
Iron (Fe)-Total			97.1		%		80-120	29-MAY-17
Lead (Pb)-Total			101.1		%		80-120	29-MAY-17
Lithium (Li)-Total			103.6		%		80-120	29-MAY-17
Magnesium (Mg)-Total			103.8		%		80-120	29-MAY-17
Manganese (Mn)-Total			101.8		%		80-120	29-MAY-17
Molybdenum (Mo)-Total			96.8		%		80-120	29-MAY-17
Nickel (Ni)-Total			98.0		%		80-120	29-MAY-17
Phosphorus (P)-Total			99.7		%		80-120	29-MAY-17
Potassium (K)-Total			101.5		%		80-120	29-MAY-17
Rubidium (Rb)-Total			96.2		%		80-120	29-MAY-17
Selenium (Se)-Total			93.0		%		80-120	29-MAY-17
Silicon (Si)-Total			106.8		%		80-120	29-MAY-17
Silver (Ag)-Total			101.4		%		80-120	29-MAY-17
Sodium (Na)-Total			103.8		%		80-120	29-MAY-17
Strontium (Sr)-Total			108.5		%		80-120	29-MAY-17
Tellurium (Te)-Total			91.5		%		80-120	29-MAY-17
Thallium (Tl)-Total			98.7		%		80-120	29-MAY-17
Thorium (Th)-Total			102.4		%		80-120	29-MAY-17
Tin (Sn)-Total			99.7		%		80-120	29-MAY-17
Titanium (Ti)-Total			97.8		%		80-120	29-MAY-17
Tungsten (W)-Total			103.5		%		80-120	29-MAY-17
Uranium (U)-Total			105.5		%		80-120	29-MAY-17
Vanadium (V)-Total			102.5		%		80-120	29-MAY-17
Zinc (Zn)-Total			95.2		%		80-120	29-MAY-17
Zirconium (Zr)-Total			99.2		%		80-120	29-MAY-17
WG2536780-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	29-MAY-17
Antimony (Sb)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Arsenic (As)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Barium (Ba)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Beryllium (Be)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	29-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3735288								
WG2536780-1 MB								
Boron (B)-Total			<0.010		mg/L		0.01	29-MAY-17
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	29-MAY-17
Calcium (Ca)-Total			<0.10		mg/L		0.1	29-MAY-17
Cesium (Cs)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Chromium (Cr)-Total			<0.0010		mg/L		0.001	29-MAY-17
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Copper (Cu)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Iron (Fe)-Total			<0.010		mg/L		0.01	29-MAY-17
Lead (Pb)-Total			<0.000090		mg/L		0.00009	29-MAY-17
Lithium (Li)-Total			<0.0020		mg/L		0.002	29-MAY-17
Magnesium (Mg)-Total			<0.010		mg/L		0.01	29-MAY-17
Manganese (Mn)-Total			<0.00030		mg/L		0.0003	29-MAY-17
Molybdenum (Mo)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Nickel (Ni)-Total			<0.0020		mg/L		0.002	29-MAY-17
Phosphorus (P)-Total			<0.10		mg/L		0.1	29-MAY-17
Potassium (K)-Total			<0.020		mg/L		0.02	29-MAY-17
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Selenium (Se)-Total			<0.0010		mg/L		0.001	29-MAY-17
Silicon (Si)-Total			<0.10		mg/L		0.1	29-MAY-17
Silver (Ag)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Sodium (Na)-Total			<0.030		mg/L		0.03	29-MAY-17
Strontium (Sr)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Thorium (Th)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Tin (Sn)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Titanium (Ti)-Total			<0.00050		mg/L		0.0005	29-MAY-17
Tungsten (W)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Uranium (U)-Total			<0.00010		mg/L		0.0001	29-MAY-17
Vanadium (V)-Total			<0.00020		mg/L		0.0002	29-MAY-17
Zinc (Zn)-Total			<0.0020		mg/L		0.002	29-MAY-17
Zirconium (Zr)-Total			<0.00040		mg/L		0.0004	29-MAY-17
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R3738838								
WG2537915-10 LCS								
Total Kjeldahl Nitrogen			98.0		%		75-125	02-JUN-17
WG2537915-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	02-JUN-17
Batch R3740973								
WG2541328-14 LCS								
Total Kjeldahl Nitrogen			90.7		%		75-125	06-JUN-17
WG2541328-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	06-JUN-17
NH3-COL-WP	**Water**							
Batch R3732779								
WG2535542-6 LCS								
Ammonia, Total (as N)			99.6		%		85-115	26-MAY-17
WG2535542-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	26-MAY-17
NO2-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Nitrite (as N)			99.2		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
NO3-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Nitrate (as N)			100.1		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
P-T-COL-WP	**Water**							
Batch R3733584								
WG2536383-10 LCS								
Phosphorus (P)-Total			98.8		%		80-120	29-MAY-17
WG2536383-6 LCS								
Phosphorus (P)-Total			96.2		%		80-120	29-MAY-17
WG2536383-5 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	29-MAY-17
WG2536383-9 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	29-MAY-17
WG2536383-12		**L1931744-1**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-WP	**Water**							
Batch R3733584								
WG2536383-12 MS		**L1931744-1**						
Phosphorus (P)-Total			91.7		%		70-130	29-MAY-17
P-T-L-COL-WP	**Water**							
Batch R3737171								
WG2539132-2 LCS								
Phosphorus (P)-Total			103.1		%		80-120	01-JUN-17
WG2539132-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	01-JUN-17
P-TD-COL-WP	**Water**							
Batch R3733584								
WG2536381-2 LCS								
Phosphorus (P)-Total	Dissolved		96.0		%		80-120	29-MAY-17
WG2536381-1 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	29-MAY-17
P-TD-L-COL-WP	**Water**							
Batch R3737171								
WG2539130-2 LCS								
Phosphorus (P)-Total	Dissolved		106.5		%		80-120	01-JUN-17
WG2539130-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	01-JUN-17
PH-WP	**Water**							
Batch R3733144								
WG2536090-17 LCS								
pH			7.42		pH units		7.3-7.5	26-MAY-17
SO4-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Sulfate (SO4)			99.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3735321								
WG2536438-2 LCS								
Total Suspended Solids			91.3		%		85-115	29-MAY-17
WG2536438-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3735321								
WG2536438-1 MB								
Total Suspended Solids			<2.0		mg/L		2	29-MAY-17
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R3732730								
WG2535527-1 DUP		**L1931744-1**						
Total Coliforms		74	60		MPN/100mL	20	65	26-MAY-17
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	26-MAY-17
WG2535527-2 MB								
Total Coliforms			<1		MPN/100mL		1	26-MAY-17
Escherichia Coli			<1		MPN/100mL		1	26-MAY-17
TURBIDITY-WP	**Water**							
Batch R3735486								
WG2535465-2 LCS								
Turbidity			100.0		%		85-115	26-MAY-17
WG2535465-1 MB								
Turbidity			<0.10		NTU		0.1	26-MAY-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	25-MAY-17 08:00	26-MAY-17 12:00	0.25	28	hours	EHTR-FM
	2	25-MAY-17 08:30	26-MAY-17 12:00	0.25	28	hours	EHTR-FM
	3	25-MAY-17 09:45	26-MAY-17 12:00	0.25	26	hours	EHTR-FM
	4	25-MAY-17 11:45	26-MAY-17 12:00	0.25	24	hours	EHTR-FM
	5	25-MAY-17 16:15	26-MAY-17 12:00	0.25	20	hours	EHTR-FM
	6	25-MAY-17 15:50	26-MAY-17 12:00	0.25	20	hours	EHTR-FM
	7	25-MAY-17 15:20	26-MAY-17 12:00	0.25	21	hours	EHTR-FM
	8	25-MAY-17 13:55	26-MAY-17 12:00	0.25	22	hours	EHTR-FM
	9	25-MAY-17 14:40	26-MAY-17 12:00	0.25	21	hours	EHTR-FM
	10	25-MAY-17 12:00	26-MAY-17 12:00	0.25	24	hours	EHTR-FM
	11	25-MAY-17 15:20	26-MAY-17 12:00	0.25	21	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1931744 were received on 26-MAY-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

L1931744-COFC

10- 232386

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Hoffman	Select: PDF ✓	Excel ✓ Digital Fax	Priority (2-4 Business Days) - 50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley St. Winnipeg, MB	Email 1:	mfhamm@kgsgroup.com	Emergency (1-2 Business Days) - 100% Surcharge - Contact ALS to confirm TAT
		Email 2:	shoffman@kgsgroup.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	204-896-1209 Fax:			
Invoice To	Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**		**Analysis Request**
	Copy of Invoice with Report? (circle) (Yes) or No	Job #:	16-0300-001	(Indicate Filtered or Preserved, F/P)
Company:		PO / AFE:		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #:	58403	
Lab Work Order # (lab use only)		ALS Contact:	Judy/Craig	Sampler: DL/ES

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROUAW-T-L-WP	F N-TOTKS-WP	F NH3-COL-WP	F P-T-COL-WP	F ETL-N-TOT-ANV-WP	P-TD-COL-WP	SOLIDS-TOTSUS-LR-WP	TC, EC-OT97-ENVPT-WP					Number of Containers
1	D-1	25-MAY-17	08:00	SW	↓	↓	↓	↓	↓	↓	↓	↓					7
2	D-2	↓	08:30	↓													7
3	D-3		09:45														7
4	D-4		11:45														7
5	D-5		16:15														7
6	D-6		15:50														7
7	D-7		15:20														7
8	D-8		13:55														7
9	D-9		14:40														7
10	S-100		12:00														7
11	FB	↓	15:20	↓	↓	↓	↓	↓	↓	↓	↓	↓					7

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

For P-TD lab should filter and preserve

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	25-MAY-17	19:30		MAY 26 2017		°C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY — GENF 18.01 Front

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	400		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.71		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	514		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	142		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	398		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	0.00043		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0136		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.614		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	81.5		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	0.00020		mg/L			29-MAY-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0367		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.2		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.00923		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.00028		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	<0.0010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.65		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00643		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	5.28		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	31.5		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.542		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	<0.00010		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00121		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	768		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.76		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	328		mg/L			26-MAY-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	390		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.71		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	518		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	148		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	390		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	0.00046		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0142		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.652		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	79.5		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	0.00023		mg/L			29-MAY-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0355		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	46.5		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.0137		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.00028		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	<0.0010		mg/L			29-MAY-17

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ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.82		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00633		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	5.43		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	36.0		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.535		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	<0.00010		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00120		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	771		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.12		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	319		mg/L			26-MAY-17

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	336		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.84		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	496		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	156		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	359		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0201		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.692		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	68.0		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0402		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	45.9		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.0120		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.00044		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	<0.0010		mg/L			29-MAY-17

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ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.88		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00683		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	4.62		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	37.5		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.527		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	0.00022		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	<0.00010		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00159		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	744		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	12.9		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	276		mg/L			26-MAY-17

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	407		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.74		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	487		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	384		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0187		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.566		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	75.2		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0350		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.8		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.00768		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.00023		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	<0.0010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	10.2		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00590		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	5.28		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	31.4		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.536		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	<0.00010		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00066		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	739		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.30		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	334		mg/L			26-MAY-17

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Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	414		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.75		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	483		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	115		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	371		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0183		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.550		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	70.9		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	<0.00020		mg/L			29-MAY-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0351		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.2		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.00871		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.00017		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	<0.0010		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	10.0		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00544		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	5.51		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	30.3		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.521		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	<0.00020		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	<0.00010		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00103		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	<0.00020		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	736		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.29		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	339		mg/L			26-MAY-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-03 (LIMITED SAMPLE-WELL DRY)
Sampled By: ES/DL
Date Collected: 25-MAY-17
Lab Sample ID: L1931757-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	399		mg/L			29-MAY-17
Carbonate (CO3)	2.88		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.34		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	372		mg/L		500	05-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	43.2		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	162		mg/L		500	05-JUL-18
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	0.0072		mg/L		0.1	29-MAY-17
Antimony (Sb)-Dissolved	0.00074		mg/L	0.006		29-MAY-17
Arsenic (As)-Dissolved	0.00061		mg/L	0.01		29-MAY-17
Barium (Ba)-Dissolved	0.0223		mg/L	1		29-MAY-17
Beryllium (Be)-Dissolved	<0.00020		mg/L			29-MAY-17
Bismuth (Bi)-Dissolved	<0.00020		mg/L			29-MAY-17
Boron (B)-Dissolved	0.174		mg/L	5		29-MAY-17
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		29-MAY-17
Calcium (Ca)-Dissolved	20.8		mg/L			29-MAY-17
Cesium (Cs)-Dissolved	<0.00010		mg/L			29-MAY-17
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Cobalt (Co)-Dissolved	0.00035		mg/L			29-MAY-17
Copper (Cu)-Dissolved	0.00084		mg/L	2.0	1.0	29-MAY-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	29-MAY-17
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		29-MAY-17
Lithium (Li)-Dissolved	0.0146		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	26.8		mg/L			29-MAY-17
Manganese (Mn)-Dissolved	0.0482		mg/L		0.05	29-MAY-17
Molybdenum (Mo)-Dissolved	0.0315		mg/L			29-MAY-17
Nickel (Ni)-Dissolved	0.0029		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 05-JUL-18
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-03 (LIMITED SAMPLE-WELL DRY)
Sampled By: ES/DL
Date Collected: 25-MAY-17
Lab Sample ID: L1931757-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals by ICP-MS						
Phosphorus (P)-Dissolved	<0.030		mg/L			29-MAY-17
Potassium (K)-Dissolved	2.43		mg/L			29-MAY-17
Rubidium (Rb)-Dissolved	0.00118		mg/L			29-MAY-17
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		29-MAY-17
Silicon (Si)-Dissolved	3.14		mg/L			29-MAY-17
Silver (Ag)-Dissolved	<0.00010		mg/L			29-MAY-17
Sodium (Na)-Dissolved	62.1		mg/L		200	29-MAY-17
Strontium (Sr)-Dissolved	0.105		mg/L			29-MAY-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			29-MAY-17
Thallium (Tl)-Dissolved	<0.00010		mg/L			29-MAY-17
Thorium (Th)-Dissolved	<0.00010		mg/L			29-MAY-17
Tin (Sn)-Dissolved	0.00040		mg/L			29-MAY-17
Titanium (Ti)-Dissolved	<0.00050		mg/L			29-MAY-17
Tungsten (W)-Dissolved	0.00148		mg/L			29-MAY-17
Uranium (U)-Dissolved	0.00490		mg/L	0.02		29-MAY-17
Vanadium (V)-Dissolved	0.00290		mg/L			29-MAY-17
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	29-MAY-17
Zirconium (Zr)-Dissolved	<0.00040		mg/L			29-MAY-17
Conductivity						
Conductivity	514		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.0		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			26-MAY-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Shannon Sawatzky
Account Manager

5-JUL-2018 Revised report - Full metals scan reporting

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3733144								
WG2536090-24 LCS								
Alkalinity, Total (as CaCO3)			103.1		%		85-115	26-MAY-17
WG2536090-21 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	26-MAY-17
CL-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Chloride (Cl)			99.5		%		90-110	26-MAY-17
WG2535719-6 LCS								
Chloride (Cl)			99.3		%		90-110	26-MAY-17
WG2535719-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
WG2535719-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
EC-WP	**Water**							
Batch R3733144								
WG2536090-23 LCS								
Conductivity			99.4		%		90-110	26-MAY-17
WG2536090-21 MB								
Conductivity			<1.0		umhos/cm		1	26-MAY-17
MET-D-L-MS-WP	**Water**							
Batch R3735288								
WG2536740-2 LCS								
Aluminum (Al)-Dissolved			102.5		%		80-120	29-MAY-17
Antimony (Sb)-Dissolved			96.6		%		80-120	29-MAY-17
Arsenic (As)-Dissolved			99.8		%		80-120	29-MAY-17
Barium (Ba)-Dissolved			100.9		%		80-120	29-MAY-17
Beryllium (Be)-Dissolved			104.3		%		80-120	29-MAY-17
Bismuth (Bi)-Dissolved			100.5		%		80-120	29-MAY-17
Boron (B)-Dissolved			104.6		%		80-120	29-MAY-17
Cadmium (Cd)-Dissolved			100.9		%		80-120	29-MAY-17
Calcium (Ca)-Dissolved			100.9		%		80-120	29-MAY-17
Cesium (Cs)-Dissolved			103.1		%		80-120	29-MAY-17
Chromium (Cr)-Dissolved			99.5		%		80-120	29-MAY-17
Cobalt (Co)-Dissolved			99.0		%		80-120	29-MAY-17
Copper (Cu)-Dissolved			97.3		%		80-120	29-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3735288								
WG2536740-2 LCS								
Iron (Fe)-Dissolved			97.3		%		80-120	29-MAY-17
Lead (Pb)-Dissolved			101.3		%		80-120	29-MAY-17
Lithium (Li)-Dissolved			106.7		%		80-120	29-MAY-17
Magnesium (Mg)-Dissolved			101.6		%		80-120	29-MAY-17
Manganese (Mn)-Dissolved			100.3		%		80-120	29-MAY-17
Molybdenum (Mo)-Dissolved			98.8		%		80-120	29-MAY-17
Nickel (Ni)-Dissolved			98.4		%		80-120	29-MAY-17
Phosphorus (P)-Dissolved			100.7		%		80-120	29-MAY-17
Potassium (K)-Dissolved			101.3		%		80-120	29-MAY-17
Rubidium (Rb)-Dissolved			100.4		%		80-120	29-MAY-17
Selenium (Se)-Dissolved			97.0		%		80-120	29-MAY-17
Silicon (Si)-Dissolved			107.7		%		80-120	29-MAY-17
Silver (Ag)-Dissolved			105.1		%		80-120	29-MAY-17
Sodium (Na)-Dissolved			100.9		%		80-120	29-MAY-17
Strontium (Sr)-Dissolved			107.4		%		80-120	29-MAY-17
Tellurium (Te)-Dissolved			100.2		%		80-120	29-MAY-17
Thallium (Tl)-Dissolved			97.8		%		80-120	29-MAY-17
Thorium (Th)-Dissolved			100.0		%		80-120	29-MAY-17
Tin (Sn)-Dissolved			100.6		%		80-120	29-MAY-17
Titanium (Ti)-Dissolved			98.6		%		80-120	29-MAY-17
Tungsten (W)-Dissolved			103.7		%		80-120	29-MAY-17
Uranium (U)-Dissolved			105.9		%		80-120	29-MAY-17
Vanadium (V)-Dissolved			101.1		%		80-120	29-MAY-17
Zinc (Zn)-Dissolved			94.8		%		80-120	29-MAY-17
Zirconium (Zr)-Dissolved			101.1		%		80-120	29-MAY-17
WG2536740-1 MB								
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	29-MAY-17
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Boron (B)-Dissolved			<0.010		mg/L		0.01	29-MAY-17
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	29-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3735288								
WG2536740-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	29-MAY-17
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	29-MAY-17
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	29-MAY-17
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	29-MAY-17
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	29-MAY-17
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	29-MAY-17
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	29-MAY-17
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	29-MAY-17
Potassium (K)-Dissolved			<0.020		mg/L		0.02	29-MAY-17
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	29-MAY-17
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	29-MAY-17
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	29-MAY-17
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	29-MAY-17
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	29-MAY-17
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	29-MAY-17
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	29-MAY-17
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	29-MAY-17
NO2-L-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Nitrite (as N)			100.8		%		90-110	26-MAY-17
WG2535719-6 LCS								
Nitrite (as N)			99.2		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
WG2535719-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
NO3-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Nitrate (as N)			100.4		%		90-110	26-MAY-17
WG2535719-6 LCS								
Nitrate (as N)			100.1		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
WG2535719-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
PH-WP	**Water**							
Batch R3733144								
WG2536090-22 LCS								
pH			7.42		pH units		7.3-7.5	26-MAY-17
SO4-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Sulfate (SO4)			100.6		%		90-110	26-MAY-17
WG2535719-6 LCS								
Sulfate (SO4)			99.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17
WG2535719-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	23-MAY-17 14:45	26-MAY-17 12:00	0.25	69	hours	EHTR-FM
	2	23-MAY-17 15:30	26-MAY-17 12:00	0.25	68	hours	EHTR-FM
	3	23-MAY-17 08:47	26-MAY-17 12:00	0.25	75	hours	EHTR-FM
	4	23-MAY-17 15:25	26-MAY-17 12:00	0.25	69	hours	EHTR-FM
	5	23-MAY-17 16:45	26-MAY-17 12:00	0.25	67	hours	EHTR-FM
	6	25-MAY-17 13:15	26-MAY-17 12:00	0.25	23	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1931757 were received on 26-MAY-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

L1931757-COFC

10- 232384

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Marcel Friedman Hamm	Select: PDF ✓	Excel ✓ Digital ✓ Fax	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley St.	Email 1:	mfhamm@kgsgroup.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Winnipeg MB R3T 5P4	Email 2:	eSalter@kgsgroup.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	204-896-1209 Fax: 204-896-0754			
Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**		**Analysis Request**
	Copy of Invoice with Report? (circle) Yes or No	Job #:	16-0300-006	(Indicate Filtered or Preserved, F/P)
Company:		PO / AFE:		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #:	58403	
Lab Work Order # (lab use only)		**ALS Contact:**	Judy	**Sampler:** ES/DL

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROUW-D-L-SP	Number of Containers
	TH-ED-01W	23-MAY-17	1445	water	X	2
	TH-ED-01P	23-MAY-17	1530		X	
	~~TH-ED-03~~	~~24-MAY-17~~	~~1815~~		~~X~~	
	TH-GD-02		0847		X	
	TH-GD-07		1525		X	
	15-RD-PW1		1645		X	
	TH-ED-03	25 May 17	1315	water	X	1
	↳ limited sample - well dry					

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
ESalter	25 May 17	1730	David I.	26-5-17	8:00 am	2.2 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY — GENF 18.01 Front

D3-F2 AUGUST 2017

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D1
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	213		mg/L			09-AUG-17
Carbonate (CO3)	12.1		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		10-AUG-17
pH						
pH	8.62		pH units			05-AUG-17
Turbidity						
*Turbidity	7.96		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0747		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00033		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00213		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0437		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.100		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	0.0000053		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	43.4		mg/L			09-AUG-17
Cesium (Cs)-Total	0.000012		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00019		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	0.00011		mg/L			09-AUG-17
Copper (Cu)-Total	0.00064		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.083		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	0.000164		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0328		mg/L			09-AUG-17
Magnesium (Mg)-Total	34.2		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0110		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.00187		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00082		mg/L			09-AUG-17
Potassium (K)-Total	9.30		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00371		mg/L			09-AUG-17
Selenium (Se)-Total	0.000100		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	5.44		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	92.8		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.237		mg/L			09-AUG-17
Sulfur (S)-Total	30.1		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00358		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D1
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.00159		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	0.00154		mg/L			09-AUG-17
Zinc (Zn)-Total	0.0049		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000113		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	511		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	80.6		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	249	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.153		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	864		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	134		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	195		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.0069		mg/L			14-AUG-17
Phosphorus (P)-Total	0.027		mg/L			09-AUG-17
Ammonia, Total (as N)	0.021		mg/L			11-AUG-17
Escherichia Coli	6		MPN/100mL	0		04-AUG-17
Total Coliforms	5380		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	1.13		mg/L			10-AUG-17
Total Nitrogen	1.13		mg/L			13-AUG-17
Total Suspended Solids	13.8		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D1
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D2
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	326		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.56		pH units			05-AUG-17
Turbidity						
*Turbidity	1.10		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0057		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00025		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00076		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0325		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.079		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	45.8		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	0.00012		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.070		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0168		mg/L			09-AUG-17
Magnesium (Mg)-Total	48.9		mg/L			09-AUG-17
Manganese (Mn)-Total	0.815		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000079		mg/L			09-AUG-17
Nickel (Ni)-Total	<0.00050		mg/L			09-AUG-17
Potassium (K)-Total	9.43		mg/L			09-AUG-17
Phosphorus (P)-Total	0.063		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00517		mg/L			09-AUG-17
Selenium (Se)-Total	0.000088		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	10.9		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	10.6		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.127		mg/L			09-AUG-17
Sulfur (S)-Total	28.9		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00030		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D2
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.000127		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	<0.000060		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	358		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	76.8		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	316	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.129		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	579		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.75		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	267		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.058		mg/L			09-AUG-17
Phosphorus (P)-Total	0.067		mg/L			09-AUG-17
Ammonia, Total (as N)	0.036		mg/L			11-AUG-17
Escherichia Coli	51		MPN/100mL	0		04-AUG-17
Total Coliforms	2410		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	2.12		mg/L			10-AUG-17
Total Nitrogen	2.12		mg/L			13-AUG-17
Total Suspended Solids	4.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D2
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D3
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	221		mg/L			09-AUG-17
Carbonate (CO3)	19.0		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.84		pH units			05-AUG-17
Turbidity						
*Turbidity	1.50		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00023		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00070		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0130		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.072		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	21.7		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	<0.010		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0154		mg/L			09-AUG-17
Magnesium (Mg)-Total	46.5		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0306		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000194		mg/L			09-AUG-17
Nickel (Ni)-Total	<0.00050		mg/L			09-AUG-17
Potassium (K)-Total	9.45		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00449		mg/L			09-AUG-17
Selenium (Se)-Total	0.000068		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	2.15		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	9.33		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.0453		mg/L			09-AUG-17
Sulfur (S)-Total	24.7		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	<0.00030		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D3
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.000373		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	<0.000060		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	284		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	64.8		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	245	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.128		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	435		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.10		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	213		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.0113		mg/L			14-AUG-17
Phosphorus (P)-Total	0.024		mg/L			09-AUG-17
Ammonia, Total (as N)	0.027		mg/L			11-AUG-17
Escherichia Coli	19		MPN/100mL	0		04-AUG-17
Total Coliforms	3270		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	1.81		mg/L			10-AUG-17
Total Nitrogen	1.81		mg/L			13-AUG-17
Total Suspended Solids	6.8		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D3
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D4
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	349		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.28		pH units			05-AUG-17
Turbidity						
*Turbidity	0.91		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0035		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00028		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00094		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0307		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.085		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	44.3		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00012		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.022		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0193		mg/L			09-AUG-17
Magnesium (Mg)-Total	53.9		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0167		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000378		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00076		mg/L			09-AUG-17
Potassium (K)-Total	6.46		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00437		mg/L			09-AUG-17
Selenium (Se)-Total	0.000183		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	4.41		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	11.1		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.128		mg/L			09-AUG-17
Sulfur (S)-Total	24.8		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	<0.00030		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D4
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.00131		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000844		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	363		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	66.9		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	333	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.215		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	589		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	8.84		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	286		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			09-AUG-17
Phosphorus (P)-Total	0.029		mg/L			09-AUG-17
Ammonia, Total (as N)	0.024		mg/L			11-AUG-17
Escherichia Coli	1		MPN/100mL	0		04-AUG-17
Total Coliforms	472		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	1.77		mg/L			10-AUG-17
Total Nitrogen	1.77		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D4
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D5
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	478		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.94		pH units			05-AUG-17
Turbidity						
*Turbidity	1.02		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0170		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00027		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00139		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0390		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.086		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	0.0000097		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	70.3		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00016		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	0.00015		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.154		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0139		mg/L			09-AUG-17
Magnesium (Mg)-Total	53.1		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0542		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000196		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00086		mg/L			09-AUG-17
Potassium (K)-Total	1.67		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00208		mg/L			09-AUG-17
Selenium (Se)-Total	0.000186		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	11.2		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	4.67		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.147		mg/L			09-AUG-17
Sulfur (S)-Total	2.68		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00082		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D5
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.000702		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000179		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	370		mg/L		500	10-AUG-17
Sulfate in Water by IC						
Sulfate (SO4)	4.62		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	394	HTC	mg/L		500	10-AUG-17
Fluoride in Water by IC						
Fluoride (F)	0.279		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	615		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.62		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	392		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.034		mg/L			09-AUG-17
Phosphorus (P)-Total	0.038		mg/L			09-AUG-17
Ammonia, Total (as N)	0.029		mg/L			11-AUG-17
Escherichia Coli	64		MPN/100mL	0		04-AUG-17
Total Coliforms	4480		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	1.80		mg/L			10-AUG-17
Total Nitrogen	1.80		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D5
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D6
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	419		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.00		pH units			05-AUG-17
Turbidity						
*Turbidity	0.95		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0179		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00026		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00088		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0368		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.119		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	58.9		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00010		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.036		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0251		mg/L			09-AUG-17
Magnesium (Mg)-Total	72.8		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0166		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000181		mg/L			09-AUG-17
Nickel (Ni)-Total	<0.00050		mg/L			09-AUG-17
Potassium (K)-Total	4.67		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00257		mg/L			09-AUG-17
Selenium (Se)-Total	0.000116		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	17.4		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	12.8		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.204		mg/L			09-AUG-17
Sulfur (S)-Total	52.6		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00071		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D6
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.000457		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000071		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	502		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	141		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	447	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.272		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	764		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.87		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	343		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.033		mg/L			09-AUG-17
Phosphorus (P)-Total	0.033		mg/L			09-AUG-17
Ammonia, Total (as N)	0.023		mg/L			11-AUG-17
Escherichia Coli	11		MPN/100mL	0		04-AUG-17
Total Coliforms	2420		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	2.55		mg/L			10-AUG-17
Total Nitrogen	2.55		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D6
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D7
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	441		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.07		pH units			05-AUG-17
Turbidity						
*Turbidity	0.91		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0145		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00024		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00154		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0240		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.012		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	52.0		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00019		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	0.00018		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.053		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0225		mg/L			09-AUG-17
Magnesium (Mg)-Total	65.1		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0297		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000240		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00104		mg/L			09-AUG-17
Potassium (K)-Total	2.49		mg/L			09-AUG-17
Phosphorus (P)-Total	0.062		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00140		mg/L			09-AUG-17
Selenium (Se)-Total	0.000174		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	6.27		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	8.89		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.131		mg/L			09-AUG-17
Sulfur (S)-Total	18.1		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00065		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D7
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.00127		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	0.00058		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000194		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	391		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	45.6		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	398	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.136		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	628		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.45		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	361		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.048		mg/L			09-AUG-17
Phosphorus (P)-Total	0.052		mg/L			09-AUG-17
Ammonia, Total (as N)	0.081		mg/L			11-AUG-17
Escherichia Coli	122		MPN/100mL	0		04-AUG-17
Total Coliforms	2130		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	2.39		mg/L			10-AUG-17
Total Nitrogen	2.39		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D7
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D8
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	429		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.17		pH units			05-AUG-17
Turbidity						
*Turbidity	1.57		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0342		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00027		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00111		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0385		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.121		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	61.5		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00012		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	0.00013		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.069		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0240		mg/L			09-AUG-17
Magnesium (Mg)-Total	71.6		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0142		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000247		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00058		mg/L			09-AUG-17
Potassium (K)-Total	4.41		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00258		mg/L			09-AUG-17
Selenium (Se)-Total	0.000147		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	14.6		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	12.2		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.193		mg/L			09-AUG-17
Sulfur (S)-Total	43.5		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00142		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D8
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.000821		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000134		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	484		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	448	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.269		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	737		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.70		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	352		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.038		mg/L			09-AUG-17
Phosphorus (P)-Total	0.043		mg/L			09-AUG-17
Ammonia, Total (as N)	0.032		mg/L			11-AUG-17
Escherichia Coli	41		MPN/100mL	0		04-AUG-17
Total Coliforms	2420		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	2.19		mg/L			10-AUG-17
Total Nitrogen	2.19		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D8
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D9
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	207		mg/L			09-AUG-17
Carbonate (CO3)	11.3		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		10-AUG-17
pH						
pH	8.61		pH units			05-AUG-17
Turbidity						
*Turbidity	3.60		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0356		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00033		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00187		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0424		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.096		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	0.0000101		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	46.6		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.036		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	0.000091		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0311		mg/L			09-AUG-17
Magnesium (Mg)-Total	31.7		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0106		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.00177		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00069		mg/L			09-AUG-17
Potassium (K)-Total	8.63		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00382		mg/L			09-AUG-17
Selenium (Se)-Total	0.000084		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	5.18		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	101		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.243		mg/L			09-AUG-17
Sulfur (S)-Total	26.1		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	0.00149		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D9
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.00141		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	0.00115		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	<0.000060		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	519		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	69.1		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	247	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.148		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	874		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	148		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	189		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.0057		mg/L			14-AUG-17
Phosphorus (P)-Total	0.020		mg/L			09-AUG-17
Ammonia, Total (as N)	0.030		mg/L			11-AUG-17
Escherichia Coli	29		MPN/100mL	0		04-AUG-17
Total Coliforms	1550		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	2.18		mg/L			10-AUG-17
Total Nitrogen	2.18		mg/L			13-AUG-17
Total Suspended Solids	6.6		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: D9
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: SW100
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	354		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	8.27		pH units			05-AUG-17
Turbidity						
*Turbidity	1.06		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0036		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00027		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	0.00101		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	0.0311		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	0.089		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	42.3		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	0.00011		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	0.019		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	0.0202		mg/L			09-AUG-17
Magnesium (Mg)-Total	56.3		mg/L			09-AUG-17
Manganese (Mn)-Total	0.0171		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	0.000394		mg/L			09-AUG-17
Nickel (Ni)-Total	0.00074		mg/L			09-AUG-17
Potassium (K)-Total	6.64		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	0.00454		mg/L			09-AUG-17
Selenium (Se)-Total	0.000140		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	4.54		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	11.4		mg/L		200	09-AUG-17
Strontium (Sr)-Total	0.130		mg/L			09-AUG-17
Sulfur (S)-Total	25.7		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	<0.00030		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: SW100
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	0.00129		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	0.000125		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	367		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	67.0		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	338	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.215		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	590		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	8.88		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	290		mg/L			05-AUG-17
Phosphorus (P)-Total Dissolved	0.021		mg/L			09-AUG-17
Phosphorus (P)-Total	0.028		mg/L			09-AUG-17
Ammonia, Total (as N)	0.026		mg/L			11-AUG-17
Escherichia Coli	4		MPN/100mL	0		04-AUG-17
Total Coliforms	1410		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	1.89		mg/L			10-AUG-17
Total Nitrogen	1.89		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

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865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: SW100
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: FIELD BLANK
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	4.4		mg/L			11-AUG-17
Carbonate (CO3)	<0.60		mg/L			11-AUG-17
Hydroxide (OH)	<0.34		mg/L			11-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	6.70		pH units			10-AUG-17
Turbidity						
*Turbidity	<0.10		NTU			04-AUG-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	09-AUG-17
Antimony (Sb)-Total	0.00018		mg/L	0.006		09-AUG-17
Arsenic (As)-Total	<0.00010		mg/L	0.01		09-AUG-17
Barium (Ba)-Total	<0.00010		mg/L	1		09-AUG-17
Beryllium (Be)-Total	<0.00010		mg/L			09-AUG-17
Bismuth (Bi)-Total	<0.000050		mg/L			09-AUG-17
Boron (B)-Total	<0.010		mg/L	5		09-AUG-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		09-AUG-17
Calcium (Ca)-Total	0.096		mg/L			09-AUG-17
Cesium (Cs)-Total	<0.000010		mg/L			09-AUG-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		09-AUG-17
Cobalt (Co)-Total	<0.00010		mg/L			09-AUG-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	09-AUG-17
Iron (Fe)-Total	<0.010		mg/L		0.3	09-AUG-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		09-AUG-17
Lithium (Li)-Total	<0.0010		mg/L			09-AUG-17
Magnesium (Mg)-Total	0.0068		mg/L			09-AUG-17
Manganese (Mn)-Total	0.00013		mg/L		0.05	09-AUG-17
Molybdenum (Mo)-Total	<0.000050		mg/L			09-AUG-17
Nickel (Ni)-Total	<0.00050		mg/L			09-AUG-17
Potassium (K)-Total	<0.050		mg/L			09-AUG-17
Phosphorus (P)-Total	<0.050		mg/L			09-AUG-17
Rubidium (Rb)-Total	<0.00020		mg/L			09-AUG-17
Selenium (Se)-Total	<0.000050		mg/L	0.05		09-AUG-17
Silicon (Si)-Total	<0.10		mg/L			09-AUG-17
Silver (Ag)-Total	<0.000010		mg/L			09-AUG-17
Sodium (Na)-Total	<0.050		mg/L		200	09-AUG-17
Strontium (Sr)-Total	<0.00020		mg/L			09-AUG-17
Sulfur (S)-Total	<0.50		mg/L			09-AUG-17
Tellurium (Te)-Total	<0.00020		mg/L			09-AUG-17
Thallium (Tl)-Total	<0.000010		mg/L			09-AUG-17
Thorium (Th)-Total	<0.00010		mg/L			09-AUG-17
Tin (Sn)-Total	<0.00010		mg/L			09-AUG-17
Titanium (Ti)-Total	<0.00030		mg/L			09-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: FIELD BLANK
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			09-AUG-17
Uranium (U)-Total	<0.000010		mg/L	0.02		09-AUG-17
Vanadium (V)-Total	<0.00050		mg/L			09-AUG-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	09-AUG-17
Zirconium (Zr)-Total	<0.000060		mg/L			09-AUG-17
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	0.27	HTC	mg/L		500	06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		04-AUG-17
Conductivity						
Conductivity	1.0		umhos/cm			10-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	3.6		mg/L			10-AUG-17
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			14-AUG-17
Phosphorus (P)-Total	<0.0010		mg/L			14-AUG-17
Ammonia, Total (as N)	<0.010		mg/L			12-AUG-17
Escherichia Coli	<1		MPN/100mL	0		04-AUG-17
Total Coliforms	<1		MPN/100mL	0		04-AUG-17
Total Kjeldahl Nitrogen	<0.20		mg/L			10-AUG-17
Total Nitrogen	<0.20		mg/L			13-AUG-17
Total Suspended Solids	<2.0		mg/L			10-AUG-17

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L1969989
Project Ref: 16-0300-006.1200.06
Sample ID: FIELD BLANK
Sampled By: DL+ATM
Date Collected: 03-AUG-17
Lab Sample ID: L1969989-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Re-issued with complete total metal scan results

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3793923								
WG2587737-10 DUP		**L1969989-1**						
Alkalinity, Total (as CaCO3)		195	194		mg/L	0.7	20	05-AUG-17
WG2587737-4 LCS								
Alkalinity, Total (as CaCO3)			107.4		%		85-115	05-AUG-17
WG2587737-9 LCS								
Alkalinity, Total (as CaCO3)			108.2		%		85-115	05-AUG-17
WG2587737-1 MB								
Alkalinity, Total (as CaCO3)			1.7	B	mg/L		1	05-AUG-17
WG2587737-6 MB								
Alkalinity, Total (as CaCO3)			1.6	B	mg/L		1	05-AUG-17
Batch R3795479								
WG2589854-4 LCS								
Alkalinity, Total (as CaCO3)			104.4		%		85-115	10-AUG-17
WG2589854-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	10-AUG-17
CL-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Chloride (Cl)			98.8		%		90-110	04-AUG-17
WG2585475-6 LCS								
Chloride (Cl)			98.8		%		90-110	04-AUG-17
WG2585475-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	04-AUG-17
WG2585475-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	04-AUG-17
EC-QT97-ENDPT-WP	**Water**							
Batch R3793439								
WG2587842-2 DUP		**L1969989-1**						
Escherichia Coli		6	5		MPN/100mL	19	65	04-AUG-17
WG2587842-1 MB								
Escherichia Coli			<1		MPN/100mL		1	04-AUG-17
EC-WP	**Water**							
Batch R3793923								
WG2587737-10 DUP		**L1969989-1**						
Conductivity		864	860		umhos/cm	0.5	10	05-AUG-17
WG2587737-3 LCS								
Conductivity			100.6		%		90-110	05-AUG-17
WG2587737-8 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WP	**Water**							
Batch R3793923								
WG2587737-8 LCS								
Conductivity			100.1		%		90-110	05-AUG-17
WG2587737-1 MB								
Conductivity			<1.0		umhos/cm		1	05-AUG-17
WG2587737-6 MB								
Conductivity			<1.0		umhos/cm		1	05-AUG-17
Batch R3795479								
WG2589854-3 LCS								
Conductivity			99.8		%		90-110	10-AUG-17
WG2589854-1 MB								
Conductivity			<1.0		umhos/cm		1	10-AUG-17
F-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Fluoride (F)			102.8		%		90-110	04-AUG-17
WG2585475-6 LCS								
Fluoride (F)			99.3		%		90-110	04-AUG-17
WG2585475-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	04-AUG-17
WG2585475-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	04-AUG-17
MET-T-CCMS-WP	**Water**							
Batch R3794465								
WG2588114-2 LCS								
Aluminum (Al)-Total			104.1		%		80-120	09-AUG-17
Antimony (Sb)-Total			104.8		%		80-120	09-AUG-17
Arsenic (As)-Total			106.3		%		80-120	09-AUG-17
Barium (Ba)-Total			103.8		%		80-120	09-AUG-17
Beryllium (Be)-Total			101.5		%		80-120	09-AUG-17
Bismuth (Bi)-Total			102.8		%		80-120	09-AUG-17
Boron (B)-Total			104.6		%		80-120	09-AUG-17
Cadmium (Cd)-Total			101.2		%		80-120	09-AUG-17
Calcium (Ca)-Total			103.6		%		80-120	09-AUG-17
Cesium (Cs)-Total			102.3		%		80-120	09-AUG-17
Chromium (Cr)-Total			102.4		%		80-120	09-AUG-17
Cobalt (Co)-Total			102.8		%		80-120	09-AUG-17
Copper (Cu)-Total			102.5		%		80-120	09-AUG-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R3794465								
WG2588114-2 LCS								
Iron (Fe)-Total			99.3		%		80-120	09-AUG-17
Lead (Pb)-Total			106.1		%		80-120	09-AUG-17
Lithium (Li)-Total			104.9		%		80-120	09-AUG-17
Magnesium (Mg)-Total			103.3		%		80-120	09-AUG-17
Manganese (Mn)-Total			104.8		%		80-120	09-AUG-17
Molybdenum (Mo)-Total			103.9		%		80-120	09-AUG-17
Nickel (Ni)-Total			103.9		%		80-120	09-AUG-17
Potassium (K)-Total			105.2		%		80-120	09-AUG-17
Phosphorus (P)-Total			102.9		%		80-120	09-AUG-17
Rubidium (Rb)-Total			108.4		%		80-120	09-AUG-17
Selenium (Se)-Total			95.1		%		80-120	09-AUG-17
Silicon (Si)-Total			103.2		%		80-120	09-AUG-17
Silver (Ag)-Total			104.3		%		80-120	09-AUG-17
Sodium (Na)-Total			102.3		%		80-120	09-AUG-17
Strontium (Sr)-Total			102.8		%		80-120	09-AUG-17
Sulfur (S)-Total			98.1		%		80-120	09-AUG-17
Tellurium (Te)-Total			96.4		%		80-120	09-AUG-17
Thallium (Tl)-Total			101.3		%		80-120	09-AUG-17
Thorium (Th)-Total			107.6		%		80-120	09-AUG-17
Tin (Sn)-Total			103.5		%		80-120	09-AUG-17
Titanium (Ti)-Total			104.4		%		80-120	09-AUG-17
Tungsten (W)-Total			107.6		%		80-120	09-AUG-17
Uranium (U)-Total			109.0		%		80-120	09-AUG-17
Vanadium (V)-Total			104.3		%		80-120	09-AUG-17
Zinc (Zn)-Total			97.9		%		80-120	09-AUG-17
Zirconium (Zr)-Total			101.2		%		80-120	09-AUG-17
WG2588114-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	09-AUG-17
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Arsenic (As)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Barium (Ba)-Total			<0.000050		mg/L		0.00005	09-AUG-17
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	09-AUG-17
Boron (B)-Total			<0.010		mg/L		0.01	09-AUG-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R3794465								
WG2588114-1 MB								
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	09-AUG-17
Calcium (Ca)-Total			<0.050		mg/L		0.05	09-AUG-17
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	09-AUG-17
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Copper (Cu)-Total			<0.00050		mg/L		0.0005	09-AUG-17
Iron (Fe)-Total			<0.010		mg/L		0.01	09-AUG-17
Lead (Pb)-Total			<0.000050		mg/L		0.00005	09-AUG-17
Lithium (Li)-Total			<0.0010		mg/L		0.001	09-AUG-17
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	09-AUG-17
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	09-AUG-17
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	09-AUG-17
Potassium (K)-Total			<0.050		mg/L		0.05	09-AUG-17
Phosphorus (P)-Total			<0.050		mg/L		0.05	09-AUG-17
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	09-AUG-17
Selenium (Se)-Total			<0.000050		mg/L		0.00005	09-AUG-17
Silicon (Si)-Total			<0.10		mg/L		0.1	09-AUG-17
Silver (Ag)-Total			<0.000010		mg/L		0.00001	09-AUG-17
Sodium (Na)-Total			<0.050		mg/L		0.05	09-AUG-17
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	09-AUG-17
Sulfur (S)-Total			<0.50		mg/L		0.5	09-AUG-17
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	09-AUG-17
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	09-AUG-17
Thorium (Th)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Tin (Sn)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	09-AUG-17
Tungsten (W)-Total			<0.00010		mg/L		0.0001	09-AUG-17
Uranium (U)-Total			<0.000010		mg/L		0.00001	09-AUG-17
Vanadium (V)-Total			<0.00050		mg/L		0.0005	09-AUG-17
Zinc (Zn)-Total			<0.0030		mg/L		0.003	09-AUG-17
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	09-AUG-17
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R3795536								
WG2586292-19 DUP		**L1969989-2**						
Total Kjeldahl Nitrogen		2.12	2.11		mg/L	0.3	20	10-AUG-17
WG2586292-14 LCS								
Total Kjeldahl Nitrogen			102.5		%		75-125	10-AUG-17
WG2586292-18 LCS								
Total Kjeldahl Nitrogen			102.3		%		75-125	10-AUG-17
WG2586292-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	10-AUG-17
WG2586292-17 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	10-AUG-17
WG2586292-20 MS		**L1969989-2**						
Total Kjeldahl Nitrogen			121.5		%		70-130	10-AUG-17
NH3-COL-WP	**Water**							
Batch R3795335								
WG2589631-10 LCS								
Ammonia, Total (as N)			101.2		%		85-115	10-AUG-17
WG2589631-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	10-AUG-17
Batch R3796272								
WG2590343-3 DUP		**L1969989-11**						
Ammonia, Total (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	12-AUG-17
WG2590343-2 LCS								
Ammonia, Total (as N)			98.3		%		85-115	11-AUG-17
WG2590343-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	11-AUG-17
WG2590343-4 MS		**L1969989-11**						
Ammonia, Total (as N)			99.5		%		75-125	11-AUG-17
NO2-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Nitrite (as N)			98.5		%		90-110	04-AUG-17
WG2585475-6 LCS								
Nitrite (as N)			97.8		%		90-110	04-AUG-17
WG2585475-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	04-AUG-17
WG2585475-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	04-AUG-17
NO3-L-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Nitrate (as N)			99.3		%		90-110	04-AUG-17
WG2585475-6 LCS								
Nitrate (as N)			99.3		%		90-110	04-AUG-17
WG2585475-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	04-AUG-17
WG2585475-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	04-AUG-17
P-T-COL-WP	**Water**							
Batch R3793726								
WG2585919-14 LCS								
Phosphorus (P)-Total			96.4		%		80-120	09-AUG-17
WG2585919-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	09-AUG-17
P-T-L-COL-WP	**Water**							
Batch R3799924								
WG2592186-10 LCS								
Phosphorus (P)-Total			99.1		%		80-120	14-AUG-17
WG2592186-9 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	14-AUG-17
P-TD-COL-WP	**Water**							
Batch R3793774								
WG2587348-10 LCS								
Phosphorus (P)-Total	Dissolved		96.4		%		80-120	09-AUG-17
WG2587348-6 LCS								
Phosphorus (P)-Total	Dissolved		95.6		%		80-120	09-AUG-17
WG2587348-5 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	09-AUG-17
WG2587348-9 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	09-AUG-17
P-TD-L-COL-WP	**Water**							
Batch R3799924								
WG2592176-18 LCS								
Phosphorus (P)-Total	Dissolved		97.1		%		80-120	14-AUG-17
WG2592176-17 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	14-AUG-17
PH-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R3793923								
WG2587737-10 DUP		**L1969989-1**						
pH		8.62	8.62	J	pH units	0.00	0.2	05-AUG-17
WG2587737-2 LCS								
pH			7.41		pH units		7.3-7.5	05-AUG-17
WG2587737-7 LCS								
pH			7.41		pH units		7.3-7.5	05-AUG-17
Batch R3795479								
WG2589854-2 LCS								
pH			7.41		pH units		7.3-7.5	10-AUG-17
SO4-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Sulfate (SO4)			99.9		%		90-110	04-AUG-17
WG2585475-6 LCS								
Sulfate (SO4)			99.9		%		90-110	04-AUG-17
WG2585475-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	04-AUG-17
WG2585475-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	04-AUG-17
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3795407								
WG2588769-2 LCS								
Total Suspended Solids			92.0		%		85-115	10-AUG-17
WG2588769-1 MB								
Total Suspended Solids			<2.0		mg/L		2	10-AUG-17
TC-QT97-ENDPT-WP	**Water**							
Batch R3793438								
WG2585778-4 DUP		**L1969989-1**						
Total Coliforms		5380	4350		MPN/100mL	21	65	04-AUG-17
WG2585778-3 MB								
Total Coliforms			<1		MPN/100mL		1	04-AUG-17
TURBIDITY-WP	**Water**							
Batch R3795278								
WG2585635-6 DUP		**L1969989-5**						
Turbidity		1.02	1.05		NTU	2.9	15	04-AUG-17
WG2585635-2 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R3795278								
WG2585635-2 LCS								
Turbidity			101.0		%		85-115	04-AUG-17
WG2585635-5 LCS								
Turbidity			101.0		%		85-115	04-AUG-17
WG2585635-1 MB								
Turbidity			<0.10		NTU		0.1	04-AUG-17
WG2585635-4 MB								
Turbidity			<0.10		NTU		0.1	04-AUG-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	03-AUG-17 14:25	05-AUG-17 12:00	0.25	46	hours	EHTR-FM
	2	03-AUG-17 13:50	05-AUG-17 12:00	0.25	46	hours	EHTR-FM
	3	03-AUG-17 12:45	05-AUG-17 12:00	0.25	47	hours	EHTR-FM
	4	03-AUG-17 11:45	05-AUG-17 12:00	0.25	48	hours	EHTR-FM
	5	03-AUG-17 10:45	05-AUG-17 12:00	0.25	49	hours	EHTR-FM
	6	03-AUG-17 10:25	05-AUG-17 12:00	0.25	50	hours	EHTR-FM
	7	03-AUG-17 10:10	05-AUG-17 12:00	0.25	50	hours	EHTR-FM
	8	03-AUG-17 09:40	05-AUG-17 12:00	0.25	50	hours	EHTR-FM
	9	03-AUG-17 09:00	05-AUG-17 12:00	0.25	51	hours	EHTR-FM
	10	03-AUG-17 11:45	05-AUG-17 12:00	0.25	48	hours	EHTR-FM
	11	03-AUG-17 09:00	10-AUG-17 12:00	0.25	171	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1969989 were received on 04-AUG-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10-224842

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1969989

Page ____ of ____

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓ Other (specify):		✓ Regular (Standard Turn)
Contact:	Marci Friedman Hamm	Select: PDF ✓ Excel ✓ Digital Fax		Priority (2-4 B
Address:	865 Waverley St. Winnipeg, MB	Email 1: MFHamm@KGSGroup.com		Emergency (
		Email 2: DLeitch@KGSGroup.com AMelvin@KGSGroup.com		Same Day or
Phone:	204-896-1209 Fax:			
Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**		
	Copy of Invoice with Report? (circle) Yes or No	Job #:	16-0300-006	
Company:		PO / AFE:		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #:	58403	
Lab Work Order # (lab use only)		**ALS Contact:**	Judy	**Sampler:** DL + ATM

L1969989-COFC

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROU4W-T-L-WP	P N-TOTKJ-WP	P P-T-COL-WP	P NH3-COL-WP	P ETL-N-TOT-AW4-WP	P-TD-COL-WP	SOL IOS-TOTSUS-LR-WP	TC, EC-QT97-ENDF-WP	Number of Containers
	D1	03-Aug-17	14:25	SW	✓	✓	✓	✓	✓	✓	✓	✓	7
	D2		13:50										
	D3		12:45										
	D4		11:45										
	D5		10:45										
	D6		10:25										
	D7		10:10										
	D8		9:40										
	D9		9:00										
	SW 200		11:45										
	Field Blank	✓	9:00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

For P-TD. lab should filter and preserve

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Ariel Mdun	Aug 3	7:59	DRI	4-8-17	8:00	8.6 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY — GENF 18.01 Front

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED03 [AUG 2]
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	270		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	0.0139		mg/L	10		10-AUG-17
pH						
pH	8.23		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	320		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	53.6		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0139		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	134		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	0.0128		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	0.00046		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00066		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0192		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.187		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	0.0000123		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	18.0		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000012		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	0.00049		mg/L			08-AUG-17
Copper (Cu)-Dissolved	0.00097		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0104		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	21.7		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.103		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.0392		mg/L			08-AUG-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED03 [AUG 2]
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00454		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	2.17		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00086		mg/L			08-AUG-17
Selenium (Se)-Dissolved	0.000167		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	4.12		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	74.1		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.0800		mg/L			08-AUG-17
Sulfur (S)-Dissolved	19.6		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	0.00089		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	0.00143		mg/L			08-AUG-17
Tungsten (W)-Dissolved	0.0130		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.00474		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	0.00244		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	0.000129		mg/L			08-AUG-17
Conductivity						
Conductivity	520		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.6		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	221		mg/L			05-AUG-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED03 [AUG 2]
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-07
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	404		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.63		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	482		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	116		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	379		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	0.0015		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00013		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0195		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.481		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	70.8		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000036		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0296		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	49.2		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.0100		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000273		mg/L			08-AUG-17

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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-07
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	10.2		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00594		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	5.03		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	31.7		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.510		mg/L			08-AUG-17
Sulfur (S)-Dissolved	41.4		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.000610		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	747		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.30		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			05-AUG-17

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-07
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: 15-PW-1
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	413		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.65		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	489		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	118		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	383		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00020		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0207		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.486		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	0.0000066		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	69.5		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000047		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	0.00069		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0299		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	51.0		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.00413		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000203		mg/L			08-AUG-17

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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: 15-PW-1
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	10.3		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00579		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	5.12		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	32.1		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.508		mg/L			08-AUG-17
Sulfur (S)-Dissolved	42.7		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.000819		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	0.0012		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	773		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.39		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	338		mg/L			05-AUG-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
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Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: 15-PW-1
Sampled By: DL+AIM
Date Collected: 01-AUG-17
Lab Sample ID: L1970036-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01W
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	392		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.61		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	511		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	143		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	397		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00043		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0139		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.547		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	78.6		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000047		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	0.00016		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0307		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	48.7		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.00908		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000243		mg/L			08-AUG-17

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Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01W
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00070		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	9.77		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00681		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	4.99		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	31.6		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.538		mg/L			08-AUG-17
Sulfur (S)-Dissolved	50.7		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	0.000020		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.00118		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	0.0017		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	783		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.84		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	321		mg/L			05-AUG-17

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Approved by

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Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01W
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01P
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	384		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.62		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	515		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	149		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	392		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00050		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0145		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.559		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	78.0		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000042		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	0.00025		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0301		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	47.8		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.0141		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000262		mg/L			08-AUG-17

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01P
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00075		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	9.64		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00636		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	5.27		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	35.8		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.528		mg/L			08-AUG-17
Sulfur (S)-Dissolved	53.3		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	0.000020		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.00118		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	786		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.18		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	315		mg/L			05-AUG-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-ED-01P
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-02
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	330		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.78		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	494		mg/L		500	09-AUG-17
Sulfate in Water by IC						
Sulfate (SO4)	156		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	362		mg/L		500	09-AUG-17
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	0.0011		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0204		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.606		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	66.9		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000035		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0345		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	47.2		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.0122		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000300		mg/L			08-AUG-17

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Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-02
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	9.85		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00705		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	4.52		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	38.0		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.519		mg/L			08-AUG-17
Sulfur (S)-Dissolved	56.4		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.00153		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	758		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.0		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	271		mg/L			05-AUG-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: TH-GD-02
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: MW100
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	402		mg/L			09-AUG-17
Carbonate (CO3)	<0.60		mg/L			09-AUG-17
Hydroxide (OH)	<0.34		mg/L			09-AUG-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		10-AUG-17
pH						
pH	7.68		pH units			05-AUG-17
TDS calculated						
TDS (Calculated)	480		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	116		mg/L		500	04-AUG-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-AUG-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-AUG-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	379		mg/L		500	06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					08-AUG-17
Aluminum (Al)-Dissolved	0.0013		mg/L		0.1	08-AUG-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		08-AUG-17
Arsenic (As)-Dissolved	0.00013		mg/L	0.01		08-AUG-17
Barium (Ba)-Dissolved	0.0195		mg/L	1		08-AUG-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			08-AUG-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			08-AUG-17
Boron (B)-Dissolved	0.485		mg/L	5		08-AUG-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		08-AUG-17
Calcium (Ca)-Dissolved	71.4		mg/L			08-AUG-17
Cesium (Cs)-Dissolved	0.000034		mg/L			08-AUG-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		08-AUG-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			08-AUG-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	08-AUG-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	08-AUG-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		08-AUG-17
Lithium (Li)-Dissolved	0.0294		mg/L			08-AUG-17
Magnesium (Mg)-Dissolved	48.8		mg/L			08-AUG-17
Manganese (Mn)-Dissolved	0.0101		mg/L		0.05	08-AUG-17
Molybdenum (Mo)-	0.000209		mg/L			08-AUG-17

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Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: MW100
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			08-AUG-17
Phosphorus (P)-Dissolved	<0.050		mg/L			08-AUG-17
Potassium (K)-Dissolved	10.0		mg/L			08-AUG-17
Rubidium (Rb)-Dissolved	0.00606		mg/L			08-AUG-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		08-AUG-17
Silicon (Si)-Dissolved	5.06		mg/L			08-AUG-17
Silver (Ag)-Dissolved	<0.000010		mg/L			08-AUG-17
Sodium (Na)-Dissolved	31.1		mg/L		200	08-AUG-17
Strontium (Sr)-Dissolved	0.512		mg/L			08-AUG-17
Sulfur (S)-Dissolved	41.1		mg/L			08-AUG-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			08-AUG-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			08-AUG-17
Thorium (Th)-Dissolved	<0.00010		mg/L			08-AUG-17
Tin (Sn)-Dissolved	<0.00010		mg/L			08-AUG-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			08-AUG-17
Tungsten (W)-Dissolved	<0.00010		mg/L			08-AUG-17
Uranium (U)-Dissolved	0.000631		mg/L	0.02		08-AUG-17
Vanadium (V)-Dissolved	<0.00050		mg/L			08-AUG-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	08-AUG-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			08-AUG-17
Conductivity						
Conductivity	746		umhos/cm			05-AUG-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.28		mg/L		250	04-AUG-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	330		mg/L			05-AUG-17

CDWQG = Health Canada Guideline Limits updated MAY 2018

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.: LBM
WO No.: L1970036
Project Ref: 16-0300-006.1200.05
Sample ID: MW100
Sampled By: DL+AIM
Date Collected: 02-AUG-17
Lab Sample ID: L1970036-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals results						

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1970036 Report Date: 11-JUL-18

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3793923								
WG2587737-4 LCS								
Alkalinity, Total (as CaCO3)			107.4		%		85-115	05-AUG-17
WG2587737-9 LCS								
Alkalinity, Total (as CaCO3)			108.2		%		85-115	05-AUG-17
WG2587737-1 MB								
Alkalinity, Total (as CaCO3)			1.7	B	mg/L		1	05-AUG-17
WG2587737-6 MB								
Alkalinity, Total (as CaCO3)			1.6	B	mg/L		1	05-AUG-17
CL-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Chloride (Cl)			98.8		%		90-110	04-AUG-17
WG2585475-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	04-AUG-17
EC-WP	**Water**							
Batch R3793923								
WG2587737-3 LCS								
Conductivity			100.6		%		90-110	05-AUG-17
WG2587737-8 LCS								
Conductivity			100.1		%		90-110	05-AUG-17
WG2587737-1 MB								
Conductivity			<1.0		umhos/cm		1	05-AUG-17
WG2587737-6 MB								
Conductivity			<1.0		umhos/cm		1	05-AUG-17
MET-D-CCMS-WP	**Water**							
Batch R3793344								
WG2587171-2 LCS								
Aluminum (Al)-Dissolved			105.0		%		80-120	08-AUG-17
Antimony (Sb)-Dissolved			98.5		%		80-120	08-AUG-17
Arsenic (As)-Dissolved			103.8		%		80-120	08-AUG-17
Barium (Ba)-Dissolved			107.8		%		80-120	08-AUG-17
Beryllium (Be)-Dissolved			97.5		%		80-120	08-AUG-17
Bismuth (Bi)-Dissolved			101.2		%		80-120	08-AUG-17
Boron (B)-Dissolved			97.9		%		80-120	08-AUG-17
Cadmium (Cd)-Dissolved			102.7		%		80-120	08-AUG-17
Calcium (Ca)-Dissolved			99.9		%		80-120	08-AUG-17
Cesium (Cs)-Dissolved			101.6		%		80-120	08-AUG-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R3793344								
WG2587171-2 LCS								
Chromium (Cr)-Dissolved			103.0		%		80-120	08-AUG-17
Cobalt (Co)-Dissolved			102.1		%		80-120	08-AUG-17
Copper (Cu)-Dissolved			101.4		%		80-120	08-AUG-17
Iron (Fe)-Dissolved			97.5		%		80-120	08-AUG-17
Lead (Pb)-Dissolved			100.9		%		80-120	08-AUG-17
Lithium (Li)-Dissolved			95.2		%		80-120	08-AUG-17
Magnesium (Mg)-Dissolved			106.2		%		80-120	08-AUG-17
Manganese (Mn)-Dissolved			104.3		%		80-120	08-AUG-17
Molybdenum (Mo)-Dissolved			103.4		%		80-120	08-AUG-17
Nickel (Ni)-Dissolved			102.8		%		80-120	08-AUG-17
Phosphorus (P)-Dissolved			103.4		%		80-120	08-AUG-17
Potassium (K)-Dissolved			103.9		%		80-120	08-AUG-17
Rubidium (Rb)-Dissolved			104.8		%		80-120	08-AUG-17
Selenium (Se)-Dissolved			97.6		%		80-120	08-AUG-17
Silicon (Si)-Dissolved			101.3		%		80-120	08-AUG-17
Silver (Ag)-Dissolved			103.9		%		80-120	08-AUG-17
Sodium (Na)-Dissolved			100.2		%		80-120	08-AUG-17
Strontium (Sr)-Dissolved			99.6		%		80-120	08-AUG-17
Sulfur (S)-Dissolved			100.5		%		80-120	08-AUG-17
Tellurium (Te)-Dissolved			101.6		%		80-120	08-AUG-17
Thallium (Tl)-Dissolved			101.6		%		80-120	08-AUG-17
Thorium (Th)-Dissolved			101.2		%		80-120	08-AUG-17
Tin (Sn)-Dissolved			103.6		%		80-120	08-AUG-17
Titanium (Ti)-Dissolved			100.3		%		80-120	08-AUG-17
Tungsten (W)-Dissolved			104.2		%		80-120	08-AUG-17
Uranium (U)-Dissolved			104.8		%		80-120	08-AUG-17
Vanadium (V)-Dissolved			103.7		%		80-120	08-AUG-17
Zinc (Zn)-Dissolved			97.5		%		80-120	08-AUG-17
Zirconium (Zr)-Dissolved			100.9		%		80-120	08-AUG-17
WG2587171-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	08-AUG-17
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	08-AUG-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R3793344								
WG2587171-1 MB								
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	08-AUG-17
Boron (B)-Dissolved			<0.010		mg/L		0.01	08-AUG-17
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	08-AUG-17
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	08-AUG-17
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	08-AUG-17
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	08-AUG-17
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	08-AUG-17
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	08-AUG-17
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	08-AUG-17
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	08-AUG-17
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	08-AUG-17
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	08-AUG-17
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	08-AUG-17
Potassium (K)-Dissolved			<0.050		mg/L		0.05	08-AUG-17
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	08-AUG-17
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	08-AUG-17
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	08-AUG-17
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	08-AUG-17
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	08-AUG-17
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	08-AUG-17
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	08-AUG-17
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	08-AUG-17
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	08-AUG-17
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	08-AUG-17
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	08-AUG-17
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	08-AUG-17
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	08-AUG-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R3793344								
WG2587171-1 MB								
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	08-AUG-17
NO2-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Nitrite (as N)			98.5		%		90-110	04-AUG-17
WG2585475-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	04-AUG-17
NO3-L-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Nitrate (as N)			99.3		%		90-110	04-AUG-17
WG2585475-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	04-AUG-17
PH-WP	**Water**							
Batch R3793923								
WG2587737-2 LCS								
pH			7.41		pH units		7.3-7.5	05-AUG-17
WG2587737-7 LCS								
pH			7.41		pH units		7.3-7.5	05-AUG-17
SO4-IC-N-WP	**Water**							
Batch R3794128								
WG2585475-10 LCS								
Sulfate (SO4)			99.9		%		90-110	04-AUG-17
WG2585475-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	04-AUG-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	02-AUG-17 16:00	05-AUG-17 12:00	0.25	68	hours	EHTR-FM
	2	01-AUG-17 12:55	05-AUG-17 12:00	0.25	95	hours	EHTR-FM
	3	01-AUG-17 14:15	05-AUG-17 12:00	0.25	94	hours	EHTR-FM
	4	02-AUG-17 08:55	05-AUG-17 12:00	0.25	75	hours	EHTR-FM
	5	02-AUG-17 09:15	05-AUG-17 12:00	0.25	75	hours	EHTR-FM
	6	02-AUG-17 11:50	05-AUG-17 12:00	0.25	72	hours	EHTR-FM
	7	02-AUG-17 12:00	05-AUG-17 12:00	0.25	72	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1970036 were received on 04-AUG-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10-224845

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

~~L1970036~~ L1970036 Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)	
Company:	KGS Group	Standard: X Other (specify):		X	Regular (Standard Turnaround Times - Business Days)
Contact:	Marci Friedman Hamm	Select: PDF X Excel X Digital X Fax			Priority (2-4 Business Days) - 50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley Street Winnipeg MB R3T 5P4	Email 1: MFHamm@KGSgroup.com			Emergency (1-
		Email 2: Dleitch@KGSgroup.com Amelvin@KGSgroup.com			Same Day or
Phone:	204-896-1209 Fax: 896-0754				
Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)	Client / Project Information			
	Copy of Invoice with Report? (circle) Yes or No	Job #:	16-0300-006		
Company:		PO / AFE:	LBM		
Contact:		LSD:	Lake Manitoba		
Address:					
Phone:	Fax:	Quote #:	Q58403		
Lab Work Order # (lab use only)		ALS Contact:	Jody	Sampler:	DL + AM

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine - Drinking Water									Number of Containers
	TH ED-03	02-Aug-17	16:00	GW	X									2
	TH-GD-07	01-Aug-17	12:55	GW	X									2
	15-PW-1	01-Aug-17	14:15	GW	X									2
	TH ED-01W	02-Aug-17	8:55	GW	X									2
	TH-ED-01P	02-Aug-17	9:15	GW	X									2
	TH-GD-02	02-Aug-17	11:50	GW	X									2
	MW100	02-Aug-17	12:00	GW	X									2
	TH-ED03	01-Aug-17	11:00	GW	Do Not Analyse Hold									

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Times on COC are correct Do not use time on bottles / TH-ED-03 on Aug 3 is to be Held (very silty)

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Ariel Melvin	Aug 3/17	7:59	DRF	4-Aug-17	8:00	8.6 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

D3-F3 OCTOBER 2017

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	301		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	8.07		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	338		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	57.4		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	138		mg/L		500	10-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	0.0043		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	0.00024		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00103		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0179		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.199		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	0.0000058		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	17.9		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	0.00030		mg/L			11-OCT-17
Copper (Cu)-Dissolved	0.00039		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0103		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	22.5		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.0813		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.0271		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved						
Nickel (Ni)-Dissolved	0.00236		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	1.83		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00048		mg/L			11-OCT-17
Selenium (Se)-Dissolved	0.000124		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	4.66		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	72.7		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.0928		mg/L			11-OCT-17
Sulfur (S)-Dissolved	21.0		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	0.00126		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	0.00662		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.00238		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	0.00220		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	0.000109		mg/L			11-OCT-17
Conductivity						
Conductivity	508		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.8		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	247		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	401		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.59		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	481		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	115		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	387		mg/L		500	10-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	0.0019		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00013		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0193		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.548		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	73.1		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000030		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0336		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	49.7		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.00963		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000259		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	10.1		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00604		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	5.07		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	30.3		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.553		mg/L			11-OCT-17
Sulfur (S)-Dissolved	42.9		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	0.00013		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.000593		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	719		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.35		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	329		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: 15-PW-1
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	396		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.53		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	482		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	118		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	388					06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00010		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0195		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.568		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	0.0000061		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	73.1		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000036		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0345		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	50.0		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.00511		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000232		mg/L			11-OCT-17

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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: 15-PW-1
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00180		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	10.1		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00559		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	5.07		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	30.9		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.547		mg/L			11-OCT-17
Sulfur (S)-Dissolved	43.6		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.000764		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	0.0054		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	723		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.44		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	324		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: 15-PW-1
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	386		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.53		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	508		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	143		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	402					06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00039		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0138		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.623		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	79.8		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000043		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	0.00018		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0344		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	49.3		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.00873		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000307		mg/L			11-OCT-17

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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	9.57		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00663		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	5.01		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	31.5		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.580		mg/L			11-OCT-17
Sulfur (S)-Dissolved	52.2		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	0.000021		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.00123		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	754		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.80		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	316		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
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Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	385		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.54		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	517		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	149		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	396		mg/L		500	10-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00044		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0145		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.675		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	78.5		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000041		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	0.00023		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0348		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	48.6		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.0141		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000294		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00066		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	9.52		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00638		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	5.30		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	35.7		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.566		mg/L			11-OCT-17
Sulfur (S)-Dissolved	54.7		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	0.000021		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.00118		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	809		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.21		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	316		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
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- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by
Hua Wo
Account Manager

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	331		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.72		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	494		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	156		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	362		mg/L		500	10-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0204		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.732		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	67.3		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000032		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0406		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	47.0		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.0123		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000324		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	9.92		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00697		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	4.50		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	37.8		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.547		mg/L			11-OCT-17
Sulfur (S)-Dissolved	56.9		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.00157		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	749		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.1		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	272		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: DL/ATM
Date Collected: 04-OCT-17
Lab Sample ID: L2003340-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: MW100
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	405		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.63		pH units			06-OCT-17
TDS calculated						
TDS (Calculated)	485		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	115		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	390					06-JUL-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					11-OCT-17
Aluminum (Al)-Dissolved	0.0021		mg/L		0.1	11-OCT-17
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Dissolved	0.00013		mg/L	0.01		11-OCT-17
Barium (Ba)-Dissolved	0.0203		mg/L	1		11-OCT-17
Beryllium (Be)-Dissolved	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Dissolved	<0.000050		mg/L			11-OCT-17
Boron (B)-Dissolved	0.585		mg/L	5		11-OCT-17
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Dissolved	74.2		mg/L			11-OCT-17
Cesium (Cs)-Dissolved	0.000030		mg/L			11-OCT-17
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Dissolved	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Dissolved	0.0341		mg/L			11-OCT-17
Magnesium (Mg)-Dissolved	49.8		mg/L			11-OCT-17
Manganese (Mn)-Dissolved	0.00939		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-	0.000263		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: MW100
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			11-OCT-17
Phosphorus (P)-Dissolved	<0.050		mg/L			11-OCT-17
Potassium (K)-Dissolved	10.2		mg/L			11-OCT-17
Rubidium (Rb)-Dissolved	0.00605		mg/L			11-OCT-17
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Dissolved	5.11		mg/L			11-OCT-17
Silver (Ag)-Dissolved	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Dissolved	30.8		mg/L		200	11-OCT-17
Strontium (Sr)-Dissolved	0.563		mg/L			11-OCT-17
Sulfur (S)-Dissolved	41.9		mg/L			11-OCT-17
Tellurium (Te)-Dissolved	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Dissolved	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Dissolved	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Dissolved	0.00021		mg/L			11-OCT-17
Titanium (Ti)-Dissolved	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Dissolved	<0.00010		mg/L			11-OCT-17
Uranium (U)-Dissolved	0.000618		mg/L	0.02		11-OCT-17
Vanadium (V)-Dissolved	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Dissolved	0.0018		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Dissolved	<0.000060		mg/L			11-OCT-17
Conductivity						
Conductivity	733		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.31		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			06-OCT-17

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003340
Project Ref: 16-0300-006
Sample ID: MW100
Sampled By: DL/ATM
Date Collected: 03-OCT-17
Lab Sample ID: L2003340-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
11-JUL-2018 AMENDED REPORT - Report re-issued with complete dissolved metals scan results						

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2003340 Report Date: 11-JUL-18

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3851699								
WG2634628-10 DUP		**L2003340-1**						
Alkalinity, Total (as CaCO3)		247	244		mg/L	1.0	20	06-OCT-17
WG2634628-14 LCS								
Alkalinity, Total (as CaCO3)			103.0		%		85-115	06-OCT-17
WG2634628-9 LCS								
Alkalinity, Total (as CaCO3)			101.7		%		85-115	06-OCT-17
WG2634628-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	06-OCT-17
WG2634628-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	06-OCT-17
CL-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-7 DUP		**L2003340-2**						
Chloride (Cl)		5.35	5.34		mg/L	0.2	20	06-OCT-17
WG2633920-2 LCS								
Chloride (Cl)			99.3		%		90-110	06-OCT-17
WG2633920-6 LCS								
Chloride (Cl)			99.6		%		90-110	06-OCT-17
WG2633920-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	06-OCT-17
WG2633920-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	06-OCT-17
WG2633920-8 MS		**L2003340-2**						
Chloride (Cl)			100.1		%		75-125	06-OCT-17
EC-WP	**Water**							
Batch R3851699								
WG2634628-10 DUP		**L2003340-1**						
Conductivity		508	509		umhos/cm	0.2	10	06-OCT-17
WG2634628-13 LCS								
Conductivity			100.1		%		90-110	06-OCT-17
WG2634628-8 LCS								
Conductivity			101.7		%		90-110	06-OCT-17
WG2634628-11 MB								
Conductivity			<1.0		umhos/cm		1	06-OCT-17
WG2634628-6 MB								
Conductivity			<1.0		umhos/cm		1	06-OCT-17
MET-D-CCMS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch	**R3852486**							
WG2636703-2	**LCS**							
Aluminum (Al)-Dissolved			100.5		%		80-120	11-OCT-17
Antimony (Sb)-Dissolved			103.7		%		80-120	11-OCT-17
Arsenic (As)-Dissolved			103.7		%		80-120	11-OCT-17
Barium (Ba)-Dissolved			102.3		%		80-120	11-OCT-17
Beryllium (Be)-Dissolved			104.7		%		80-120	11-OCT-17
Bismuth (Bi)-Dissolved			99.0		%		80-120	11-OCT-17
Boron (B)-Dissolved			111.3		%		80-120	11-OCT-17
Cadmium (Cd)-Dissolved			101.4		%		80-120	11-OCT-17
Calcium (Ca)-Dissolved			103.6		%		80-120	11-OCT-17
Cesium (Cs)-Dissolved			102.5		%		80-120	11-OCT-17
Chromium (Cr)-Dissolved			99.6		%		80-120	11-OCT-17
Cobalt (Co)-Dissolved			100.1		%		80-120	11-OCT-17
Copper (Cu)-Dissolved			99.7		%		80-120	11-OCT-17
Iron (Fe)-Dissolved			98.0		%		80-120	11-OCT-17
Lead (Pb)-Dissolved			100.9		%		80-120	11-OCT-17
Lithium (Li)-Dissolved			106.3		%		80-120	11-OCT-17
Magnesium (Mg)-Dissolved			108.1		%		80-120	11-OCT-17
Manganese (Mn)-Dissolved			101.1		%		80-120	11-OCT-17
Molybdenum (Mo)-Dissolved			103.7		%		80-120	11-OCT-17
Nickel (Ni)-Dissolved			100.3		%		80-120	11-OCT-17
Phosphorus (P)-Dissolved			102.4		%		80-120	11-OCT-17
Potassium (K)-Dissolved			99.8		%		80-120	11-OCT-17
Rubidium (Rb)-Dissolved			98.4		%		80-120	11-OCT-17
Selenium (Se)-Dissolved			99.4		%		80-120	11-OCT-17
Silicon (Si)-Dissolved			100.9		%		80-120	11-OCT-17
Silver (Ag)-Dissolved			102.4		%		80-120	11-OCT-17
Sodium (Na)-Dissolved			101.9		%		80-120	11-OCT-17
Strontium (Sr)-Dissolved			101.5		%		80-120	11-OCT-17
Sulfur (S)-Dissolved			105.5		%		80-120	11-OCT-17
Tellurium (Te)-Dissolved			105.0		%		80-120	11-OCT-17
Thallium (Tl)-Dissolved			98.1		%		80-120	11-OCT-17
Thorium (Th)-Dissolved			100.9		%		80-120	11-OCT-17
Tin (Sn)-Dissolved			102.5		%		80-120	11-OCT-17
Titanium (Ti)-Dissolved			98.4		%		80-120	11-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R3852486								
WG2636703-2 LCS								
Tungsten (W)-Dissolved			101.4		%		80-120	11-OCT-17
Uranium (U)-Dissolved			104.0		%		80-120	11-OCT-17
Vanadium (V)-Dissolved			102.0		%		80-120	11-OCT-17
Zinc (Zn)-Dissolved			96.5		%		80-120	11-OCT-17
Zirconium (Zr)-Dissolved			101.7		%		80-120	11-OCT-17
WG2636703-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	11-OCT-17
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	11-OCT-17
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	11-OCT-17
Boron (B)-Dissolved			<0.010		mg/L		0.01	11-OCT-17
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	11-OCT-17
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	11-OCT-17
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	11-OCT-17
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	11-OCT-17
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	11-OCT-17
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	11-OCT-17
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	11-OCT-17
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	11-OCT-17
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	11-OCT-17
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	11-OCT-17
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	11-OCT-17
Potassium (K)-Dissolved			<0.050		mg/L		0.05	11-OCT-17
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	11-OCT-17
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	11-OCT-17
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	11-OCT-17
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	11-OCT-17
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	11-OCT-17
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R3852486								
WG2636703-1 MB								
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	11-OCT-17
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	11-OCT-17
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	11-OCT-17
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	11-OCT-17
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	11-OCT-17
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	11-OCT-17
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	11-OCT-17
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	11-OCT-17
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	11-OCT-17
NO2-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-7 DUP		**L2003340-2**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-OCT-17
WG2633920-2 LCS								
Nitrite (as N)			99.5		%		90-110	06-OCT-17
WG2633920-6 LCS								
Nitrite (as N)			100.6		%		90-110	06-OCT-17
WG2633920-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	06-OCT-17
WG2633920-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	06-OCT-17
WG2633920-8 MS		**L2003340-2**						
Nitrite (as N)			99.3		%		75-125	06-OCT-17
NO3-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-7 DUP		**L2003340-2**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-OCT-17
WG2633920-2 LCS								
Nitrate (as N)			100.7		%		90-110	06-OCT-17
WG2633920-6 LCS								
Nitrate (as N)			100.2		%		90-110	06-OCT-17
WG2633920-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	06-OCT-17
WG2633920-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	06-OCT-17
WG2633920-8 MS		**L2003340-2**						
Nitrate (as N)			100.5		%		75-125	06-OCT-17
PH-WP	**Water**							
Batch R3851699								
WG2634628-10 DUP		**L2003340-1**						
pH		8.07	8.08	J	pH units	0.01	0.2	06-OCT-17
WG2634628-12 LCS								
pH			7.41		pH units		7.3-7.5	06-OCT-17
WG2634628-7 LCS								
pH			7.41		pH units		7.3-7.5	06-OCT-17
SO4-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-7 DUP		**L2003340-2**						
Sulfate (SO4)		115	115		mg/L	0.0	20	06-OCT-17
WG2633920-2 LCS								
Sulfate (SO4)			99.5		%		90-110	06-OCT-17
WG2633920-6 LCS								
Sulfate (SO4)			100.3		%		90-110	06-OCT-17
WG2633920-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	06-OCT-17
WG2633920-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	06-OCT-17
WG2633920-8 MS		**L2003340-2**						
Sulfate (SO4)			N/A	MS-B	%		-	06-OCT-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	04-OCT-17 16:30	06-OCT-17 12:00	0.25	43	hours	EHTR-FM
	2	03-OCT-17 13:45	06-OCT-17 12:00	0.25	70	hours	EHTR-FM
	3	03-OCT-17 14:30	06-OCT-17 12:00	0.25	70	hours	EHTR-FM
	4	04-OCT-17 14:30	06-OCT-17 12:00	0.25	46	hours	EHTR-FM
	5	04-OCT-17 13:50	06-OCT-17 12:00	0.25	46	hours	EHTR-FM
	6	04-OCT-17 09:15	06-OCT-17 12:00	0.25	51	hours	EHTR-FM
	7	03-OCT-17 13:45	06-OCT-17 12:00	0.25	70	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2003340 were received on 06-OCT-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2003340-COFC

COC Number: 15 - 551101

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Dis...	Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply
Company:	KGS Group	Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Marci Friedman Hamm	Quality Control (QC) Report with Report ☒ YES ☐ NO	PRIORITY (Business Days): 4 day [P4] ☐ / 3 day [P3] ☐ / 2 day [P2] ☐ — EMERGENCY: 1 Business day [E1] ☐ / Same Day, Weekend or Statutory holiday [E0] ☐
Phone:	204-896-1209	☐ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs:
Street:	865 Waverley St	Email 1 or Fax mfhamm@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Winnipeg, MB	Email 2 amelvin@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3 dleitch@kgsgroup.com	
Invoice To	Same as Report To ☒ YES ☐ NO	**Invoice Distribution**	**Analysis Request**
	Copy of Invoice with Report ☒ YES ☐ NO	Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
Company:		Email 1 or Fax Accounts Payable	
Contact:		Email 2 wmacquarrie@kgsgroup.com	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	16-0340-006	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)	L2003340	ALS Contact: Judy	Sampler: DL + ATM

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RMW-D-L-WP	Number of Containers
1	TH-ED-03	04-OCT-17	16:30	GW	X	2
2	TH-GD-07	03-OCT-17	13:45	GW	X	2
3	15-PW-1	03-OCT-17	14:30	GW	X	2
4	TH-ED-01W	04-OCT-17	14:30	GW	X	2
5	TH-ED-01P	04-OCT-17	13:50	GW	X	2
	~~TH-GD-02~~			~~GW~~		
6	~~MW100~~ TH-GD-02	04-OCT-17	9:15	GW	X	2
7	MW100	03-OCT-17	13:45	GW	X	2

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	
Are samples for human drinking water use? ☐ YES ☐ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
8.3					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	Oct 5/17	19:15	DRE	6-10-17	8:00			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	209		mg/L			11-OCT-17
Carbonate (CO3)	5.16		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-OCT-17
pH						
pH	8.48		pH units			06-OCT-17
Turbidity						
*Turbidity	24.7		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0592		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	0.00014		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00195		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0423		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.101		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	42.1		mg/L			11-OCT-17
Cesium (Cs)-Total	0.000012		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00015		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	0.00012		mg/L			11-OCT-17
Copper (Cu)-Total	0.00051		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.081		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000242		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0319		mg/L			11-OCT-17
Magnesium (Mg)-Total	33.8		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0103		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.00216		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00077		mg/L			11-OCT-17
Potassium (K)-Total	8.27		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00346		mg/L			11-OCT-17
Selenium (Se)-Total	0.000076		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	5.87		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	99.4		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.248		mg/L			11-OCT-17
Sulfur (S)-Total	28.9		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00248		mg/L			11-OCT-17

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Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00165		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00174		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000110		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	518		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	77.6		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	245					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.143		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	862		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	149		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	180		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.0067		mg/L			16-OCT-17
Phosphorus (P)-Total	0.040		mg/L			13-OCT-17
Ammonia, Total (as N)	<0.010		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	1.23		mg/L			11-OCT-17
Total Nitrogen	1.23		mg/L			12-OCT-17
Total Suspended Solids	51.0		mg/L			12-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1050		MPN/100mL	0		06-OCT-17
Escherichia Coli	114		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	403		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.83		pH units			06-OCT-17
Turbidity						
*Turbidity	0.93		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0158		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00074		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0406		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.102		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	62.3		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.023		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0329		mg/L			11-OCT-17
Magnesium (Mg)-Total	66.6		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0288		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000946		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00071		mg/L			11-OCT-17
Potassium (K)-Total	7.17		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00386		mg/L			11-OCT-17
Selenium (Se)-Total	0.000087		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	6.99		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	21.1		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.196		mg/L			11-OCT-17
Sulfur (S)-Total	41.9		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00085		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00367		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00054		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000107		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	501		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	112		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	430					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.261		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	766		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	32.8		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	331		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.026		mg/L			13-OCT-17
Phosphorus (P)-Total	0.032		mg/L			13-OCT-17
Ammonia, Total (as N)	0.024		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	1.22		mg/L			11-OCT-17
Total Nitrogen	1.22		mg/L			12-OCT-17
Total Suspended Solids	<2.0		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		06-OCT-17
Escherichia Coli	37		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	282		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	8.14		pH units			06-OCT-17
Turbidity						
*Turbidity	1.01		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00061		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0122		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.070		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	22.4		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00034		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0171		mg/L			11-OCT-17
Magnesium (Mg)-Total	53.1		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0185		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000229		mg/L			11-OCT-17
Nickel (Ni)-Total	<0.00050		mg/L			11-OCT-17
Potassium (K)-Total	9.50		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00437		mg/L			11-OCT-17
Selenium (Se)-Total	0.000080		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	4.42		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	10.4		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.0506		mg/L			11-OCT-17
Sulfur (S)-Total	25.2		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	<0.00030		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.000405		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	<0.000060		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	305		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	66.8		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	275					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.142		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	448		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.52		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	231		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.0109		mg/L			16-OCT-17
Phosphorus (P)-Total	0.023		mg/L			13-OCT-17
Ammonia, Total (as N)	0.023		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	1.54		mg/L			11-OCT-17
Total Nitrogen	1.54		mg/L			12-OCT-17
Total Suspended Solids	<2.0		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	613		MPN/100mL	0		06-OCT-17
Escherichia Coli	23		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	406		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.88		pH units			06-OCT-17
Turbidity						
*Turbidity	60.4		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.103		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00100		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0323		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.086		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	42.1		mg/L			11-OCT-17
Cesium (Cs)-Total	0.000018		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00032		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	0.00013		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.097		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000165		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0234		mg/L			11-OCT-17
Magnesium (Mg)-Total	60.3		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0256		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000581		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00073		mg/L			11-OCT-17
Potassium (K)-Total	7.05		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00394		mg/L			11-OCT-17
Selenium (Se)-Total	0.000134		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	2.91		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	13.0		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.129		mg/L			11-OCT-17
Sulfur (S)-Total	31.7		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	0.00011		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00500		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00232		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00069		mg/L			11-OCT-17
Zinc (Zn)-Total	0.0032		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000152		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	407		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	73.5		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	353	HTC	mg/L		500	10-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.240		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	653		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	11.6		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.021		mg/L			13-OCT-17
Phosphorus (P)-Total	0.052		mg/L			13-OCT-17
Ammonia, Total (as N)	0.092		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	2.17		mg/L			11-OCT-17
Total Nitrogen	2.17		mg/L			12-OCT-17
Total Suspended Solids	120		mg/L			12-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		06-OCT-17
Escherichia Coli	260		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	471		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	8.06		pH units			06-OCT-17
Turbidity						
*Turbidity	9.02		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0669		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00145		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0502		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.137		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	65.1		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00020		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	0.00014		mg/L			11-OCT-17
Copper (Cu)-Total	0.00066		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.117		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000105		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0169		mg/L			11-OCT-17
Magnesium (Mg)-Total	54.2		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0501		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000881		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00123		mg/L			11-OCT-17
Potassium (K)-Total	5.02		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00228		mg/L			11-OCT-17
Selenium (Se)-Total	0.000160		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	3.79		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	7.16		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.186		mg/L			11-OCT-17
Sulfur (S)-Total	31.8		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00222		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00250		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00099		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000249		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	439		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	72.9		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	386					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.357		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	691		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.66		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	386		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.034		mg/L			13-OCT-17
Phosphorus (P)-Total	0.076		mg/L			13-OCT-17
Ammonia, Total (as N)	0.049		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	1.62		mg/L			11-OCT-17
Total Nitrogen	1.62		mg/L			12-OCT-17
Total Suspended Solids	10.4		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		06-OCT-17
Escherichia Coli	18		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	476		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-OCT-17
pH						
pH	8.06		pH units			06-OCT-17
Turbidity						
*Turbidity	3.70		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0259		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00095		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0275		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.093		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	45.6		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00037		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.047		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0290		mg/L			11-OCT-17
Magnesium (Mg)-Total	74.1		mg/L			11-OCT-17
Manganese (Mn)-Total	0.00705		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000295		mg/L			11-OCT-17
Nickel (Ni)-Total	<0.00050		mg/L			11-OCT-17
Potassium (K)-Total	7.14		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00294		mg/L			11-OCT-17
Selenium (Se)-Total	0.000118		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	14.2		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	15.6		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.176		mg/L			11-OCT-17
Sulfur (S)-Total	71.7		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00143		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00107		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00058		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000117		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	544		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	157		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	419					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.239		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	817		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	10.1		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	390		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.026		mg/L			13-OCT-17
Phosphorus (P)-Total	0.030		mg/L			13-OCT-17
Ammonia, Total (as N)	0.018		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	1.93		mg/L			11-OCT-17
Total Nitrogen	1.93		mg/L			12-OCT-17
Total Suspended Solids	3.8		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1050		MPN/100mL	0		06-OCT-17
Escherichia Coli	27		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	518		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.025		mg/L	10		11-OCT-17
pH						
pH	7.75		pH units			06-OCT-17
Turbidity						
*Turbidity	20.3		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.109		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00140		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0931		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.037		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	0.0000064		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	131		mg/L			11-OCT-17
Cesium (Cs)-Total	0.000019		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00058		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	0.00034		mg/L			11-OCT-17
Copper (Cu)-Total	0.00164		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.201		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000182		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0555		mg/L			11-OCT-17
Magnesium (Mg)-Total	176		mg/L			11-OCT-17
Manganese (Mn)-Total	0.756		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.00429		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00156		mg/L			11-OCT-17
Potassium (K)-Total	9.76		mg/L			11-OCT-17
Phosphorus (P)-Total	0.155		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00367		mg/L			11-OCT-17
Selenium (Se)-Total	0.000143		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	10.1		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	23.9		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.346		mg/L			11-OCT-17
Sulfur (S)-Total	302		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00628		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.0444		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00141		mg/L			11-OCT-17
Zinc (Zn)-Total	0.0082		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000241		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	1330		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	724		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0060		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.025	DLM	mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	1050					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.24		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	1430		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	8.31		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	425		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.046		mg/L			13-OCT-17
Phosphorus (P)-Total	0.192		mg/L			13-OCT-17
Ammonia, Total (as N)	0.028		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	2.03		mg/L			11-OCT-17
Total Nitrogen	2.03		mg/L			12-OCT-17
Total Suspended Solids	76.6		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	231		MPN/100mL	0		06-OCT-17
Escherichia Coli	<1		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	466		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-OCT-17
pH						
pH	8.20		pH units			06-OCT-17
Turbidity						
*Turbidity	7.50		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0522		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00103		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0290		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.099		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	48.0		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00017		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	0.00011		mg/L			11-OCT-17
Copper (Cu)-Total	0.00052		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.085		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000058		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0290		mg/L			11-OCT-17
Magnesium (Mg)-Total	75.1		mg/L			11-OCT-17
Manganese (Mn)-Total	0.00749		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000381		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00052		mg/L			11-OCT-17
Potassium (K)-Total	6.89		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00300		mg/L			11-OCT-17
Selenium (Se)-Total	0.000131		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	13.0		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	15.9		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.183		mg/L			11-OCT-17
Sulfur (S)-Total	71.1		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00333		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00157		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00086		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000216		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	548		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	162		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	429					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.244		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	814		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	10.3		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	382		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.029		mg/L			13-OCT-17
Phosphorus (P)-Total	0.039		mg/L			13-OCT-17
Ammonia, Total (as N)	0.025		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	2.14		mg/L			11-OCT-17
Total Nitrogen	2.14		mg/L			12-OCT-17
Total Suspended Solids	6.4		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		06-OCT-17
Escherichia Coli	249		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	215		mg/L			11-OCT-17
Carbonate (CO3)	7.44		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-OCT-17
pH						
pH	8.50		pH units			06-OCT-17
Turbidity						
*Turbidity	4.40		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0092		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	0.00013		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00167		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0335		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.099		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	34.1		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.011		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000068		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0268		mg/L			11-OCT-17
Magnesium (Mg)-Total	26.9		mg/L			11-OCT-17
Manganese (Mn)-Total	0.00378		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.00193		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00051		mg/L			11-OCT-17
Potassium (K)-Total	6.31		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00273		mg/L			11-OCT-17
Selenium (Se)-Total	0.000079		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	6.19		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	86.8		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.198		mg/L			11-OCT-17
Sulfur (S)-Total	30.1		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	<0.00030		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00131		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00125		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	<0.000060		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	488		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	69.4		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	196	HTC	mg/L		500	10-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.139		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	845		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	151		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	189		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.0052		mg/L			16-OCT-17
Phosphorus (P)-Total	0.024		mg/L			13-OCT-17
Ammonia, Total (as N)	0.017		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	0.98		mg/L			11-OCT-17
Total Nitrogen	0.98		mg/L			12-OCT-17
Total Suspended Solids	8.2		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	74		MPN/100mL	0		06-OCT-17
Escherichia Coli	20		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: SW100
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	409		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	7.91		pH units			06-OCT-17
Turbidity						
*Turbidity	32.0		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0336		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	0.00102		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	0.0304		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	0.089		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	38.6		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	0.00018		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	0.030		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	0.000060		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	0.0235		mg/L			11-OCT-17
Magnesium (Mg)-Total	59.0		mg/L			11-OCT-17
Manganese (Mn)-Total	0.0178		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	0.000578		mg/L			11-OCT-17
Nickel (Ni)-Total	0.00050		mg/L			11-OCT-17
Potassium (K)-Total	6.98		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	0.00363		mg/L			11-OCT-17
Selenium (Se)-Total	0.000113		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	2.77		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	12.7		mg/L		200	11-OCT-17
Strontium (Sr)-Total	0.131		mg/L			11-OCT-17
Sulfur (S)-Total	32.4		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	0.00120		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: SW100
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	0.00231		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	0.00052		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	0.000113		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	403		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	73.4		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	339					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	0.240		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	647		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	11.5		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	335		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	0.0163		mg/L			16-OCT-17
Phosphorus (P)-Total	0.062		mg/L			13-OCT-17
Ammonia, Total (as N)	0.107		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	2.19		mg/L			11-OCT-17
Total Nitrogen	2.19		mg/L			12-OCT-17
Total Suspended Solids	63.0		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		06-OCT-17
Escherichia Coli	281		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: SW100
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	<1.2		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	6.24		pH units			06-OCT-17
Turbidity						
*Turbidity	<0.10		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	11-OCT-17
Aluminum (Al)-Total	<0.0030		mg/L		0.1	17-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		17-OCT-17
Arsenic (As)-Total	<0.00010		mg/L	0.01		17-OCT-17
Arsenic (As)-Total	<0.00010		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	<0.00010		mg/L	1		11-OCT-17
Barium (Ba)-Total	<0.00010		mg/L	1		17-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			17-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			17-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	<0.010		mg/L	5		11-OCT-17
Boron (B)-Total	<0.010		mg/L	5		17-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		17-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	0.069		mg/L			11-OCT-17
Calcium (Ca)-Total	<0.050		mg/L			17-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			17-OCT-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		11-OCT-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		17-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			17-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	17-OCT-17
Iron (Fe)-Total	<0.010		mg/L		0.3	11-OCT-17
Iron (Fe)-Total	<0.010		mg/L		0.3	17-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		17-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	<0.0010		mg/L			17-OCT-17
Lithium (Li)-Total	<0.0010		mg/L			11-OCT-17
Magnesium (Mg)-Total	0.0065		mg/L			11-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Magnesium (Mg)-Total	<0.0050		mg/L			17-OCT-17
Manganese (Mn)-Total	<0.00010		mg/L		0.05	11-OCT-17
Manganese (Mn)-Total	<0.00010		mg/L		0.05	17-OCT-17
Molybdenum (Mo)-Total	<0.000050		mg/L			17-OCT-17
Molybdenum (Mo)-Total	<0.000050		mg/L			11-OCT-17
Nickel (Ni)-Total	<0.00050		mg/L			17-OCT-17
Nickel (Ni)-Total	<0.00050		mg/L			11-OCT-17
Potassium (K)-Total	<0.050		mg/L			11-OCT-17
Potassium (K)-Total	<0.050		mg/L			17-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			17-OCT-17
Rubidium (Rb)-Total	<0.00020		mg/L			11-OCT-17
Rubidium (Rb)-Total	<0.00020		mg/L			17-OCT-17
Selenium (Se)-Total	<0.000050		mg/L	0.05		17-OCT-17
Selenium (Se)-Total	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	<0.10		mg/L			11-OCT-17
Silicon (Si)-Total	<0.10		mg/L			17-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			17-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	<0.050		mg/L		200	11-OCT-17
Sodium (Na)-Total	<0.050		mg/L		200	17-OCT-17
Strontium (Sr)-Total	<0.00020		mg/L			17-OCT-17
Strontium (Sr)-Total	<0.00020		mg/L			11-OCT-17
Sulfur (S)-Total	<0.50		mg/L			11-OCT-17
Sulfur (S)-Total	<0.50		mg/L			17-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			17-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			17-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			17-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			17-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	<0.00030		mg/L			17-OCT-17
Titanium (Ti)-Total	<0.00030		mg/L			11-OCT-17
Tungsten (W)-Total	<0.00010		mg/L			17-OCT-17
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	<0.000010		mg/L	0.02		17-OCT-17
Uranium (U)-Total	<0.000010		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	<0.00050		mg/L			17-OCT-17
Vanadium (V)-Total	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	17-OCT-17
Zirconium (Zr)-Total	<0.000060		mg/L			17-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Zirconium (Zr)-Total	<0.000060		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	06-JUL-18
TDS (Calculated)	<5.0		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	<0.20					18-OCT-17
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	1.1		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	<1.0		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			16-OCT-17
Phosphorus (P)-Total	<0.0010		mg/L			16-OCT-17
Ammonia, Total (as N)	<0.010		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	<0.20		mg/L			11-OCT-17
Total Nitrogen	<0.20		mg/L			12-OCT-17
Total Suspended Solids	<2.0		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	<1		MPN/100mL	0		06-OCT-17
Escherichia Coli	<1		MPN/100mL	0		06-OCT-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 11-JUL-18
PO No.:
WO No.: L2003343
Project Ref: 16-0300-006
Sample ID: TRIP BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-12
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	<1.2		mg/L			11-OCT-17
Carbonate (CO3)	<0.60		mg/L			11-OCT-17
Hydroxide (OH)	<0.34		mg/L			11-OCT-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		11-OCT-17
pH						
pH	5.93		pH units			06-OCT-17
Turbidity						
*Turbidity	<0.10		NTU			06-OCT-17
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	11-OCT-17
Antimony (Sb)-Total	<0.00010		mg/L	0.006		11-OCT-17
Arsenic (As)-Total	<0.00010		mg/L	0.01		11-OCT-17
Barium (Ba)-Total	<0.00010		mg/L	1		11-OCT-17
Beryllium (Be)-Total	<0.00010		mg/L			11-OCT-17
Bismuth (Bi)-Total	<0.000050		mg/L			11-OCT-17
Boron (B)-Total	<0.010		mg/L	5		11-OCT-17
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		11-OCT-17
Calcium (Ca)-Total	<0.050		mg/L			11-OCT-17
Cesium (Cs)-Total	<0.000010		mg/L			11-OCT-17
Chromium (Cr)-Total	<0.00010		mg/L	0.05		11-OCT-17
Cobalt (Co)-Total	<0.00010		mg/L			11-OCT-17
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	11-OCT-17
Iron (Fe)-Total	<0.010		mg/L		0.3	11-OCT-17
Lead (Pb)-Total	<0.000050		mg/L	0.01		11-OCT-17
Lithium (Li)-Total	<0.0010		mg/L			11-OCT-17
Magnesium (Mg)-Total	0.0091		mg/L			11-OCT-17
Manganese (Mn)-Total	0.00012		mg/L		0.05	11-OCT-17
Molybdenum (Mo)-Total	<0.000050		mg/L			11-OCT-17
Nickel (Ni)-Total	<0.00050		mg/L			11-OCT-17
Potassium (K)-Total	<0.050		mg/L			11-OCT-17
Phosphorus (P)-Total	<0.050		mg/L			11-OCT-17
Rubidium (Rb)-Total	<0.00020		mg/L			11-OCT-17
Selenium (Se)-Total	<0.000050		mg/L	0.05		11-OCT-17
Silicon (Si)-Total	<0.10		mg/L			11-OCT-17
Silver (Ag)-Total	<0.000010		mg/L			11-OCT-17
Sodium (Na)-Total	<0.050		mg/L		200	11-OCT-17
Strontium (Sr)-Total	<0.00020		mg/L			11-OCT-17
Sulfur (S)-Total	<0.50		mg/L			11-OCT-17
Tellurium (Te)-Total	<0.00020		mg/L			11-OCT-17
Thallium (Tl)-Total	<0.000010		mg/L			11-OCT-17
Thorium (Th)-Total	<0.00010		mg/L			11-OCT-17
Tin (Sn)-Total	<0.00010		mg/L			11-OCT-17
Titanium (Ti)-Total	<0.00030		mg/L			11-OCT-17

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Project Ref: 16-0300-006
Sample ID: TRIP BLANK
Sampled By: DL/ATM
Date Collected: 05-OCT-17
Lab Sample ID: L2003343-12
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			11-OCT-17
Uranium (U)-Total	<0.000010		mg/L	0.02		11-OCT-17
Vanadium (V)-Total	<0.00050		mg/L			11-OCT-17
Zinc (Zn)-Total	<0.0030		mg/L		5.0	11-OCT-17
Zirconium (Zr)-Total	<0.000060		mg/L			11-OCT-17
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	06-JUL-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	06-OCT-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		06-OCT-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		06-OCT-17
Hardness Calculated						
Hardness (as CaCO3)	<0.20					06-JUL-18
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		06-OCT-17
Conductivity						
Conductivity	<1.0		umhos/cm			06-OCT-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	06-OCT-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	<1.0		mg/L			06-OCT-17
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			16-OCT-17
Phosphorus (P)-Total	<0.0010		mg/L			16-OCT-17
Ammonia, Total (as N)	<0.010		mg/L			12-OCT-17
Total Kjeldahl Nitrogen	<0.20		mg/L			11-OCT-17
Total Nitrogen	<0.20		mg/L			12-OCT-17
Total Suspended Solids	<2.0		mg/L			11-OCT-17
Total and E. coli to endpoint by QT97						
Total Coliforms	<1		MPN/100mL	0		06-OCT-17
Escherichia Coli	<1		MPN/100mL	0		06-OCT-17

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Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
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* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

11-JUL-2018 AMENDED REPORT - Report re-issued with complete total metal scan results

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2003343 Report Date: 11-JUL-18

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3851699								
WG2634628-14 LCS								
Alkalinity, Total (as CaCO3)			103.0		%		85-115	06-OCT-17
WG2634628-19 LCS								
Alkalinity, Total (as CaCO3)			104.8		%		85-115	06-OCT-17
WG2634628-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	06-OCT-17
WG2634628-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	06-OCT-17
CL-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-6 LCS								
Chloride (Cl)			99.6		%		90-110	06-OCT-17
WG2633920-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	06-OCT-17
EC-WP	**Water**							
Batch R3851699								
WG2634628-13 LCS								
Conductivity			100.1		%		90-110	06-OCT-17
WG2634628-18 LCS								
Conductivity			95.7		%		90-110	06-OCT-17
WG2634628-11 MB								
Conductivity			<1.0		umhos/cm		1	06-OCT-17
WG2634628-16 MB								
Conductivity			<1.0		umhos/cm		1	06-OCT-17
F-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-6 LCS								
Fluoride (F)			101.2		%		90-110	06-OCT-17
WG2633920-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	06-OCT-17
MET-T-CCMS-WP	**Water**							
Batch R3852486								
WG2636319-2 LCS								
Aluminum (Al)-Total			104.7		%		80-120	11-OCT-17
Antimony (Sb)-Total			101.0		%		80-120	11-OCT-17
Arsenic (As)-Total			100.9		%		80-120	11-OCT-17
Barium (Ba)-Total			103.3		%		80-120	11-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R3852486								
WG2636319-2 LCS								
Beryllium (Be)-Total			108.9		%		80-120	11-OCT-17
Bismuth (Bi)-Total			99.0		%		80-120	11-OCT-17
Boron (B)-Total			109.3		%		80-120	11-OCT-17
Cadmium (Cd)-Total			100.1		%		80-120	11-OCT-17
Calcium (Ca)-Total			98.7		%		80-120	11-OCT-17
Cesium (Cs)-Total			102.4		%		80-120	11-OCT-17
Chromium (Cr)-Total			99.9		%		80-120	11-OCT-17
Cobalt (Co)-Total			100.4		%		80-120	11-OCT-17
Copper (Cu)-Total			97.9		%		80-120	11-OCT-17
Iron (Fe)-Total			97.5		%		80-120	11-OCT-17
Lead (Pb)-Total			101.0		%		80-120	11-OCT-17
Lithium (Li)-Total			106.6		%		80-120	11-OCT-17
Magnesium (Mg)-Total			107.0		%		80-120	11-OCT-17
Manganese (Mn)-Total			101.8		%		80-120	11-OCT-17
Molybdenum (Mo)-Total			102.5		%		80-120	11-OCT-17
Nickel (Ni)-Total			98.7		%		80-120	11-OCT-17
Potassium (K)-Total			100.5		%		80-120	11-OCT-17
Phosphorus (P)-Total			101.8		%		80-120	11-OCT-17
Rubidium (Rb)-Total			100.5		%		80-120	11-OCT-17
Selenium (Se)-Total			96.9		%		80-120	11-OCT-17
Silicon (Si)-Total			106.1		%		80-120	11-OCT-17
Silver (Ag)-Total			102.0		%		80-120	11-OCT-17
Sodium (Na)-Total			99.8		%		80-120	11-OCT-17
Strontium (Sr)-Total			103.0		%		80-120	11-OCT-17
Sulfur (S)-Total			105.0		%		80-120	11-OCT-17
Tellurium (Te)-Total			99.98		%		80-120	11-OCT-17
Thallium (Tl)-Total			99.3		%		80-120	11-OCT-17
Thorium (Th)-Total			103.5		%		80-120	11-OCT-17
Tin (Sn)-Total			103.4		%		80-120	11-OCT-17
Titanium (Ti)-Total			99.0		%		80-120	11-OCT-17
Tungsten (W)-Total			110.5		%		80-120	11-OCT-17
Uranium (U)-Total			104.6		%		80-120	11-OCT-17
Vanadium (V)-Total			103.0		%		80-120	11-OCT-17
Zinc (Zn)-Total			97.4		%		80-120	11-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R3852486								
WG2636319-2 LCS								
Zirconium (Zr)-Total			100.2		%		80-120	11-OCT-17
WG2636319-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	11-OCT-17
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Arsenic (As)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Barium (Ba)-Total			<0.000050		mg/L		0.00005	11-OCT-17
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	11-OCT-17
Boron (B)-Total			<0.010		mg/L		0.01	11-OCT-17
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	11-OCT-17
Calcium (Ca)-Total			<0.050		mg/L		0.05	11-OCT-17
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	11-OCT-17
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Copper (Cu)-Total			<0.00050		mg/L		0.0005	11-OCT-17
Iron (Fe)-Total			<0.010		mg/L		0.01	11-OCT-17
Lead (Pb)-Total			<0.000050		mg/L		0.00005	11-OCT-17
Lithium (Li)-Total			<0.0010		mg/L		0.001	11-OCT-17
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	11-OCT-17
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	11-OCT-17
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	11-OCT-17
Potassium (K)-Total			<0.050		mg/L		0.05	11-OCT-17
Phosphorus (P)-Total			<0.050		mg/L		0.05	11-OCT-17
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	11-OCT-17
Selenium (Se)-Total			<0.000050		mg/L		0.00005	11-OCT-17
Silicon (Si)-Total			<0.10		mg/L		0.1	11-OCT-17
Silver (Ag)-Total			<0.000010		mg/L		0.00001	11-OCT-17
Sodium (Na)-Total			<0.050		mg/L		0.05	11-OCT-17
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	11-OCT-17
Sulfur (S)-Total			<0.50		mg/L		0.5	11-OCT-17
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	11-OCT-17
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	11-OCT-17
Thorium (Th)-Total			<0.00010		mg/L		0.0001	11-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R3852486								
WG2636319-1 MB								
Tin (Sn)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	11-OCT-17
Tungsten (W)-Total			<0.00010		mg/L		0.0001	11-OCT-17
Uranium (U)-Total			<0.000010		mg/L		0.00001	11-OCT-17
Vanadium (V)-Total			<0.00050		mg/L		0.0005	11-OCT-17
Zinc (Zn)-Total			<0.0030		mg/L		0.003	11-OCT-17
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	11-OCT-17
N-TOTKJ-WP	**Water**							
Batch R3852506								
WG2635425-19 DUP		**L2003343-4**						
Total Kjeldahl Nitrogen		2.17	2.05		mg/L	5.5	20	11-OCT-17
WG2635425-14 LCS								
Total Kjeldahl Nitrogen			90.0		%		75-125	11-OCT-17
WG2635425-18 LCS								
Total Kjeldahl Nitrogen			87.8		%		75-125	11-OCT-17
WG2635425-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	11-OCT-17
WG2635425-17 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	11-OCT-17
WG2635425-20 MS		**L2003343-4**						
Total Kjeldahl Nitrogen			96.1		%		70-130	11-OCT-17
NH3-COL-WP	**Water**							
Batch R3853744								
WG2638515-10 LCS								
Ammonia, Total (as N)			96.2		%		85-115	12-OCT-17
WG2638515-6 LCS								
Ammonia, Total (as N)			100.7		%		85-115	12-OCT-17
WG2638515-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	12-OCT-17
WG2638515-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	12-OCT-17
NO2-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-6 LCS								
Nitrite (as N)			100.6		%		90-110	06-OCT-17
WG2633920-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	06-OCT-17
NO3-L-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-6 LCS								
Nitrate (as N)			100.2		%		90-110	06-OCT-17
WG2633920-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	06-OCT-17
P-T-COL-WP	**Water**							
Batch R3853472								
WG2634808-2 LCS								
Phosphorus (P)-Total			98.0		%		80-120	13-OCT-17
WG2634808-1 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	13-OCT-17
P-T-L-COL-WP	**Water**							
Batch R3857548								
WG2640487-2 LCS								
Phosphorus (P)-Total			82.9		%		80-120	16-OCT-17
WG2640487-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	16-OCT-17
P-TD-COL-WP	**Water**							
Batch R3853477								
WG2634805-2 LCS								
Phosphorus (P)-Total	Dissolved		97.0		%		80-120	13-OCT-17
WG2634805-6 LCS								
Phosphorus (P)-Total	Dissolved		97.2		%		80-120	13-OCT-17
WG2634805-1 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	13-OCT-17
WG2634805-5 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	13-OCT-17
P-TD-L-COL-WP	**Water**							
Batch R3857548								
WG2640478-7 DUP		**L2003343-12**						
Phosphorus (P)-Total	Dissolved	<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	16-OCT-17
WG2640478-2 LCS								
Phosphorus (P)-Total	Dissolved		105.6		%		80-120	16-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-TD-L-COL-WP	**Water**							
Batch R3857548								
WG2640478-6 LCS								
Phosphorus (P)-Total	Dissolved		92.0		%		80-120	16-OCT-17
WG2640478-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	16-OCT-17
WG2640478-5 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	16-OCT-17
WG2640478-8 MS		**L2003343-11**						
Phosphorus (P)-Total	Dissolved		79.0		%		70-130	16-OCT-17
PH-WP	**Water**							
Batch R3851699								
WG2634628-12 LCS								
pH			7.41		pH units		7.3-7.5	06-OCT-17
WG2634628-17 LCS								
pH			7.41		pH units		7.3-7.5	06-OCT-17
SO4-IC-N-WP	**Water**							
Batch R3851267								
WG2633920-6 LCS								
Sulfate (SO4)			100.3		%		90-110	06-OCT-17
WG2633920-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	06-OCT-17
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3853623								
WG2637638-2 LCS								
Total Suspended Solids			95.3		%		85-115	11-OCT-17
WG2637638-1 MB								
Total Suspended Solids			<2.0		mg/L		2	11-OCT-17
SOLIDS-TOTSUS-WP	**Water**							
Batch R3855787								
WG2638400-10 LCS								
Total Suspended Solids			98.0		%		85-115	12-OCT-17
WG2638400-9 MB								
Total Suspended Solids			<5.0		mg/L		5	12-OCT-17
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R3849714								
WG2633776-2 DUP		**L2003343-1**						
Total Coliforms		1050	921		MPN/100mL	13	65	06-OCT-17
Escherichia Coli		114	88		MPN/100mL	25	65	06-OCT-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R3849714								
WG2633776-1 MB								
Total Coliforms			<1		MPN/100mL		1	06-OCT-17
Escherichia Coli			<1		MPN/100mL		1	06-OCT-17
TURBIDITY-WP	**Water**							
Batch R3850189								
WG2633758-12 DUP		**L2003343-9**						
Turbidity		4.40	4.45		NTU	1.1	15	06-OCT-17
WG2633758-2 LCS								
Turbidity			99.5		%		85-115	06-OCT-17
WG2633758-5 LCS								
Turbidity			98.5		%		85-115	06-OCT-17
WG2633758-1 MB								
Turbidity			<0.10		NTU		0.1	06-OCT-17
WG2633758-4 MB								
Turbidity			<0.10		NTU		0.1	06-OCT-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	05-OCT-17 15:30	06-OCT-17 12:00	0.25	20	hours	EHTR-FM
	2	05-OCT-17 15:10	06-OCT-17 12:00	0.25	21	hours	EHTR-FM
	3	05-OCT-17 14:00	06-OCT-17 12:00	0.25	22	hours	EHTR-FM
	4	05-OCT-17 12:30	06-OCT-17 12:00	0.25	24	hours	EHTR-FM
	5	05-OCT-17 11:30	06-OCT-17 12:00	0.25	24	hours	EHTR-FM
	6	05-OCT-17 11:15	06-OCT-17 12:00	0.25	25	hours	EHTR-FM
	7	05-OCT-17 11:00	06-OCT-17 12:00	0.25	25	hours	EHTR-FM
	8	05-OCT-17 10:30	06-OCT-17 12:00	0.25	25	hours	EHTR-FM
	9	05-OCT-17 09:45	06-OCT-17 12:00	0.25	26	hours	EHTR-FM
	10	05-OCT-17 12:30	06-OCT-17 12:00	0.25	24	hours	EHTR-FM
	11	05-OCT-17 09:40	06-OCT-17 12:00	0.25	26	hours	EHTR-FM
	12	05-OCT-17	06-OCT-17 12:00	0.25	24	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2003343 were received on 06-OCT-17 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2003343-COFC

COC Number: 15 - 551102

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	KGS Group
Contact:	Marci Friedman Hamm
Phone:	204-896-1209
	Company address below will appear on the final report
Street:	865 Waverley St.
City/Province:	Winnipeg, MB
Postal Code:	R3T 5P4
Invoice To	Same as Report To ☒ YES ☐ NO
	Copy of Invoice with Report ☒ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☒ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☒ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	mfhamm@kgsgroup.com
Email 2	amelvin@kgsgroup.com
Email 3	dleitch@kgsgroup.com
Invoice Distribution	
Select Invoice Distribution:	☒ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Accounts Payable
Email 2	vmacquarrie@kgsgroup.com

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply	
Regular [R]	☒ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days) 4 day [P4]	☒
3 day [P3]	☐
2 day [P2]	☐
EMERGENCY 1 Business day [E1]	☐
Same Day, Weekend or Statutory holiday [E0]	☐
Date and Time Required for all E&P TATs:	
For tests that can not be performed according to the service level selected, you will be contacted.	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58703	AFE/Cost Center:	PO#:
Job #:	16-0300-006	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)	L2003343	ALS Contact: Judy	Sampler: DL + ATM

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RCAN-TOT-L-WP	N-TOTKJ-WP	P-T-COL-WP	NH3-COL-WP	ETL-N-TOT-ANY-WP	P-TD-COL-WP	SOLIDS-TOTSUS-LR-WP	TC,EC-QT97-ENVPT-WP	Number of Containers
					P	P	P	P					
1	D1	05-OCT-17	15:30	SW									7
2	D2		15:10										7
3	D3		14:00										7
4	D4		12:30										7
5	D5		11:30										7
6	D6		11:15										7
7	D7		11:00										7
8	D8		10:30										7
9	D9		9:45										7
10	SW100		12:30										7
11	Field Blank		9:40										7
12	Trip Blank												7

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	For P-TD lab should filter and preserve
Are samples for human drinking water use? ☐ YES ☐ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice Packs	☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
		6.3			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	Oct 5/17	19:15	ASL	06/10/17	8:30			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

D3-F4 MAY 2018

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	253		mg/L			01-JUN-18
Carbonate (CO3)	6.00		mg/L			01-JUN-18
Hydroxide (OH)	<0.34		mg/L			01-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	8.46		pH units			31-MAY-18
TDS calculated						
TDS (Calculated)	295		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	33.7		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	125		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	0.0189		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	0.00029		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	0.00072		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0230		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.168		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	0.0000056		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	16.5		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	0.00022		mg/L			01-JUN-18
Copper (Cu)-Dissolved	0.00046		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	0.012		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0112		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	20.3		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.0421		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.0224		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00224		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	2.64		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00082		mg/L			01-JUN-18
Selenium (Se)-Dissolved	0.000061		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	3.35		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	73.0		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.103		mg/L			01-JUN-18
Sulfur (S)-Dissolved	13.5		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	0.00064		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	0.00118		mg/L			01-JUN-18
Tungsten (W)-Dissolved	0.00117		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.00322		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	0.00411		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	0.000158		mg/L			01-JUN-18
Conductivity						
Conductivity	489		umhos/cm			31-MAY-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.7		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	218		mg/L			31-MAY-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	408		mg/L			01-JUN-18
Carbonate (CO3)	<0.60		mg/L			01-JUN-18
Hydroxide (OH)	<0.34		mg/L			01-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.93		pH units			31-MAY-18
TDS calculated						
TDS (Calculated)	493		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	397		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	0.0018		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0199		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.548		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	76.6		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000032		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0371		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	50.1		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.00962		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000263		mg/L			01-JUN-18

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Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	10.6		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00625		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	5.27		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	33.3		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.561		mg/L			01-JUN-18
Sulfur (S)-Dissolved	45.6		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.000656		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	782		umhos/cm			31-MAY-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.34		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	335		mg/L			31-MAY-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: 15-RD-PW01
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	407		mg/L			01-JUN-18
Carbonate (CO3)	<0.60		mg/L			01-JUN-18
Hydroxide (OH)	<0.34		mg/L			01-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.84		pH units			31-MAY-18
TDS calculated						
TDS (Calculated)	490		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	118		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	389		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0178		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.573		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	77.4		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000034		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Dissolved	0.00027		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	0.000093		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0380		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	47.4		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.00873		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000181		mg/L			01-JUN-18

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Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: 15-RD-PW01
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00082		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	10.2		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00574		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	5.15		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	31.9		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.562		mg/L			01-JUN-18
Sulfur (S)-Dissolved	44.8		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.000904		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	0.0049		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	788		umhos/cm			31-MAY-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.38		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	334		mg/L			31-MAY-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

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Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: 15-RD-PW01
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	395		mg/L			01-JUN-18
Carbonate (CO3)	<0.60		mg/L			01-JUN-18
Hydroxide (OH)	<0.34		mg/L			01-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	7.86		pH units			31-MAY-18
TDS calculated						
TDS (Calculated)	528		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	147		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	420		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	0.00033		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0144		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.639		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	86.3		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000045		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	0.00019		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0380		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	49.7		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.00927		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000257		mg/L			01-JUN-18

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PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00063		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	11.0		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00705		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	5.29		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	33.9		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.587		mg/L			01-JUN-18
Sulfur (S)-Dissolved	57.5		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	0.000024		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.00135		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	820		umhos/cm			31-MAY-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.98		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	323		mg/L			31-MAY-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	384		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	7.59		pH units			01-JUN-18
TDS calculated						
TDS (Calculated)	532		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	153		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	414		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	0.00049		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0154		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.668		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	83.2		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000035		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	0.00024		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0379		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	50.1		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.0150		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000282		mg/L			01-JUN-18

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Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	0.00074		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	10.4		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00674		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	5.48		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	39.8		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.577		mg/L			01-JUN-18
Sulfur (S)-Dissolved	58.6		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	0.000020		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.00127		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	0.0013		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	827		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.33		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	315		mg/L			01-JUN-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

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Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

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Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: THGD-02
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	334		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.70		pH units			01-JUN-18
TDS calculated						
TDS (Calculated)	502		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	157		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	369		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	0.0019		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0202		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.700		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	70.5		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000034		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0435		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	46.9		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.0118		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000307		mg/L			01-JUN-18

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: THGD-02
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	9.86		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00678		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	4.56		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	39.7		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.546		mg/L			01-JUN-18
Sulfur (S)-Dissolved	60.1		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.00168		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	799		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.0		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	274		mg/L			01-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: THGD-02
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	<1.2		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	5.71		pH units			01-JUN-18
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	<0.20		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	<0.00010		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	<0.010		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	<0.050		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	<0.0010		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	<0.0050		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	<0.00010		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			01-JUN-18

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Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Nickel (Ni)-Dissolved	<0.00050					01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	<0.00020		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	<0.050		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	<0.050		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	<0.00010		mg/L			01-JUN-18
Sulfur (S)-Dissolved	<0.50		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	<1.0		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	<1.0		mg/L			01-JUN-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: FIELD BLANK
Sampled By: DL + LM
Date Collected: 29-MAY-18
Lab Sample ID: L2103324-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	405		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.69		pH units			01-JUN-18
TDS calculated						
TDS (Calculated)	494		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	116		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	403		mg/L		500	19-JUN-18
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					01-JUN-18
Aluminum (Al)-Dissolved	0.0013		mg/L		0.1	01-JUN-18
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Dissolved	0.0197		mg/L	1		01-JUN-18
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-JUN-18
Boron (B)-Dissolved	0.553		mg/L	5		01-JUN-18
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Dissolved	78.2		mg/L			01-JUN-18
Cesium (Cs)-Dissolved	0.000027		mg/L			01-JUN-18
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Dissolved	0.0367		mg/L			01-JUN-18
Magnesium (Mg)-Dissolved	50.5		mg/L			01-JUN-18
Manganese (Mn)-Dissolved	0.00930		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-	0.000195		mg/L			01-JUN-18

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PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Nickel (Ni)-Dissolved	<0.00050		mg/L			01-JUN-18
Phosphorus (P)-Dissolved	<0.050		mg/L			01-JUN-18
Potassium (K)-Dissolved	11.1		mg/L			01-JUN-18
Rubidium (Rb)-Dissolved	0.00619		mg/L			01-JUN-18
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Dissolved	5.33		mg/L			01-JUN-18
Silver (Ag)-Dissolved	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Dissolved	33.1		mg/L		200	01-JUN-18
Strontium (Sr)-Dissolved	0.566		mg/L			01-JUN-18
Sulfur (S)-Dissolved	46.5		mg/L			01-JUN-18
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Dissolved	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Dissolved	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-JUN-18
Tungsten (W)-Dissolved	<0.00010		mg/L			01-JUN-18
Uranium (U)-Dissolved	0.000654		mg/L	0.02		01-JUN-18
Vanadium (V)-Dissolved	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Dissolved	<0.000060		mg/L			01-JUN-18
Conductivity						
Conductivity	788		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.33		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			01-JUN-18

CDWQG = Health Canada Guideline Limits updated **MAY 2018**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103324
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL + LM
Date Collected: 28-MAY-18
Lab Sample ID: L2103324-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Dissolved Metals.						

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2103324 Report Date: 19-JUN-18

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4063723								
WG2786145-24 LCS								
Alkalinity, Total (as CaCO3)			100.9		%		85-115	31-MAY-18
WG2786145-21 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	31-MAY-18
Batch R4066127								
WG2787670-5 DUP		**L2103324-5**						
Alkalinity, Total (as CaCO3)		315	313		mg/L	0.5	20	01-JUN-18
WG2787670-4 LCS								
Alkalinity, Total (as CaCO3)			100.3		%		85-115	01-JUN-18
WG2787670-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	01-JUN-18
CL-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-2 LCS								
Chloride (Cl)			99.4		%		90-110	31-MAY-18
WG2785417-6 LCS								
Chloride (Cl)			99.1		%		90-110	31-MAY-18
WG2785417-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-MAY-18
WG2785417-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-MAY-18
EC-WP	**Water**							
Batch R4063723								
WG2786145-23 LCS								
Conductivity			97.4		%		90-110	31-MAY-18
WG2786145-21 MB								
Conductivity			<1.0		umhos/cm		1	31-MAY-18
Batch R4066127								
WG2787670-5 DUP		**L2103324-5**						
Conductivity		827	829		umhos/cm	0.2	10	01-JUN-18
WG2787670-3 LCS								
Conductivity			97.9		%		90-110	01-JUN-18
WG2787670-1 MB								
Conductivity			<1.0		umhos/cm		1	01-JUN-18
MET-D-CCMS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch	**R4066027**							
WG2786344-2	**LCS**							
Aluminum (Al)-Dissolved			103.5		%		80-120	01-JUN-18
Antimony (Sb)-Dissolved			103.5		%		80-120	01-JUN-18
Arsenic (As)-Dissolved			107.1		%		80-120	01-JUN-18
Barium (Ba)-Dissolved			109.1		%		80-120	01-JUN-18
Beryllium (Be)-Dissolved			105.0		%		80-120	01-JUN-18
Bismuth (Bi)-Dissolved			100.3		%		80-120	01-JUN-18
Boron (B)-Dissolved			102.5		%		80-120	01-JUN-18
Cadmium (Cd)-Dissolved			103.7		%		80-120	01-JUN-18
Calcium (Ca)-Dissolved			104.4		%		80-120	01-JUN-18
Cesium (Cs)-Dissolved			101.8		%		80-120	01-JUN-18
Chromium (Cr)-Dissolved			98.6		%		80-120	01-JUN-18
Cobalt (Co)-Dissolved			103.1		%		80-120	01-JUN-18
Copper (Cu)-Dissolved			106.6		%		80-120	01-JUN-18
Iron (Fe)-Dissolved			97.9		%		80-120	01-JUN-18
Lead (Pb)-Dissolved			103.1		%		80-120	01-JUN-18
Lithium (Li)-Dissolved			106.7		%		80-120	01-JUN-18
Magnesium (Mg)-Dissolved			103.0		%		80-120	01-JUN-18
Manganese (Mn)-Dissolved			102.0		%		80-120	01-JUN-18
Molybdenum (Mo)-Dissolved			103.8		%		80-120	01-JUN-18
Nickel (Ni)-Dissolved			106.2		%		80-120	01-JUN-18
Phosphorus (P)-Dissolved			116.1		%		80-120	01-JUN-18
Potassium (K)-Dissolved			106.7		%		80-120	01-JUN-18
Rubidium (Rb)-Dissolved			112.1		%		80-120	01-JUN-18
Selenium (Se)-Dissolved			104.0		%		80-120	01-JUN-18
Silicon (Si)-Dissolved			106.0		%		80-120	01-JUN-18
Silver (Ag)-Dissolved			106.6		%		80-120	01-JUN-18
Sodium (Na)-Dissolved			105.7		%		80-120	01-JUN-18
Strontium (Sr)-Dissolved			101.8		%		80-120	01-JUN-18
Sulfur (S)-Dissolved			104.4		%		80-120	01-JUN-18
Tellurium (Te)-Dissolved			101.2		%		80-120	01-JUN-18
Thallium (Tl)-Dissolved			101.7		%		80-120	01-JUN-18
Thorium (Th)-Dissolved			100.3		%		80-120	01-JUN-18
Tin (Sn)-Dissolved			102.7		%		80-120	01-JUN-18
Titanium (Ti)-Dissolved			105.6		%		80-120	01-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4066027								
WG2786344-2 LCS								
Tungsten (W)-Dissolved			101.3		%		80-120	01-JUN-18
Uranium (U)-Dissolved			105.0		%		80-120	01-JUN-18
Vanadium (V)-Dissolved			106.9		%		80-120	01-JUN-18
Zinc (Zn)-Dissolved			101.3		%		80-120	01-JUN-18
Zirconium (Zr)-Dissolved			102.2		%		80-120	01-JUN-18
WG2786344-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-JUN-18
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-JUN-18
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-JUN-18
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	01-JUN-18
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-JUN-18
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	01-JUN-18
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-JUN-18
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-JUN-18
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-JUN-18
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-JUN-18
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-JUN-18
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-JUN-18
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-JUN-18
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	01-JUN-18
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-JUN-18
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	01-JUN-18
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-JUN-18
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-JUN-18
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-JUN-18
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-JUN-18
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4066027								
WG2786344-1 MB								
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-JUN-18
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	01-JUN-18
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-JUN-18
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-JUN-18
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	01-JUN-18
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-JUN-18
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-JUN-18
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-JUN-18
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	01-JUN-18
NO2-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-2 LCS								
Nitrite (as N)			100.8		%		90-110	31-MAY-18
WG2785417-6 LCS								
Nitrite (as N)			100.2		%		90-110	31-MAY-18
WG2785417-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	31-MAY-18
WG2785417-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	31-MAY-18
NO3-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-2 LCS								
Nitrate (as N)			99.8		%		90-110	31-MAY-18
WG2785417-6 LCS								
Nitrate (as N)			99.2		%		90-110	31-MAY-18
WG2785417-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	31-MAY-18
WG2785417-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	31-MAY-18
PH-WP	**Water**							
Batch R4063723								
WG2786145-22 LCS								
pH			7.41		pH units		7.3-7.5	31-MAY-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R4066127								
WG2787670-5 DUP		**L2103324-5**						
pH		7.59	7.61	J	pH units	0.02	0.2	01-JUN-18
WG2787670-2 LCS								
pH			7.41		pH units		7.3-7.5	01-JUN-18
SO4-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-2 LCS								
Sulfate (SO4)			100.8		%		90-110	31-MAY-18
WG2785417-6 LCS								
Sulfate (SO4)			100.6		%		90-110	31-MAY-18
WG2785417-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	31-MAY-18
WG2785417-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	31-MAY-18

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	28-MAY-18 12:00	31-MAY-18 12:00	0.25	72	hours	EHTR-FM
	2	28-MAY-18 14:50	31-MAY-18 12:00	0.25	69	hours	EHTR-FM
	3	28-MAY-18 15:17	31-MAY-18 12:00	0.25	69	hours	EHTR-FM
	4	29-MAY-18 11:40	31-MAY-18 12:00	0.25	48	hours	EHTR-FM
	5	29-MAY-18 12:00	01-JUN-18 12:00	0.25	72	hours	EHTR-FM
	6	29-MAY-18 15:47	01-JUN-18 12:00	0.25	68	hours	EHTR-FM
	7	29-MAY-18 16:15	01-JUN-18 12:00	0.25	68	hours	EHTR-FM
	8	28-MAY-18 18:00	01-JUN-18 12:00	0.25	90	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2103324 were received on 31-MAY-18 07:45.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2103324-COFC

COC Number: 14 - 450657

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	PDF, EXCEL, EDD (DIGITAL)	R – Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman Hamm	Quality Control (QC) Report with Report	Yes / No	P – Priority (2-4 business days if received by 3pm)
Address:	865 Waverley St, Winnipeg, MB R3T 5P4	Criteria on Report - provide details below if box checked		E – Emergency (1-2 business days if received by 3pm)
Phone:	204-896-1209	Select Distribution:	EMAIL / MAIL / FAX	E2 – Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	dleitch@kgsgroup.com	Analysis Request
Invoice To	Same as Report To: Yes / No	Invoice Distribution		Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
	Copy of Invoice with Report: Yes / No	Select Invoice Distribution:	EMAIL / MAIL / FAX	
Company:		Email 1 or Fax	Account Payable	
Contact:		Email 2	wmacqurrie@kgsgroup.com	
Project Information		Oil and Gas Required Fields (client use)		
ALS Quote #:	Q58403	Approver ID:	Cost Center:	
Job #:	16-0300-006	GL Account:	Routing Code:	
PO / AFE:		Activity Code:		
LSD:		Location:		
ALS Lab Work Order # (lab use only)		ALS Contact: Judy	Sampler: DL + LM	

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RQ11W-D-L-WP	Number of Containers
	TH-ED-03	28-MAY-18	12:00	GW	X	2
	TH-GD-07	28-MAY-18	14:50	GW	X	2
	15-PW-01	28-MAY-18	15:17	GW	X	2
	~~TH-ED-01~~ TH-ED-01W	29-MAY-18	11:40	GW	X	2
	TH-ED-01P	29-MAY-18	12:00	GW	X	2
	TH-GD-02	29-MAY-18	15:47	GW	X	2
	Field Blank	29-MAY-18	16:15	GW	X	2
	S-100	28-MAY-18	18:00	GW	X	2

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)	SAMPLE CONDITION AS RECEIVED (lab use only)
Are samples taken from a Regulated DW System? Yes / No		Frozen / SIF Observations Yes / No
Are samples for human drinking water use? Yes / No		Ice packs Yes / No / Custody seal intact Yes / No
		Cooling Initiated

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)		FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date: / Time:
	May 31/18	20:15		MAY 31 2018	14:45		

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326a v08 Front/03 October 2013

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	200		mg/L			04-JUN-18
Carbonate (CO3)	4.80		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	8.45		pH units			01-JUN-18
Turbidity						
*Turbidity	2.55		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0236		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00015		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00179		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0451		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.090		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	40.6		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Total	0.00056		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.025		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000059		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0315		mg/L			01-JUN-18
Magnesium (Mg)-Total	30.9		mg/L			01-JUN-18
Manganese (Mn)-Total	0.00509		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.00183		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00072		mg/L			01-JUN-18
Potassium (K)-Total	8.02		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00301		mg/L			01-JUN-18
Selenium (Se)-Total	0.000077		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	4.03		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	92.1		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.239		mg/L			01-JUN-18
Sulfur (S)-Total	33.6		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00092		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00146		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00125		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000061		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	494		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	85.1		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	229	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.149		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	840		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	134		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	172		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0037		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0123		mg/L			04-JUN-18
Ammonia, Total (as N)	<0.010		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	1.01		mg/L			04-JUN-18
Total Nitrogen	1.01		mg/L			04-JUN-18
Total Suspended Solids	2.9		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	365		MPN/100mL	0		31-MAY-18
Escherichia Coli	7		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D1
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	514		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	8.22		pH units			01-JUN-18
Turbidity						
*Turbidity	1.03		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0283		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00012		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00139		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0394		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.114		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	66.5		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00020		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00021		mg/L			01-JUN-18
Copper (Cu)-Total	0.00069		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.111		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0352		mg/L			01-JUN-18
Magnesium (Mg)-Total	75.2		mg/L			01-JUN-18
Manganese (Mn)-Total	0.0323		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000222		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00131		mg/L			01-JUN-18
Potassium (K)-Total	6.46		mg/L			01-JUN-18
Phosphorus (P)-Total	0.089		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00363		mg/L			01-JUN-18
Selenium (Se)-Total	0.000171		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	3.27		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	25.0		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.222		mg/L			01-JUN-18
Sulfur (S)-Total	29.2		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00125		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00176		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00096		mg/L			01-JUN-18
Zinc (Zn)-Total	0.0049		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000248		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	511		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	62.0		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0020		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	476	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.286		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	841		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	23.5		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	421		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0588		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0717		mg/L			04-JUN-18
Ammonia, Total (as N)	0.023		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	1.75		mg/L			04-JUN-18
Total Nitrogen	1.75		mg/L			04-JUN-18
Total Suspended Solids	2.4		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	1730		MPN/100mL	0		31-MAY-18
Escherichia Coli	70		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	316		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.93		pH units			01-JUN-18
Turbidity						
*Turbidity	0.99		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0097		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00070		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0209		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.082		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	36.6		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.016		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0183		mg/L			01-JUN-18
Magnesium (Mg)-Total	49.9		mg/L			01-JUN-18
Manganese (Mn)-Total	0.0522		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000176		mg/L			01-JUN-18
Nickel (Ni)-Total	<0.00050		mg/L			01-JUN-18
Potassium (K)-Total	8.92		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00410		mg/L			01-JUN-18
Selenium (Se)-Total	0.000064		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	3.01		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	9.96		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.0855		mg/L			01-JUN-18
Sulfur (S)-Total	26.6		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	<0.00030		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.000316		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	<0.000060		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	326		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	60.3		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	297	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.133		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	562		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.81		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	259		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0055		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0222		mg/L			04-JUN-18
Ammonia, Total (as N)	0.076		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	1.99		mg/L			04-JUN-18
Total Nitrogen	1.99		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	866		MPN/100mL	0		31-MAY-18
Escherichia Coli	31		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D3
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	444		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.94		pH units			01-JUN-18
Turbidity						
*Turbidity	1.96		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0461		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00011		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00133		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0452		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.168		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	62.4		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00025		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00013		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.049		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000078		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0269		mg/L			01-JUN-18
Magnesium (Mg)-Total	67.2		mg/L			01-JUN-18
Manganese (Mn)-Total	0.0726		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000481		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00082		mg/L			01-JUN-18
Potassium (K)-Total	12.1		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00586		mg/L			01-JUN-18
Selenium (Se)-Total	0.000169		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	5.31		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	15.5		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.202		mg/L			01-JUN-18
Sulfur (S)-Total	34.7		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00166		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00118		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000144		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	467		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	76.8		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0013		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	433	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.309		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	782		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.4		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	364		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0230		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0334		mg/L			04-JUN-18
Ammonia, Total (as N)	0.261		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	2.56		mg/L			04-JUN-18
Total Nitrogen	2.56		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	411		MPN/100mL	0		31-MAY-18
Escherichia Coli	172		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D4
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	520		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	8.00		pH units			01-JUN-18
Turbidity						
*Turbidity	1.05		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0146		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00011		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00236		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0472		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.112		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	0.0000070		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	89.0		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00044		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00035		mg/L			01-JUN-18
Copper (Cu)-Total	0.00072		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.200		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0177		mg/L			01-JUN-18
Magnesium (Mg)-Total	58.3		mg/L			01-JUN-18
Manganese (Mn)-Total	0.137		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000517		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00182		mg/L			01-JUN-18
Potassium (K)-Total	3.37		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00353		mg/L			01-JUN-18
Selenium (Se)-Total	0.000280		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	8.98		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	6.97		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.183		mg/L			01-JUN-18
Sulfur (S)-Total	14.1		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00099		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00173		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00068		mg/L			01-JUN-18
Zinc (Zn)-Total	0.0059		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000426		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	445		mg/L		500	04-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	30.2		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	462	HTC	mg/L		500	04-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.374		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	740		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.39		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	426		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0225		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0331		mg/L			04-JUN-18
Ammonia, Total (as N)	0.019		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	2.11		mg/L			04-JUN-18
Total Nitrogen	2.11		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	1020		MPN/100mL	0		31-MAY-18
Escherichia Coli	18		MPN/100mL	0		31-MAY-18

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D5
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	472		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	8.08		pH units			01-JUN-18
Turbidity						
*Turbidity	2.89		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0951		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00125		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0441		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.124		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	74.1		mg/L			01-JUN-18
Cesium (Cs)-Total	0.000011		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00030		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00017		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.135		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000075		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0280		mg/L			01-JUN-18
Magnesium (Mg)-Total	76.6		mg/L			01-JUN-18
Manganese (Mn)-Total	0.114		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000419		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00074		mg/L			01-JUN-18
Potassium (K)-Total	7.94		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00429		mg/L			01-JUN-18
Selenium (Se)-Total	0.000165		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	9.87		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	14.8		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.229		mg/L			01-JUN-18
Sulfur (S)-Total	51.7		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00411		mg/L			01-JUN-18

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00136		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00080		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000193		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	534		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	500	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.323		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	857		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	11.4		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	387		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0301		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0437		mg/L			04-JUN-18
Ammonia, Total (as N)	0.035		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	1.94		mg/L			04-JUN-18
Total Nitrogen	1.94		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		31-MAY-18
Escherichia Coli	52		MPN/100mL	0		31-MAY-18

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D6
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	411		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.77		pH units			01-JUN-18
Turbidity						
*Turbidity	1.63		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0097		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00194		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0330		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.024		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	50.8		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00015		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00023		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.088		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0307		mg/L			01-JUN-18
Magnesium (Mg)-Total	71.2		mg/L			01-JUN-18
Manganese (Mn)-Total	0.167		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.00161		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00128		mg/L			01-JUN-18
Potassium (K)-Total	4.61		mg/L			01-JUN-18
Phosphorus (P)-Total	0.059		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00184		mg/L			01-JUN-18
Selenium (Se)-Total	0.000184		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	3.75		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	10.8		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.137		mg/L			01-JUN-18
Sulfur (S)-Total	42.3		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00058		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00823		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00062		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000173		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	439		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	98.3		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	420	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.158		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	726		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.98		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0386		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0475		mg/L			04-JUN-18
Ammonia, Total (as N)	0.018		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	1.88		mg/L			04-JUN-18
Total Nitrogen	1.88		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			04-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	960		MPN/100mL	0		31-MAY-18
Escherichia Coli	4		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D7
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	476		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	8.29		pH units			01-JUN-18
Turbidity						
*Turbidity	10.8		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.283		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00162		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0425		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.126		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	77.8		mg/L			01-JUN-18
Cesium (Cs)-Total	0.000030		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00070		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00031		mg/L			01-JUN-18
Copper (Cu)-Total	0.00084		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.305		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000176		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0251		mg/L			01-JUN-18
Magnesium (Mg)-Total	69.7		mg/L			01-JUN-18
Manganese (Mn)-Total	0.0688		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000455		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00127		mg/L			01-JUN-18
Potassium (K)-Total	6.45		mg/L			01-JUN-18
Phosphorus (P)-Total	0.086		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00410		mg/L			01-JUN-18
Selenium (Se)-Total	0.000184		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	5.30		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	11.6		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.223		mg/L			01-JUN-18
Sulfur (S)-Total	39.0		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.0113		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00188		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00181		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000450		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	498		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	90.2		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	481	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.315		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	802		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	8.12		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	390		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0502		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0725		mg/L			04-JUN-18
Ammonia, Total (as N)	0.037		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	2.26		mg/L			04-JUN-18
Total Nitrogen	2.26		mg/L			04-JUN-18
Total Suspended Solids	15.1		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	230		MPN/100mL	0		31-MAY-18
Escherichia Coli	49		MPN/100mL	0		31-MAY-18

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Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D8
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	212		mg/L			04-JUN-18
Carbonate (CO3)	3.96		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		04-JUN-18
pH						
pH	8.41		pH units			01-JUN-18
Turbidity						
*Turbidity	9.37		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.167		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00014		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00169		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0425		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.102		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	47.4		mg/L			01-JUN-18
Cesium (Cs)-Total	0.000020		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00041		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00014		mg/L			01-JUN-18
Copper (Cu)-Total	0.00072		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.169		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000153		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0333		mg/L			01-JUN-18
Magnesium (Mg)-Total	30.5		mg/L			01-JUN-18
Manganese (Mn)-Total	0.00804		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.00187		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00100		mg/L			01-JUN-18
Potassium (K)-Total	7.97		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00362		mg/L			01-JUN-18
Selenium (Se)-Total	0.000077		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	4.54		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	97.5		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.255		mg/L			01-JUN-18
Sulfur (S)-Total	34.4		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00735		mg/L			01-JUN-18

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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00151		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	0.00156		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000152		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	516		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	77.6		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	244	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.146		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	917		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	147		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	180		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0031		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0136		mg/L			04-JUN-18
Ammonia, Total (as N)	0.010		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	0.82		mg/L			04-JUN-18
Total Nitrogen	0.82		mg/L			04-JUN-18
Total Suspended Solids	10.4		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		31-MAY-18
Escherichia Coli	613		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: D9
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: FIELD BLANK 2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	<1.2		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	6.08		pH units			01-JUN-18
Turbidity						
*Turbidity	<0.10		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.0030		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	<0.00010		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	<0.00010		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	<0.010		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	<0.050		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	<0.00010		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	<0.00010		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	<0.010		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	<0.000050		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	<0.0010		mg/L			01-JUN-18
Magnesium (Mg)-Total	<0.0050		mg/L			01-JUN-18
Manganese (Mn)-Total	<0.00010		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	<0.000050		mg/L			01-JUN-18
Nickel (Ni)-Total	<0.00050		mg/L			01-JUN-18
Potassium (K)-Total	<0.050		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	<0.00020		mg/L			01-JUN-18
Selenium (Se)-Total	<0.000050		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	<0.10		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	<0.050		mg/L		200	01-JUN-18
Strontium (Sr)-Total	<0.00020		mg/L			01-JUN-18
Sulfur (S)-Total	<0.50		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	<0.00030		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: FIELD BLANK 2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	<0.000010		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	<0.000060		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	<0.20	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	<1.0		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	<1.0		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			06-JUN-18
Phosphorus (P)-Total	<0.0010		mg/L			05-JUN-18
Ammonia, Total (as N)	<0.010		mg/L			01-JUN-18
Total Kjeldahl Nitrogen	<0.20		mg/L			04-JUN-18
Total Nitrogen	<0.20		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	<1		MPN/100mL	0		31-MAY-18
Escherichia Coli	<1		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: FIELD BLANK 2
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: SW-100
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	449		mg/L			04-JUN-18
Carbonate (CO3)	<0.60		mg/L			04-JUN-18
Hydroxide (OH)	<0.34		mg/L			04-JUN-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		04-JUN-18
pH						
pH	7.99		pH units			01-JUN-18
Turbidity						
*Turbidity	1.87		NTU			31-MAY-18
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0433		mg/L		0.1	01-JUN-18
Antimony (Sb)-Total	0.00011		mg/L	0.006		01-JUN-18
Arsenic (As)-Total	0.00125		mg/L	0.01		01-JUN-18
Barium (Ba)-Total	0.0464		mg/L	1		01-JUN-18
Beryllium (Be)-Total	<0.00010		mg/L			01-JUN-18
Bismuth (Bi)-Total	<0.000050		mg/L			01-JUN-18
Boron (B)-Total	0.171		mg/L	5		01-JUN-18
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		01-JUN-18
Calcium (Ca)-Total	66.8		mg/L			01-JUN-18
Cesium (Cs)-Total	<0.000010		mg/L			01-JUN-18
Chromium (Cr)-Total	0.00030		mg/L	0.05		01-JUN-18
Cobalt (Co)-Total	0.00013		mg/L			01-JUN-18
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-JUN-18
Iron (Fe)-Total	0.051		mg/L		0.3	01-JUN-18
Lead (Pb)-Total	0.000080		mg/L	0.01		01-JUN-18
Lithium (Li)-Total	0.0271		mg/L			01-JUN-18
Magnesium (Mg)-Total	65.9		mg/L			01-JUN-18
Manganese (Mn)-Total	0.0734		mg/L		0.05	01-JUN-18
Molybdenum (Mo)-Total	0.000486		mg/L			01-JUN-18
Nickel (Ni)-Total	0.00081		mg/L			01-JUN-18
Potassium (K)-Total	12.3		mg/L			01-JUN-18
Phosphorus (P)-Total	<0.050		mg/L			01-JUN-18
Rubidium (Rb)-Total	0.00581		mg/L			01-JUN-18
Selenium (Se)-Total	0.000160		mg/L	0.05		01-JUN-18
Silicon (Si)-Total	5.65		mg/L			01-JUN-18
Silver (Ag)-Total	<0.000010		mg/L			01-JUN-18
Sodium (Na)-Total	15.4		mg/L		200	01-JUN-18
Strontium (Sr)-Total	0.199		mg/L			01-JUN-18
Sulfur (S)-Total	35.9		mg/L			01-JUN-18
Tellurium (Te)-Total	<0.00020		mg/L			01-JUN-18
Thallium (Tl)-Total	<0.000010		mg/L			01-JUN-18
Thorium (Th)-Total	<0.00010		mg/L			01-JUN-18
Tin (Sn)-Total	<0.00010		mg/L			01-JUN-18
Titanium (Ti)-Total	0.00179		mg/L			01-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: SW-100
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Total Metals in Water by CRC ICPMS						
Tungsten (W)-Total	<0.00010		mg/L			01-JUN-18
Uranium (U)-Total	0.00120		mg/L	0.02		01-JUN-18
Vanadium (V)-Total	<0.00050		mg/L			01-JUN-18
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-JUN-18
Zirconium (Zr)-Total	0.000131		mg/L			01-JUN-18
TDS calculated						
TDS (Calculated)	473		mg/L		500	19-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	76.8		mg/L		500	31-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0011		mg/L	1		31-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		31-MAY-18
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	438	HTC	mg/L		500	19-JUN-18
Fluoride in Water by IC						
Fluoride (F)	0.312		mg/L	1.5		31-MAY-18
Conductivity						
Conductivity	782		umhos/cm			01-JUN-18
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.4		mg/L		250	31-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	368		mg/L			01-JUN-18
Phosphorus (P)-Total Dissolved	0.0226		mg/L			06-JUN-18
Phosphorus (P)-Total	0.0321		mg/L			04-JUN-18
Ammonia, Total (as N)	0.262		mg/L			31-MAY-18
Total Kjeldahl Nitrogen	2.62		mg/L			04-JUN-18
Total Nitrogen	2.62		mg/L			04-JUN-18
Total Suspended Solids	<2.0		mg/L			01-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	461		MPN/100mL	0		31-MAY-18
Escherichia Coli	178		MPN/100mL	0		31-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 19-JUN-18
PO No.:
WO No.: L2103336
Project Ref: 16-0300-006
Sample ID: SW-100
Sampled By: DZ & LM
Date Collected: 30-MAY-18
Lab Sample ID: L2103336-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

19-JUN-2018 AMENDED REPORT - Complete ICP-MS Scan results reported for Total Metals

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2103336 Report Date: 19-JUN-18

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4066127								
WG2787670-4 LCS								
Alkalinity, Total (as CaCO3)			100.3		%		85-115	01-JUN-18
WG2787670-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	01-JUN-18
CL-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-6 LCS								
Chloride (Cl)			99.1		%		90-110	31-MAY-18
WG2785417-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-MAY-18
EC-WP	**Water**							
Batch R4066127								
WG2787670-3 LCS								
Conductivity			97.9		%		90-110	01-JUN-18
WG2787670-1 MB								
Conductivity			<1.0		umhos/cm		1	01-JUN-18
F-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-6 LCS								
Fluoride (F)			102.0		%		90-110	31-MAY-18
WG2785417-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	31-MAY-18
MET-T-CCMS-WP	**Water**							
Batch R4066027								
WG2786218-2 LCS								
Aluminum (Al)-Total			93.4		%		80-120	01-JUN-18
Antimony (Sb)-Total			102.3		%		80-120	01-JUN-18
Arsenic (As)-Total			98.5		%		80-120	01-JUN-18
Barium (Ba)-Total			97.8		%		80-120	01-JUN-18
Beryllium (Be)-Total			105.1		%		80-120	01-JUN-18
Bismuth (Bi)-Total			101.0		%		80-120	01-JUN-18
Boron (B)-Total			107.6		%		80-120	01-JUN-18
Cadmium (Cd)-Total			98.8		%		80-120	01-JUN-18
Calcium (Ca)-Total			98.5		%		80-120	01-JUN-18
Cesium (Cs)-Total			98.8		%		80-120	01-JUN-18
Chromium (Cr)-Total			97.9		%		80-120	01-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4066027								
WG2786218-2 LCS								
Cobalt (Co)-Total			94.9		%		80-120	01-JUN-18
Copper (Cu)-Total			97.5		%		80-120	01-JUN-18
Iron (Fe)-Total			97.4		%		80-120	01-JUN-18
Lead (Pb)-Total			102.6		%		80-120	01-JUN-18
Lithium (Li)-Total			104.9		%		80-120	01-JUN-18
Magnesium (Mg)-Total			97.2		%		80-120	01-JUN-18
Manganese (Mn)-Total			97.6		%		80-120	01-JUN-18
Molybdenum (Mo)-Total			103.6		%		80-120	01-JUN-18
Nickel (Ni)-Total			95.7		%		80-120	01-JUN-18
Potassium (K)-Total			94.8		%		80-120	01-JUN-18
Phosphorus (P)-Total			96.5		%		80-120	01-JUN-18
Rubidium (Rb)-Total			102.8		%		80-120	01-JUN-18
Selenium (Se)-Total			98.5		%		80-120	01-JUN-18
Silicon (Si)-Total			98.8		%		80-120	01-JUN-18
Silver (Ag)-Total			102.3		%		80-120	01-JUN-18
Sodium (Na)-Total			98.2		%		80-120	01-JUN-18
Strontium (Sr)-Total			102.7		%		80-120	01-JUN-18
Sulfur (S)-Total			97.8		%		80-120	01-JUN-18
Tellurium (Te)-Total			99.3		%		80-120	01-JUN-18
Thallium (Tl)-Total			98.9		%		80-120	01-JUN-18
Thorium (Th)-Total			99.1		%		80-120	01-JUN-18
Tin (Sn)-Total			97.3		%		80-120	01-JUN-18
Titanium (Ti)-Total			89.9		%		80-120	01-JUN-18
Tungsten (W)-Total			100.6		%		80-120	01-JUN-18
Uranium (U)-Total			98.2		%		80-120	01-JUN-18
Vanadium (V)-Total			99.5		%		80-120	01-JUN-18
Zinc (Zn)-Total			95.8		%		80-120	01-JUN-18
Zirconium (Zr)-Total			96.4		%		80-120	01-JUN-18
WG2786218-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	01-JUN-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	01-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4066027								
WG2786218-1 MB								
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	01-JUN-18
Boron (B)-Total			<0.010		mg/L		0.01	01-JUN-18
Cadmium (Cd)-Total			<0.000005C		mg/L		0.000005	01-JUN-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	01-JUN-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	01-JUN-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	01-JUN-18
Iron (Fe)-Total			<0.010		mg/L		0.01	01-JUN-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	01-JUN-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	01-JUN-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	01-JUN-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	01-JUN-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	01-JUN-18
Potassium (K)-Total			<0.050		mg/L		0.05	01-JUN-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	01-JUN-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	01-JUN-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	01-JUN-18
Silicon (Si)-Total			<0.10		mg/L		0.1	01-JUN-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	01-JUN-18
Sodium (Na)-Total			<0.050		mg/L		0.05	01-JUN-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	01-JUN-18
Sulfur (S)-Total			<0.50		mg/L		0.5	01-JUN-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	01-JUN-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	01-JUN-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	01-JUN-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	01-JUN-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	01-JUN-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	01-JUN-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	01-JUN-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	01-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R4067372								
WG2784609-15 DUP		**L2103336-9**						
Total Kjeldahl Nitrogen		0.82	0.87		mg/L	5.4	20	04-JUN-18
WG2784609-10 LCS								
Total Kjeldahl Nitrogen			85.8		%		75-125	04-JUN-18
WG2784609-14 LCS								
Total Kjeldahl Nitrogen			99.3		%		75-125	04-JUN-18
WG2784609-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	04-JUN-18
WG2784609-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	04-JUN-18
WG2784609-16 MS		**L2103336-9**						
Total Kjeldahl Nitrogen			108.5		%		70-130	04-JUN-18
NH3-COL-WP	**Water**							
Batch R4063901								
WG2786268-2 LCS								
Ammonia, Total (as N)			101.1		%		85-115	31-MAY-18
WG2786268-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	31-MAY-18
Batch R4065200								
WG2787276-2 LCS								
Ammonia, Total (as N)			107.3		%		85-115	01-JUN-18
WG2787276-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	01-JUN-18
NO2-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-6 LCS								
Nitrite (as N)			100.2		%		90-110	31-MAY-18
WG2785417-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	31-MAY-18
NO3-L-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-6 LCS								
Nitrate (as N)			99.2		%		90-110	31-MAY-18
WG2785417-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	31-MAY-18
P-T-L-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-L-COL-WP	**Water**							
Batch R4067214								
WG2787705-11 DUP		**L2103336-6**						
Phosphorus (P)-Total		0.0437	0.0419		mg/L	4.3	20	04-JUN-18
WG2787705-10 LCS								
Phosphorus (P)-Total			95.8		%		80-120	04-JUN-18
WG2787705-6 LCS								
Phosphorus (P)-Total			95.3		%		80-120	04-JUN-18
WG2787705-5 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	04-JUN-18
WG2787705-9 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	04-JUN-18
WG2787705-12 MS		**L2103336-7**						
Phosphorus (P)-Total			99.1		%		70-130	04-JUN-18
P-TD-L-COL-WP	**Water**							
Batch R4075179								
WG2789730-14 LCS								
Phosphorus (P)-Total	Dissolved		96.0		%		80-120	06-JUN-18
WG2789730-13 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	06-JUN-18
PH-WP	**Water**							
Batch R4066127								
WG2787670-2 LCS								
pH			7.41		pH units		7.3-7.5	01-JUN-18
SO4-IC-N-WP	**Water**							
Batch R4066989								
WG2785417-6 LCS								
Sulfate (SO4)			100.6		%		90-110	31-MAY-18
WG2785417-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	31-MAY-18
SOLIDS-TOTSUS-WP	**Water**							
Batch R4067113								
WG2786137-10 LCS								
Total Suspended Solids			100.3		%		85-115	01-JUN-18
WG2786137-9 MB								
Total Suspended Solids			<2.0		mg/L		2	01-JUN-18

Quality Control Report

Workorder: L2103336 Report Date: 19-JUN-18

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TOTSUS-WP	**Water**							
Batch R4069870								
WG2787669-10 LCS								
Total Suspended Solids			90.9		%		85-115	04-JUN-18
WG2787669-9 MB								
Total Suspended Solids			<2.0		mg/L		2	04-JUN-18
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R4064349								
WG2785370-2 DUP		**L2103336-1**						
Total Coliforms		365	248		MPN/100mL	38	65	31-MAY-18
Escherichia Coli		7	4		MPN/100mL	56	65	31-MAY-18
WG2785370-1 MB								
Total Coliforms			<1		MPN/100mL		1	31-MAY-18
Escherichia Coli			<1		MPN/100mL		1	31-MAY-18
TURBIDITY-WP	**Water**							
Batch R4063711								
WG2786143-2 LCS								
Turbidity			105.0		%		85-115	31-MAY-18
WG2786143-5 LCS								
Turbidity			103.5		%		85-115	31-MAY-18
WG2786143-1 MB								
Turbidity			<0.10		NTU		0.1	31-MAY-18
WG2786143-4 MB								
Turbidity			<0.10		NTU		0.1	31-MAY-18

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	30-MAY-18 17:10	01-JUN-18 12:00	0.25	43	hours	EHTR-FM
	2	30-MAY-18 16:30	01-JUN-18 12:00	0.25	43	hours	EHTR-FM
	3	30-MAY-18 15:40	01-JUN-18 12:00	0.25	44	hours	EHTR-FM
	4	30-MAY-18 15:15	01-JUN-18 12:00	0.25	45	hours	EHTR-FM
	5	30-MAY-18 10:30	01-JUN-18 12:00	0.25	49	hours	EHTR-FM
	6	30-MAY-18 10:10	01-JUN-18 12:00	0.25	50	hours	EHTR-FM
	7	30-MAY-18 09:50	01-JUN-18 12:00	0.25	50	hours	EHTR-FM
	8	30-MAY-18 09:20	01-JUN-18 12:00	0.25	51	hours	EHTR-FM
	9	30-MAY-18 08:40	01-JUN-18 12:00	0.25	51	hours	EHTR-FM
	10	30-MAY-18 16:30	01-JUN-18 12:00	0.25	43	hours	EHTR-FM
	11	30-MAY-18 13:15	01-JUN-18 12:00	0.25	47	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2103336 were received on 31-MAY-18 07:45.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2103336-COFC

COC Number: 14 - 450656

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	R ☒ Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman Hamm	Quality Control (QC) Report with Report	☒ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	865 Waverley St., Winnipeg, MB, R3T 5P4	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
Phone:	204-896-1209	Select Distribution:	☒ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	dleitch@kgsgroup.com	

Invoice To		Invoice Distribution	
	Same as Report To ☒ Yes ☐ No	Select Invoice Distribution:	☒ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☒ Yes ☐ No	Email 1 or Fax	Accounts Payable
Company:		Email 2	wmacgnarrie@kgsgroup.com
Contact:		Oil and Gas Required Fields (client use)	

Project Information			
ALS Quote #:	Q58403	Approver ID:	Cost Center:
Job #:	16-0300-006	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Judy	Sampler: DL + LM

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RCAHW-T-L-WP	N-TOTKJ-WP	@T-COL-WP	NH3-COL-WP	ETL-N-TOT-ANY-WP	P-TD-COL-WP	SOLIDS-TOTSUS-LR-WP	TC,EC-QT97-ENDPT-WP	Number of Containers
	D1	30-MAY-18	17:10	SW									6
	D2		16:30										6
	D3		15:40										6
	D4		13:15										6
	D5		10:30										6
	D6		10:10										6
	D7		9:50										6
	D8		9:20										6
	D9		8:40										6
	Field Blank 2		16:30										6
	SW-100		13:15										6

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	For P-TD lab should filter and preserve
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
					5

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 30 05	Time: May 30/18	Received by:	Date: MAY 31 2018	Time: 7:45	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS
GROUP
CONSULTING
ENGINEERS

Memorandum

To:	James Betke, P.Eng.	**Date:**	August 11, 2021
		Project No.:	18-0300-005.1208
From:	Jason Mann, M.Sc., P.Geo.		
Re:	Lake St. Martin Outlet Channel Groundwater and Surface Water Baseline Data Summary		

1.0 INTRODUCTION

The following memorandum is a summary of baseline groundwater and surface water data collected as part of the Lake St. Martin Outlet Channel project. A site plan of the area showing sample locations is provided in Figure 1. KGS Group conducted four sampling events during 2019 and twice during 2020 including both groundwater and surface water monitoring and sampling during the field programs.

2.0 GROUNDWATER QUALITY

Sampling

KGS Group conducted groundwater sampling at monitoring wells and pump wells located along the existing emergency channel and along the proposed channel alignment, as well as at sentinel wells located in the community of Dauphin River. In 2019, four programs were conducted including March, June, September and October. In total, groundwater sampling was conducted at 38 locations in 2019 (Table 1). In 2020, two sampling programs were conducted in June and October, and included 10 locations (Table 1). Locations of sample wells are shown on Figure 1.

3.0 SURFACE WATER QUALITY

Sampling

KGS Group conducted surface water sampling at one location (SW-R3) during two water monitoring events in June and October of 2019. Additional surface water sampling locations were added in the 2020 programs to include 6 additional sites (LSMOC – Inlet 1A, LSMOC - Outlet – 1A, BC-02, BC-05, CR3-1, and CR3-2) for a total of 7 locations during monitoring programs in each of the 2020 events (Table 1). These sampling locations are shown on Figure 1.

4.0 ANALYSIS

Laboratory data for groundwater wells and surface water sample locations has been tabulated and are compared to applicable Health Canada (HC) and Canadian Council of Ministers of the Environment (CCME) water quality guidelines in Tables 2 through 7. Table 8 shows summaries and statistical data of groundwater parameters across sampling events.

Prepared By:



Paul Lindell, P.Eng.
Environmental Engineer

Approved By:



Jason Mann, M.Sc., P.Geo.
Environmental Department Head/
Associate Principal

PJL/jr
Enclosure

STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This memorandum has been prepared for Manitoba Infrastructure (MI) in accordance with the agreement between KGS Group and MI (the "Agreement"). This memorandum represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar documents. The information, data, recommendations and conclusions in this memorandum are subject to the constraints and limitations in the Agreement and the qualifications in this memorandum. This memorandum must be read as a whole, and sections or parts should not be read out of context.

This memorandum is based on information made available to KGS Group by MI. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this memorandum apply only as they existed at the time of KGS Group's work.

Third Party Use of Memorandum

Any use a third party makes of this memorandum or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this memorandum.

Geo-Environmental Statement of Limitations

KGS Group prepared the geo-environmental conclusions and recommendations for this memorandum in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this memorandum is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of MI. As this memorandum is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

TABLES

KGS GROUP

TABLE 1

SUMMARY OF GROUNDWATER AND SURFACE WATER FIELD CHEMISTRY MEASUREMENTS AND COMPLETED LAB ANALYSES

LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Duplicate Sample ID	Date	Time	Temp. (°C)	Field pH	Field E.C. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Laboratory Analysis Parameter Sets						
										ROU-4W+Metals [1]		Bacteria [2]	Surface Water Sample Set [3]	Isotopes		
														Stable		Radioactive
										Dissolved Metals	Total Metals			Oxygen-18 (^{18}O)	Deuterium (^{2}H)	Tritium (^{3}H)
GROUNDWATER SAMPLES																
PW19-KGS-01		12-Mar-2019	18:00	5.2	8.1	782	-	-	-	x		x		x	x	x
		11-Jun-2019	9:40	5.3	7.32	688	0.37	32.2	-	x		x		x	x	x
		24-Oct-2019	13:45	5.4	7.42	717	0.47	135.8	-	x		x		x	x	x
	PW-200								-	x		x		x	x	x
		11-Mar-2020	9:50	5.2	6.68	748	0.93	354.6	-	x		x		x	x	x
		17-Jun-2020	16:30	5.3	7.2	684	0.59	-4.6	-	x		x		x	x	x
		27-Oct-2020	10:10	5.1	7.38	710	0.22	29.9	-	x		x		x	x	x
PW19-KGS-02		13-Mar-2019	16:40	6.4	7.9	796	-	-	-	x		x		x	x	x
	PW19-KGS-05								-	x		x		x	x	x
		11-Jun-2019	11:50	6.4	7.34	724	0.99	-29.3	-	x		x		x	x	x
		24-Oct-2019	16:10	6.1	7.32	751	1.86	161	-	x		x		x	x	x
		16-Jun-2020	17:20	8.2	6.98	810	1.36	-14.6	-	x		x		x	x	x
		28-Oct-2020	17:30	0.5	7.14	794	3.12	68.2	-	x		x		x	x	x
	PW-100								-	x		x		x	x	x
PW19-KGS-03		14-Mar-2019	17:40	6.7	7.8	663	-	-	-	x		x		x	x	x
	PW19-KGS-04								-	x				x	x	x
		11-Jun-2019	16:19	5.5	7.3	591	0.36	-3.3	-	x		x		x	x	x
	PW19-KGS-200								-	x		x		x	x	x
		24-Oct-2019	10:35	7.3	7.25	569	0.5	127.7	-	x		x		x	x	x
		16-Jun-2020	10:05	5.7	7.12	523	0.65	7.9	-	x		x		x	x	x
	PW19-KGS-300								-	x		x		x	x	x
		27-Oct-2020	17:10	7.5	7.24	592	0.44	10.6	-	x		x		x	x	x
TH15-04		8-Mar-2019	11:15	1.9	7.37	536	3.12	53.2	-	x				x	x	
TH15-05		8-Mar-2019	12:45	2.9	6.86	532	3.33	70.7	-	x				x	x	
TH19-KGS-01		9-Mar-2019	10:40	3.6	7.35	957	5.9	-45.9	-	x				x	x	
TH19-KGS-02B		11-Mar-2019	7:55	2	7.63	1888	9.42	19.3	-	x						
TH19-KGS-03A		8-Mar-2019	18:36	0	7.02	606	13.72	146.7	-	x						
TH19-KGS-04		9-Mar-2019	12:18	5.8	7.58	1018	1.17	-53.8	-	x				x	x	
TH19-KGS-05		8-Mar-2019	12:45	2.9	6.86	532	3.33	70.7	-	x				x	x	
TH19-KGS-07		7-Mar-2019	10:50	5.9	7.1	688	1.98	-46.8	-	x						
TH19-KGS-07A		7-Mar-2019	10:12	0.4	6.95	852	8	27.6	-	x						
TH19-KGS-08		8-Mar-2019	14:55	2.2	6.93	546	2.06	73.5	-	x				x	x	
TH19-KGS-09		12-Mar-2019	14:08	5.5	7.56	737	1.33	-74.5	-	x				x	x	
TH19-KGS-10		9-Mar-2019	17:35	3.6	7.57	707	2.19	-63.4	-	x				x	x	
	TH200								-	x				x	x	
TH19-KGS-100		7-Mar-2019	14:15	1.1	6.85	756	2.12	59.8	-	x				x	x	
TH19-KGS-11		8-Mar-2019	9:30	3.3	6.64	786	3.32	85.6	-	x				x	x	
TH19-KGS-11A		8-Mar-2019	9:10	1	6.51	648	7.5	87.2	-	x						

TABLE 1
SUMMARY OF GROUNDWATER AND SURFACE WATER FIELD CHEMISTRY MEASUREMENTS AND COMPLETED LAB ANALYSES
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Duplicate Sample ID	Date	Time	Temp. (°C)	Field pH	Field E.C. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Laboratory Analysis Parameter Sets						
										ROU-4W+Metals [1]		Bacteria [2]	Surface Water Sample Set [3]	Isotopes		
														Stable		Radioactive
										Dissolved Metals	Total Metals			Oxygen-18 (^{18}O)	Deuterium (^{2}H)	Tritium (^{3}H)
GROUNDWATER SAMPLES																
TH19-KGS-12		7-Mar-2019	15:30	1.9	6.79	904	5.21	59.2	-	x				x	x	
		12-Jun-2019	13:30	5.4	7.48	733	1.99	-9.2	-	x		x		x	x	x
		23-Oct-2019	16:15	4	7.36	748	2.55	145.3	-	x		x		x	x	x
		16-Jun-2020	14:45	8.5	6.99	810	0.19	20.1	-	x		x		x	x	x
		18-Oct-2020	12:50	3.7	7.47	759	3.67	75.3	-	x		x		x	x	x
TH19-KGS-12B		14-Mar-2019	13:00	2.4	7.82	918	8.38	76	-	x						
TH19-KGS-13		7-Mar-2019	16:40	2.6	7.08	786	1.86	75.5	-	x				x	x	
TH19-KGS-13A		7-Mar-2019	17:10	0.3	7	436	3.98	42.7	-	x						
TH19-KGS-14		8-Mar-2019	16:10	3	6.9	592	2.91	68.2	-	x				x	x	
TH19-KGS-14A		8-Mar-2019	16:15	1.7	6.84	446	11.29	49	-	x						
TH19-KGS-15		9-Mar-2019	16:25	4.3	7.15	769	3.13	-71.5	-	x				x	x	
TH19-KGS-16		15-Mar-2019	9:00	-	-	-	-	-	-	x				x	x	
	TH19-KGS-500								-	x				x	x	
TH19-KGS-16B		9-Mar-2019	16:00	3	6.89	889	9.29	-46.4	-	x						
TH19-KGS-17		10-Mar-2019	16:10	3.6	7.58	640	2.3	-23	-	x				x	x	x
		12-Jun-2019	18:25	7.7	7.54	626	1.63	-2.08	-	x		x		x	x	x
		23-Oct-2019	12:40	3.5	7.41	633	3	124	-	x		x		x	x	x
		16-Jun-2020	12:15	8.3	7.03	686	2.64	-29	-	x		x		x	x	x
		27-Oct-2020	15:10	3.7	6.68	641	1.49	16.4	-	x		x		x	x	x
TH19-KGS-17A		10-Mar-2019	16:00	3.2	7.2	544	12.02	-30.7	-	x						
TH19-KGS-17B		10-Mar-2019	16:20	0.3	7.12	904	12.13	-31.8	-	x						
TH19-KGS-18		11-Mar-2019	13:50	5.6	6.7	957	2.26	-81.5	-	x				x	x	x
		12-Jun-2019	10:20	6.7	7.03	972	2.51	-16.8	-	x		x		x	x	x
		23-Oct-2019	11:45	4.6	6.65	1023	3.5	122.3	-	x		x		x	x	x
		16-Jun-2020	11:00	9.5	6.56	567	3.84	8.4	-	x		x		x	x	x
		27-Oct-2020	13:40	5	6.51	910	2.51	27.2	-	x		x		x	x	x
TH19-KGS-18A		11-Mar-2019	14:43	2.1	6.97	497	8.84	88.5	-	x						
TH19-KGS-19		11-Mar-2019	17:44	2.3	8.76	770	6.18	-93.2	-	x				x	x	x
		12-Jun-2019	9:50	13.4	7.79	915	4.3	-8.6	-	x		x		x	x	x
		23-Oct-2019	16:40	5.7	8.17	783	8.47	131.9	-	x		x		x	x	x
		17-Jun-2020	13:12	16.3	7.83	813	6.59	-15.5	-	x		x		x	x	x
		27-Oct-2020	11:40	4.7	7.06	947	8.07	2.6	-	x		x		x	x	x
TH19-KGS-19A		11-Mar-2019	17:21	2.3	7.07	787	2.5	-81.6	-	x						
TH19-KGS-20		14-Mar-2019	14:25	3.8	7.28	1008	1.97	-38.1	-	x				x	x	
	TH300								-	x				x	x	

TABLE 1
SUMMARY OF GROUNDWATER AND SURFACE WATER FIELD CHEMISTRY MEASUREMENTS AND COMPLETED LAB ANALYSES
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Duplicate Sample ID	Date	Time	Temp. (°C)	Field pH	Field E.C. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Laboratory Analysis Parameter Sets						
										ROU-4W+Metals [1]		Bacteria [2]	Surface Water Sample Set [3]	Isotopes		
														Stable		Radioactive
										Dissolved Metals	Total Metals			Oxygen-18 (^{18}O)	Deuterium (^{2}H)	Tritium (^{3}H)
GROUNDWATER SAMPLES																
Sentinel Well 1 - (SW19-KGS-01)		8-Mar-2019	13:30	5.7	7.7	940	-	-	-	x		x		x	x	x
		18-Jun-2020	11:25	5.2	7.08	784	0.34	41.2	-	x		x		x	x	x
Sentinel Well 2 - (SW19-KGS-02)		27-Sep-2019	10:50	9.7	8.4	1202	-	-	-	x		x		x		x
		18-Jun-2020	15:15	5	7.01	1102	0.56	1.5	-	x		x		x	x	x
		Oct. 29, 2020	12:25	4.9	7.3	1163	0.71	75	-	x		x		x	x	x
Sentinel Well 3 - (SW19-KGS-03)		27-Sep-2019	14:45	6.4	8.15	961	-	-	-	x		x		x		x
		18-Jun-2020	13:50	5.4	6.93	874	0.63	3.1	-	x		x		x	x	x
		Oct. 29, 2020	11:02	5.4	6.91	921	1.13	82.2	-	x		x		x	x	x
SURFACE WATER SAMPLES																
SW-R3		11-Jun-2019	14:00	17.8	8.58	456	6.97	17.5	-	x	x	x		x	x	x
		24-Oct-2019	11:40	1.4	7.06	180	13.7	148.8	-	x	x	x		x	x	x
		17-Jun-2020	12:03	22.5	8.04	286	8.3	-9.8	21.8				x	x	x	x
		28-Oct-2020	10:08	0.6	7.29	389	12.89	64.6	-				x	x	x	x
	SW-100												x	x	x	x
LSMOC - Inlet-1A		17-Jun-2020	17:00	24.05	8.5	793	6.06	-16	7.13				x	x	x	x
		28-Oct-2020	15:25	1	6.48	1278	12.5	93.9	8.33				x	x	x	x
LSMOC - Outlet-1A		17-Jun-2020	13:30	19.5	8	625	7.16	-6.6	6.22				x	x	x	x
		28-Oct-2020	12:45	0.1	6	415	12.5	27.1	17.51				x	x	x	x
BC-02		17-Jun-2020	17:35	25.9	8.42	407	6.45	-13.5	34.6				x	x	x	x
		28-Oct-2020	12:15	0.6	8.09	573	12.86	68.1	-				x	x	x	x
BC-05		17-Jun-2020	17:25	26.3	8.35	434	5.3	-23.9	60.7				x	x	x	x
		28-Oct-2020	11:45	0.4	7.78	630	11.23	71.6	12.76				x	x	x	x
CR3-1		17-Jun-2020	13:58	22.3	7.27	229	0.06	-20.3	0.38				x	x	x	x
		28-Oct-2020	11:20	0.1	6.98	281	6.53	67.1	-				x	x	x	x
CR3-2		17-Jun-2020	14:14	25.5	7.75	258	4.38	-22.2	5.03				x	x	x	x
		28-Oct-2020	11:04	0.7	7.1	291	5.58	62.5	-				x	x	x	x

Notes:

1. ROU-4W plus metals includes: conductivity, hardness, pH, TDS (calculated), turbidity, alkalinity, bicarbonate, carbonate, chloride, fluoride, hydroxide, nitrate and nitrite, sulfate, aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, cesium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, rubidium, selenium, silicon, silver, sodium, strontium, sulfur, tellurium, thallium, thorium, tin, titanium, tungsten, uranium, vanadium, zinc, and zirconium
2. Bacteria test includes: escherichia Coli and total coliforms
3. Surface water sample set includes: BTEX, F1-F4, conductivity, total nitrogen, mercury (dissolved and total), ammonia by colour, total phosphorus, total dissolved phosphorus, total suspended solids, and turbidity.

TABLE 2
GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
PW19-KGS-01	12-Mar-2019	15:40	245.485	246.125	1.908	244.217	-	-	
	11-Jun-2019	8:50			1.122	245.003	20.217	0.655	
	24-Oct-2019	13:00			0.43	245.695	-	-	
	17-Jun-2020	15:46			0.508	245.617	-	-	
	27-Oct-2020	9:03			0.883	245.242	-	-	
PWS19-KGS-02	11-Jun-2019	11:50	243.041	243.713	-0.837	244.55	-	0.88	Temporary 1.457 m casing added to measure flowing well; Measured 0.62 m below casing
	24-Oct-2019	-			Flowing	-	-	-	
	16-Jun-2020	17:20			Flowing	-	-	-	
	28-Oct-2020	17:20			Flowing	-	-	-	
PW19-KGS-03	14-Mar-2019	10:45	232.628	233.309	2.688	230.621	-	-	
	15-Mar-2019	13:28			2.677	230.632	-	-	
	11-Jun-2019	17:30			3.143	230.166	-	-	
	24-Oct-2019	8:54			2	231.309	-	-	
	17-Jun-2020	9:06			2.404	230.905	12.5	-	
	27-Oct-2020	16:30			2.903	230.406	-	-	
TH15-01A	26-Feb-2015	9:18	246.623	247.54	2.09	245.45	-	0.91	Final reading of multiple measurements taken in month
	1-May-2015	17:00			1.48	246.06	-	-	
	14-Sep-2015	-			2.395	245.145	-	-	
	15-Mar-2019	9:02			3.65	243.89	28.07	-	
	12-Jun-2019	14:05			2.865	244.675	28.07	0.897	
	24-Oct-2019	14:30			2.18	245.36	28.14	0.91	
	17-Jun-2020	-			2.335	245.205	28.075	-	Assumed static
	28-Oct-2020	16:00			2.927	244.613	28.02	-	
TH15-01B	26-Feb-2015	9:19	246.623	247.63	3.54	244.09	-	1.01	
	1-May-2015	17:00			3.805	243.825	-	-	
	14-Sep-2015	12:00			3.664	243.966	-	-	
	15-Mar-2019	9:08			4.705	242.925	9.734	-	Assumed static
	12-Jun-2019	14:05			4.314	243.316	9.734	1.01	
	24-Oct-2019	14:30			3.588	244.042	9.749	1.03	
	17-Jun-2020	-			4.208	243.422	9.733	-	Assumed static
	28-Oct-2020	16:00			4.354	243.276	9.681	-	
TH15-01C	26-Feb-2015	9:20	246.623	247.56	3.79	243.77	-	0.94	
	1-May-2015	17:00			3.965	243.595	-	-	
	14-Sep-2015	12:00			3.92	243.64	-	-	
	15-Mar-2019	9:08			4.57	242.99	5.28	-	
	12-Jun-2019	14:05			4.358	243.202	5.284	0.938	
	24-Oct-2019	14:30			3.531	244.029	5.27	0.93	
	17-Jun-2020	-			4.165	243.395	5.282	-	Assumed static
	28-Oct-2020	16:00			4.42	243.14	5.27	-	
TH15-02A	22-Feb-2015	11:23	235.763	236.664	1.7	234.964	-	0.88	
	1-May-2015	16:40			2.13	234.534	-	-	
	16-Sep-2015	12:00			2.409	234.255	-	-	
	15-Mar-2019	11:07			4.104	232.56	7.55	-	
	11-Jun-2019	-			2.666	233.998	7.557	0.88	
	23-Oct-2009	-			1.838	234.826	7.55	0.92	
	16-Jun-2020	15:42			2.520	234.144	7.555	-	
	28-Oct-2020	10:15			2.635	234.029	7.55	-	
TH15-03	23-Feb-2015	10:40	237.5096	238.297	2.830	235.467	-	0.79	
	1-May-2015	16:30			2.660	235.637	-	-	
	15-Mar-2019	10:54			3.798	234.499	-	-	Assumed static
	11-Jun-2019	-			3.531	234.766	7.508	-	
	23-Oct-2019	14:49			3.027	235.270	7.514	1.075	
	16-Jun-2020	15:48			3.260	235.037	7.508	-	Assumed static
	28-Oct-2020	10:30			3.374	234.923	7.5	-	
TH15-03A	23-Feb-2015	10:41	237.005	237.919	3.680	234.239	-	0.91	
	1-May-2015	16:30			3.000	234.919	-	-	Plugged at 2.09 m
	16-Sep-2015	12:00			3.600	234.319	-	-	
	15-Mar-2019	10:56			4.181	233.738	5.669	-	
	11-Jun-2019	-			3.683	234.236	5.667	-	
	23-Oct-2019	14:50			2.763	235.156	5.66	1.35	
	16-Jun-2020	15:48			3.486	234.433	5.667	-	
	28-Oct-2020	10:30			3.783	234.136	5.665	-	
TH15-04	24-Feb-2015	10:00	236.255	237.075	0.245	236.83	-	0.82	
	1-May-2015	16:20			0.27	236.805	-	-	
	16-Sep-2015	12:00			0.715	236.36	-	-	
	26-Feb-2019	-			2.22	234.855	-	-	
	14-Mar-2019	8:35			2.239	234.836	-	-	
	11-Jun-2019	13:15			1.19	235.885	12.923	0.883	
	19-Oct-2019	-			0	237.075	-	0.88	Installed packer
	16-Jun-2020	14:21			0.555	236.52	12.925	-	Removed packer and water still rising
	27-Oct-2020	17:30			0.695	236.38	-	-	Frozen

TABLE 2
GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
TH15-04A	24-Feb-2015	8:01	236.027	236.927	3	233.927	-	0.9	
	1-May-2015	16:20			2.26	234.667	-	-	Plugged at 1.36 m below grade
	16-Sep-2015	12:00			3.055	233.872	-	-	
	26-Feb-2019	-			3.76	233.167	-	-	
	8-Mar-2019	10:15			3.77	233.157	6.914	-	
	12-Jun-2019	13:15			2.901	234.026	6.91	1.029	
	23-Oct-2019	-			2.255	234.672	6.91	1.02	
	16-Jun-2020	14:16			2.945	233.982	6.912	-	
	27-Oct-2020	17:30			3.065	233.862	6.91	-	
TH15-05	24-Feb-2015	8:05	234.347	235.277	2.84	232.437	-	0.93	
	1-May-2015	16:10			2.3	232.977	-	-	Plugged at 1.37 m below grade
	16-Sep-2015	12:00			2.793	232.484	-	-	
	27-Feb-2019	-			3.2	232.077	-	-	
	8-Mar-2019	12:19			3.16	232.117	9.922	-	
	12-Jun-2019	13:09			3.08	232.197	9.949	1.162	
	23-Oct-2019	14:06			2.336	232.941	9.958	1.185	
	16-Jun-2020	14:07			2.705	232.572	9.996	-	
	27-Oct-2020	17:33			2.9	232.377	10	-	
TH15-05A	24-Feb-2015	8:06	234.306	235.206	2.850	232.356	-	0.9	
	1-May-2015	16:10			2.400	232.806	-	-	Plugged at 1.5 m below grade
	16-Sep-2015	12:00			2.786	232.420	-	-	
	8-Mar-2019	12:02			3.16	232.046	6.416	-	
	12-Jun-2019	13:05			3.033	232.173	6.412	1.105	
	23-Oct-2019	14:16			2.275	232.931	6.45	1.13	
	16-Jun-2020	14:08			Dry	-	2.64	-	Frozen
	27-Oct-2020	17:33			2.854	232.352	6.415	-	
TH15-06	24-Feb-2015	9:00	228.857	229.367	4.270	225.097	-	0.51	
	1-May-2015	16:00			3.590	225.777	-	-	
	16-Sep-2015	12:00			4.376	224.991	-	-	
	10-Mar-2019	8:52			5.356	224.011	9.562	-	
	12-Jun-2019	-			4.271	225.096	9.554	0.85	
	23-Oct-2019	13:15			3.642	225.725	-	-	
	16-Jun-2020	13:39			3.854	225.513	9.563	-	
	27-Oct-2020	15:35			4.23	225.137	9.541	-	
TH15-06A	24-Feb-2015	9:01	228.187	229.11	3.050	226.060	-	0.92	
	1-May-2015	16:00			2.340	226.770	-	-	
	16-Sep-2015	12:00			2.984	226.126	-	-	
	27-Feb-2019	12:00			4.550	224.560	-	-	
	10-Mar-2019	8:50			4.644	224.466	-	-	
	12-Jun-2019	-			3.022	226.088	5.59	1.05	
	23-Oct-2019	13:15			2.365	226.745	-	-	
	16-Jun-2020	13:38			2.499	226.611	5.595	-	
	27-Oct-2020	15:35			2.699	226.411	5.59	-	
TH15-07	10-Mar-2019	8:17	227.5264	228.664	3.415	225.249	9.977	-	
	12-Jun-2019	11:20			2.423	226.241	9.978	1.18	
	23-Oct-2019	-			2.005	226.659	9.993	1.145	
	16-Jun-2020	13:46			2.118	226.546	9.98	-	
	27-Oct-2020	15:30			2.29	226.374	9.98	-	
TH15-07A	24-Feb-2015	9:05	228.1296	228.917	1.160	227.757	-	-	
	1-May-2015	15:50			0.970	227.947	-	-	
	16-Sep-2015	12:00			1.298	227.619	-	-	
	10-Mar-2019	8:19			4.456	224.461	5.36	-	
	12-Jun-2019	11:20			1.33	227.587	5.359	0.919	
	23-Oct-2019	-			0.999	227.918	5.363	0.865	
	16-Jun-2020	13:46			1.11	227.807	5.36	-	
	27-Oct-2020	15:30			1.205	227.712	5.38	-	
TH15-08A	1-May-2015	15:40	227.3449	228.279	3.330	224.949	-	-	
	16-Sep-2015	12:00			4.105	224.174	-	-	
	10-Mar-2019	9:39			4.828	223.451	10.255	-	
	12-Jun-2019	11:28			4.048	224.231	10.245	1.128	
	23-Oct-2019	12:28			3.462	224.817	-	-	
	16-Jun-2020	13:12			3.577	224.702	10.26	-	
	27-Oct-2020	15:20			4.043	224.236	10.241	-	
TH15-08B	24-Feb-2015	9:10	227.3449	228.265	1.320	226.945	-	-	
	1-May-2015	15:40			1.115	227.150	-	-	
	16-Sep-2015	12:00			1.415	226.850	-	-	
	10-Mar-2019	9:42			2.247	226.018	5.356	-	
	12-Jun-2019	11:28			1.471	226.794	5.358	1.13	
	23-Oct-2019	13:00			1.16	227.105	-	-	
	16-Jun-2020	13:13			1.223	227.042	5.315	-	
	27-Oct-2020	15:20			1.335	226.930	5.386	-	

TABLE 2
GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
TH15-09A	1-May-2015	15:30	226.695	227.454	1.120	226.334	-	-	
	16-Sep-2015	12:00			1.305	226.149	-	-	
	10-Mar-2019	11:15			2.126	225.328	6.407	-	
	12-Jun-2019	11:37			1.36	226.094	6.363	0.904	
	23-Oct-2019	-			1.152	226.302	6.35	0.89	
	16-Jun-2020	13:07			1.195	226.259	6.332	-	
	27-Oct-2020	15:09			1.227	226.227	6.31	-	
TH15-09B	24-Feb-2015	9:25	226.695	227.42	1.425	225.995	-	-	
	1-May-2015	15:30			0.935	226.485	-	-	
	16-Sep-2015	12:00			1.169	226.251	-	-	
	26-Feb-2019	-			1.950	225.470	-	-	
	10-Mar-2019	11:20			1.985	225.435	3.779	-	
	12-Jun-2019	11:37			1.194	226.226	3.799	0.856	
	23-Oct-2019	-			1.004	226.416	3.78	0.84	
	16-Jun-2020	13:08			1.049	226.371	3.8	-	
	27-Oct-2020	15:09			1.078	226.342	3.78	-	
TH15-10A	1-May-2015	15:20	224.168	225.361	3.950	221.411	-	-	
	16-Sep-2015	12:00			2.386	222.975	-	-	
	25-Feb-2019	-			3.120	222.241	-	-	
	11-Mar-2019	13:36			3.158	222.203	10.44	-	
	12-Jun-2019	11:57			2.567	222.794	10.491	1.229	
	23-Oct-2019	-			1.993	223.368	10.495	-	
	16-Jun-2020	11:36			1.84	223.521	10.465	-	
	27-Oct-2020	14:15			2.086	223.275	10.41	-	
TH15-10B	1-May-2015	15:20	224.168	225.4	1.340	224.060	-	-	
	16-Sep-2015	12:00			1.715	223.685	-	-	
	25-Feb-2019	-			2.900	222.500	-	-	
	11-Mar-2019	13:39			2.901	222.499	6.029	-	
	12-Jun-2019	11:57			1.817	223.583	6.023	1.271	
	23-Oct-2019	-			1.38	224.020	6.02	-	
	16-Jun-2020	11:37			1.479	223.921	6.033	-	
	27-Oct-2020	14:15			1.579	223.821	6.003	-	
TH15-11A	1-May-2015	15:10	221.9015	222.62	1.460	221.160	-	-	
	16-Sep-2015	12:00			1.485	221.135	-	-	
	25-Feb-2019	-			1.970	220.650	-	-	
	13-Mar-2019	12:32			1.968	220.652	8.405	-	
	12-Jun-2019	11:00			1.44	221.180	8.405	0.91	
	23-Oct-2019	11:45			1.165	221.455	-	-	
	16-Jun-2020	11:30			1.093	221.527	8.41	-	
	27-Oct-2020	14:04			1.31	221.310	8.41	-	
TH15-11B	1-May-2015	15:10	221.9015	222.538	0.800	221.738	-	-	
	16-Sep-2015	12:00			1.095	221.443	-	-	
	25-Feb-2019	-			1.650	220.888	-	-	
	13-Mar-2019	12:34			1.653	220.885	4.706	-	
	12-Jun-2019	11:00			1.095	221.443	4.634	0.825	
	10/23/209	11:45			0.83	221.708	-	-	
	16-Jun-2020	11:30			0.902	221.636	4.64	-	
	27-Oct-2020	14:04			1.015	221.523	4.63	-	
TH15-12A	24-Feb-2015	14:01	221.082	222.052	1.580	220.472	-	-	
	1-May-2015	15:00			1.415	220.637	-	-	
	16-Sep-2015	12:00			1.690	220.362	-	-	
	25-Feb-2019	-			2.650	219.402	-	-	
	11-Mar-2019	17:01			2.67	219.382	7.581	-	
	12-Jun-2019	19:20			1.779	220.273	7.563	1.09	
	23-Oct-2019	10:27			1.16	220.892	-	-	
	16-Jun-2020	10:00			1.517	220.535	7.485	-	
	27-Oct-2020	10:30			1.63	220.422	7.43	-	
TH15-12B	24-Feb-2015	14:02	221.082	222.092	1.320	220.772	-	-	
	1-May-2015	15:00			1.185	220.907	-	-	
	16-Sep-2015	12:00			1.382	220.710	-	-	
	25-Feb-2019	-			2.070	220.022	-	-	
	11-Mar-2019	17:00			2.081	220.011	5.3	-	
	12-Jun-2019	19:20			1.421	220.671	5.312	1.14	
	23-Oct-2019	10:27			1.47	220.622	-	-	
	16-Jun-2020	10:02			1.558	220.534	5.273	-	
	27-Oct-2020	10:30			1.667	220.425	5.22	-	
TH19-KGS-01	9-Mar-2019	9:33	245.457	245.915	1.688	244.227	21.753	-	
	11-Jun-2019	9:28			0.993	244.922	21.79	0.525	
	24-Oct-2019	13:00			0.3	245.615	21.8	0.45	
	9-Mar-2020	17:15			1.14	244.775	-	0.33	
	17-Jun-2020	-			0.38	245.535	21.8	0.45	
	27-Oct-2020	10:00			0.75	245.165	21.78	-	

TABLE 2
GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
TH19-KGS-02	13-Mar-2019	7:40	245.172	246.287	2.08	244.207	-	-	
	11-Jun-2019	9:15			2.017	244.27	-	1.035	
	24-Oct-2019	13:00			0.575	245.712	19.143	1.03	
	9-Mar-2020	15:37			1.33	244.957	19.14	0.912	
	17-Jun-2020	15:30			0.68	245.607	19.125	-	
	27-Oct-2020	9:06			0.54	245.747	-	-	Frozen
TH19-KGS-02b	9-Mar-2019	8:20	245.204	245.992	2.44	243.552	8.354	-	
	11-Jun-2019	9:20			1.729	244.263	-	0.943	Frozen
	24-Oct-2019	-			0.936	245.056	8.36	0.89	
	9-Mar-2020	16:07			0.863	245.129	-	0.8	Frozen
	17-Jun-2020	15:35			1.02	244.972	8.35	-	
	27-Oct-2020	9:06			1.276	244.716	-	-	
TH19-KGS-03a	8-Mar-2019	18:10	245.388	246.316	1.562	244.754	2.5	-	
	11-Jun-2019	10:28			1.264	245.052	1.634	0.965	
	24-Oct-2019	15:15			1.126	245.19	2.489	-	
	17-Jun-2020	18:25			1.24	245.076	2.44	-	
	28-Oct-2020	16:26			1.305	245.011	2.47	-	
TH19-KGS-04	9-Mar-2019	11:45	244.935	245.671	1.519	244.152	23.835	-	
	11-Jun-2019	11:07			0.81	244.861	23.829	-	
	24-Oct-2019	15:00			0.14	245.531	23.834	0.82	
	17-Jun-2020	17:45			0.26	245.411	23.91	-	
	10/28/20120	16:00			0.59	245.081	-	-	
TH19-KGS-04a	11-Jun-2019	11:07	245.011	245.802	0.18	245.622	-	-	Reading taken below ground surface due to damaged well
	24-Oct-2019	-			0.945	244.857	2.138	-	
	17-Jun-2020	17:45			1.055	244.747	2.01	-	
	28-Oct-2020	16:00			1.095	244.707	1.89	-	
TH19-KGS-07	7-Mar-2019	9:32	243.215	243.992	0.063	243.929	11.49	-	Frozen
	11-Jun-2019	9:30			Flowing	-	-	1.53	Added 0.48 m casing; still flowing with extension installed
	24-Oct-2019	-			Flowing	-	-	-	Added 1.575 m extension; still flowing. Installed packer
	17-Jun-2020	17:43			-	-	-	-	Damaged well
	28-Oct-2020	16:40			Flowing	-	-	-	Damaged well
TH19-KGS-07a	7-Mar-2019	7:30	243.193	244.042	1.045	242.997	2.642	-	Frozen
	11-Jun-2019	9:45			1.032	243.01	2.639	-	
	24-Oct-2019	-			0.83	243.212	-	-	
	28-Oct-2020	16:45			1.06	242.982	-	-	Soft bottom
TH19-KGS-08	8-Mar-2019	14:04	233.734	234.612	Flowing	-	19.188	-	Artesian conditions
	12-Jun-2019	12:50			Flowing	-	19.191	1.072	Artesian conditions remain after adding 1.55 m casing extension
	23-Oct-2019	-			Flowing	-	-	-	Artesian conditions remain after adding 1.53 m casing extension
	16-Jun-2020	14:00			Flowing	-	19.205	-	Artesian conditions remain after adding 1.83 m casing extension
	27-Oct-2020	17:30			0	234.612	-	-	Frozen at top of pipe
TH19-KGS-08a	8-Mar-2019	14:59	234.217	234.921	Dry	-	2.48	-	
	12-Jun-2019	12:50			2.428	232.493	2.48	0.73	
	23-Oct-2019	-			1.75	233.171	2.49	0.62	
	28-Oct-2020	10:50			2.435	232.486	2.48	-	
TH19-KGS-09	12-Mar-2019	13:54	241.489	242.617	0.047	242.57	18.898	-	
	11-Jun-2019	-			-0.643	243.26	-	-	Removed 0.544 m of casing and added 1.55 m of temporary casing (1.011 m) to measure flowing well; measured 0.363 m below added height
	23-Oct-2019	-			-1.25	243.867	-	-	Added casing
	16-Jun-2020	17:00			-0.63	243.247	18.765	1.17	Added casing; new stickup of 1.17m
	28-Oct-2020	14:30			0	242.617	-	-	Frozen at top of pipe
TH19-KGS-10	9-Mar-2019	16:50	228.82	229.858	5.28	224.578	14.575	-	
	12-Jun-2019	12:27			4.174	225.684	14.57	1.029	
	23-Oct-2019	15:27			3.441	226.417	14.574	1.025	
	16-Jun-2020	13:24			3.645	226.213	14.575	-	
	27-Oct-2020	15:43			4.033	225.825	14.59	-	
TH19-KGS-10a	9-Mar-2019	16:52	229.115	229.918	2.06	227.858	2.187	-	
	12-Jun-2019	12:27			1.362	228.556	2.188	0.893	
	23-Oct-2019	-			1.168	228.75	2.195	0.869	
	16-Jun-2020	13:22			1.31	228.608	2.19	-	
	27-Oct-2020	15:22			1.375	228.543	2.19	-	
TH19-KGS-100	7-Mar-2019	13:38	240.653	241.741	1.405	240.336	2.948	-	Frozen
	11-Jun-2019	13:40			1.253	240.488	2.939	1.16	
	23-Oct-2019	17:36			1.053	240.688	2.933	1.16	
	16-Jun-2020	16:16			1.161	240.58	2.936	-	
	28-Oct-2020	15:15			1.187	240.554	-	-	Frozen
TH19-KGS-11	8-Mar-2019	8:08	236.92	237.915	1.932	235.983	16.815	-	Frozen
	11-Jun-2019	14:55			0.76	237.155	17.808	1.03	
	23-Oct-2019	16:55			0	237.915	16.82	1.075	Installed packer
	16-Jun-2020	15:31			1.78	236.135	16.812	-	Removed packer
	28-Oct-2020	13:51			-	-	-	-	Frozen at 0.22 m

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GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
TH19-KGS-11a	8-Mar-2019	8:50	236.432	237.153	1.631	235.522	2.53	-	
	11-Jun-2019	14:58			1.142	236.011	2.532	0.82	
	23-Oct-2019	16:55			0.786	236.367	2.54	0.8	
	28-Oct-2020	13:51			1.111	236.042	2.528	-	
TH19-KGS-12	7-Mar-2019	14:50	240.795	241.779	5.294	236.485	15.87	-	
	11-Jun-2019	14:00			4.1	237.679	-	-	
	23-Oct-2019	15:31			2.501	239.278	18.87	1.07	
	16-Jun-2020	14:39			3.142	238.637	15.92	-	
	28-Oct-2020	12:30			3.6	238.179	15.91	-	
TH19-KGS-12b	12-Mar-2019	-	240.834	241.897	0.18	241.717	9.659	-	GWL taken after removing frozen packer
	11-Jun-2019	-			2.751	239.146	9.655	1.17	
	23-Oct-2019	15:06			2.061	239.836	9.655	1.195	
	16-Jun-2020	14:35			2.62	239.277	9.652	-	
	28-Oct-2020	12:30			2.08	239.817	9.65	-	
TH19-KGS-13	7-Mar-2019	15:55	237.054	238.001	2.045	235.956	14.613	-	
	11-Jun-2019	14:25			0.891	237.11	14.615	0.964	
	23-Oct-2019	-			-0.87	238.871	-	-	Temporary 1.53 m casing added to measure flowing well; Measured 0.66 m below added casing height
	16-Jun-2020	15:55			-0.04	238.041	14.62	-	Temporary 1.83 m casing added to measure flowing well; Measured 1.790m below added casing height
	28-Oct-2020	13:41			-	-	-	-	Frozen at 0.28
TH19-KGS-13a	7-Mar-2019	16:29	237.025	237.81	1.37	236.44	2.172	-	
	11-Jun-2019	-			0.99	236.82	2.1	0.99	
	23-Oct-2019	-			0.745	237.065	2.16	0.73	
	16-Jun-2020	15:55			0.96	236.85	2.15	-	
	28-Oct-2020	13:43			1.02	236.79	2.14	-	
TH19-KGS-14	8-Mar-2019	15:40	232.921	233.994	1.65	232.344	11.794	-	
	11-Jun-2019	15:30			1.031	232.963	11.79	1.118	
	24-Oct-2019	11:07			-0.046	234.04	-	-	Temporary 1.596 m casing added to measure flowing well; Measured 1.55 m below casing height
	17-Jun-2020	9:17			-	-	-	-	Packer stuck in casing
	28-Oct-2020	9:24			-	-	-	-	Packer stuck in casing
TH19-KGS-14a	8-Mar-2019	15:50	233.008	233.894	1.82	232.074	2.485	-	
	11-Jun-2019	17:07			1.319	232.575	2.485	1.008	
	24-Oct-2019	11:00			1.068	232.826	-	-	
	17-Jun-2020	10:59			1.216	232.678	2.482	-	
	28-Oct-2020	9:13			1.34	232.554	-	-	
TH19-KGS-15	8-Mar-2019	17:11	232.609	233.818	3.258	230.56	11.453	-	
	11-Jun-2019	17:00			3.82	229.998	11.447	-	
	24-Oct-2019	11:43			2.958	230.86	11.457	1.235	
	17-Jun-2020	10:43			3.36	230.458	11.452	-	
	27-Oct-2020	16:10			3.664	230.154	-	-	
TH19-KGS-16	15-Mar-2019	11:52	233.038	233.807	1.411	232.396	-	-	
	11-Jun-2019	16:37			0.27	233.537	10.264	-	
	24-Oct-2019	10:00			-0.855	234.662	10.27	0.956	Temporary 1.575 m casing added to measure flowing well; Measured 0.72 m below added casing height
	17-Jun-2020	12:43			-0.1	233.907	-	-	Temporary 1.83 m casing added to measure flowing well; Measured 1.73 m below added casing height
	27-Oct-2020	16:30			0.024	233.783	-	-	Frozen; GWL taken after thawing and installation of 0.024 m of casing
TH19-KGS-16a	9-Mar-2019	15:27	232.602	233.694	Dry	-	2.612	-	
	11-Jun-2019	11:13			2.594	231.1	2.612	1.08	
	24-Oct-2019	10:00			2.565	231.129	2.615	1.072	
	17-Jun-2020	12:06			2.57	231.124	2.615	-	
	27-Oct-2020	16:30			2.57	231.124	2.615	-	
TH19-KGS-16b	9-Mar-2019	16:30	232.907	234.023	3.404	230.619	3.983	-	
	11-Jun-2019	16:37			3.601	230.422	3.981	-	
	24-Oct-2019	10:00			3.255	230.768	3.99	1.14	
	17-Jun-2020	12:03			3.533	230.49	3.982	-	
	28-Oct-2020	8:46			3.498	230.525	3.982	-	
TH19-KGS-17	10-Mar-2019	11:50	225.028	225.698	3.292	222.406	12.745	-	
	11-Jun-2019	17:59			2.475	223.223	-	-	
	24-Oct-2019	12:08			1.77	223.928	-	0.75	
	16-Jun-2020	11:58			2.014	223.684	12.755	-	
	27-Oct-2020	14:36			2.5	223.198	12.74	-	
TH19-KGS-17a	10-Mar-2019	11:48	225.238	225.829	1.866	223.963	2.14	-	
	11-Jun-2019	17:59			1.188	224.641	2.14	0.736	
	24-Oct-2019	12:04			0.828	225.001	-	0.695	
	16-Jun-2020	11:53			0.916	224.913	2.14	-	
	27-Oct-2020	14:40			1.039	224.79	2.15	-	
TH19-KGS-17b	10-Mar-2019	11:52	225.26	226.09	7.648	218.442	8.428	-	
	13-Mar-2019	13:26			1.884	224.206	-	-	Not static
	11-Jun-2019	17:57			1.731	224.359	8.414	0.998	
	24-Oct-2019	12:00			1.316	224.774	-	1.065	
	16-Jun-2020	11:55			1.34	224.75	8.415	-	
	27-Oct-2020	14:40			1.495	224.595	8.415	-	

TABLE 2
GROUNDWATER ELEVATION MEASUREMENTS
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Date	Time	Ground Elevation (m)	Top of Casing Elevation (m)	Depth to Water from Top of Casing (m)	Groundwater Elevation (m)	Depth To Bottom from Top of Casing (m)	Stickup Height (m)	Comments
TH19-KGS-18	11-Mar-2019	14:22	221.4033	222.447	3.46	218.987	13.123	-	
	11-Jun-2019	18:48			2.965	219.482	-	-	
	23-Oct-2019	12:00			2.667	219.78	-	1.18	
	16-Jun-2020	11:00			1.188	221.259	2.488	-	Pipe possibly broken or blocked
	27-Oct-2020	12:43			2.975	219.472	13.02	-	
TH19-KGS-18a	11-Mar-2019	14:43	221.427	222.157	0.801	221.356	2.123	-	
	11-Jun-2019	-			1.058	221.099	1.23	0.84	Frozen
	23-Oct-2019	10:45			0.78	221.377	-	0.862	
	16-Jun-2020	11:00			0.95	221.207	1.98	-	
	27-Oct-2020	12:43			0.93	221.227	1.45	-	
TH19-KGS-19	11-Mar-2019	16:00	220.585	221.487	2.623	218.864	12.362	-	
	11-Jun-2019	19:15			2.098	219.389	8.38	0.945	
	23-Oct-2019	10:00			2.692	218.795	-	1.08	
	16-Jun-2020	9:19			1.755	219.732	8.46	-	
	27-Oct-2020	11:34			2.125	219.362	-	-	
TH19-KGS-19a	11-Mar-2019	16:52	221.013	221.932	1.875	220.057	2.558	-	
	11-Jun-2019	18:45			1.2	220.732	2.55	1.04	
	23-Oct-2019	10:30			0.995	220.937	-	1.025	
	16-Jun-2020	10:04			1.065	220.867	2.55	-	
	27-Oct-2020	10:30			1.16	220.772	2.545	-	
TH19-KGS-20	14-Mar-2019	13:51	242.523	243.285	0.799	242.486	25.79	-	GWL measurement taken after removal of packer
	12-Jun-2019	-			1.525	241.76	25.69	0.905	Added casing
	24-Oct-2019	-			-0.795	244.08	25.83	0.95	Temporary 1.570 m casing added to measure flowing well; Measured 0.795 below added casing height
	17-Jun-2020	-			-0.71	243.995	-	-	Temporary 1.83 m casing added to measure flowing well; Measured 1.12 m below added casing height
	28-Oct-2020	-			-	-	-	-	Frozen plug
TH20-KGS-01	22-Feb-2020	12:00	245.143	246.142	0.9	245.242	-	-	Measurements taken one day after installation
	2-Mar-2020	11:33			0.89	245.252	-	-	Frozen
	17-Jun-2020	17:36			0.68	245.462	19.01	-	
	28-Oct-2020	14:30			-	-	-	-	Frozen at 1.012
TH20-KGS-02	2-Mar-2020	-	244.922	245.88	0.39	245.49	-	-	Frozen
	17-Jun-2020	17:59			0.485	245.395	2.38	-	Frozen
	28-Oct-2020	14:45			-	-	-	-	Frozen at 0.45 m
TH20-KGS-03	24-Feb-2020	7:40	245.021	246.07	1.42	244.65	-	-	GWL measurement taken 30 minutes after installation
	2-Mar-2020	-			0.88	245.19	-	-	Frozen
	17-Jun-2020	18:00			0.62	245.45	20.39	-	Soft bottom
	28-Oct-2020	14:45			0.926	245.144	-	-	Frozen
TH20-KGS-04	25-Feb-2020	7:40	245.172	246.136	1.25	244.886	-	-	GWL measurement taken on same day as installation
	2-Mar-2020	-			1.03	245.106	-	-	Frozen
	17-Jun-2020	18:13			0.69	245.446	16.32	-	Soft bottom
	28-Oct-2020	15:30			-	-	-	-	Frozen at 1.012
TH20-KGS-05	26-Feb-2020	7:40	245.202	246.105	1.09	245.015	-	-	GWL measurement taken 30 minutes after installation
	2-Mar-2020	-			0.92	245.185	-	-	Frozen
	9-Mar-2020	16:52			1.125	244.98	16.14	0.84	
	13-Mar-2020	-			1.05	245.055	-	-	
	17-Jun-2020	18:35			0.61	245.495	3.72	-	Frozen
	28-Oct-2020	15:00			-	-	-	-	Frozen at 0.865 m
TH20-KGS-06b	5-Mar-2020	9:30	245.399	246.611	1.525	245.086	-	-	
	9-Mar-2020	12:00			1.51	245.101	-	1.173	
	13-Mar-2020	12:57			-	-	-	-	
	17-Jun-2020	16:03			1.12	245.491	19.2	-	
	27-Oct-2020	10:00			1.45	245.161	20.01	-	
TH20-KGS-07	5-Mar-2020	12:00	245.404	246.37	0.44	245.93	-	-	
	9-Mar-2020	17:50			0.51	245.86	-	0.91	
	13-Mar-2020	-			1.293	245.077	-	-	
	17-Jun-2020	15:40			0.845	245.525	18.3	-	
	27-Oct-2020	9:30			1.205	245.165	18.29	-	
TH20-KGS-08	9-Mar-2020	18:05	245.357	246.298	1.18	245.118	-	0.908	
	13-Mar-2020	-			1.215	245.083	-	-	
	17-Jun-2020	-			0.785	245.513	17.75	-	
	27-Oct-2020	9:18			1.139	245.159	17.75	-	
Sentinel Well 1	8-Mar-2019	17:50	-	-	2.530	-	-	-	To be surveyed in winter/spring 2021
	18-Jun-2020	11:05			1.39	-	13.304	0.64	To be surveyed in winter/spring 2021
Sentinel Well 2	18-Jun-2020	-	-	-	Flowing	-	16.2	0.53	To be surveyed in winter/spring 2021
Sentinel Well 3	18-Jun-2020	13:23	-	-	0.273	-	14.05	0.74	To be surveyed in winter/spring 2021

Notes:
1. "-" = no value

TABLE 3
GENERAL WATER QUALITY
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																						
				pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Fluoride	Sulphate	Ammonia	Unionized Ammonia [2]	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Sodium	Total Phosphorus	Phosphorus - Total Dissolved	T.D.S.	T.S.S.	T.K.N.	Turbidity (NTU)	E. Coli	Total Coliform (MPN/100mL)
HC-CDWQ [3]																										
Drinking Water - MAC				-	-	-	-	-	-	-	-	1.5	-	-	-	-	10 [9]	1.0 [9]	-	-	-	-	-	-	0.1/0.3/1.0 [13]	None Detectable per 100 mL	None Detectable per 100 mL
Drinking Water - AO				7.0 - 10.5	-	-	-	-	-	80-100[5]	250	-	500	-	-	-	-	-	200	-	-	500	-	-	-	-	-
CCME [4] - Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				6.5 - 9.0	-	-	-	-	-	-	120 [6a] 640 [6b]	0.12 [7]	-		0.019 [8]	-	3 [10a] 124 [10b]	0.06	-	[11]	-	-	[12]	-	Narrative [14]	-	-
GROUNDWATER SAMPLES																										
PW19-KGS-01		12-Mar-2019	L2245232-28	8.16	741	329	401	<0.60	<0.34	366	13.4	**0.249**	78.9	-	-	0.0093	0.0093	<0.0010	31.3	<0.030	-	437	-	-	1.04	0	0
		11-Jun-2019	L2290890-1	7.65	705	338	412	<0.60	<0.34	353	9.05	**0.263**	77.0	-	-	<0.0051	<0.0050	<0.0010	27.9	<0.030	-	428	-	-	1.12	0	0
		24-Oct-2019	L2371920-1	8.18	694	363	443	<0.60	<0.34	420	9.35	**0.305**	78.6	-	-	<0.0051	<0.0050	<0.0010	28.0	0.037	-	467	-	-	78.3	0	0
	PW-200		L2371920-4	8.21	697	357	436	<0.60	<0.34	431	9.87	**0.302**	79.3	-	-	<0.0051	<0.0050	<0.0010	29.0	<0.030	-	469	-	-	81.2	0	0
	RPD			0.4%	0.4%	1.7%	1.6%	NC	NC	2.6%	5.4%	1.0%	0.9%	-	-	NC	NC	NC	*3.5%*	*NC*	*NC*	*0.4%*	*NC*	*NC*	3.6%	*NC*	*NC*
		17-Jun-2020	L2463404-1	7.89	866	378	461	<0.60	<0.34	396	29.0	**0.339**	87.5	-	-	<0.0051	<0.0050	<0.0010	45.4	<0.030	-	515	-	-	3.20	0	0
		27-Oct-2020	L2523514-1	8.26	726	327	398	<0.60	<0.34	336	9.46	**0.251**	70.5	-	-	<0.0051	<0.0050	<0.0010	26.9	<0.030	-	409	-	-	1.91	0	0
PW19-KGS-02		13-Mar-2019	L2245232-26	8.14	744	336	410	<0.60	<0.34	372	12.6	**0.289**	88.2	-	-	<0.0051	<0.0050	<0.0010	33.9	<0.030	-	455	-	-	233	0	0
	PW19-KGS-05		L2245232-27	8.18	755	329	401	<0.60	<0.34	380	12.6	**0.280**	88.8	-	-	<0.010	<0.010	<0.0020	34.1	<0.030	-	454	-	-	180	0	0
	RPD			*0.5%*	*1.5%*	*2.1%*	*2.2%*	*NC*	*NC*	*2.1%*	*0.0%*	*3.2%*	*0.7%*	-	-	*NC*	*NC*	*NC*	*0.6%*	*NC*	*NC*	*0.2%*	*NC*	*NC*	*25.7%*	*NC*	*NC*
		11-Jun-2019	L2290890-2	7.79	735	327	399	<0.60	<0.34	362	14.1	**0.317**	89.0	-	-	<0.0051	<0.0050	<0.0010	35.7	<0.030	-	449	-	-	2.57	0	0
		24-Oct-2019	L2371920-2	8.22	729	366	446	<0.60	<0.34	371	8.52	**0.339**	93.1	-	-	0.0082	0.0082	<0.0010	31.9	<0.030	-	471	-	-	1.33	0	3
		16-Jun-2020	L2462330-4	8.32	736	334	399	3.96	<0.34	378	10.9	**0.310**	89.6	-	-	<0.0051	<0.0050	<0.0010	32.9	<0.030	-	453	-	-	1.13	0	0
		28-Oct-2020	L2523514-2	8.24	787	329	401	<0.60	<0.34	344	16.9	**0.330**	85.5	-	-	<0.0051	<0.0050	<0.0010	34.5	<0.030	-	444	-	-	2.96	0	0
	PW-100		L2523514-8	8.08	790	326	398	<0.60	<0.34	350	16.8	**0.344**	85.4	-	-	<0.0051	<0.0050	<0.0010	35.7	<0.030	-	445	-	-	2.47	0	0
	RPD			*2.0%*	*0.4%*	*0.9%*	*0.8%*	*NC*	*NC*	*1.7%*	*0.6%*	*4.2%*	*0.1%*	-	-	*NC*	*NC*	*NC*	*3.4%*	*NC*	*NC*	*0.2%*	*NC*	*NC*	*18.0%*	*NC*	*NC*
PW19-KGS-03		14-Mar-2019	L2245232-24	8.17	626	335	409	<0.60	<0.34	362	1.06	**0.197**	36.8	-	-	0.016	0.016	<0.0020	8.44	<0.030	-	364	-	-	2.75	0	5
	PW19-KGS-04		L2245232-25	8.22	622	333	406	<0.60	<0.34	361	1.01	**0.212**	37.2	-	-	0.0123	0.0123	<0.0010	8.45	<0.030	-	362	-	-	2.41	-	-
	RPD			*0.6%*	*0.6%*	*0.6%*	*0.7%*	*NC*	*NC*	*0.3%*	*4.8%*	*7.3%*	*1.1%*	-	-	*26.1%*	*26.1%*	*NC*	*0.1%*	*NC*	*NC*	*0.6%*	*NC*	*NC*	*13.2%*	*NC*	*NC*
		11-Jun-2019	L2290890-3	7.71	606	330	402	<0.60	<0.34	344	1.12	**0.175**	31.3	-	-	<0.0051	<0.0050	<0.0010	8.58	<0.030	-	349	-	-	2.16	0	0
	PW19-KGS-200		L2290890-4	7.71	609	333	406	<0.60	<0.34	348	1.15	**0.176**	31.8	-	-	<0.0051	<0.0050	<0.0010	8.60	<0.030	-	352	-	-	2.33	0	0
	RPD			*0.0%*	*0.5%*	*0.9%*	*1.0%*	*NC*	*NC*	*1.2%*	*2.6%*	*0.6%*	*1.6%*	-	-	*NC*	*NC*	*NC*	*0.2%*	*NC*	*NC*	*0.9%*	*NC*	*NC*	*7.6%*	*NC*	*NC*
		24-Oct-2019	L2371920-3	8.11	550	331	403	<0.60	<0.34	327	0.91	**0.181**	31.8	-	-	<0.0051	<0.0050	<0.0010	3.76	<0.030	-	344	-	-	1.06	0	130
		17-Jun-2020	L2462330-5	8.24	536	300	365	<0.60	<0.34	314	0.86	**0.199**	25.8	-	-	<0.0051	<0.0050	<0.0010	5.83	<0.030	-	313	-	-	2.10	0	200
	PW19-KGS-300		L2462330-6	8.23	535	298	363	<0.60	<0.34	315	0.87	**0.198**	25.9	-	-	<0.0051	<0.0050	<0.0010	5.72	<0.030	-	312	-	-	1.37	0	165
	RPD			*0.1%*	*0.2%*	*0.7%*	*0.5%*	*NC*	*NC*	*0.3%*	*1.2%*	*0.5%*	*0.4%*	-	-	*NC*	*NC*	*NC*	*1.9%*	*NC*	*NC*	*0.3%*	*NC*	*NC*	*42.1%*	*NC*	*19.2%*
		27-Oct-2020	L2523514-3	8.21	608	318	388	<0.60	<0.34	318	0.99	**0.202**	27.1	-	-	<0.0051	<0.0050	<0.0010	7.05	<0.030	-	329	-	-	0.82	0	0
Sentinel Well 1 - (SW19-KGS-01)		18-Jun-2020	L2463404-2	8.29	700	330	400	1.08	<0.34	368	9.60	**0.273**	80.4	-	-	<0.0051	<0.0050	<0.0010	27.3	<0.030	-	432	-	-	0.52	0	0
		8-Mar-2019	L2242160-1	7.68	881	395	482	<0.60	<0.34	406	26.20	**0.324**	80.9	-	-	<0.0051	0.0051	<0.0010	48.0	<0.030	-	520	-	-	32.9	0	0
Sentinel Well 2 - (SW19-KGS-02)		27-Sep-2019	L2356084-1	8.27	1170	349	426	<0.60	<0.34	432	91.4	**0.269**	198	-	-	<0.010	<0.010	<0.0020	111	<0.030	-	748	-	-	62.0	0	4
		18-Jun-2020	L2463404-3	8.26	1180	345	421	<0.60	<0.34	449	97.2	**0.284**	204	-	-	<0.010	<0.010	<0.0020	107	<0.030	-	759	-	-	0.91	0	0
		29-Oct-2020	L2523514-9	8.06	1240	340	415	<0.60	<0.34	424	89.0	**0.291**	187	-	-	<0.0051	<0.0050	<0.0010	106	<0.030	-	722	-	-	1.17	0	0
Sentinel Well 3 - (SW19-KGS-03)		27-Sep-2019	L2356084-2	8.15	913	386	471	<0.60	<0.34	407	40.5	**0.287**	115	-	-	<0.010	<0.010	0.0049	61.9	<0.030	-	576	-	-	83.4	0	6
		18-Jun-2020	L2463404-4	8.33	930	373	447	3.96	<0.34	420	42.4	**0.308**	117	-	-	<0.010	<0.010	<0.0020	58.5	<0.030	-	576	-	-	1.29	0	0
		29-Oct-2020	L2523514-10	8.03	979	374	456	<0.60	<0.34	407	39.3	**0.319**	109	-	-	<0.0051	<0.0050	<0.0010	59.8	<0.030	-	562	-	-	1.44	0	2
TH15-04		8-Mar-2019	L2245232-4	7.90	470	237	289	<0.60	<0.34	241	1.93	**0.272**	35.4	-	-	0.0178	0.0159	0.0019	19.3	<0.030	-	275	-	-	1630	-	-
TH15-05		8-Mar-2019	L2245232-6	7.80	577	341	416	<0.60	<0.34	338	0.89	**0.231**	22.1	-	-	<0.0051	<0.0050	<0.0010	6.91	<0.030	-	342	-	-	>4000	-	-
TH19-KGS-01B		9-Mar-2019	L2245232-12	8.14	773	376	458	<0.60	<0.34	376	21.6	**0.287**	94.7	-	-	<0.010	<0.010	<0.0020	38.4	<0.030	-	497	-	-	>4000	-	-
TH19-KGS-02B		11-Mar-2019	L2245232-18	8.07	1970	269	328	<0.60	<0.34	834	93.9	**0.32**	737	-	-	<0.051	<0.050	0.014	178	<0.030	-	1430	-	-	1180	-	-
TH19-KGS-03A		8-Mar-2019	L2245232-40	8.05	650	360	439	<0.60	<0.34	367	13.6	**0.199**	11.1	-	-	0.0502	0.0442	0.0060	14.0	0.092	-	373	-	-	>4000	-	-
TH19-KGS-04		9-Mar-2019	L2245232-7	7.99	987	346	423	<0.60	<0.34	438	54.2	**0.281**	164	-	-	<0.010	<0.010	<0.0020	69.3	<0.030	-	632	-	-	347	-	-
TH19-KGS-07		7-Mar-2019	L2245232-11	8.16	654	303	369	<0.60	<0.34	331	14.9	**0.600**	64.8	-	-	<0.0051	<0.0050	<0.0010	28.2	<0.030	-	391	-	-	101	-	-
TH19-KGS-07A		7-Mar-2019	L2245232-10	7.74	689	434	530	<0.60	<0.34	393	4.31	**0.373**	12.2	-	-	0.018	0.0129	0.0051	10.2	0.053	-	419	-	-	>4000	-	-
TH19-KGS-08		8-Mar-2019	L2245232-36	8.19	600	341	416	<0.60	<0.34	352	1.07	**0.237**	22.1	-	-	0.006	0.0060	<0.0010	7.17	<0.030	-	347	-	-	267	-	-
TH19-KGS-09		12-Mar-2019	L2245232-2	7.98	737	377	460	<0.60	<0.34	417	3.81	**0.222**	77.7	-	-	<0.010	<0.010	<0.0020	21.6	<0.030	-	460	-	-	745	-	-
TH19-KGS-10		9-Mar-2019	L2245232-5	7.98	669	415	506	<0.60	<0.34	403	1.38	**0.329**	21.7	-	-	0.0052	0.0052	<0.0010	8.14	<0.030	-	404	-	-	>4000	-	-
	TH200		L2245232-30	8.11	691	414	505	<0.60	<0.34	412	1.36	**0.320**	21.6	-	-	<0.0051	<0.0050	<0.0010	8.22	<0.030	-	406	-	-	>4000	-	-
	RPD			*1.6%*	*3.2%*	*0.2%*	*0.2%*	*NC*	*NC*	*2.2%*	*1.5%*	*2.8%*	*0.5%*	-	-	*NC*	*NC*	*NC*	*1.0%*	*NC*	*NC*	*0.5%*	*NC*	*NC*	*NC*	*NC*	*NC*

TABLE 3
GENERAL WATER QUALITY
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																					
				pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Fluoride	Sulphate	Ammonia	Unionized Ammonia [2]	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Sodium	Total Phosphorus	Phosphorus - Total Dissolved	T.D.S.	T.S.S.	T.K.N.	Turbidity (NTU)	E. Coli	Total Coliform (MPN/100mL)
HC-CDWQ [3]																										
Drinking Water - MAC				-	-	-	-	-	-	-	-	1.5	-	-	-	-	10 [9]	1.0 [9]	-	-	-	-	-	-	0.1/0.3/1.0 (13)	None Detectable per 100 mL	None Detectable per 100 mL
Drinking Water - AO				7.0 - 10.5	-	-	-	-	-	80-100 [5]	250	-	500	-	-	-	-	-	200	-	-	500	-	-	-	-	-
CCME [4] - Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				6.5 - 9.0	-	-	-	-	-	-	120 [6a] 640 [6b]	0.12 [7]	-		0.019 [8]	-	3 [10a] 124 [10b]	0.06	-	(11)	-	-	(12)	-	Narrative (14)	-	-
TH19-KGS-100		7-Mar-2019	L2245232-41	7.62	767	461	562	<0.60	<0.34	*450*	6.32	**0.208**	1.71	-	-	<0.010	<0.010	0.0044	12.5	0.129	-	439	-	-	307	-	-
TH19-KGS-11		8-Mar-2019	L2245232-37	8.23	732	275	335	<0.60	<0.34	*316*	9.93	**1.15**	121	-	-	0.0317	0.0272	0.0045	39.4	<0.030	-	440	-	-	>4000	-	-
TH19-KGS-11A		8-Mar-2019	L2245232-20	7.12	669	397	484	<0.60	<0.34	*331*	0.13	0.086	0.37	-	-	0.0172	0.0156	0.0017	6.65	0.046	-	354	-	-	>4000	-	-
TH19-KGS-12		7-Mar-2019	L2245232-19	8.39	727	319	376	6.24	<0.34	*426*	17.9	**0.321**	81.0	-	-	<0.0051	<0.0050	<0.0010	27.4	<0.030	-	446	-	-	>4000	-	-
		12-Jun-2019	L2290890-5	7.85	777	414	505	<0.60	<0.34	*402*	4.20	**0.292**	71.5	-	-	<0.0051	<0.0050	<0.0010	30.1	<0.030	-	475	-	-	>4000	<10	<10
		23-Oct-2019	L2371438-4	8.37	715	475	567	6.36	<0.34	*332*	5.27	**0.356**	65.9	-	-	0.0183	0.0152	0.0031	51.2	<0.030	-	*508*	-	-	>4000	-	-
		16-Jun-2020	L2462330-3	8.24	717	380	463	<0.60	<0.34	*402*	4.39	**0.391**	46.9	-	-	0.0121	0.0121	<0.0010	29.3	<0.030	-	429	-	-	3020	<1	<1
		28-Oct-2020	L2523514-4	8.20	775	412	502	<0.60	<0.34	*377*	3.06	**0.319**	59.2	-	-	0.0101	0.0101	<0.0010	26.4	<0.030	-	450	-	-	3240	0	0
TH19-KGS-12B		14-Mar-2019	L2245232-34	8.29	791	371	452	<0.60	<0.34	*425*	13.6	**0.573**	81.8	-	-	<0.010	<0.010	<0.0020	31.1	0.049	-	481	-	-	676	-	-
TH19-KGS-13		7-Mar-2019	L2245232-1	7.80	724	361	440	<0.60	<0.34	*405*	2.82	**0.238**	82.3	-	-	0.018	0.016	0.0023	21.3	<0.030	-	449	-	-	3970	-	-
TH19-KGS-13A		7-Mar-2019	L2245232-17	7.54	460	276	337	<0.60	<0.34	*257*	2.14	**0.148**	1.79	-	-	<0.0051	<0.0050	0.0012	9.08	0.056	-	261	-	-	>4000	-	-
TH19-KGS-14		8-Mar-2019	L2245232-39	8.15	650	348	425	<0.60	<0.34	*363*	1.60	**0.266**	41.0	-	-	<0.0051	<0.0050	<0.0010	12.6	<0.030	-	380	-	-	2840	-	-
TH19-KGS-14A		8-Mar-2019	L2245232-9	7.58	483	330	403	<0.60	<0.34	*296*	1.08	**0.216**	3.44	-	-	0.0217	0.0189	0.0029	2.84	0.035	-	305	-	-	>4000	-	-
TH19-KGS-15		9-Mar-2019	L2245232-29	8.22	661	355	432	<0.60	<0.34	*383*	2.88	**0.249**	33.3	-	-	0.0175	0.0175	<0.0010	10.3	<0.030	-	383	-	-	599	-	-
TH19-KGS-16		15-Mar-2019	L2245232-14	8.07	632	336	410	<0.60	<0.34	*374*	2.78	**0.446**	44.5	-	-	0.107	0.101	0.0063	21.9	<0.030	-	390	-	-	>4000	-	-
	TH19-KGS-500		L2245232-13	7.96	674	353	431	<0.60	<0.34	*360*	5.52	**0.416**	54.0	-	-	0.141	0.134	0.0071	21.1	<0.030	-	408	-	-	896	-	-
	RPD			*1.4%*	*6.4%*	*4.9%*	*5.0%*	*NC*	*NC*	*3.8%*	*66.0%*	*7.0%*	*19.3%*	-	-	*27.4%*	*28.1%*	*11.9%*	*3.7%*	*NC*	*NC*	*4.5%*	*NC*	*NC*	*NC*	*NC*	*NC*
TH19-KGS-16B		9-Mar-2019	L2245232-35	7.95	809	472	575	<0.60	<0.34	*623*	2.31	**0.183**	22.9	-	-	0.052	0.047	0.0044	8.26	0.102	-	*521*	-	-	>4000	-	-
TH19-KGS-17		10-Mar-2019	L2245232-23	8.19	674	363	443	<0.60	<0.34	*384*	1.33	**0.272**	42.6	-	-	0.0094	0.0081	0.0013	9.43	<0.030	-	390	-	-	>4000	-	-
		12-Jun-2019	L2290890-6	7.71	622	332	405	<0.60	<0.34	*342*	0.96	**0.214**	42.2	-	-	0.0089	0.0089	<0.0010	16.0	<0.030	-	365	-	-	860	<10	<10
		23-Oct-2019	L2371438-3	8.23	591	365	446	<0.60	<0.34	*350*	0.92	**0.237**	40.6	-	-	0.008	0.0067	0.0013	9.11	<0.030	-	379	-	-	2000	-	-
		16-Jun-2020	L2462330-2	8.12	617	323	394	<0.60	<0.34	*365*	0.86	**0.275**	43.9	-	-	<0.0051	<0.0050	<0.0010	9.00	<0.030	-	361	-	-	>4000	<1	<1
		27-Oct-2020	L2523514-5	8.20	637	322	393	<0.60	<0.34	*418*	0.92	**0.245**	42.7	-	-	<0.0051	<0.0050	<0.0010	8.63	0.094	-	378	-	-	>4000	0	0
TH19-KGS-17A		10-Mar-2019	L2245232-21	7.93	578	348	425	<0.60	<0.34	*317*	2.54	**0.127**	2.91	-	-	0.0118	0.0104	0.0014	4.40	0.056	-	321	-	-	>4000	-	-
TH19-KGS-17B		10-Mar-2019	L2245232-15	8.29	846	481	587	<0.60	<0.34	*528*	3.39	**0.603**	106	-	-	0.051	0.039	0.0121	39.5	<0.030	-	*587*	-	-	>4000	-	-
TH19-KGS-18		11-Mar-2019	L2245232-38	7.77	1040	646	789	<0.60	<0.34	*637*	1.26	**0.181**	3.00	-	-	<0.010	<0.010	<0.0020	12.3	<0.030	-	*607*	-	-	>4000	-	-
		12-Jun-2019	L2290890-7	7.14	989	627	764	<0.60	<0.34	*620*	0.83	**0.135**	<0.60	-	-	<0.010	<0.010	<0.0020	11.3	<0.030	-	*587*	-	-	>4000	<10	<10
		23-Oct-2019	L2371438-2	7.86	913	675	823	<0.60	<0.34	*600*	0.22	**0.123**	<0.60	-	-	0.011	0.011	<0.0020	11.2	<0.030	-	*611*	-	-	2370	-	-
		16-Jun-2020	L2462330-1	7.41	566	331	404	<0.60	<0.34	*333*	0.38	**0.127**	5.69	-	-	<0.0051	<0.0050	<0.0010	6.56	<0.030	-	323	-	-	821	0	1
		27-Oct-2020	L2523514-6	7.81	908	537	655	<0.60	<0.34	*498*	0.17	**0.143**	1.20	-	-	<0.0051	<0.0050	<0.0010	9.36	<0.030	-	498	-	-	1880	0	0
TH19-KGS-18A		11-Mar-2019	L2245232-22	7.48	489	277	337	<0.60	<0.34	*129*	1.49	**0.125**	6.43	-	-	0.0202	0.0182	0.0019	70.2	<0.030	-	287	-	-	3110	-	-
TH19-KGS-19		11-Mar-2019	L2245232-31	8.47	785	348	403	10.4	<0.34	*431*	14.0	**0.376**	110	-	-	0.046	0.042	0.0034	37.1	0.041	-	497	-	-	468	-	-
		12-Jun-2019	L2290890-8	8.29	902	529	646	<0.60	<0.34	*489*	7.08	**0.288**	110	-	-	0.016	0.016	<0.0020	48.5	<0.030	-	*633*	-	-	>4000	<10	10
		23-Oct-2019	L2371438-1	8.30	841	514	620	3.48	<0.34	*400*	4.32	**0.325**	71.4	-	-	0.14	0.136	0.0042	43.1	<0.030	-	*541*	-	-	37.7	-	-
		17-Jun-2020	L2462330-7	8.34	860	476	566	7.2	<0.34	*487*	2.30	**0.275**	68.2	-	-	<0.010	<0.010	<0.0020	34.6	<0.030	-	*533*	-	-	36.3	0	1
		27-Oct-2020	L2523514-7	8.21	890	466	568	<0.60	<0.34	*491*	1.88	**0.242**	68.5	-	-	0.0166	0.0166	<0.0010	23.4	<0.030	-	*521*	-	-	32.4	0	1
TH19-KGS-19A		11-Mar-2019	L2245232-16	7.48	846	518	632	<0.60	<0.34	*523*	6.58	**0.148**	4.13	-	-	0.032	0.030	0.0022	8.37	<0.030	-	*506*	-	-	>4000	-	-
TH19-KGS-20		14-Mar-2019	L2245232-32	8.31	951	362	436	3	<0.34	*215*	21.3	**0.539**	147	-	-	0.029	0.024	0.0056	139	<0.030	-	*594*	-	-	>4000	-	-
	TH300		L2245232-33	8.30	945	353	426	2.28	<0.34	*215*	21.3	**0.535**	147	-	-	0.036	0.032	0.0048	141	<0.030	-	*591*	-	-	>4000	-	-
	RPD			*0.1%*	*0.6%*	*2.5%*	*2.3%*	*27.3%*	*NC*	*0.0%*	*0.0%*	*0.7%*	*0.0%*	-	-	*21.5%*	*28.6%*	*15.4%*	*1.4%*	*NC*	*NC*	*0.5%*	*NC*	*NC*	*NC*	*NC*	*NC*
TRIP BLANK		9-Mar-2019	L2245232-8	***5.92***	1.0	1.7	2.1	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	<0.050	<0.030	-	<5.0	-	-	<0.10	0	0
TRIP BLANK		11-Jun-2019	L2290890-9	***5.70***	<1.0	1.6	2	<0.60	<0.34	0.4	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	<0.050	<0.030	-	<5.0	-	-	0.44	0	0
TRIP BLANK		26-Oct-2020	L2523514-11	***5.57***	<1.0	<1.0	<1.2	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	<0.050	<0.030	-	<5.0	-	-	<0.10	0	0
TRIP BLANK		17-Jun-2020	L2463404-8	***5.55***	<1.0	<1.0	<1.2	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	<0.050	<0.030	-	<5.0	-	-	<0.10	0	0
FIELD BLANK		7-Mar-2019	L2245232-3	***6.48***	1.2	2.0	2.4	<0.60	<0.34	<0.20	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	<0.050	<0.030	-	<5.0	-	-	<0.10	-	-
FIELD BLANK		12-Jun-2019	L2290890-11	***6.12***	<1.0	1.7	2.1	<0.60	<0.34	0.4	<0.10	<0.020	<0.30	-	-	<0.0051	<0.0050	<0.0010	0.123	<0.030	-	<5.0	-	-	0.17	0	0

TABLE 3
GENERAL WATER QUALITY
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																						
				pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Fluoride	Sulphate	Ammonia	Unionized Ammonia [2]	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Sodium	Total Phosphorus	Phosphorus - Total Dissolved	T.D.S.	T.S.S.	T.K.N.	Turbidity (NTU)	E. Coli	Total Coliform (MPN/100mL)
HC-CDWQ [3]																										
Drinking Water - MAC				-	-	-	-	-	-	-	-	1.5	-	-	-	-	10 [9]	1.0 [9]	-	-	-	-	-	-	0.1/0.3/1.0 (13)	None Detectable per 100 mL	None Detectable per 100 mL
Drinking Water - AO				7.0 - 10.5	-	-	-	-	-	80-100[5]	250	-	500	-	-	-	-	-	200	-	-	500	-	-	-	-	-
CCME [4] - Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				6.5 - 9.0	-	-	-	-	-	-	120 [6a] 640 [6b]	0.12 [7]	-		0.019 [8]	-	3 [10a] 124 [10b]	0.06	-	(11)	-	-	-	-	Narrative (14)	-	-
SURFACE WATER SAMPLES																										
BC-02		17-Jun-2020	L2463404-7	8.42	-	-	-	-	-	-	-	-	-	0.029	0.003977	<0.070	<0.020	<0.010	-	0.0551	0.0085	-	3.2	1.14	2.12	-	-
		28-Oct-2020	L2523516-3	8.09	-	-	-	-	-	-	-	-	-	0.026	0.000274	<0.070	0.020	<0.010	-	0.0162	-	-	8.6	1.28	5.25	-	-
BC-05		17-Jun-2020	L2463404-6	8.35	-	-	-	-	-	-	-	-	-	0.016	0.001954	<0.070	<0.020	<0.010	-	0.0486	0.0089	-	35.0	1.30	26.3	-	-
		28-Oct-2020	L2523516-4	7.78	-	-	-	-	-	-	-	-	-	0.016	0.000082	<0.070	<0.020	<0.010	-	0.0223	-	-	10.8	1.07	5.19	-	-
CR3-1		17-Jun-2020	L2462330-10	7.27	-	-	-	-	-	-	-	-	-	0.01	0.000086	<0.070	<0.020	<0.010	-	0.0073	0.0053	-	<3.0	0.64	0.16	-	-
		28-Oct-2020	L2523516-5	*6.98*	-	-	-	-	-	-	-	-	-	0.010	0.000008	<0.070	<0.020	<0.010	-	0.0051	-	-	<3.0	0.50	0.16	-	-
CR3-2		17-Jun-2020	L2462330-11	7.75	-	-	-	-	-	-	-	-	-	0.013	0.000416	<0.070	<0.020	<0.010	-	0.0093	0.0065	-	4.6	0.63	3.68	-	-
		28-Oct-2020	L2523516-6	7.1	-	-	-	-	-	-	-	-	-	0.017	0.000019	<0.070	0.064	<0.010	-	0.0104	-	-	<3.0	0.53	0.89	-	-
LSMOC-INLET-1A		17-Jun-2020	L2463404-5	8.5	-	-	-	-	-	-	-	-	-	0.025	0.003589	<0.070	<0.020	<0.010	-	0.0275	0.0055	-	8.4	0.84	4.85	-	-
		28-Oct-2020	L2523516-1	***6.48***	-	-	-	-	-	-	-	-	-	0.047	0.000013	<0.070	<0.020	<0.010	-	0.0204	-	-	5.8	1.21	4.46	-	-
LSMOC-OUTLET-1A		17-Jun-2020	L2462330-9	8	-	-	-	-	-	-	-	-	-	0.010	0.000368	<0.070	<0.020	<0.010	-	0.0207	0.0105	-	<3.0	0.52	4.38	-	-
		27-Oct-2020	L2523516-2	***6***	-	-	-	-	-	-	-	-	-	0.031	0.000003	<0.070	0.051	<0.010	-	0.0670	-	-	11.4	0.48	14.1	-	-
SW-R3		11-Jun-2019	L2290890-10	8.57	456	262	290	14	<0.34	*269*	0.970	0.159	17	-	-	<0.0051	<0.0050	<0.0010	6.84	<0.030	-	267	-	-	6.93	-	-
		24-Oct-2019	L2371920-5	8.02	176	107	131	<0.60	<0.34	*106*	0.66	0.044	1.52	-	-	<0.0051	<0.0050	<0.0010	0.92	<0.030	-	103	-	-	1.2	1	>200
		17-Jun-2020	L2462330-8	-	-	-	-	-	-	-	-	-	-	0.012	0.000593	<0.070	<0.020	<0.010	-	0.0171	0.0084	-	8.0	0.55	16.1	-	-
		28-Oct-2020	L2523516-7	-	-	-	-	-	-	-	-	-	-	0.010	0.000017	<0.070	<0.020	<0.010	-	0.0052	-	-	<3.0	0.49	1.58	-	-
	SW-100		L2523516-8	-	-	-	-	-	-	-	-	-	-	0.013	0.000022	<0.070	<0.020	<0.010	-	0.0045	-	-	<3.0	0.48	1.54	-	-
	RPD			*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*26.1%*	*26.1%*	*NC*	*NC*	*NC*	*NC*	*14.4%*	*NC*	*NC*	*NC*	*2.1%*	*2.6%*	*NC*	*NC*
Laboratory Detection Limits				*0.10*	*1.0*	*1.0*	*1.2*	*0.60*	*0.34*	*0.20*	*0.10*	*0.020*	*0.30*	*0.010*	-	*0.0051*	*0.0050*	*0.0010*	*0.050*	*0.030*	-	*5.0*	-	-	*0.10*	-	-

E.C. = Electrical Conductivity T.O.C. = Total Organic Carbon
B.O.D. = Biochemical Oxygen Dema T.K.N. = Total Kjeldahl Nitrogen
C.O.D. = Chemical Oxygen Demand T.D.S. = Total Dissolved Solids
D.O.C. = Dissolved Organic Carbon T.S.S. = Total Suspended Solids
TCU = True Colour Units S.A.R. = Sodium Absorption Ratio (no units)
NTU = Nephelometric Turbidity Units

Notes:
"-" = No Data

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified. Groundwater metals samples - dissolved (filtered and preserved in field). Surface water metals samples - Total (preserved in field)
2. Unionized ammonia calculated on Table 4 using pH, temperature, and laboratory analyzed ammonia values.
3. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated Sept 2020.
   MAC = Maximum Acceptable Concentration = The maximum concentration of a parameter that is designed to protect those individuals most at risk, such as children and the elderly.
   AO = Aesthetic Objective = A guideline which addresses a parameter that may affect consumer acceptance of drinking water, such as taste, odour, and colour.
4. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated 2018
   Guidelines for Canadian Drinking Water Quality.
   Community Water Supplies (Health Canada - Canadian Drinking Water Quality Guidelines)
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
   Canadian Water Quality Guidelines for the Protection of Agriculture
5. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as CaCO3) provide acceptable balance between corrosion and incrustation.
   Where water is softened by sodium ion exchange, it is recommended that a separate, unsoftened supply be retained for culinary and drinking purposes.

TABLE 3
GENERAL WATER QUALITY
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																					
				pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Fluoride	Sulphate	Ammonia	Unionized Ammonia [2]	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Sodium	Total Phosphorus	Phosphorus - Total Dissolved	T.D.S.	T.S.S.	T.K.N.	Turbidity (NTU)	E. Coli	Total Coliform (MPN/100mL)
HC-CDWQ [3]																									
Drinking Water - MAC				-	-	-	-	-	-	-	-	1.5	-	-	-	-	10 [9]	1.0 [9]	-	-	-	-	-	-	0.1/0.3/1.0 (13)	None Detectable per 100 mL	None Detectable per 100 mL
Drinking Water - AO				7.0 - 10.5	-	-	-	-	-	80-100 [5]	250	-	500	-	-	-	-	-	200	-	-	500	-	-	-	-	-
CCME [4] - Canadian Water Quality Guidelines for the Protection of Aquatic Life																									
Freshwater				6.5 - 9.0	-	-	-	-	-	-	120 [6a] 640 [6b]	0.12 [7]	-		0.019 [8]	-	3 [10a] 124 [10b]	0.06	-	(11)	-	-	(12)	-	Narrative (14)	-	-

6. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long term concentration - Derived with mostly no- and some low-effect data and are intended to protect against negative effects to aquatic ecosystem structure and function during indefinite exposures (e.g. abide by the guiding principle as per CCME 2007). Refer to Factsheet for more explanation.
   b. Short term concentration - Derived with severe-effects data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events (e.g. inappropriate application or disposal of the substance of concern).
   c. Guideline is dependant on type of plant. See CCME summary table for details.
   Foliar damage
   = 100-178 mg/L for almond apricots and plums
   = 178-355 mg/L for grapes, peppers, potatoes and tomatoes
   = 355-710 mg/L for alfalfa, barley, corn, and cucumbers
   >710 mg/L for cauliflower, cotton, safflower, sesame, sorghum, sugar beets, and sunflowers
   Rootstocks
   = 180-600 mg/L for stone fruit (peaches, plums, etc.)
   = 710-900 mg/L for grapes
   Cultivars
   = 110-180 mg/L for strawberries
   = 230-460 mg/L for grapes
   = 250 mg/L for boysenberries, blackberries, and raspberries
7. Interim Water Quality Guideline for the Protection of Aquatic Life.
8. Guideline for total ammonia is temperature and pH dependent. See Fact Sheet for details.
9. Systems using chloramine disinfection or that have naturally occurring ammonia should monitor the level of nitrate/nitrite in the distribution system. Homeowners with a well should test the concentration of nitrate/nitrite in their water supply.
10. All nitrate concentrations presented here will be for the ion only (i.e. as mg NO_3-/L). Conversion factors for some of the commonly reported units in the literature are provided in the Factsheet.
    For protection from direct toxic effects; the guidelines do not consider indirect effects due to eutrophication.
    Freshwater: Derived from toxicity tests utilizing $NaNO_3$.
    Marine: Derived from toxicity tests utilizing $NaNO_3$ and KNO_3.
    a. Long term concentration - Derived with mostly no- and some low-effect data and are intended to protect against negative effects to aquatic ecosystem structure and function during indefinite exposures (e.g. abide by the guiding principle as per CCME 2007).
    b. Short term concentration - Derived with severe-effects data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events (e.g. inappropriate application or disposal of the substance of concern).
11. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.
    Trigger ranges (mg/L):

ultra-oligotrophic	<0.004	meso-eutrophic	0.020-0.035
oligotrophic	0.004-0.010	eutrophic	0.035-0.10
mesotrophic	0.010-0.020	hyper-eutrophic	>0.10

12. Suspended Sediments Guideline (see Total Particulate Matter fact sheet for complete details):
    Clear Flow:
    Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g. 24 hr period).
    Maximum average increase of 5 mg/L from background levels for longer term exposures (eg. inputs lasting between 24 hrs and 30 days).
    High Flow:
    Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L.
    Should not increase more than 10% of background levels when background is >250 mg/L.
13. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
    a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
    b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
    c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time.
    If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process. Turbidity values greater than 1 NTU are shaded.
14. Turbidity Guidelines (see fact sheet for complete details):
    Clear Flow:
    Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24 hr period).
    Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30 day period).
    High Flow or Turbid Waters:
    Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
    Should not increase more than 10% of background levels when background is >80 NTUs.

	- Exceedance of HC-CDWQ Criteria MAC
Italic	- Exceedance of HC-CDWQ Criteria AO
BOLD	- Exceedance of CCME Criteria for the Protection of Aquatic Life

TABLE 4
UNIONIZED AMMONIA
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Date	ALS Sample ID	pH [1]	Temp. (°C)	Temp. [1] (°K)	pKa [2]	f [3]	Ammonia (mg/L)	Unionized Ammonia (mg/L) [4]
BC-02	17-Jun-2020	L2463404-7	8.42	25.9	299.05	9.22	0.1371	0.029	0.003977
	28-Oct-2020	L2523516-3	8.09	0.6	273.75	10.06	0.0105	0.026	0.000274
BC-05	17-Jun-2020	L2463404-6	8.35	26.3	299.45	9.21	0.1221	0.016	0.001954
	28-Oct-2020	L2523516-4	7.78	0.4	273.55	10.07	0.0051	0.016	0.000082
CR3-1	17-Jun-2020	L2462330-10	7.27	22.3	295.45	9.33	0.0086	0.01	0.000086
	28-Oct-2020	L2523516-5	6.98	0.1	273.25	10.08	0.0008	0.010	0.000008
CR3-2	17-Jun-2020	L2462330-11	7.75	25.5	298.65	9.23	0.0320	0.013	0.000416
	28-Oct-2020	L2523516-6	7.1	0.7	273.85	10.06	0.0011	0.017	0.000019
LSMOC-INLET-1A	17-Jun-2020	L2463404-5	8.5	24.05	297.2	9.28	0.1436	0.025	0.003589
	28-Oct-2020	L2523516-1	6.48	1	274.15	10.05	0.0003	0.047	0.000013
LSMOC-OUTLET-1A	17-Jun-2020	L2462330-9	8	19.5	292.65	9.42	0.0368	0.010	0.000368
	27-Oct-2020	L2523516-2	6	0.1	273.25	10.08	0.0001	0.031	0.000003
SW-R3	17-Jun-2020	L2462330-8	8.04	22.5	295.65	9.32	0.0495	0.012	0.000593
	28-Oct-2020	L2523516-7	7.29	0.6	273.75	10.06	0.0017	0.010	0.000017
	28-Oct-2020	L2523516-8	7.29	0.6	273.75	10.06	0.0017	0.013	0.000022
PWQO									0.019

Notes:
1. pH and temperature values from field data.
2. pKa = 0.09018+2729.92/T, T = Temp. in Kelvins
3. $f = 1/(10^{(pKa - pH)} + 1)$
4. Unionized Ammonia = f x (Ammonia)
5. PWQO - Provincial Water Quality Objectives, of the Ministry of Environment and Energy (MOEE), July 1994.

BOLD - Exceeds PWQO

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																		
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury
HC-CDWQ [2]																						
Drinking Water - MAC				-	0.006	0.010	2.0	-	-	5.0	0.007	[9]	-	0.05	-	2.0	-	0.005	-	-	0.12	0.001
Drinking Water - AO				0.1- 0.2 [4] (OG)	-	-	-	-	-	-	-	-	-	-	-	1.0	0.3	-	-	-	0.02	-
CCME[3]																						
Freshwater Aquatic Life				0.005 - 0.1 [5]	-	0.005	-	-	-	29 [6] 1.5 [7]	0.00009[8a] 0.001[8b]	-	-	0.0089 (III)[10] 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	0.430[11a]/ 3.600[11b]	0.000026 (inorganic) 0.000004 (methyl)[12]
GROUNDWATER SAMPLES																						
PW19-KGS-01		12-Mar-2019	L2245232-28	<0.0010	<0.00010	0.00038	0.0249	<0.00010	<0.000050	0.156	0.0000068	55.6	<0.000010	<0.00010	0.00025	**0.00452**	<0.010	0.000068	0.0245	55.2	0.00503	-
		11-Jun-2019	L2290890-1	<0.0010	<0.00010	0.00049	0.0254	<0.00010	<0.000050	0.133	<0.0000050	51.9	<0.000010	<0.00010	0.00024	<0.00020	0.051	<0.000050	0.0247	54.3	*0.051*	-
		24-Oct-2019	L2371920-1	**0.206**	<0.00010	0.00063	0.0290	<0.00010	<0.000050	0.142	<0.0000050	66.6	0.000054	0.00060	0.00049	0.00186	***0.390***	0.00122	0.0242	61.5	*0.0226*	-
	PW-200		L2371920-4	**0.212**	<0.00010	0.00064	0.0295	<0.00010	<0.000050	0.144	<0.0000050	68.0	0.000055	0.00063	0.00051	0.00153	***0.412***	0.00118	0.0243	63.4	*0.0228*	-
	RPD			*2.9%*	*NC*	*1.6%*	*1.7%*	*NC*	*NC*	*1.4%*	*NC*	*2.1%*	*1.8%*	*4.9%*	*4.0%*	*19.5%*	*5.5%*	*3.3%*	*0.4%*	*3.0%*	*0.9%*	*NC*
		17-Jun-2020	L2463404-1	<0.0010	<0.00010	0.00036	0.0282	<0.00010	<0.000050	0.180	<0.0000050	61.3	0.000010	<0.00010	0.00016	<0.00020	0.134	<0.000050	0.0312	59.1	0.0162	-
		27-Oct-2020	L2523514-1	<0.0010	<0.00010	0.00078	0.0243	<0.00010	<0.000050	0.145	<0.0000050	51.7	<0.000010	<0.00010	0.00019	<0.00020	0.152	<0.000050	0.0227	50.2	0.00596	-
PW19-KGS-02		13-Mar-2019	L2245232-26	<0.0010	<0.00010	0.00135	0.0242	<0.00010	<0.000050	0.145	<0.0000050	58.5	<0.000010	<0.00010	0.00015	0.00066	0.121	<0.000050	0.0252	55.0	0.00465	-
	PW19-KGS-05		L2245232-27	<0.0010	<0.00010	0.00136	0.0243	<0.00010	<0.000050	0.150	<0.0000050	60.3	0.000010	<0.00010	0.00014	<0.00020	0.128	<0.000050	0.0254	55.7	0.00462	-
	RPD			*NC*	*NC*	*0.7%*	*0.4%*	*NC*	*NC*	*3.4%*	*NC*	*3.0%*	*NC*	*NC*	*6.9%*	*NC*	*5.6%*	*NC*	*0.8%*	*1.3%*	*0.6%*	*NC*
		11-Jun-2019	L2290890-2	<0.0010	<0.00010	0.00161	0.0250	<0.00010	<0.000050	0.129	<0.0000050	55.1	0.000012	<0.00010	0.00016	0.00122	0.112	0.000057	0.0253	54.6	*0.112*	-
		24-Oct-2019	L2371920-2	<0.0010	<0.00010	0.00125	0.0258	<0.00010	<0.000050	0.137	<0.0000050	57.2	0.000016	<0.00010	0.00015	0.00079	0.116	0.000070	0.0245	55.5	0.00436	-
		16-Jun-2020	L2462330-4	<0.0010	<0.00010	0.00129	0.0246	<0.00010	<0.000050	0.144	<0.0000050	57.8	<0.000010	<0.00010	0.00015	0.00050	0.138	0.000055	0.0253	56.7	0.00495	-
		28-Oct-2020	L2523514-2	<0.0010	<0.00010	0.00185	0.0245	<0.00010	<0.000050	0.139	<0.0000050	54.2	0.000010	<0.00010	0.00015	<0.00020	0.191	<0.000050	0.0240	50.6	0.00685	-
	PW-100		L2523514-8	<0.0010	<0.00010	0.00182	0.0248	<0.00010	<0.000050	0.139	<0.0000050	55.4	0.000023	<0.00010	0.00016	<0.00020	0.202	<0.000050	0.0249	51.4	0.00694	-
	RPD			*NC*	*NC*	*1.6%*	*1.2%*	*NC*	*NC*	*0.0%*	*NC*	*2.2%*	*78.8%*	*NC*	*6.5%*	*NC*	*5.6%*	*NC*	*3.7%*	*1.6%*	*1.3%*	*NC*
PW19-KGS-03		14-Mar-2019	L2245232-24	0.0011	<0.00010	0.00069	0.0590	<0.00010	<0.000050	0.102	<0.0000050	62.9	<0.000010	<0.00010	0.00110	0.00020	***0.339***	<0.000050	0.0184	49.8	*0.151*	-
	PW19-KGS-04		L2245232-25	<0.0010	<0.00010	0.00071	0.0590	<0.00010	<0.000050	0.101	<0.0000050	62.4	<0.000010	<0.00010	0.00112	<0.00020	***0.337***	<0.000050	0.0184	49.7	*0.152*	-
	RPD			*NC*	*NC*	*2.9%*	*0.0%*	*NC*	*NC*	*1.0%*	*NC*	*0.8%*	*NC*	*NC*	*1.8%*	*NC*	*0.6%*	*NC*	*0.0%*	*0.2%*	*0.7%*	*NC*
		11-Jun-2019	L2290890-3	<0.0010	<0.00010	0.00037	0.0538	<0.00010	<0.000050	0.092	<0.0000050	56.4	<0.000010	<0.00010	0.00056	<0.00020	0.216	<0.000050	0.0194	49.4	*0.216*	-
	PW19-KGS-200		L2290890-4	<0.0010	<0.00010	0.00037	0.0527	<0.00010	<0.000050	0.091	<0.0000050	56.8	<0.000010	<0.00010	0.00058	<0.00020	0.202	<0.000050	0.0197	50.2	*0.202*	-
	RPD			*NC*	*NC*	*0.0%*	*2.1%*	*NC*	*NC*	*1.1%*	*NC*	*0.7%*	*NC*	*NC*	*3.5%*	*NC*	*6.7%*	*NC*	*1.5%*	*1.6%*	*6.7%*	*NC*
		24-Oct-2019	L2371920-3	0.0090	<0.00010	0.00110	0.0619	<0.00010	<0.000050	0.068	<0.0000050	68.3	<0.000010	0.00010	0.00198	0.00041	1.25	0.000065	0.0124	38.0	*0.276*	-
		17-Jun-2020	L2462330-5	0.0018	<0.00010	0.00072	0.0487	<0.00010	<0.000050	0.077	<0.0000050	55.6	<0.000010	<0.00010	0.00094	<0.00020	0.243	<0.000050	0.0139	42.4	*0.119*	-
	PW19-KGS-300		L2462330-6	0.0019	<0.00010	0.00067	0.0492	<0.00010	<0.000050	0.076	<0.0000050	55.2	0.000011	<0.00010	0.00090	<0.00020	0.248	0.000074	0.0139	42.9	*0.119*	-
	RPD			*5.4%*	*NC*	*7.2%*	*1.0%*	*NC*	*NC*	*1.3%*	*NC*	*0.7%*	*NC*	*NC*	*4.3%*	*NC*	*2.0%*	*NC*	*0.0%*	*1.2%*	*0.0%*	*NC*
		27-Oct-2020	L2523514-3	<0.0010	<0.00010	0.00091	0.0546	<0.00010	<0.000050	0.094	<0.0000050	56.2	<0.000010	<0.00010	0.00082	<0.00020	***0.362***	<0.000050	0.0160	43.1	*0.126*	-
Sentinel Well 1 - (SW19-KGS-01)		18-Jun-2020	L2463404-2	<0.0010	<0.00010	0.00050	0.0245	<0.00010	<0.000050	0.143	<0.0000050	58.6	0.000012	<0.00010	0.00022	<0.00020	0.072	<0.000050	0.0253	53.8	0.00547	-
		8-Mar-2019	L2242160-1	0.0010	<0.00010	0.00031	0.0450	<0.00010	<0.000050	0.186	<0.0000050	59.3	0.000036	<0.00010	0.000310	0.000230	<0.010	<0.000050	0.0326	62.5	0.0668	-
Sentinel Well 2 - (SW19-KGS-02)		27-Sep-2019	L2356084-1	<0.0010	<0.00010	<0.00010	0.0115	<0.00010	<0.000050	0.235	<0.0000050	61.6	0.000048	0.00013	0.00073	<0.00020	<0.010	<0.000050	0.0379	67.6	0.0114	-
		18-Jun-2020	L2463404-3	<0.0010	<0.00010	<0.00010	0.0124	<0.00010	<0.000050	0.190	<0.0000050	70.1	0.000020	<0.00010	0.00017	<0.00020	0.099	<0.000050	0.0381	66.6	0.00999	-
		29-Oct-2020	L2523514-9	<0.0010	<0.00010	<0.00010	0.0122	<0.00010	<0.000050	0.203	<0.0000050	65.0	0.000014	<0.00010	0.00017	<0.00020	0.102	<0.000050	0.0364	63.5	0.0103	-
Sentinel Well 3 - (SW19-KGS-03)		27-Sep-2019	L2356084-2	0.0019	<0.00010	0.00013	0.0187	<0.00010	<0.000050	0.247	<0.0000050	53.7	0.000023	0.00075	0.00020	0.00020	<0.010	<0.000050	0.0333	66.2	0.00319	-
		18-Jun-2020	L2463404-4	<0.0010	<0.00010	0.00019	0.0175	<0.00010	<0.000050	0.190	<0.0000050	64.8	0.000019	<0.00010	0.00023	<0.00020	0.110	<0.000050	0.0339	62.8	0.0146	-
		29-Oct-2020	L2523514-10	<0.0010	<0.00010	0.00022	0.0180	<0.00010	<0.000050	0.206	<0.0000050	60.2	0.000020	<0.00010	0.00024	<0.00020	0.116	<0.000050	0.0326	62.4	0.0152	-
TH15-04		8-Mar-2019	L2245232-4	0.0188	0.00018	0.00168	0.0269	<0.00010	<0.000050	0.117	<0.0000050	39.3	<0.000010	<0.00010	0.00017	0.00126	0.110	0.000073	0.0170	34.8	0.0156	-
TH15-05		8-Mar-2019	L2245232-6	<0.0010	<0.00010	0.00034	0.0716	<0.00010	<0.000050	0.091	<0.0000050	56.0	<0.000010	<0.00010	0.00021	<0.00020	0.132	<0.000050	0.0171	48.0	0.0134	-
TH19-KGS-01B		9-Mar-2019	L2245232-12	<0.0010	<0.00010	0.00012	0.0202	<0.00010	<0.000050	0.158	<0.0000050	51.3	<0.000010	<0.00010	0.00033	<0.00020	***0.921***	<0.000050	0.0286	60.1	*0.0241*	-
TH19-KGS-02B		11-Mar-2019	L2245232-18	0.0028	0.00018	0.00032	0.0279	<0.00010	<0.000050	0.202	0.0000081	123	<0.000010	<0.00010	0.00097	0.00292	<0.010	<0.000050	0.0568	128	*0.108*	-
TH19-KGS-03A		8-Mar-2019	L2245232-40	0.0143	<0.00010	0.00089	0.0364	<0.00010	<0.000050	0.028	0.0000055	73.0	<0.000010	0.00020	0.00049	0.00071	***0.756***	<0.000050	0.0129	44.9	*0.0770*	-
TH19-KGS-04		9-Mar-2019	L2245232-7	0.0026	0.00053	0.00196	0.0179	<0.00010	<0.000050	0.157	<0.0000050	61.5	<0.000010	0.00011	0.00037	<0.00020	0.023	<0.000050	0.0274	69.1	0.0190	-
TH19-KGS-07		7-Mar-2019	L2245232-11	0.0014	<0.00010	0.00025	0.0411	<0.00010	<0.000050	0.112	<0.0000050	41.9	<0.000010	<0.00010	0.00056	<0.00020	***0.778***	<0.000050	0.0223	55.0	0.00748	-

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																	
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury
HC-CDWQ [2]																						
Drinking Water - MAC				-	0.006	0.010	2.0	-	-	5.0	0.007	[9]	-	0.05	-	2.0	-	0.005	-	-	0.12	0.001
Drinking Water - AO				0.1- 0.2 [4] (OG)	-	-	-	-	-	-	-	-	-	-	-	1.0	0.3	-	-	-	0.02	-
CCME[3]																						
Freshwater Aquatic Life				0.005 - 0.1 [5]	-	0.005	-	-	-	29 [6] 1.5 [7]	0.00009[8a] 0.001[8b]	-	-	0.0089 (III)[10] 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	0.430[11a]/ 3.600[11b]	0.000026 (inorganic) 0.000004 (methyl)[12]
GROUNDWATER SAMPLES																						
TH19-KGS-07A		7-Mar-2019	L2245232-10	0.0161	0.00016	0.00217	0.0671	<0.00010	<0.000050	0.034	<0.0000050	88.1	<0.000010	<0.00010	<0.00010	<0.00020	0.010	<0.000050	0.0167	42.1	*0.113*	-
TH19-KGS-08		8-Mar-2019	L2245232-36	0.0047	<0.00010	0.00020	0.0602	<0.00010	<0.000050	0.102	<0.0000050	58.3	<0.000010	<0.00010	0.00019	<0.00020	0.062	<0.000050	0.0172	50.2	*0.0261*	-
TH19-KGS-09		12-Mar-2019	L2245232-2	0.0016	<0.00010	0.00062	0.0273	<0.00010	<0.000050	0.141	<0.0000050	62.9	<0.000010	<0.00010	0.00022	<0.00020	0.058	<0.000050	0.0233	63.0	0.0189	-
TH19-KGS-10		9-Mar-2019	L2245232-5	0.0029	<0.00010	0.00100	0.0585	<0.00010	<0.000050	0.091	<0.0000050	58.7	<0.000010	<0.00010	0.00020	<0.00020	<0.010	<0.000050	0.0207	62.2	0.0100	-
	TH200		L2245232-30	0.0029	<0.00010	0.00100	0.0601	<0.00010	<0.000050	0.091	<0.0000050	59.5	<0.000010	<0.00010	0.00021	<0.00020	<0.010	<0.000050	0.0207	64.0	0.0103	-
	RPD			*0.0%*	*NC*	*0.0%*	*2.7%*	*NC*	*NC*	*0.0%*	*NC*	*1.4%*	*NC*	*NC*	*4.9%*	*NC*	*NC*	*NC*	*0.0%*	*2.9%*	*3.0%*	*NC*
TH19-KGS-100		7-Mar-2019	L2245232-41	0.0101	<0.00010	0.00082	0.0507	<0.00010	<0.000050	0.056	<0.0000050	81.0	<0.000010	0.00019	0.00022	0.00128	***0.420***	0.000053	0.0181	60.3	*0.139*	-
TH19-KGS-11		8-Mar-2019	L2245232-37	0.0042	<0.00010	0.00206	0.0164	<0.00010	<0.000050	0.412	<0.0000050	56.2	0.000022	<0.00010	0.00014	<0.00020	0.044	<0.000050	0.0311	42.6	0.0163	-
TH19-KGS-11A		8-Mar-2019	L2245232-20	0.0134	<0.00010	0.00129	0.0386	<0.00010	<0.000050	0.044	<0.0000050	70.1	<0.000010	<0.00010	0.00153	0.00035	***1.09***	<0.000050	0.0059	38.0	*0.603*	-
TH19-KGS-12		7-Mar-2019	L2245232-19	0.0027	0.00017	0.00040	0.0416	<0.00010	<0.000050	0.138	<0.0000050	51.2	<0.000010	<0.00010	0.00085	0.00067	***1.64***	<0.000050	0.0350	72.3	*0.125*	-
		12-Jun-2019	L2290890-5	0.0011	0.00024	0.00041	0.0602	<0.00010	<0.000050	0.115	<0.0000050	48.5	<0.000010	<0.00010	0.00088	0.00022	***1.82***	<0.000050	0.0361	68.2	*1.82*	-
		23-Oct-2019	L2371438-4	0.0057	0.00063	0.00109	0.0919	<0.00010	<0.000050	0.109	<0.0000050	37.5	<0.000010	0.00017	0.00071	0.00058	***0.422***	<0.000050	0.0327	57.9	*0.0686*	-
		16-Jun-2020	L2462330-3	0.0010	0.00011	0.00121	0.0783	<0.00010	<0.000050	0.126	<0.0000050	45.5	<0.000010	<0.00010	0.00057	0.00041	***0.597***	<0.000050	0.0359	70.1	*0.209*	-
		28-Oct-2020	L2523514-4	0.0062	0.00025	0.00214	0.107	<0.00010	<0.000050	0.135	<0.0000050	45.3	<0.000010	0.00020	0.00168	0.00030	***0.423***	<0.000050	0.0353	64.1	*0.227*	-
TH19-KGS-12B		14-Mar-2019	L2245232-34	0.0048	0.00075	0.00071	0.0197	<0.00010	<0.000050	0.167	0.0000147	57.6	<0.000010	<0.00010	0.00267	0.00324	<0.010	<0.000050	0.0432	68.2	*0.0753*	-
TH19-KGS-13		7-Mar-2019	L2245232-1	<0.0010	0.00012	0.00093	0.0234	<0.00010	<0.000050	0.116	0.0000065	60.5	0.000014	<0.00010	0.00022	<0.00020	0.053	0.000247	0.0258	61.7	0.0145	-
TH19-KGS-13A		7-Mar-2019	L2245232-17	0.0268	<0.00010	0.00111	0.0240	<0.00010	<0.000050	0.026	0.0000227	49.5	<0.000010	0.00013	0.00072	0.00165	0.199	0.000119	0.0080	32.4	*0.506*	-
TH19-KGS-14		8-Mar-2019	L2245232-39	0.0017	<0.00010	0.00027	0.0371	<0.00010	<0.000050	0.136	<0.0000050	60.5	0.000010	<0.00010	0.00013	<0.00020	0.034	<0.000050	0.0233	51.4	*0.0209*	-
TH19-KGS-14A		8-Mar-2019	L2245232-9	0.0096	<0.00010	0.00137	0.0374	<0.00010	<0.000050	0.023	0.0000101	68.2	<0.000010	0.00011	0.00019	0.00096	***0.433***	<0.000050	0.0059	30.5	*0.142*	-
TH19-KGS-15		9-Mar-2019	L2245232-29	0.0041	0.00018	0.00065	0.0353	<0.00010	<0.000050	0.124	0.0000098	65.2	<0.000010	0.00021	0.00054	0.00044	<0.010	<0.000050	0.0253	53.4	*0.0825*	-
TH19-KGS-16		15-Mar-2019	L2245232-14	0.0339	0.00094	0.00185	0.0449	<0.00010	<0.000050	0.169	0.0000090	61.3	0.000020	0.00014	0.00036	0.00165	0.018	0.000084	0.0233	53.7	*0.0665*	-
	TH19-KGS-500		L2245232-13	0.0034	0.00086	0.00177	0.0428	<0.00010	<0.000050	0.158	0.0000090	58.8	0.000014	<0.00010	0.00034	0.00076	<0.010	0.000056	0.0227	51.7	*0.0638*	-
	RPD			*163.5%*	*8.9%*	*4.4%*	*4.8%*	*NC*	*NC*	*6.7%*	*0.0%*	*4.2%*	*35.3%*	*NC*	*5.7%*	*73.9%*	*NC*	*40.0%*	*2.6%*	*3.8%*	*4.1%*	*NC*
TH19-KGS-16B		9-Mar-2019	L2245232-35	0.838	<0.00010	0.00122	0.0816	<0.00010	<0.000050	0.103	0.0000301	129	0.000049	**0.00153**	0.00195	0.00353	***0.934***	0.00166	0.0186	73.1	*0.390*	-
TH19-KGS-17		10-Mar-2019	L2245232-23	0.0048	0.00100	0.00296	0.0417	<0.00010	<0.000050	0.094	<0.0000050	55.8	<0.000010	0.00014	0.00022	0.00020	0.016	<0.000050	0.0189	59.5	*0.0242*	-
		12-Jun-2019	L2290890-6	0.0045	0.00015	0.00270	0.0429	<0.00010	<0.000050	0.085	<0.0000050	49.8	<0.000010	<0.00010	0.00025	<0.00020	0.063	<0.000050	0.0170	53.0	*0.063*	-
		23-Oct-2019	L2371438-3	0.0015	<0.00010	0.00137	0.0428	<0.00010	<0.000050	0.082	<0.0000050	53.9	<0.000010	<0.00010	0.00011	0.00033	0.159	<0.000050	0.0174	52.2	*0.0405*	-
		16-Jun-2020	L2462330-2	0.0030	<0.00010	0.00120	0.0414	<0.00010	<0.000050	0.087	<0.0000050	55.5	<0.000010	<0.00010	<0.00010	<0.00020	0.140	<0.000050	0.0177	55.0	*0.0204*	-
		27-Oct-2020	L2523514-5	**1.25**	<0.00010	0.00134	0.0607	0.00012	<0.000050	0.094	0.0000064	67.7	0.000298	**0.00224**	0.00119	0.00168	***1.35***	0.00282	0.0192	60.5	*0.0417*	-
TH19-KGS-17A		10-Mar-2019	L2245232-21	0.0125	0.00018	0.00113	0.0319	<0.00010	<0.000050	0.027	0.0000079	61.6	<0.000010	0.00064	0.00029	**0.00459**	0.061	0.000102	0.0073	39.6	*0.454*	-
TH19-KGS-17B		10-Mar-2019	L2245232-15	0.0060	0.00033	0.00098	0.0365	<0.00010	<0.000050	0.130	0.0000078	41.1	<0.000010	**0.00104**	0.00022	0.00320	<0.010	0.000069	0.0599	103	0.0115	-
TH19-KGS-18		11-Mar-2019	L2245232-38	0.0023	0.00031	0.00101	0.0975	<0.00010	<0.000050	0.093	<0.0000050	114	<0.000010	<0.00010	0.00086	0.00048	0.213	<0.000050	0.0400	85.4	*0.0478*	-
		12-Jun-2019	L2290890-7	0.0018	0.00011	0.00190	0.154	<0.00010	<0.000050	0.052	<0.0000050	116	<0.000010	<0.00010	0.00154	<0.00020	***1.08***	<0.000050	0.0357	80.1	*1.08*	-
		23-Oct-2019	L2371438-2	0.0100	<0.00010	0.00099	0.154	<0.00010	<0.000050	0.060	<0.0000050	119	0.000010	<0.00010	0.00073	0.00035	***1.71***	0.000134	0.0323	73.3	*0.0643*	-
		16-Jun-2020	L2462330-1	0.0163	0.00014	0.00163	0.0434	<0.00010	<0.000050	0.028	<0.0000050	77.6	<0.000010	0.00047	0.00065	<0.00020	***1.78***	<0.000050	0.0089	33.9	*0.112*	-
		27-Oct-2020	L2523514-6	0.0030	<0.00010	0.00163	0.0871	<0.00010	<0.000050	0.063	<0.0000050	108	<0.000010	0.00020	0.00042	<0.00020	***1.53***	<0.000050	0.0227	55.2	*0.0492*	-
TH19-KGS-18A		11-Mar-2019	L2245232-22	0.0198	0.00038	0.00317	0.0104	<0.00010	<0.000050	0.027	<0.0000050	25.9	0.000018	0.00011	0.00043	0.00130	0.237	0.000081	0.0150	15.5	*0.123*	-
TH19-KGS-19		11-Mar-2019	L2245232-31	0.0292	0.00429	**0.0121**	0.0292	<0.00010	<0.000050	0.116	<0.0000050	44.9	0.000016	**0.00233**	0.00013	0.00200	<0.010	0.000052	0.0334	77.3	0.00082	-
		12-Jun-2019	L2290890-8	0.0128	0.00027	**0.0167**	0.0881	0.00014	<0.000050	0.097	0.0000097	66.7	0.000051	<0.00010	0.00035	0.00101	<0.010	0.000068	0.0351	78.2	<0.010	-
		23-Oct-2019	L2371438-1	0.0060	<0.00010	**0.00629**	0.0983	<0.00010	<0.000050	0.097	<0.0000050	34.4	<0.000010	<0.00010	0.00018	<0.00020	0.018	<0.000050	0.0331	76.2	*0.189*	-
		17-Jun-2020	L2462330-7	0.0025	<0.00010	**0.00520**	0.265	<0.00010	<0.000050	0.112	<0.0000050	50.3	<0.000010	0.00012	0.00108	0.00048	0.015	<0.000050	0.0335	87.7	*0.406*	-
		27-Oct-2020	L2523514-7	0.0094	<0.00010	0.00352	0.195	<0.00010	<0.000050	0.112	<0.0000050	62.7	<0.000010	0.00012	<0.00010	<0.00020	0.026	<0.000050	0.0341	81.2	***0.469***	-

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																	
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury
HC-CDWQ [2]																						
Drinking Water - MAC				-	0.006	0.010	2.0	-	-	5.0	0.007	[9]	-	0.05	-	2.0	-	0.005	-	-	0.12	0.001
Drinking Water - AO				0.1- 0.2 [4] (OG)	-	-	-	-	-	-	-	-	-	-	-	1.0	0.3	-	-	-	0.02	-
CCME[3]																						
Freshwater Aquatic Life				0.005 - 0.1 [5]	-	0.005	-	-	-	29 [6] 1.5 [7]	0.00009[8a] 0.001[8b]	-	-	0.0089 (III)[10] 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	0.430[11a]/ 3.600[11b]	0.000026 (inorganic) 0.000004 (methyl)[12]
GROUNDWATER SAMPLES																						
TH19-KGS-19A		11-Mar-2019	L2245232-16	0.0134	<0.00010	**0.00695**	0.0621	<0.00010	<0.000050	0.048	0.0000094	118	<0.000010	0.00043	0.00152	0.00165	2.44	0.000095	0.0100	55.4	*0.487*	-
TH19-KGS-20		14-Mar-2019	L2245232-32	0.0013	0.00021	0.00053	0.0152	<0.00010	<0.000050	0.142	<0.0000050	32.5	<0.000010	<0.00010	0.00085	0.00023	<0.010	<0.000050	0.0326	32.5	0.0197	-
	TH300		L2245232-33	0.0010	0.00020	0.00047	0.0151	<0.00010	<0.000050	0.150	<0.0000050	32.1	<0.000010	<0.00010	0.00075	0.00022	<0.010	<0.000050	0.0327	32.7	0.0199	-
	RPD			*26.1%*	*4.9%*	*12.0%*	*0.7%*	*NC*	*NC*	*5.5%*	*NC*	*1.2%*	*NC*	*NC*	*12.5%*	*4.4%*	*NC*	*NC*	*0.3%*	*0.6%*	*1.0%*	*NC*
TRIP BLANK		9-Mar-2019	L2245232-8	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	-
TRIP BLANK		11-Jun-2019	L2290890-9	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	0.141	<0.000010	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	<0.0010	0.0120	<0.010	-
TRIP BLANK		26-Oct-2020	L2523514-11	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	-
TRIP BLANK		17-Jun-2020	L2463404-8	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	-
FIELD BLANK		7-Mar-2019	L2245232-3	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.010	<0.0000050	<0.050	<0.000010	<0.00010	<0.00010	<0.00020	<0.010	<0.000050	<0.0010	<0.0050	<0.00010	-
FIELD BLANK		12-Jun-2019	L2290890-11	0.0025	<0.00010	<0.00010	0.00018	<0.00010	<0.000050	<0.010	<0.0000050	0.106	<0.000010	<0.00010	<0.00010	0.00091	<0.010	<0.000050	<0.0010	0.0325	<0.010	-
SURFACE WATER SAMPLES																						
BC-02		17-Jun-2020	L2463404-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
BC-05		17-Jun-2020	L2463404-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
CR3-1		17-Jun-2020	L2462330-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
CR3-2		17-Jun-2020	L2462330-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
LSMOC-INLET-1A		17-Jun-2020	L2463404-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
LSMOC-OUTLET-1A		17-Jun-2020	L2462330-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		27-Oct-2020	L2523516-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
SW-R3		11-Jun-2019	L2290890-10	**0.263**	<0.00010	0.00098	0.0396	<0.00010	<0.000050	0.040	<0.0000050	40.0	0.000032	0.00046	0.00019	0.00164	0.294	0.000149	0.0143	42.0	*0.0210*	-
		24-Oct-2019	L2371920-5	0.0342	<0.00010	0.00068	0.00697	<0.00010	<0.000050	<0.010	0.0000128	21.5	<0.000010	0.00016	<0.00010	<0.00050	0.035	<0.000050	0.0023	13.5	0.00204	-
		17-Jun-2020	L2462330-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
		28-Oct-2020	L2523516-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
	SW-100		L2523516-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0000050
	RPD			*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*
Laboratory Detection Limits				*0.0010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.000050*	*0.010*	*0.0000050*	*0.050*	*0.000010*	*0.00010*	*0.00010*	*0.00020*	*0.010*	*0.000050*	*0.0010*	*0.0050*	*0.00010*	*0.0000050*

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																	
				Molybdenum	Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
HC-CDWQ [2]																						
Drinking Water - MAC				-	-	-	-	-	0.05	-	[14]	-	7.0	-	-	-	-	-	0.02	-	-	-
Drinking Water - AO				-	-	-	-	-	-	-	-	200	-	-	-	-	-	-	-	-	5	-
CCME [3]																						
Freshwater Aquatic Life				0.073 [10]	[8e]	[13]	-	-	0.001	-	0.00025 [15]	-	-	-	0.0008	-	-	-	0.033 [7] 0.015 [8]	-	0.037 [7a] 0.007 [8a]	-
GROUNDWATER SAMPLES																						
PW19-KGS-01		12-Mar-2019	L2245232-28	0.00113	0.00060	<0.030	4.93	0.00142	<0.000050	5.61	<0.000010	31.3	0.217	<0.00020	0.000011	<0.00010	<0.00030	<0.00010	0.00165	<0.00050	**0.0089**	<0.000060
		11-Jun-2019	L2290890-1	0.00106	0.00065	<0.030	4.91	0.00139	<0.000050	5.81	<0.000010	27.9	0.214	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.00184	<0.00050	0.0013	<0.000060
		24-Oct-2019	L2371920-1	0.000894	0.00141	0.037	4.93	0.00202	<0.000050	6.14	<0.000010	28.0	0.222	<0.00020	0.000014	<0.00010	0.0130	<0.00010	0.00211	0.00056	0.0042	0.00026
	PW-200		L2371920-4	0.000916	0.00143	<0.030	5.05	0.00210	<0.000050	6.14	<0.000010	29.0	0.228	<0.00020	0.000014	<0.00010	0.0128	<0.00010	0.00212	0.00055	0.0026	0.00028
	RPD			*2.4%*	*1.4%*	*NC*	*2.4%*	*3.9%*	*NC*	*0.0%*	*NC*	*3.5%*	*2.7%*	*NC*	*0.0%*	*NC*	*1.6%*	*NC*	*0.5%*	*1.8%*	*47.1%*	*7.4%*
		17-Jun-2020	L2463404-1	0.00149	<0.00050	<0.030	6.44	0.00338	<0.000050	4.50	0.000010	45.4	0.227	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000875	<0.00050	<0.0010	<0.00020
		27-Oct-2020	L2523514-1	0.00106	<0.00050	<0.030	4.40	0.00128	<0.000050	5.72	<0.000010	26.9	0.222	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.00162	<0.00050	<0.0010	<0.00020
PW19-KGS-02		13-Mar-2019	L2245232-26	0.000395	<0.00050	<0.030	4.81	0.00264	<0.000050	5.48	<0.000010	33.9	0.215	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000773	<0.00050	0.0025	<0.000060
	PW19-KGS-05		L2245232-27	0.000381	<0.00050	<0.030	4.99	0.00253	<0.000050	5.44	<0.000010	34.1	0.212	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000794	<0.00050	0.0014	<0.000060
	RPD			*3.6%*	*NC*	*NC*	*3.7%*	*4.3%*	*NC*	*0.7%*	*NC*	*0.6%*	*1.4%*	*NC*	*NC*	*NC*	*NC*	*NC*	*2.7%*	*NC*	*56.4%*	*NC*
		11-Jun-2019	L2290890-2	0.000424	<0.00050	<0.030	4.71	0.00241	<0.000050	5.80	<0.000010	35.7	0.202	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000996	<0.00050	0.0040	<0.000060
		24-Oct-2019	L2371920-2	0.000343	<0.00050	<0.030	5.06	0.00281	<0.000050	5.50	<0.000010	31.9	0.207	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000727	<0.00050	0.0019	<0.00020
		16-Jun-2020	L2462330-4	0.000406	<0.00050	<0.030	4.73	0.00266	<0.000050	5.39	<0.000010	32.9	0.205	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000739	<0.00050	<0.0010	<0.00020
		28-Oct-2020	L2523514-2	0.000503	<0.00050	<0.030	4.50	0.00253	<0.000050	5.69	<0.000010	34.5	0.218	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000935	<0.00050	<0.0010	<0.00020
	PW-100		L2523514-8	0.000502	<0.00050	<0.030	4.53	0.00244	**0.00151**	5.74	<0.000010	35.7	0.222	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000952	<0.00050	<0.0010	<0.00020
	RPD			*0.2%*	*NC*	*NC*	*0.7%*	*3.6%*	*NC*	*0.9%*	*NC*	*3.4%*	*1.8%*	*NC*	*NC*	*NC*	*NC*	*NC*	*1.8%*	*NC*	*NC*	*NC*
PW19-KGS-03		14-Mar-2019	L2245232-24	0.000434	0.00170	<0.030	3.39	0.00210	<0.000050	5.34	<0.000010	8.44	0.155	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.00114	<0.00050	0.0027	<0.000060
	PW19-KGS-04		L2245232-25	0.000433	0.00165	<0.030	3.45	0.00196	<0.000050	5.35	<0.000010	8.45	0.155	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.00116	<0.00050	0.0025	<0.000060
	RPD			*0.2%*	*3.0%*	*NC*	*1.8%*	*6.9%*	*NC*	*0.2%*	*NC*	*0.1%*	*0.0%*	*NC*	*NC*	*NC*	*NC*	*NC*	*1.7%*	*NC*	*7.7%*	*NC*
		11-Jun-2019	L2290890-3	0.000131	0.00097	<0.030	4.30	0.00257	<0.000050	5.46	<0.000010	8.58	0.149	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000491	<0.00050	0.0011	<0.000060
	PW19-KGS-200		L2290890-4	0.000118	0.00094	<0.030	4.28	0.00258	<0.000050	5.41	<0.000010	8.60	0.147	<0.00020	0.000010	<0.00010	<0.00030	<0.00010	0.000481	<0.00050	<0.0010	<0.000060
	RPD			*10.4%*	*3.1%*	*NC*	*0.5%*	*0.4%*	*NC*	*0.9%*	*NC*	*0.2%*	*1.4%*	*NC*	*NC*	*NC*	*NC*	*NC*	*2.1%*	*NC*	*NC*	*NC*
		24-Oct-2019	L2371920-3	0.000440	0.00505	<0.030	2.51	0.00179	0.000067	5.22	0.000011	3.76	0.123	<0.00020	<0.000010	0.00075	0.00035	<0.00010	0.00221	0.00117	0.0013	0.00060
		17-Jun-2020	L2462330-5	0.000318	0.00214	<0.030	2.83	0.00170	<0.000050	4.51	<0.000010	5.83	0.128	<0.00020	0.000015	<0.00010	<0.00030	<0.00010	0.00179	<0.00050	<0.0010	<0.00020
	PW19-KGS-300		L2462330-6	0.000335	0.00215	<0.030	2.83	0.00173	<0.000050	4.55	<0.000010	5.72	0.130	<0.00020	0.000015	<0.00010	<0.00030	<0.00010	0.00179	<0.00050	<0.0010	<0.00020
	RPD			*5.2%*	*0.5%*	*NC*	*0.0%*	*1.7%*	*NC*	*0.9%*	*NC*	*1.9%*	*1.6%*	*NC*	*0.0%*	*NC*	*NC*	*NC*	*0.0%*	*NC*	*NC*	*NC*
		27-Oct-2020	L2523514-3	0.000355	0.00140	<0.030	3.32	0.00210	<0.000050	5.10	<0.000010	7.05	0.148	<0.00020	0.000010	<0.00010	<0.00030	<0.00010	0.00145	<0.00050	<0.0010	<0.00020
Sentinel Well 1 - (SW19-KGS-01)		18-Jun-2020	L2463404-2	0.00117	0.00053	<0.030	4.52	0.00125	<0.000050	6.02	<0.000010	27.3	0.230	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.00195	<0.00050	<0.0010	<0.00020
		8-Mar-2019	L2242160-1	0.00105	0.00106	<0.030	6.34	0.00319	0.000051	5.55	<0.000010	48	0.236	<0.00020	0.000011	<0.00010	<0.00030	<0.00010	0.00218	<0.00050	<0.0010	0.000066
Sentinel Well 2 - (SW19-KGS-02)		27-Sep-2019	L2356084-1	0.00514	0.00171	<0.030	8.08	0.00483	0.000053	4.28	<0.000010	111	0.254	<0.00020	<0.000010	<0.00010	<0.00030	0.00016	0.000190	<0.00050	<0.0010	<0.00020
		18-Jun-2020	L2463404-3	0.000083	<0.00050	<0.030	7.43	0.00401	<0.000050	4.02	0.000023	107	0.248	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000200	<0.00050	<0.0010	<0.00020
		29-Oct-2020	L2523514-9	0.000102	<0.00050	<0.030	7.39	0.00408	0.000791	4.37	<0.000010	106	0.246	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000183	<0.00050	<0.0010	<0.00020
Sentinel Well 3 - (SW19-KGS-03)		27-Sep-2019	L2356084-2	0.00149	0.00070	<0.030	7.37	0.00380	<0.000050	5.11	<0.000010	61.9	0.238	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000179	<0.00050	<0.0010	<0.00020
		18-Jun-2020	L2463404-4	0.000182	<0.00050	<0.030	6.56	0.00342	<0.000050	4.75	<0.000010	58.5	0.241	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000175	<0.00050	<0.0010	<0.00020
		29-Oct-2020	L2523514-10	0.000188	<0.00050	<0.030	6.74	0.00356	0.000544	4.74	<0.000010	59.8	0.240	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000164	<0.00050	<0.0010	<0.00020
TH15-04		8-Mar-2019	L2245232-4	0.00196	0.00145	<0.030	2.39	0.00116	0.000081	4.70	<0.000010	19.3	0.161	<0.00020	<0.000010	0.00267	<0.00030	0.00026	0.000793	<0.00050	0.0014	0.000082
TH15-05		8-Mar-2019	L2245232-6	0.000417	0.00063	<0.030	3.48	0.00241	<0.000050	4.74	<0.000010	6.91	0.161	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000317	<0.00050	<0.0010	<0.000060
TH19-KGS-01B		9-Mar-2019	L2245232-12	0.00604	0.00121	<0.030	4.95	0.00252	<0.000050	5.01	<0.000010	38.4	0.216	<0.00020	0.000014	<0.00010	<0.00030	0.00015	0.000448	<0.00050	0.0020	<0.000060
TH19-KGS-02B		11-Mar-2019	L2245232-18	0.0161	0.00405	<0.030	6.93	0.00195	0.000719	5.33	<0.000010	178	0.520	<0.00020	0.000037	0.00028	<0.00030	0.0950	0.0103	<0.00050	0.0038	0.000106
TH19-KGS-03A		8-Mar-2019	L2245232-40	0.000905	0.00072	0.092	0.634	0.00116	0.000107	6.06	<0.000010	14.0	0.125	<0.00020	<0.000010	0.00023	<0.00030	<0.00010	0.00116	<0.00050	0.0048	0.000172
TH19-KGS-04		9-Mar-2019	L2245232-7	0.00208	0.00089	<0.030	5.35	0.00231	0.000112	5.88	<0.000010	69.3	0.259	<0.00020	0.000020	<0.00010	<0.00030	0.00063	0.00119	<0.00050	0.0024	<0.000060
TH19-KGS-07		7-Mar-2019	L2245232-11	0.00482	<0.00050	<0.030	4.29	0.00245	<0.000050	4.56	<0.000010	28.2	0.198	<0.00020	<0.000010	<0.00010	<0.00030	0.00406	0.000404	<0.00050	0.0017	<0.000060
TH19-KGS-07A		7-Mar-2019	L2245232-10	0.00102	<0.00050	0.053	2.04	0.00108	0.000123	13.0	<0.000010	10.2	0.173	<0.00020	<0.000010	<0.00010	<0.00030	0.00013	0.000994	0.00088	<0.0010	0.000144
TH19-KGS-08		8-Mar-2019	L2245232-36	0.000317	<0.00050	<0.030	4.13	0.00252	<0.000050	4.85	<0.000010	7.17	0.161	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000262	<0.00050	0.0036	<0.000060
TH19-KGS-09		12-Mar-2019	L2245232-2	0.000518	<0.00050	<0.030	4.94	0.00273	<0.000050	5.38	<0.000010	21.6	0.191	<0.00020	0.000014	<0.00010	<0.00030	0.00010	0.000432	<0.00050	<0.0010	<0.000060

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																	
				Molybdenum	Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
HC-CDWQ [2]																						
Drinking Water - MAC				-	-	-	-	-	0.05	-	[14]	-	7.0	-	-	-	-	-	0.02	-	-	-
Drinking Water - AO				-	-	-	-	-	-	-	-	200	-	-	-	-	-	-	-	-	5	-
CCME[3]																						
Freshwater Aquatic Life				0.073[10]	[8e]	[13]	-	-	0.001	-	0.00025[15]	-	-	-	0.0008	-	-	-	0.033[7] 0.015[8]	-	0.037 [7a] 0.007 [8a]	-
GROUNDWATER SAMPLES																						
TH19-KGS-10		9-Mar-2019	L2245232-5	0.00102	0.00069	<0.030	3.32	0.00214	<0.000050	5.92	<0.000010	8.14	0.178	<0.00020	0.000014	<0.00010	<0.00030	0.00194	0.00259	<0.00050	<0.0010	<0.000060
	TH200		L2245232-30	0.00105	0.00069	<0.030	3.49	0.00229	<0.000050	5.88	<0.000010	8.22	0.184	<0.00020	0.000014	<0.00010	<0.00030	0.00200	0.00261	<0.00050	<0.0010	<0.000060
	RPD			*2.9%*	*0.0%*	*NC*	*5.0%*	*6.8%*	*NC*	*0.7%*	*NC*	*1.0%*	*3.3%*	*NC*	*0.0%*	*NC*	*NC*	*3.0%*	*0.8%*	*NC*	*NC*	*NC*
TH19-KGS-100		7-Mar-2019	L2245232-41	0.000134	<0.00050	0.129	0.532	0.00061	0.000159	9.96	<0.000010	12.5	0.203	<0.00020	<0.000010	<0.00010	0.00036	<0.00010	0.000316	<0.00050	<0.0010	0.000182
TH19-KGS-11		8-Mar-2019	L2245232-37	0.00464	0.00091	<0.030	5.88	0.00419	0.000142	4.29	<0.000010	39.4	0.291	<0.00020	<0.000010	0.00015	<0.00030	0.00197	0.000908	<0.00050	<0.0010	0.000061
TH19-KGS-11A		8-Mar-2019	L2245232-20	0.000394	0.00118	0.046	0.577	0.00084	0.000115	11.2	<0.000010	6.65	0.0968	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000357	<0.00050	0.0027	0.000113
TH19-KGS-12		7-Mar-2019	L2245232-19	0.0147	0.00303	<0.030	5.12	0.00238	<0.000050	5.47	<0.000010	27.4	0.260	<0.00020	0.000035	0.00012	<0.00030	0.00131	0.000077	<0.00050	0.0021	<0.000060
		12-Jun-2019	L2290890-5	0.0164	0.00373	<0.030	4.55	0.00208	<0.000050	5.81	<0.000010	30.1	0.234	<0.00020	<0.000010	<0.00010	<0.00030	0.00048	0.000106	<0.00050	0.0016	<0.000060
		23-Oct-2019	L2371438-4	0.0470	0.00573	<0.030	4.57	0.00213	0.000098	5.22	<0.000010	51.2	0.222	<0.00020	<0.000010	0.00019	<0.00030	0.00138	0.000043	<0.00050	0.0013	<0.00020
		16-Jun-2020	L2462330-3	0.00380	0.00167	<0.030	4.50	0.00203	<0.000050	6.17	<0.000010	29.3	0.244	<0.00020	<0.000010	0.00022	<0.00030	0.00018	0.000235	<0.00050	0.0034	<0.00020
		28-Oct-2020	L2523514-4	0.00605	0.00540	<0.030	4.55	0.00200	<0.000050	6.07	<0.000010	26.4	0.261	<0.00020	<0.000010	<0.00010	<0.00030	0.00024	0.000273	<0.00050	0.0013	<0.00020
TH19-KGS-12B		14-Mar-2019	L2245232-34	0.00812	0.00284	0.049	5.82	0.00151	0.000216	7.08	<0.000010	31.1	0.307	<0.00020	0.000033	0.00035	<0.00030	0.0573	0.00416	<0.00050	**0.0289**	0.000226
TH19-KGS-13		7-Mar-2019	L2245232-1	0.000721	0.00066	<0.030	4.37	0.00292	0.000088	5.18	<0.000010	21.3	0.202	<0.00020	<0.000010	<0.00010	<0.00030	0.00510	0.00120	<0.00050	0.0019	<0.000060
TH19-KGS-13A		7-Mar-2019	L2245232-17	0.00207	0.00110	0.056	0.981	0.00097	0.000382	6.02	<0.000010	9.08	0.117	<0.00020	<0.000010	0.00013	0.00158	<0.00010	0.000901	<0.00050	**0.0093**	0.000209
TH19-KGS-14		8-Mar-2019	L2245232-39	0.000275	<0.00050	<0.030	4.00	0.00281	<0.000050	4.72	<0.000010	12.6	0.162	<0.00020	<0.000010	<0.00010	<0.00030	0.00013	0.000199	<0.00050	0.0014	<0.000060
TH19-KGS-14A		8-Mar-2019	L2245232-9	0.000266	0.00052	0.035	0.791	0.00076	0.000088	5.06	<0.000010	2.84	0.0961	<0.00020	<0.000010	0.00026	0.00049	<0.00010	0.000417	<0.00050	**0.0142**	0.000145
TH19-KGS-15		9-Mar-2019	L2245232-29	0.00505	0.00267	<0.030	5.57	0.00319	0.000109	5.88	<0.000010	10.3	0.186	<0.00020	0.000027	0.00031	<0.00030	0.00704	0.00125	<0.00050	0.0027	0.000182
TH19-KGS-16		15-Mar-2019	L2245232-14	0.00749	0.00254	<0.030	4.57	0.00326	0.000113	4.87	<0.000010	21.9	0.162	<0.00020	<0.000010	<0.00010	0.00115	0.00208	0.00131	<0.00050	**0.0079**	0.000265
	TH19-KGS-500		L2245232-13	0.00483	0.00235	<0.030	4.50	0.00304	0.000106	4.59	<0.000010	21.1	0.160	<0.00020	<0.000010	<0.00010	<0.00030	0.00213	0.00123	<0.00050	0.0051	0.000103
	RPD			*43.2%*	*7.8%*	*NC*	*1.5%*	*7.0%*	*6.4%*	*5.9%*	*NC*	*3.7%*	*1.2%*	*NC*	*NC*	*NC*	*NC*	*2.4%*	*6.3%*	*NC*	*43.1%*	*88.0%*
TH19-KGS-16B		9-Mar-2019	L2245232-35	0.000866	0.00356	0.102	2.63	0.00265	<0.000050	8.20	<0.000010	8.26	0.177	<0.00020	0.000029	0.00024	0.0205	0.00041	0.0101	0.00259	**0.0103**	0.000878
TH19-KGS-17		10-Mar-2019	L2245232-23	0.00164	0.00148	<0.030	3.90	0.00217	0.000130	4.39	<0.000010	9.43	0.162	<0.00020	<0.000010	<0.00010	<0.00030	0.00186	0.000389	<0.00050	<0.0010	<0.000060
		12-Jun-2019	L2290890-6	0.0101	0.00087	<0.030	3.47	0.00227	0.000912	4.66	<0.000010	16.0	0.146	<0.00020	<0.000010	<0.00010	<0.00030	0.00038	0.000263	<0.00050	<0.0010	<0.000060
		23-Oct-2019	L2371438-3	0.000591	<0.00050	<0.030	3.18	0.00192	<0.000050	4.35	<0.000010	9.11	0.166	<0.00020	<0.000010	<0.00010	<0.00030	0.00012	0.000137	<0.00050	<0.0010	<0.00020
		16-Jun-2020	L2462330-2	0.000557	<0.00050	<0.030	3.34	0.00187	0.000140	4.29	<0.000010	9.00	0.163	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000116	<0.00050	<0.0010	<0.00020
		27-Oct-2020	L2523514-5	0.000300	0.00344	0.094	3.84	0.00528	<0.000050	6.22	<0.000010	8.63	0.169	<0.00020	0.000020	<0.00010	0.0471	<0.00010	0.000232	0.00216	**0.0071**	0.00189
TH19-KGS-17A		10-Mar-2019	L2245232-21	0.000599	0.00090	0.056	1.23	0.00087	0.000079	8.29	<0.000010	4.40	0.110	<0.00020	<0.000010	0.00036	0.00060	<0.00010	0.00149	0.00113	0.0060	0.000341
TH19-KGS-17B		10-Mar-2019	L2245232-15	0.0187	0.00089	<0.030	5.34	0.00146	**0.00304**	6.21	<0.000010	39.5	0.371	<0.00020	<0.000010	0.00039	0.00046	0.00011	**0.0297**	0.00134	0.0058	0.000481
TH19-KGS-18		11-Mar-2019	L2245232-38	0.00526	0.00259	<0.030	2.88	0.00226	0.000111	10.7	<0.000010	12.3	0.308	<0.00020	<0.000010	<0.00010	<0.00030	0.00101	0.000459	<0.00050	**0.0099**	0.000108
		12-Jun-2019	L2290890-7	0.00167	0.00461	<0.030	2.22	0.00167	<0.000050	10.6	<0.000010	11.3	0.290	<0.00020	<0.000010	<0.00010	<0.00030	0.00016	0.000586	<0.00050	0.0047	0.000193
		23-Oct-2019	L2371438-2	0.000785	0.00177	<0.030	1.98	0.00147	0.000095	9.86	0.000022	11.2	0.305	<0.00020	<0.000010	<0.00010	0.00047	<0.00010	0.000294	<0.00050	0.0014	<0.00020
		16-Jun-2020	L2462330-1	0.000534	0.00174	<0.030	0.616	0.00131	0.000918	6.99	<0.000010	6.56	0.108	<0.00020	<0.000010	<0.00010	0.00081	0.00013	0.000545	0.00102	<0.0010	0.00053
		27-Oct-2020	L2523514-6	0.000614	0.00136	<0.030	1.14	0.00157	0.000063	8.64	<0.000010	9.36	0.227	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	0.000475	<0.00050	<0.0010	0.00046
TH19-KGS-18A		11-Mar-2019	L2245232-22	0.000610	0.00060	<0.030	1.08	0.00154	0.000339	5.84	<0.000010	70.2	0.0751	<0.00020	0.000012	<0.00010	0.00068	<0.00010	0.000037	<0.00050	0.0045	0.000082
TH19-KGS-19		11-Mar-2019	L2245232-31	0.00887	0.00138	0.041	5.32	0.00379	**0.00134**	19.2	<0.000010	37.1	0.283	<0.00020	<0.000010	0.00015	0.00037	0.121	0.00218	0.00796	0.0051	0.000191
		12-Jun-2019	L2290890-8	0.00524	0.00216	<0.030	5.01	0.00370	0.000281	8.02	0.000021	48.5	0.921	<0.00020	0.000119	<0.00010	0.00061	0.0293	0.00203	0.00135	0.0026	0.000287
		23-Oct-2019	L2371438-1	0.00790	0.00089	<0.030	3.10	0.00167	0.000101	7.92	<0.000010	43.1	0.511	<0.00020	<0.000010	0.00092	<0.00030	0.0172	0.00186	<0.00050	0.0014	0.00023
		17-Jun-2020	L2462330-7	0.00415	0.00311	<0.030	4.20	0.00146	<0.000050	7.21	<0.000010	34.6	0.920	<0.00020	<0.000010	0.00019	<0.00030	0.00355	0.00146	<0.00050	0.0030	0.00021
		27-Oct-2020	L2523514-7	0.000099	<0.00050	<0.030	4.15	0.00144	0.000337	8.12	<0.000010	23.4	0.711	<0.00020	<0.000010	0.00016	0.00032	0.00189	0.000842	<0.00050	<0.0010	0.00031
TH19-KGS-19A		11-Mar-2019	L2245232-16	0.00213	0.00141	<0.030	2.28	0.00180	0.000081	8.56	<0.000010	8.37	0.184	<0.00020	<0.000010	0.00019	0.00059	<0.00010	0.000651	0.00094	0.0060	0.000931
TH19-KGS-20		14-Mar-2019	L2245232-32	0.00806	0.00129	<0.030	4.50	0.00202	0.000527	3.97	<0.000010	139	0.224	<0.00020	<0.000010	<0.00010	<0.00030	0.00603	0.00155	<0.00050	<0.0010	<0.000060
	TH300		L2245232-33	0.00774	0.00115	<0.030	4.41	0.00197	0.000450	3.99	<0.000010	141	0.219	<0.00020	<0.000010	<0.00010	<0.00030	0.00595	0.00145	<0.00050	<0.0010	<0.000060
	RPD			*4.1%*	*11.5%*	*NC*	*2.0%*	*2.5%*	*15.8%*	*0.5%*	*NC*	*1.4%*	*2.3%*	*NC*	*NC*	*NC*	*NC*	*1.3%*	*6.7%*	*NC*	*NC*	*NC*

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date Sampled	ALS Sample ID	Parameter [1]																	
				Molybdenum	Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
HC-CDWQ [2]																						
Drinking Water - MAC				-	-	-	-	-	0.05	-	[14]	-	7.0	-	-	-	-	-	0.02	-	-	-
Drinking Water - AO				-	-	-	-	-	-	-	-	200	-	-	-	-	-	-	-	-	5	-
CCME [3]																						
Freshwater Aquatic Life				0.073 [10]	[8e]	[13]	-	-	0.001	-	0.00025 [15]	-	-	-	0.0008	-	-	-	0.033 [7] 0.015 [8]	-	0.037 [7a] 0.007 [8a]	-
GROUNDWATER SAMPLES																						
TRIP BLANK		9-Mar-2019	L2245232-8	<0.000050	<0.00050	<0.030	<0.050	<0.00020	<0.000050	<0.050	<0.000010	<0.050	<0.00010	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0010	<0.000060
TRIP BLANK		11-Jun-2019	L2290890-9	<0.000050	<0.00050	<0.030	<0.050	<0.00020	<0.000050	<0.050	<0.000010	<0.050	<0.00010	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0010	<0.000060
TRIP BLANK		26-Oct-2020	L2523514-11	<0.000050	<0.00050	<0.030	<0.050	<0.00020	0.000090	<0.050	<0.000010	<0.050	<0.00010	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0010	<0.00020
TRIP BLANK		17-Jun-2020	L2463404-8	<0.000050	<0.00050	<0.030	<0.050	<0.00020	<0.000050	<0.050	<0.000010	<0.050	<0.00010	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0010	<0.00020
FIELD BLANK		7-Mar-2019	L2245232-3	<0.000050	<0.00050	<0.030	<0.050	<0.00020	<0.000050	<0.050	<0.000010	<0.050	0.00014	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	<0.0010	<0.000060
FIELD BLANK		12-Jun-2019	L2290890-11	<0.000050	<0.00050	<0.030	0.078	<0.00020	<0.000050	<0.050	<0.000010	0.123	0.00012	<0.00020	<0.000010	<0.00010	<0.00030	<0.00010	<0.000010	<0.00050	0.0033	<0.000060
SURFACE WATER SAMPLES																						
BC-02		17-Jun-2020	L2463404-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BC-05		17-Jun-2020	L2463404-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CR3-1		17-Jun-2020	L2462330-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CR3-2		17-Jun-2020	L2462330-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LSMOC-INLET-1A		17-Jun-2020	L2463404-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LSMOC-OUTLET-1A		17-Jun-2020	L2462330-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27-Oct-2020	L2523516-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW-R3		11-Jun-2019	L2290890-10	0.000566	0.00105	<0.030	3.48	0.00220	0.000066	1.33	<0.000010	6.85	0.117	<0.00020	0.000011	<0.00010	0.0106	<0.00010	0.00191	0.00120	<0.0030	0.00029
		24-Oct-2019	L2371920-5	0.000085	<0.00050	<0.030	2.00	0.00355	0.000108	4.17	<0.000010	1.03	0.0233	<0.00020	<0.000010	<0.00010	0.00117	<0.00010	0.000061	<0.00050	<0.0030	<0.00020
		17-Jun-2020	L2462330-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28-Oct-2020	L2523516-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW-100		L2523516-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RPD			*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*
Laboratory Detection Limits				*0.000050*	*0.00050*	*0.030*	*0.050*	*0.00020*	*0.000050*	*0.050*	*0.000010*	*0.050*	*0.00010*	*0.00020*	*0.000010*	*0.00010*	*0.00030*	*0.00010*	*0.000010*	*0.00050*	*0.0010*	*0.00020*

Notes:
"-" = No Data

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified. Groundwater samples - dissolved (filtered and preserved in field). Surface water samples - Total (preserved in field)
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated September 2020.
   MAC = Maximum Acceptable Concentration = The maximum concentration of a parameter that is designed to protect those individuals most at risk, such as children and the elderly.
   AO = Aesthetic Objective = A guideline which addresses a parameter that may affect consumer acceptance of drinking water, such as taste, odour, and colour.
   OG = Operational Guideline = Guideline meant for a parameter which may affect treatment plant processes or drinking water distribution systems.
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated December 2019.
   Guidelines for Canadian Drinking Water Quality.
   Community Water Supplies (Health Canada - Canadian Drinking Water Quality Guidelines)
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
   Canadian Water Quality Guidelines for the Protection of Agriculture Water Uses
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
   The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5.
   The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater or equal to 6.5.

TABLE 5
METALS IN WATER
LAKE ST. MARTIN OUTLET CHANNEL

6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.
   a. The short-term benchmark is for dissolved zinc and is calculated using the following equation: Benchmark = exp(0.833[ln(hardness mg·L^{-1})] + 0.240[ln(DOC mg·L^{-1})] + 0.526). The value in the table is for surface water of 50 mg CaCO3·L−1 hardness and 0.5 mg·L−1 dissolved organic carbon (DOC). The benchmark equation is valid between hardness 13.8 and 250.5 mg CaCO3·L−1 and DOC 0.3 and 17.3 mg·L−1. (value is in µg/L)
7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
   a. The long-term CWQG is for dissolved zinc and is calculated using the following equation: CWQG = exp(0.947[ln(hardness mg·L^{-1})] - 0.815[pH] + 0.398[ln(DOC mg·L^{-1})] + 4.625). The value in the table is for surface water of 50 mg CaCO3·L−1 hardness, pH of 7.5 and 0.5 mg·L−1 DOC. The CWQG equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1. (value is in µg/L)
8. Guidelines for the following metals are specific to the hardness of the sample, expressed as CaCO3 in mg/L:

		Hardness Range (mg/L)	*Example Hardness (mg/L)	**Guideline (mg/L)
Cadmium	Long-Term [a]	50	-	0.00009
		0-16	-	0.00004
		17-280	100	0.00016
		>280	-	0.00037
	Short-Term [b]	50	-	0.00100
		0-5.2	-	0.00011
		5.3-360	100	0.00210
		>360	-	0.00770
Copper [c]		0-81	-	0.00200
		82-180	100	0.00236
		>180	-	0.00400
		Unknown	-	0.00200
Lead [d]		0-60	-	0.00100
		61-180	100	0.00318
		>180	-	0.00700
		Unknown	-	0.00100
Nickel [e]		0-60	-	0.02500
		61-180	100	0.09558
		>180	-	0.15000
		Unknown	-	0.02500

Sample ID	Date	Metal	Hardness (mg/L)	***Applicable Guideline (mg/L)
TH19-KGS-02B	11/Mar/2019	Copper	834	0.004
TH19-KGS-12B	14/Mar/2019	Copper	425	0.004
TH19-KGS-16B	9/Mar/2019	Copper	623	0.004
		Lead		0.007
TH19-KGS-17B	10/Mar/2019	Copper	528	0.004
TH19-KGS-19	11/Mar/2019	Copper	431	0.004
PW19-KGS-01	24/Oct/2019	Lead	420	0.007
PW-200 DUP	24/Oct/2019	Lead	431	0.007
TH19-KGS-17	27/Oct/2020	Lead	418	0.007

*The table on the left uses the equations defined by CCME to caclulate a guideline when hardness is within the defined Hardness Range. These equations are applicable only to the rows where an Example Hardness value of 100 is input

**This Guideline column lists the guidelines related to each Hardness Range for each metal. An example guideline value in the rows requiring use of the equation was calculated, using the example value of 100 mg/L

***The table above lists those samples and parameters of which the lab results exceeded the minimum guideline value, thus requring a comparison to the hardness of the samples to determine the applicable guideline. The Applicable Guidelines for these specific samples are listed in the right-most column

9. Guideline value not required, as there is no evidence of adverse health effects from calcium in drinking water. Calcium contributes to hardness.
10. Interim Water Quality Guideline.
11. These values are for a water hardness of 50 mg/L as CaCO3 and pH 7.5. The freshwater benchmark equation and the CWQG look-up table must be used in order to obtain a site-specific benchmark and CWQG, respectively,based on the hardness and pH of the water body of interest. Note that it is not appropriate to apply the manganese freshwater guidelines to marine or estuarine environments. Both the benchmark and guideline values were derived for dissolved manganese in order to represent the bioavailable form.
    a. The CWQG for manganese (i.e. long-term guideline) is found using the CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese. The long-term CWQG is for dissolved manganese and is found manually using the look-up table below or using the CWQG and benchmark calculator (Appendix B). The CWQG table is valid between hardness of 25 and 670 mg/L and pH 5.8 and 8.4, which are the ranges of data used to derive the hardness and pH slopes.
    b. The short-term benchmark is calculated using the benchmark calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese or the following equation: Benchmark = exp($^{0.878[kb(hardness)]+4.76}$) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. The benchmark equation is valid between hardness of 25 and 250 mg/L, which is the range of data used to derive the hardness slope.
12. Interim Guideline - may not fully protect high trophic level fish.
13. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (mg/L):

ultra-oligotrophic	<0.004	meso-eutrophic	0.020-0.035
oligotrophic	0.004-0.010	eutrophic	0.035-0.10
mesotrophic	0.010-0.020	hyper-eutrophic	>0.10

14. Guideline value not required. Drinking water does not contribute significantly to an individual's intake of silver.
15. This guideline is not applicable to silver nanoparticles and was derived based on the total concentration of silver.

	- Exceedance of HC-CDWQ Criteria MAC
Italic	- Exceedance of HC-CDWQ Criteria AO
BOLD	- Exceedance of CCME Criteria for the Protection of Aquatic Life

TABLE 6
PETROLEUM HYDROCARBONS IN SURFACE WATER
LAKE ST. MARTIN OUTLET CHANNEL

KGS Sample ID	Duplicate Sample ID	Date	ALS Sample ID	Parameter [1]								
				Benzene	Toluene [4a, 4b]	Ethyl-benzene [5a, 5b]	Xylenes (-o,-m,-p) [6a, 6b]	F1-BTEX (C6 - C10)	F2 (C10 - C16)	F3 (C16 - C34)	F4 (C34 - C50)	Total Hydrocarbons (C6 - C50)
SURFACE WATER SAMPLES												
BC-02		17-Jun-2020	L2463404-7	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-3	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
BC-05		17-Jun-2020	L2463404-6	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-4	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
CR3-1		17-Jun-2020	L2462330-10	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-5	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
CR3-2		17-Jun-2020	L2462330-11	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-6	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
LSMOC-INLET-1A		17-Jun-2020	L2463404-5	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-1	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
LSMOC-OUTLET-1A		17-Jun-2020	L2462330-9	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		27-Oct-2020	L2523516-2	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
SW-R3		17-Jun-2020	L2462330-8	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
		28-Oct-2020	L2523516-7	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
	SW-100		L2523516-8	<0.00050	<0.0010	<0.00050	<0.00064	<0.10	<0.10	<0.25	<0.25	<0.38
	RPD			*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*
Laboratory Detection Limits				*0.0005*	*0.001*	*0.0005*	*0.00064*	*0.1*	*0.1*	*0.25*	*0.25*	*0.38*
HC-CDWQ [2]												
Drinking Water Quality - MAC				0.005	0.060	0.140	0.090	-	-	-	-	-
Drinking Water Quality - AO				-	0.024	0.0016	0.020	-	-	-	-	-
CCME [3]												
Canadian Water Quality Guidelines for the Protection of Aquatic Life												
Freshwater Aquatic Life				0.37	0.002	0.090	-	-	-	-	-	-

Notes:
"-" = No Data

1. All concentrations in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Guidelines for Canadian Drinking Water Quality (HC-GCDWQ). Updated June 2019.
   MAC = Maximum Acceptable Concentration = The maximum concentration of a parameter that is designed to protect those individuals most at risk, such as children and the elderly.
   AO = Aesthetic Objective = A guideline which addresses a parameter that may affect consumer acceptance of drinking water, such as taste, odour, and colour.
3. CCME - Canadian Council of Ministers of the Environment. Canadian Water Quality Guidelines, 1999. Updated 2018.
   a. Community Water Supplies (Health Canada - Canadian Drinking Water Quality Guidelines)
   b. Canadian Water Quality Guidelines for the Protection of Aquatic Life
   c. Canadian Water Quality Guidelines for the Protection of Agriculture
4. Toluene
   a. Health basis of MAC: Adverse neurological effects, including vibration thresholds, colour discrimination, auditory thresholds, attention, memory and psychomotor functions.
   b. Other Health Considerations: Insufficient information to determine whether toluene is carcinogenic to humans.
5. Ethylbenzene
   a. Health basis of MAC: Effects on the liver and pituitary gland.
   b. Other Health Considerations: Tumour formation at various sites in animals, including kidney, lung, liver and testes.
6. Xylenes
   a. Health basis of MAC: Adverse neuromuscular effects.
   b. Other Health Considerations: Insufficient information to determine whether xylenes are carcinogenic to humans.

	- Exceedance of HC-CDWQ Criteria MAC
Italic	- Exceedance of HC-CDWQ Criteria AO
BOLD	- Exceedance of CCME Criteria for the Protection of Aquatic Life

TABLE 7
HISTORICAL GROUNDWATER QUALITY DATA FROM 2019-2020 OF THE LSMOC
LAKE ST. MARTIN OUTLET CHANNEL

Parameter[3]	HC-CDWQG[4]	CCME[5]	Statistics[6]						
			n[2]	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile
PH (PH units)	7.0-10.5 (AO)	6.5-9.0	72	7.12	8.57	8.03	0.30	7.48	8.35
Hardness as Caco3	80-100 (AO)	-	72	*106*	*834*	*392.50*	*107.01*	*249.8*	*609*
Chloride	250 (AO)	120/640	72	0.13	97.2	13.06	22.38	0.53	69.86
Fluoride	1.5 (MAC)	0.12	72	0.044	**1.15**	**0.28**	**0.15**	**0.13**	0.55
Sulphate	500 (AO)	-	72	0.37	737	71.97	93.92	1.75	176.65
Nitrate(as N)	10 (MAC)	3/124	72	0.005	0.136	0.02	0.03	0.01	0.07
Nitrite(as N)	1.0 (MAC)	0.06	72	0.001	0.014	0.004	0.003	0.001	0.012
Calcium	-	-	72	20.8	129	62.20	21.81	36.11	116.90
Magnesium	-	-	72	13.1	128	57.58	17.79	32.46	83.09
Potassium	-	-	72	0.532	8.08	4.03	1.82	0.72	7.13
Sodium	200 (AO)	-	72	0.916	178	31.14	32.44	5.19	106.45
T.D.S.	500 (AO)	-	72	103	*1430*	462.39	164.86	281.60	*673.05*
TotalPhosphorus	-	-	72	0.035	0.129	0.07	0.03	0.04	0.11
E. Coli (MPL/100mL)	None Detectable per 100 mL	-	36	0	1	0.03	0.18	0	0
Total Coliform (MPL/100mL)	None Detectable per 100 mL	-	36	0	200	12.1	42.63	0	76
Conductivity (µS/cm)	-	-	72	176	1970	756	230	477	1099
Aluminum, Dissolved	0.1-0.2 (AO)	0.005-0.1	72	0.001	***1.25***	0.051	***0.21***	0.001	***0.11***
Antimony, Dissolved	0.006 (MAC)	-	72	0.00011	0.00429	0.00049	0.00085	0.00011	0.00099
Arsenic, Dissolved	0.01 (MAC)	0.005	72	0.00012	0.0167	0.00169	0.0026	0.00021	0.01
Barium, Dissolved	2.0 (MAC)	-	72	0.00618	0.265	0.0496	0.043	0.012	0.13
Beryllium, Dissolved	-	-	72	0.00012	0.00014	0.00013	0.000014	0.000121	0.00014
Bismuth, Dissolved	-	-	72	0.000025	0.000025	0.000025	0.000[7]	0.000025	0.000025
Boron, Dissolved	5.0 (MAC)	1.5-29	72	0.012	0.412	0.117	0.063	0.027	0.2
Cadmium, Dissolved	0.007 (MAC)	0.00009/0.001	72	0.0000055	0.00003	0.0000109	0.000007	0.000006	0.000025
Cesium, Dissolved	-	-	72	0.00001	0.000298	0.0000348	0.000059	0.00001	0.000054
Chromium, Dissolved	0.05 (MAC)	0.001(VI)/0.0089(III)	72	0.0001	0.00233	0.00048	0.00063	0.00011	0.0021
Cobalt, Dissolved	-	-	72	0.00011	0.00267	0.00056	0.00054	0.000143	0.0016
Copper, Dissolved	2.0 (MAC)/1.0 (AO)	-	72	0.0002	0.00459	0.00124	0.0012	0.0002	0.0035
Iron, Dissolved	0.3 (AO)	0.3	72	0.01	***2.44***	***0.435***	***0.576***	0.01495	***1.71***
Lead, Dissolved	0.005 (MAC)	-	72	0.000052	0.00282	0.00036	0.00072	0.000053	0.0017
Lithium, Dissolved	-	-	72	0.0021	0.0599	0.025	0.011	0.007685	0.04
Manganese, Dissolved	0.12 (MAC)/0.02 (AO)	0.43-3.6	72	0.00082	***1.82***	***0.139***	***0.272***	0.0045	***0.497***
Molybdenum, Dissolved	-	0.073	72	0.000081	0.047	0.00348	0.00667	0.00012	0.015
Nickel, Dissolved	-	-	72	0.00052	0.00573	0.00185	0.00135	0.0006	0.00483
Rubidium, Dissolved	-	-	72	0.00061	0.00528	0.0023	0.0010	0.000925	0.004
Selenium, Dissolved	0.05 (MAC)	0.001	72	0.000051	0.00304	0.0003	0.0005	0.0000547	0.00098
Silicon, Dissolved	-	-	72	0.707	19.2	6.19	2.51	4.17	10.65
Silver, Dissolved	-	0.00025	72	0.00001	0.000023	0.000017	0.000006	0.0000102	0.000023
Strontium, Dissolved	7	-	72	0.0223	0.92	0.23	0.15	0.10	0.52
Tellurium, Dissolved	-	-	72	0.0001	0.0001	0.0001	0.000[7]	0.0001	0.0001
Thallium, Dissolved	-	0.0008	72	0.00001	0.000119	0.0000255	0.000026	0.0000108	0.000053
Tin, Dissolved	-	-	72	0.00012	0.00267	0.000413	0.00057	0.00013	0.001
Titanium, Dissolved	-	-	72	0.00032	0.0471	0.005	0.012	0.000344	0.026
Tungsten, Dissolved	-	-	72	0.0001	0.121	0.011	0.027	0.00012	0.0704
Uranium, Dissolved	0.02 (MAC)	0	72	0.000037	0.0297	0.002	0.004	0.000093	0.0032
Vanadium, Dissolved		0.015/0.033	72	0.00056	0.00796	0.002	0.002	0.00057	0.005
Zinc, Dissolved	-	-	72	0.0011	0.0289	0.004	0.005	0.0013	0.01
Zirconium, Dissolved	-	-	72	0.000061	0.00189	0.0003	0.0004	0.0001	0.0009

Notes:
1. This table shows parameters with established guidelines.
2. "n" refers to number of samples.
3. Results are in mg/L unless otherwise specified in the parameter column.
4. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated September 2020.
   MAC = Maximum Acceptable Concentration = The maximum concentration of a parameter that is designed to protect those individuals most at risk, such as children and the elderly.
   AO = Aesthetic Objective = A guideline which addresses a parameter that may affect consumer acceptance of drinking water, such as taste, odour, and colour.
   OG = Operational Guideline = Guideline meant for a parameter which may affect treatment plant processes or drinking water distribution systems.
5. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines for the protection of Freshwater Aquatic Life, 1999. Updated December 2019.
6. For statistical calculations, half detection limit values are used for the results of the laboratory analyses reported as less than the detection limit values.
7. Results of the laboratory analyses less than the detection limit values.

	- Exceedance of HC-CDWQ Criteria MAC
Italic	- Exceedance of HC-CDWQ Criteria AO
BOLD	- Exceedance of CCME Criteria for the Protection of Aquatic Life

TABLE 8
ISOTOPE DATA - LSMOC 2019-2020
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Duplicate Sample ID	Date	$\delta^{18}O$		$\delta^{2}H$		E3H			
			Result	Repeat	Result	Repeat	Result	± 1σ	Repeat	± 1σ
			VSMOW	± 0.2‰	VSMOW	± 0.8‰	± 0.8 T.U.		± 0.8 T.U.	
BC-02	-	17-Jun-2020	-10.54	-	-82.06	-	-	-	-	-
		28-Oct-2020	-10.73	-	-86.72	-	-	-	-	-
BC-05	-	17-Jun-2020	-11.14	-11.07	-85.12	-85.06	-	-	-	-
		28-Oct-2020	-11.75	-11.61	-91.79	-90.95	-	-	-	-
CR3-1	-	17-Jun-2020	-12.41	-	-89.75	-	-	-	-	-
		28-Oct-2020	-13.25	-	-96.67	-	-	-	-	-
CR3-2	-	17-Jun-2020	-12.47	-	-89.83	-	-	-	-	-
		28-Oct-2020	-13.09	-	-96.32	-	-	-	-	-
LSMOC INLET- 1A	-	17-Jun-2020	-7.63	-	-69.95	-	-	-	-	-
		28-Oct-2020	-7.88	-7.81	-72.08	-72.06	-	-	-	-
LSMOC OUTLET- 1A	-	17-Jun-2020	-9.46	-9.36	-80.35	-80.11	-	-	-	-
		27-Oct-2020	-10.17	-10.13	-85.85	-85.45	-	-	-	-
PW19-KGS-01	-	12-Mar-2019	-14.64	-14.60	-113.02	-112.81	<0.8	0.3	-	-
		11-Jun-2019	-14.69	-14.65	-114.25	-114.23	<0.8	0.8	-	-
		24-Oct-2019	-14.87	-14.79	-113.88	-113.94	< 0.8	0.2	-	-
	PW-200	24-Oct-2019	-15.09	-	-114.97	-	< 0.8	0.2	-	-
	-	17-Jun-2020	-14.93	-14.92	-113.94	-114.16	-	-	-	-
		27-Oct-2020	-15.00	-14.92	-114.41	-114.40	-	-	-	-
PW19-KGS-02	-	13-Mar-2019	-14.81	-	-113.18	-	<0.8	0.3	-	-
	PW19-KGS-05	13-Mar-2019	-15.19	-	-114.56	-	<0.8	0.3	-	-
	-	11-Jun-2019	-14.76	-	-114.39	-	<0.8	0.8	-	-
		24-Oct-2019	-15.11	-	-114.15	-	< 0.8	0.2	-	-
		16-Jun-2020	-15.22	-	-114.90	-	-	-	-	-
		28-Oct-2020	-15.28	-	-115.47	-	-	-	-	-
	PW-100	28-Oct-2020	-15.23	-	-115.40	-	-	-	-	-
PW19-KGS-03	-	14-Mar-2019	-14.92	-14.90	-111.49	-111.57	1.7	0.4	-	-
	PW19-KGS-04	14-Mar-2019	-15.00	-	-111.60	-	1.9	0.4	-	-
	-	11-Jun-2019	-14.68	-14.71	-112.66	-112.62	<0.8	0.8	-	-
	PW19-KGS-200	11-Jun-2019	-14.73	-	-112.61	-	<0.8	0.8	-	-
	-	24-Oct-2019	-13.62	-13.58	-97.15	-97.62	7.3	0.6	6.3	0.5
		17-Jun-2020	-14.73	-	-108.26	-	-	-	-	-
	PW19-KGS-300	17-Jun-2020	-14.83	-	-108.20	-	-	-	-	-
	-	27-Oct-2020	-14.93	-	-111.13	-	-	-	-	-
Sentinel Well 1 (SW19-KGS-01)	-	8-Mar-2019	-15.01	-15.03	-114.68	-113.97	<0.8	0.3	-	-
		18-Jun-2020	-15.62	-	-114.73	-	-	-	-	-
Sentinel Well 2 (SW19-KGS-02)	-	27-Sep-2019	-15.29	-15.35	-116.35	-115.60	< 0.8	0.3	-	-
		18-Jun-2020	-15.79	-	-117.26	-	-	-	-	-
		29-Oct-2020	-15.25	-	-116.37	-	-	-	-	-
Sentinel Well 3 (SW19-KGS-03)	-	27-Sep-2019	-15.21	-15.22	-114.63	-114.84	< 0.8	0.3	-	-
		18-Jun-2020	-15.58	-15.57	-115.47	-115.91	-	-	-	-
		29-Oct-2020	-15.09	-	-114.86	-	-	-	-	-
SW-R3	-	11-Jun-2019	-11.48	-11.52	-98.79	-98.59	7.3	0.8	-	-
		24-Oct-2019	-14.58	-14.56	-102.10	-102.51	8.2	0.6	-	-
		17-Jun-2020	-11.32	-	-87.43	-	-	-	-	-
		28-Oct-2020	-13.38	-	-100.06	-	-	-	-	-
	SW-100	28-Oct-2020	-13.35	-13.33	-99.46	-99.38	-	-	-	-
TH15-04	-	8-Mar-2019	-15.04	-	-112.65	-	-	-	-	-
TH15-05	-	8-Mar-2019	-15.16	-	-112.77	-	-	-	-	-
TH19-KGS-01	-	9-Mar-2019	-14.62	-	-114.07	-	-	-	-	-
TH19-KGS-04	-	9-Mar-2019	-14.83	-14.87	-113.99	-113.75	-	-	-	-
TH19-KGS-08	-	8-Mar-2019	-15.14	-	-112.26	-	-	-	-	-
TH19-KGS-09	-	12-Mar-2019	-15.21	-	-114.44	-	-	-	-	-
TH19-KGS-10	-	9-Mar-2019	-15.21	-	-112.31	-	-	-	-	-
	TH200	9-Mar-2019	-15.21	-	-112.80	-	-	-	-	-

ISOTOPE DATA - LSMOC 2019-2020
LAKE ST. MARTIN OUTLET CHANNEL

Sample ID	Duplicate Sample ID	Date	$\delta^{18}O$		$\delta^{2}H$		E3H			
			Result	Repeat	Result	Repeat	Result	± 1σ	Repeat	± 1σ
			VSMOW	± 0.2‰	VSMOW	± 0.8‰	± 0.8 T.U.		± 0.8 T.U.	
TH19-KGS-100	-	7-Mar-2019	-14.80	-	-108.59	-	-	-	-	-
TH19-KGS-11	-	8-Mar-2019	-15.12	-15.16	-115.62	-115.73	-	-	-	-
TH19-KGS-12	-	7-Mar-2019	-15.33	-	-115.76	-	-	-	-	-
		12-Jun-2019	-15.54	-	-119.09	-	<0.8	0.8	-	-
		23-Oct-2019	-16.17	-	-119.73	-	< 0.8	0.2	-	-
		16-Jun-2020	-16.27	-	-119.72	-	-	-	-	-
		28-Oct-2020	-16.19	-	-120.34	-	-	-	-	-
TH19-KGS-13	-	7-Mar-2019	-14.06	-14.10	-112.59	-112.80	-	-	-	-
TH19-KGS-14	-	8-Mar-2019	-15.18	-	-113.03	-	-	-	-	-
TH19-KGS-15	-	9-Mar-2019	-15.19	-15.17	-112.73	-112.66	-	-	-	-
TH19-KGS-16	-	15-Mar-2019	-14.99	-15.01	-112.14	-112.18	-	-	-	-
	TH19-KGS-500	15-Mar-2019	-15.19	-	-112.75	-	-	-	-	-
TH19-KGS-17	-	10-Mar-2019	-15.11	-	-112.37	-	<0.8	0.3	-	-
		11-Jun-2019	-14.17	-13.99	-110.08	-109.25	<0.8	0.8	-	-
		23-Oct-2019	-15.40	-	-113.58	-	< 0.8	0.2	-	-
		16-Jun-2020	-15.27	-15.23	-113.09	-112.77	-	-	-	-
		27-Oct-2020	-15.19	-15.17	-113.33	-113.22	-	-	-	-
TH19-KGS-18	-	11-Mar-2019	-14.87	-	-109.46	-	<0.8	0.3	-	-
		12-Jun-2019	-14.43	-	-108.74	-	10.6	0.8	-	-
		23-Oct-2019	-14.94	-	-108.99	-	10.7	0.8	-	-
		16-Jun-2020	-14.74	-	-105.73	-	-	-	-	-
		27-Oct-2020	-14.71	-	-108.28	-	-	-	-	-
TH19-KGS-19	-	11-Mar-2019	-15.13	-	-112.49	-	<0.8	0.3	<0.8	0.5
		12-Jun-2019	-14.94	-	-113.71	-	<0.8	0.8	-	-
		23-Oct-2019	-15.39	-15.34	-114.44	-114.12	< 0.8	0.2	-	-
		17-Jun-2020	-15.27	-	-113.47	-	-	-	-	-
		27-Oct-2020	-15.19	-	-113.88	-	-	-	-	-
TH19-KGS-20	-	14-Mar-2019	-14.76	-14.68	-114.41	-114.65	-	-	-	-
	TH300	14-Mar-2019	-14.59	-	-114.05	-	-	-	-	-

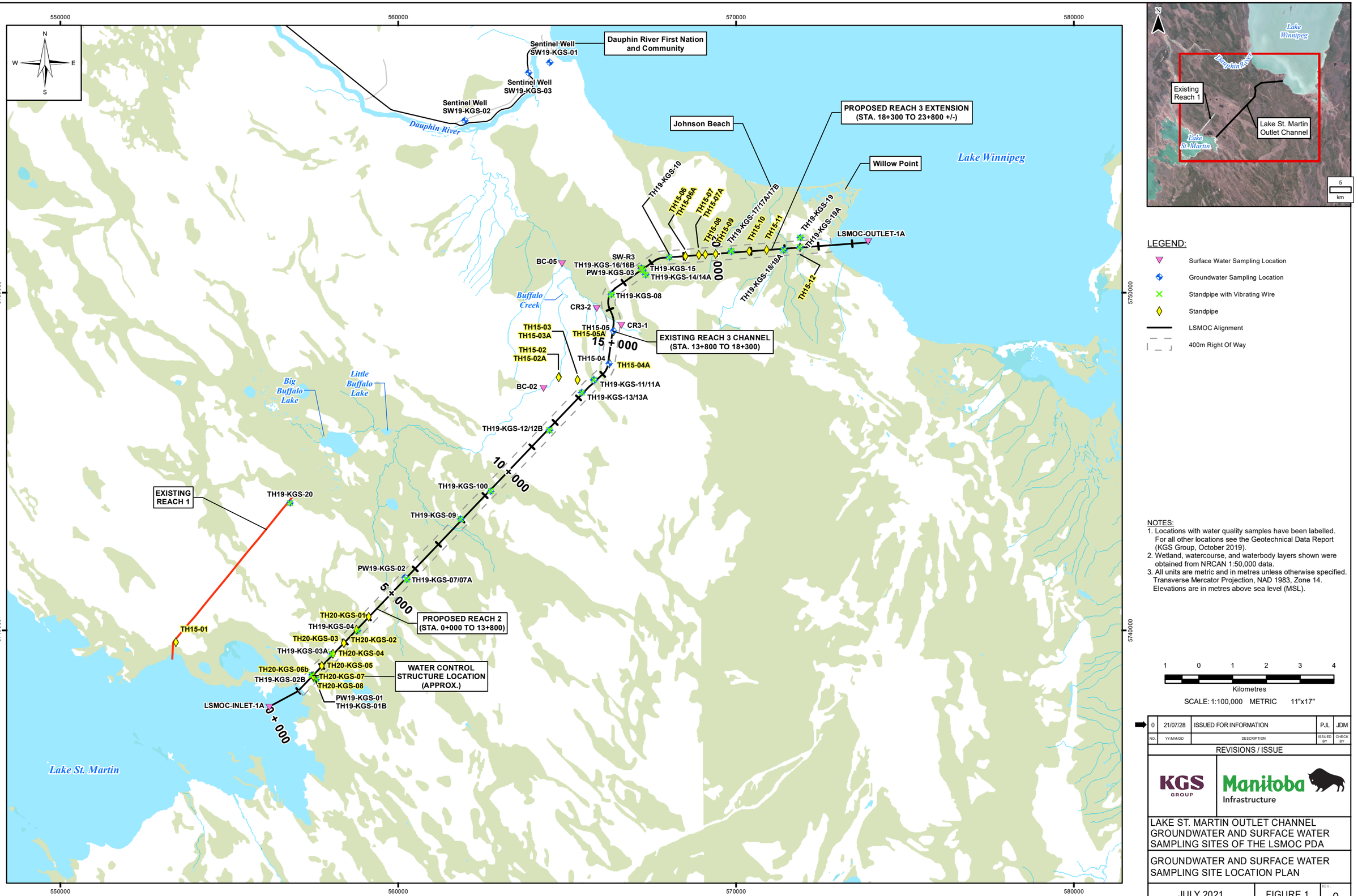
Note:

Tritium is reported in Tritium Units.
1TU = 3.221 Picocurries/L per IAEA, 2000 Report.
1TU = 0.11919 Becquerels/L per IAEA, 2000 Report.

FIGURE

KGS GROUP

Portions of data Produced by KGS Group, under Licence with the Province of Manitoba
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LEGEND:

- Surface Water Sampling Location
- Groundwater Sampling Location
- Standpipe with Vibrating Wire
- Standpipe
- LSMOC Alignment
- 400m Right Of Way

NOTES:
1. Locations with water quality samples have been labelled. For all other locations see the Geotechnical Data Report (KGS Group, October 2019).
2. Wetland, watercourse, and waterbody layers shown were obtained from NRCAN 1:50,000 data.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

1 0 1 2 3 4
Kilometres

SCALE: 1:100,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	21/07/28	ISSUED FOR INFORMATION	PJL	JDM

REVISIONS / ISSUE

KGS GROUP

Manitoba Infrastructure

LAKE ST. MARTIN OUTLET CHANNEL GROUNDWATER AND SURFACE WATER SAMPLING SITES OF THE LSMOC PDA

GROUNDWATER AND SURFACE WATER SAMPLING SITE LOCATION PLAN

JULY 2021 | FIGURE 1 | REV: 0

FileName: P:\Projects\2018\18-0300-005\Dwg\GIS\MXD\Detailed Design\Conceptual_Groundwater_Model_for_EIS\18-0300-005_Fig01.mxd
11"x17" PLOT SCALE 1:1

APPENDIX A

Laboratory Data

KGS GROUP

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 21-MAR-19
PO No.:
WO No.: L2242160
Project Ref: 18-0300-005
Sample ID: WELL 1
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2242160-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	482		mg/L			13-MAR-19
Carbonate (CO3)	<0.60		mg/L			13-MAR-19
Hydroxide (OH)	<0.34		mg/L			13-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		12-MAR-19
pH						
pH	7.68		pH units			12-MAR-19
Turbidity						
*Turbidity	32.9		NTU			11-MAR-19
TDS calculated						
TDS (Calculated)	520		mg/L		500	21-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	80.9		mg/L		500	09-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		09-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0051		mg/L	10		09-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	406		mg/L		500	21-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.324		mg/L	1.5		09-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					20-MAR-19
Aluminum (Al)-Dissolved	0.0010		mg/L		0.1	20-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		20-MAR-19
Arsenic (As)-Dissolved	0.00031		mg/L	0.01		20-MAR-19
Barium (Ba)-Dissolved	0.0450		mg/L	1		20-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			20-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			20-MAR-19
Boron (B)-Dissolved	0.186		mg/L	5		20-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		20-MAR-19
Calcium (Ca)-Dissolved	59.3		mg/L			20-MAR-19
Cesium (Cs)-Dissolved	0.000036		mg/L			20-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		20-MAR-19
Cobalt (Co)-Dissolved	0.00031		mg/L			20-MAR-19
Copper (Cu)-Dissolved	0.00023		mg/L	2.0	1.0	20-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	20-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		20-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 21-MAR-19
PO No.:
WO No.: L2242160
Project Ref: 18-0300-005
Sample ID: WELL 1
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2242160-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0326		mg/L			20-MAR-19
Magnesium (Mg)-Dissolved	62.5		mg/L			20-MAR-19
Manganese (Mn)-Dissolved	0.0668		mg/L		0.05	20-MAR-19
Molybdenum (Mo)-Dissolved	0.00105		mg/L			20-MAR-19
Nickel (Ni)-Dissolved	0.00106		mg/L			20-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			20-MAR-19
Potassium (K)-Dissolved	6.34		mg/L			20-MAR-19
Rubidium (Rb)-Dissolved	0.00319		mg/L			20-MAR-19
Selenium (Se)-Dissolved	0.000051		mg/L	0.05		20-MAR-19
Silicon (Si)-Dissolved	5.55		mg/L			20-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			20-MAR-19
Sodium (Na)-Dissolved	48.0		mg/L		200	20-MAR-19
Strontium (Sr)-Dissolved	0.236		mg/L			20-MAR-19
Sulfur (S)-Dissolved	30.4		mg/L			20-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			20-MAR-19
Thallium (Tl)-Dissolved	0.000011		mg/L			20-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			20-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			20-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			20-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			20-MAR-19
Uranium (U)-Dissolved	0.00218		mg/L	0.02		20-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			20-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	20-MAR-19
Zirconium (Zr)-Dissolved	0.000066		mg/L			20-MAR-19
Conductivity						
Conductivity	881		umhos/cm			12-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	26.2		mg/L		250	09-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	395		mg/L			12-MAR-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		09-MAR-19
Escherichia Coli	0		MPN/100mL	0		09-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 21-MAR-19
PO No.:
WO No.: L2242160
Project Ref: 18-0300-005
Sample ID: WELL 1
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2242160-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

21-MAR-2019 Revised report - Re-analysis of lab filtered dissolved metals.

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: ERIC LEVAY

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4561039								
WG3005284-9 LCS								
Alkalinity, Total (as CaCO3)			104.0		%		85-115	12-MAR-19
WG3005284-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	12-MAR-19
CL-L-IC-N-WP	**Water**							
Batch R4558311								
WG3003210-6 LCS								
Chloride (Cl)			97.5		%		90-110	09-MAR-19
WG3003210-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	09-MAR-19
EC-WP	**Water**							
Batch R4561039								
WG3005284-8 LCS								
Conductivity			99.3		%		90-110	12-MAR-19
WG3005284-6 MB								
Conductivity			<1.0		umhos/cm		1	12-MAR-19
F-IC-N-WP	**Water**							
Batch R4558311								
WG3003210-6 LCS								
Fluoride (F)			98.3		%		90-110	09-MAR-19
WG3003210-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	09-MAR-19
MET-D-CCMS-WP	**Water**							
Batch R4574955								
WG3010568-2 LCS								
Aluminum (Al)-Dissolved			100.3		%		80-120	20-MAR-19
Antimony (Sb)-Dissolved			98.5		%		80-120	20-MAR-19
Arsenic (As)-Dissolved			96.2		%		80-120	20-MAR-19
Barium (Ba)-Dissolved			98.1		%		80-120	20-MAR-19
Beryllium (Be)-Dissolved			101.9		%		80-120	20-MAR-19
Bismuth (Bi)-Dissolved			96.4		%		80-120	20-MAR-19
Boron (B)-Dissolved			100.8		%		80-120	20-MAR-19
Cadmium (Cd)-Dissolved			98.4		%		80-120	20-MAR-19
Calcium (Ca)-Dissolved			99.5		%		80-120	20-MAR-19
Cesium (Cs)-Dissolved			100.8		%		80-120	20-MAR-19
Chromium (Cr)-Dissolved			98.4		%		80-120	20-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4574955								
WG3010568-2 LCS								
Cobalt (Co)-Dissolved			97.3		%		80-120	20-MAR-19
Copper (Cu)-Dissolved			97.8		%		80-120	20-MAR-19
Iron (Fe)-Dissolved			90.7		%		80-120	20-MAR-19
Lead (Pb)-Dissolved			99.98		%		80-120	20-MAR-19
Lithium (Li)-Dissolved			102.7		%		80-120	20-MAR-19
Magnesium (Mg)-Dissolved			109.5		%		80-120	20-MAR-19
Manganese (Mn)-Dissolved			97.6		%		80-120	20-MAR-19
Molybdenum (Mo)-Dissolved			99.7		%		80-120	20-MAR-19
Nickel (Ni)-Dissolved			97.3		%		80-120	20-MAR-19
Phosphorus (P)-Dissolved			100.9		%		80-120	20-MAR-19
Potassium (K)-Dissolved			94.0		%		80-120	20-MAR-19
Rubidium (Rb)-Dissolved			96.2		%		80-120	20-MAR-19
Selenium (Se)-Dissolved			97.5		%		80-120	20-MAR-19
Silicon (Si)-Dissolved			101.9		%		80-120	20-MAR-19
Silver (Ag)-Dissolved			102.2		%		80-120	20-MAR-19
Sodium (Na)-Dissolved			103.4		%		80-120	20-MAR-19
Strontium (Sr)-Dissolved			103.7		%		80-120	20-MAR-19
Sulfur (S)-Dissolved			104.8		%		80-120	20-MAR-19
Tellurium (Te)-Dissolved			98.1		%		80-120	20-MAR-19
Thallium (Tl)-Dissolved			98.0		%		80-120	20-MAR-19
Thorium (Th)-Dissolved			97.6		%		80-120	20-MAR-19
Tin (Sn)-Dissolved			99.6		%		80-120	20-MAR-19
Titanium (Ti)-Dissolved			96.1		%		80-120	20-MAR-19
Tungsten (W)-Dissolved			97.0		%		80-120	20-MAR-19
Uranium (U)-Dissolved			103.5		%		80-120	20-MAR-19
Vanadium (V)-Dissolved			98.8		%		80-120	20-MAR-19
Zinc (Zn)-Dissolved			98.7		%		80-120	20-MAR-19
Zirconium (Zr)-Dissolved			99.9		%		80-120	20-MAR-19
WG3010568-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	20-MAR-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4574955								
WG3010568-1 MB								
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	20-MAR-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	20-MAR-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	20-MAR-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	20-MAR-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	20-MAR-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	20-MAR-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	20-MAR-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	20-MAR-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	20-MAR-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	20-MAR-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	20-MAR-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	20-MAR-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	20-MAR-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	20-MAR-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	20-MAR-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	20-MAR-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	20-MAR-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	20-MAR-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	20-MAR-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	20-MAR-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	20-MAR-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	20-MAR-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	20-MAR-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	20-MAR-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	20-MAR-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	20-MAR-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	20-MAR-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	20-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R4558311								
WG3003210-6 LCS								
Nitrite (as N)			96.7		%		90-110	09-MAR-19
WG3003210-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	09-MAR-19
NO3-L-IC-N-WP	**Water**							
Batch R4558311								
WG3003210-6 LCS								
Nitrate (as N)			97.5		%		90-110	09-MAR-19
WG3003210-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	09-MAR-19
PH-WP	**Water**							
Batch R4561039								
WG3005284-7 LCS								
pH			7.38		pH units		7.3-7.5	12-MAR-19
SO4-IC-N-WP	**Water**							
Batch R4558311								
WG3003210-6 LCS								
Sulfate (SO4)			97.7		%		90-110	09-MAR-19
WG3003210-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	09-MAR-19
TC,EC-QT51-WP	**Water**							
Batch R4555143								
WG3003646-1 MB								
Total Coliforms			0		MPN/100mL		1	09-MAR-19
Escherichia Coli			0		MPN/100mL		1	09-MAR-19
TURBIDITY-WP	**Water**							
Batch R4560508								
WG3005350-2 DUP		**L2242160-1**						
Turbidity		32.9	33.1		NTU	0.6	15	11-MAR-19
WG3005350-3 LCS								
Turbidity			100.5		%		85-115	11-MAR-19
WG3005350-1 MB								
Turbidity			<0.10		NTU		0.1	11-MAR-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	08-MAR-19 13:30	12-MAR-19 12:00	0.25	95	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2242160 were received on 09-MAR-19 12:34.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2242160-COFC

COC Number: 17 - 747518

Page of

Report To	Contact and company name below will appear on the final report	Report Format / L	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: ☒ PDF ☒ EXCEL | EDD (DIGITAL)	Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Eric Leray	Quality Control (QC) Report with Report ☒ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Phone:	204-229-1136	☐ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☐ EMAIL | ☐ MAIL ☐ FAX	
Street:	865 Waverley St	Email 1 or Fax eleray@kgsgroup.com	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
City/Province:	Winn MB	Email 2	For tests that can not be performed according to the service level selected, you will be contacted.
Postal Code:	R3T 5P4	Email 3	
Invoice To	Same as Report To ☒ YES ☐ NO	Invoice Distribution	Analysis Request
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	
Company:	KGS Group	Email 1 or Fax	
Contact:	Eric Leray	Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	18-0300-005	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact:	Sampler:

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	TC, EC-QTSI	ROUWW-inst-D-L	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	Well 1	08/03/19	13:30	W		X	X			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☒ NO	
Are samples for human consumption/ use? | | YES | | NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
7.9							

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 09/03/19	Time: 12:34	Received by: BAD	Date: 4 Mar 19	Time: 12:34	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	440		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.018		mg/L	10		21-MAR-19
pH						
pH	7.80		pH units			19-MAR-19
Turbidity						
*Turbidity	3970		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	449		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	82.3		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0023		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.016		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	405		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.238		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00012		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00093		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0234		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.116		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000065		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	60.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000014		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00022		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.053		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000247		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0258		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	61.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0145		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000721		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00066		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.37		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00292		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000088		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.18		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	21.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.202		mg/L			19-MAR-19
Sulfur (S)-Dissolved	28.1		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00510		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00120		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0019		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	724		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.82		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	361		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-09
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	460		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	7.98		pH units			19-MAR-19
Turbidity						
*Turbidity	745		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	460		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	77.7		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	417		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.222		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0016		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00062		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0273		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.141		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	62.9		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00022		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.058		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-09
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0233		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	63.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0189		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000518		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.94		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00273		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.38		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	21.6		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.191		mg/L			19-MAR-19
Sulfur (S)-Dissolved	26.6		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000014		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000432		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	737		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	3.81		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	377		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-09
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: FIELD
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	2.4		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	6.48		pH units			19-MAR-19
Turbidity						
*Turbidity	<0.10		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	<0.20		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	<0.00010		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	<0.010		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	<0.050		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Sample ID: FIELD
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	<0.0010		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	<0.0050		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	<0.00010		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	<0.050		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	<0.00020		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	<0.050		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	<0.050		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.00014		mg/L			19-MAR-19
Sulfur (S)-Dissolved	<0.50		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	1.2		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	2.0		mg/L			19-MAR-19

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Project Ref: 18-0300-05
Sample ID: FIELD
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-04
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	289		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.0178		mg/L	10		21-MAR-19
pH						
pH	7.90		pH units			19-MAR-19
Turbidity						
*Turbidity	1630		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	275		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	35.4		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0019		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0159		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	241		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.272		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0188		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00018		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00168		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0269		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.117		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	39.3		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00017		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00126		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.110		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000073		mg/L	0.01		19-MAR-19

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PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-04
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0170		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	34.8		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0156		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00196		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00145		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	2.39		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00116		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000081		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.70		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	19.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.161		mg/L			19-MAR-19
Sulfur (S)-Dissolved	13.4		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00267		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00026		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000793		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0014		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000082		mg/L			19-MAR-19
Conductivity						
Conductivity	470		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.93		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	237		mg/L			19-MAR-19

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Date: 29-MAR-19
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WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-04
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-10
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	506		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.0052		mg/L	10		21-MAR-19
pH						
pH	7.98		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	404		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	21.7		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0052		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	403		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.329		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0029		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00100		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0585		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.091		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	58.7		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00020		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-10
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0207		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	62.2		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0100		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00102		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00069		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.32		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00214		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.92		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.14		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.178		mg/L			19-MAR-19
Sulfur (S)-Dissolved	7.54		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000014		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00194		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00259		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	669		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.38		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	415		mg/L			19-MAR-19

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Project Ref: 18-0300-05
Sample ID: TH19-KGS-10
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-05
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	416		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	7.80		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	342		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	22.1		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	338		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.231		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00034		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0716		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.091		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	56.0		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00021		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.132		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-05
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0171		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	48.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0134		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000417		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00063		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.48		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00241		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.74		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	6.91		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.161		mg/L			19-MAR-19
Sulfur (S)-Dissolved	7.26		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000317		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	577		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.89		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	341		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH15-05
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-04
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	423		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	7.99		pH units			19-MAR-19
Turbidity						
*Turbidity	347		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	632		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	164		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	438		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.281		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0026		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00053		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00196		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0179		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.157		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	61.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00011		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00037		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.023		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-04
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0274		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	69.1		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0190		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00208		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00089		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.35		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00231		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000112		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.88		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	69.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.259		mg/L			19-MAR-19
Sulfur (S)-Dissolved	55.6		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000020		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00063		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00119		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0024		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	987		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	54.2		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	346		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-04
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TRIP BLANK
Sampled By:
Date Collected:
Lab Sample ID: L2245232-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	2.1		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	5.92		pH units			19-MAR-19
Turbidity						
*Turbidity	<0.10		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	<0.20		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	LAB					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	<0.00010		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	<0.010		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	<0.050		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TRIP BLANK
Sampled By:
Date Collected:
Lab Sample ID: L2245232-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	<0.0010		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	<0.0050		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	<0.00010		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	<0.050		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	<0.00020		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	<0.050		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	<0.050		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	<0.00010		mg/L			19-MAR-19
Sulfur (S)-Dissolved	<0.50		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	1.0		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	1.7		mg/L			19-MAR-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		16-MAR-19
Escherichia Coli	0		MPN/100mL	0		16-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TRIP BLANK
Sampled By:
Date Collected:
Lab Sample ID: L2245232-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-14A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	403		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.0217		mg/L	10		21-MAR-19
pH						
pH	7.58		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	305		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	3.44		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0029		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0189		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	296		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.216		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0096		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00137		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0374		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.023		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000101		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	68.2		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00011		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00019		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00096		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.433		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-14A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0059		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	30.5		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.142		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000266		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00052		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.035		mg/L			19-MAR-19
Potassium (K)-Dissolved	0.791		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00076		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000088		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.06		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	2.84		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.0961		mg/L			19-MAR-19
Sulfur (S)-Dissolved	1.36		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00026		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00049		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000417		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0142		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000145		mg/L			19-MAR-19
Conductivity						
Conductivity	483		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.08		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	330		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-14A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-07A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	530		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.0180		mg/L	10		21-MAR-19
pH						
pH	7.74		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	419		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	12.2		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0051		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0129		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	393		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.373		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0161		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00016		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00217		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0671		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.034		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	88.1		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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PO No.:
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Project Ref: 18-0300-05
Sample ID: TH19-KGS-07A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0167		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	42.1		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.113		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00102		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.053		mg/L			19-MAR-19
Potassium (K)-Dissolved	2.04		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00108		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000123		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	13.0		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	10.2		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.173		mg/L			19-MAR-19
Sulfur (S)-Dissolved	5.26		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00013		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000994		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00088		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000144		mg/L			19-MAR-19
Conductivity						
Conductivity	689		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.31		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	434		mg/L			19-MAR-19

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PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-07A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-07
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-11
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	369		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	8.16		pH units			19-MAR-19
Turbidity						
*Turbidity	101		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	391		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	64.8		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	331		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.600		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0014		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00025		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0411		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.112		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	41.9		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00056		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.778		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-07
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-11
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0223		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	55.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.00748		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00482		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.29		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00245		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.56		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	28.2		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.198		mg/L			19-MAR-19
Sulfur (S)-Dissolved	22.0		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00406		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000404		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0017		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	654		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.9		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	303		mg/L			19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-07
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-11
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-01B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-12
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	458		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	8.14		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	497		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	94.7		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	376		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.287		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00012		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0202		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.158		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	51.3		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00033		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.921		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-01B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-12
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0286		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	60.1		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0241		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00604		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00121		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.95		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00252		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.01		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	38.4		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.216		mg/L			19-MAR-19
Sulfur (S)-Dissolved	31.6		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000014		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00015		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000448		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0020		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	773		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	21.6		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	376		mg/L			19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-01B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-12
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-500
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-13
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	431		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.141		mg/L	10		21-MAR-19
pH						
pH	7.96		pH units			19-MAR-19
Turbidity						
*Turbidity	896		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	408		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	54.0		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0071		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.134		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	360		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.416		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0034		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00086		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00177		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0428		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.158		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000090		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	58.8		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000014		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00034		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00076		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000056		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-500
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-13
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0227		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	51.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0638		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00483		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00235		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.50		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00304		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000106		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.59		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	21.1		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.160		mg/L			19-MAR-19
Sulfur (S)-Dissolved	18.2		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00213		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00123		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0051		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000103		mg/L			19-MAR-19
Conductivity						
Conductivity	674		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.52		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	353		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-500
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-13
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-14
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	410		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.107		mg/L	10		21-MAR-19
pH						
pH	8.07		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	390		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	44.5		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0063		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.101		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	374		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.446		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0339		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00094		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00185		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0449		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.169		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000090		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	61.3		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000020		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00014		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00036		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00165		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.018		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000084		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-14
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0233		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	53.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0665		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00749		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00254		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.57		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00326		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000113		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.87		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	21.9		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.162		mg/L			19-MAR-19
Sulfur (S)-Dissolved	18.9		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00115		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00208		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00131		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0079		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000265		mg/L			19-MAR-19
Conductivity						
Conductivity	632		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.78		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	336		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16
Sampled By:
Date Collected: 15-MAR-19
Lab Sample ID: L2245232-14
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17B
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-15
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	587		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.051		mg/L	10		21-MAR-19
pH						
pH	8.29		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	587		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	106		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0121		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.039		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	528		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.603		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0060		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00033		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00098		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0365		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.130		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000078		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	41.1		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00104		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00022		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00320		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000069		mg/L	0.01		19-MAR-19

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865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17B
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-15
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0599		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	103		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0115		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.0187		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00089		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.34		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00146		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.00304		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	6.21		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	39.5		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.371		mg/L			19-MAR-19
Sulfur (S)-Dissolved	35.6		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00039		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00046		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00011		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.0297		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00134		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0058		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000481		mg/L			19-MAR-19
Conductivity						
Conductivity	846		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	3.39		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	481		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17B
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-15
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-16
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	632		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	0.032		mg/L	10		21-MAR-19
pH						
pH	7.48		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	506		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	4.13		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0022		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.030		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	523		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.148		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0134		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00695		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0621		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.048		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000094		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	118		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00043		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00152		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00165		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	2.44		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000095		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-16
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0100		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	55.4		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.487		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00213		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00141		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	2.28		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00180		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000081		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	8.56		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.37		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.184		mg/L			19-MAR-19
Sulfur (S)-Dissolved	1.43		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00019		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00059		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000651		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00094		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0060		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000931		mg/L			19-MAR-19
Conductivity						
Conductivity	846		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.58		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	518		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-16
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-17
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	337		mg/L			20-MAR-19
Carbonate (CO3)	<0.60		mg/L			20-MAR-19
Hydroxide (OH)	<0.34		mg/L			20-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	7.54		pH units			19-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	261		mg/L		500	20-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	1.79		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0012		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	257		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.148		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0268		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00111		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0240		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.026		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000227		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	49.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00013		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00072		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00165		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.199		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000119		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-17
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0080		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	32.4		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.506		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00207		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00110		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.056		mg/L			19-MAR-19
Potassium (K)-Dissolved	0.981		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00097		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000382		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	6.02		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	9.08		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.117		mg/L			19-MAR-19
Sulfur (S)-Dissolved	1.61		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00013		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00158		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000901		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0093		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000209		mg/L			19-MAR-19
Conductivity						
Conductivity	460		umhos/cm			19-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.14		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	276		mg/L			19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-13A
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-17
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-02B
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-18
Matrix: WATER

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	328		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.051		mg/L	10		21-MAR-19
pH						
pH	8.07		pH units			23-MAR-19
Turbidity						
*Turbidity	1180		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	1430		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	737		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.014		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.050	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	834		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.32		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0028		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00018		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00032		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0279		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.202		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000081		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	123		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00097		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00292		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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865 Waverly Street - 3rd Floor
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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-02B
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-18
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0568		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	128		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.108		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.0161		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00405		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	6.93		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00195		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000719		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.33		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	178		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.520		mg/L			19-MAR-19
Sulfur (S)-Dissolved	270		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000037		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00028		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.0950		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.0103		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0038		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000106		mg/L			19-MAR-19
Conductivity						
Conductivity	1970		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	93.9		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	269		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-02B
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-18
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-19
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	376		mg/L			25-MAR-19
Carbonate (CO3)	6.24		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	8.39		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	446		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	81.0		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	426		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.321		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0027		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00017		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00040		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0416		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.138		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	51.2		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00085		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00067		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	1.64		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-19
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0350		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	72.3		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.125		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.0147		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00303		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.12		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00238		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.47		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	27.4		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.260		mg/L			19-MAR-19
Sulfur (S)-Dissolved	26.0		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000035		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00012		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00131		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000077		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0021		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	727		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.9		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	319		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-19
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-20
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	484		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0172		mg/L	10		21-MAR-19
pH						
pH	7.12		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	354		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	0.37		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0017		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0156		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	331		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.086		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0134		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00129		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0386		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.044		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	70.1		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00153		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00035		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	1.09		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-20
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0059		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	38.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.603		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000394		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00118		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.046		mg/L			19-MAR-19
Potassium (K)-Dissolved	0.577		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00084		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000115		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	11.2		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	6.65		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.0968		mg/L			19-MAR-19
Sulfur (S)-Dissolved	0.69		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000357		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0027		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000113		mg/L			19-MAR-19
Conductivity						
Conductivity	669		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.13		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	397		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-20
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17A
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-21
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	425		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0118		mg/L	10		21-MAR-19
pH						
pH	7.93		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	321		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	2.91		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0014		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0104		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	317		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.127		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0125		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00018		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00113		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0319		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.027		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000079		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	61.6		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00064		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00029		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00459		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.061		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000102		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17A
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-21
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0073		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	39.6		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.454		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000599		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00090		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.056		mg/L			19-MAR-19
Potassium (K)-Dissolved	1.23		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00087		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000079		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	8.29		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	4.40		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.110		mg/L			19-MAR-19
Sulfur (S)-Dissolved	1.33		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00036		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00060		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00149		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00113		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0060		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000341		mg/L			19-MAR-19
Conductivity						
Conductivity	578		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.54		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	348		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17A
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-21
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-18A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-22
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	337		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0202		mg/L	10		21-MAR-19
pH						
pH	7.48		pH units			23-MAR-19
Turbidity						
*Turbidity	3110		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	287		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	6.43		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0019		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0182		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	129		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.125		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0198		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00038		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00317		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0104		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.027		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	25.9		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000018		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00011		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00043		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00130		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.237		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000081		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-18A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-22
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0150		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	15.5		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.123		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000610		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00060		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	1.08		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00154		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000339		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.84		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	70.2		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.0751		mg/L			19-MAR-19
Sulfur (S)-Dissolved	2.40		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000012		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00068		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000037		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0045		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000082		mg/L			19-MAR-19
Conductivity						
Conductivity	489		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.49		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	277		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-18A
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-22
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-23
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	443		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0094		mg/L	10		21-MAR-19
pH						
pH	8.19		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	390		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	42.6		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0013		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0081		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	384		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.272		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0048		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00100		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00296		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0417		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.094		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	55.8		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00014		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00022		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.016		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-23
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0189		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	59.5		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0242		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00164		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00148		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.90		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00217		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000130		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.39		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	9.43		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.162		mg/L			19-MAR-19
Sulfur (S)-Dissolved	14.5		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00186		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000389		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	674		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.33		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	363		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-17
Sampled By:
Date Collected: 10-MAR-19
Lab Sample ID: L2245232-23
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-03
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-24
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	409		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.016		mg/L	10		21-MAR-19
pH						
pH	8.17		pH units			23-MAR-19
Turbidity						
*Turbidity	2.75		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	364		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	36.8		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.016		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	362		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.197		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0011		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00069		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0590		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.102		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	62.9		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00110		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.339		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-03
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-24
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0184		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	49.8		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.151		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000434		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00170		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.39		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00210		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.34		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.44		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.155		mg/L			19-MAR-19
Sulfur (S)-Dissolved	13.2		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00114		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0027		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	626		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.06		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	335		mg/L			23-MAR-19
Total Coliform and E.coli						
Total Coliforms	5		MPN/100mL	0		16-MAR-19
Escherichia Coli	0		MPN/100mL	0		16-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-03
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-24
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-04
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-25
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	406		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0123		mg/L	10		21-MAR-19
pH						
pH	8.22		pH units			23-MAR-19
Turbidity						
*Turbidity	2.41		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	362		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	37.2		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0123		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	361		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.212		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00071		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0590		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.101		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	62.4		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00112		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.337		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-04
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-25
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0184		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	49.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.152		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000433		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00165		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.45		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00196		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.35		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.45		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.155		mg/L			19-MAR-19
Sulfur (S)-Dissolved	12.9		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00116		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0025		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	622		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.01		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	333		mg/L			23-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-04
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-25
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-02
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-26
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	410		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	8.14		pH units			23-MAR-19
Turbidity						
*Turbidity	233		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	455		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	88.2		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	372		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.289		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00135		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0242		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.145		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	58.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00015		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00066		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.121		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-02
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-26
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0252		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	55.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.00465		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000395		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.81		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00264		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.48		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	33.9		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.215		mg/L			19-MAR-19
Sulfur (S)-Dissolved	31.2		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000773		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0025		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	744		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	12.6		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	336		mg/L			23-MAR-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		16-MAR-19
Escherichia Coli	0		MPN/100mL	0		16-MAR-19

KGS Group Consultants (Winnipeg)
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-02
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-26
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-05
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-27
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	401		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	8.18		pH units			23-MAR-19
Turbidity						
*Turbidity	180		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	454		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	88.8		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	380		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.280		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00136		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0243		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.150		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	60.3		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00014		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.128		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-05
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-27
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0254		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	55.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.00462		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000381		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.99		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00253		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.44		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	34.1		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.212		mg/L			19-MAR-19
Sulfur (S)-Dissolved	30.8		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000794		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0014		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	755		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	12.6		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	329		mg/L			23-MAR-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		16-MAR-19
Escherichia Coli	0		MPN/100mL	0		16-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-05
Sampled By:
Date Collected: 13-MAR-19
Lab Sample ID: L2245232-27
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-01
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-28
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	401		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0093		mg/L	10		21-MAR-19
pH						
pH	8.16		pH units			23-MAR-19
Turbidity						
*Turbidity	1.04		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	437		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	78.9		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0093		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	366		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.249		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00038		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0249		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.156		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000068		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	55.6		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00025		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00452		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000068		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-01
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-28
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0245		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	55.2		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.00503		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00113		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00060		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.93		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00142		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.61		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	31.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.217		mg/L			19-MAR-19
Sulfur (S)-Dissolved	27.2		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000011		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00165		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0089		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	741		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.4		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	329		mg/L			23-MAR-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		16-MAR-19
Escherichia Coli	0		MPN/100mL	0		16-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: PW19-KGS-01
Sampled By:
Date Collected: 12-MAR-19
Lab Sample ID: L2245232-28
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-15
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-29
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	432		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0175		mg/L	10		21-MAR-19
pH						
pH	8.22		pH units			23-MAR-19
Turbidity						
*Turbidity	599		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	383		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	33.3		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0175		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	383		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.249		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0041		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00018		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00065		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0353		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.124		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000098		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	65.2		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00021		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00054		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00044		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-15
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-29
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0253		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	53.4		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0825		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00505		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00267		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.57		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00319		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000109		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.88		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	10.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.186		mg/L			19-MAR-19
Sulfur (S)-Dissolved	12.0		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000027		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00031		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00704		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00125		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0027		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000182		mg/L			19-MAR-19
Conductivity						
Conductivity	661		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.88		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	355		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-15
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-29
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH200
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-30
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	505		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	8.11		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	406		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	21.6		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	412		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.320		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0029		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00100		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0601		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.091		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	59.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00021		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH200
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-30
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0207		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	64.0		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0103		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00105		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00069		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	3.49		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00229		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	5.88		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.22		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.184		mg/L			19-MAR-19
Sulfur (S)-Dissolved	7.71		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000014		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00200		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00261		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	691		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.36		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	414		mg/L			23-MAR-19

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865 Waverly Street - 3rd Floor
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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH200
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-30
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-31
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	403		mg/L			25-MAR-19
Carbonate (CO3)	10.4		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.046		mg/L	10		21-MAR-19
pH						
pH	8.47		pH units			23-MAR-19
Turbidity						
*Turbidity	468		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	497		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	110		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0034		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.042		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	431		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.376		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0292		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00429		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.0121		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0292		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.116		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	44.9		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000016		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00233		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00013		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00200		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000052		mg/L	0.01		19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-31
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0334		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	77.3		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.00082		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00887		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00138		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.041		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.32		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00379		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.00134		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	19.2		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	37.1		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.283		mg/L			19-MAR-19
Sulfur (S)-Dissolved	35.4		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00015		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00037		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.121		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00218		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00796		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0051		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000191		mg/L			19-MAR-19
Conductivity						
Conductivity	785		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.0		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	348		mg/L			23-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-19
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-31
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-20
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-32
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	436		mg/L			25-MAR-19
Carbonate (CO3)	3.00		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.029		mg/L	10		21-MAR-19
pH						
pH	8.31		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	594		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	147		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0056		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.024		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	215		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.539		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0013		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00021		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00053		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0152		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.142		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	32.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00085		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00023		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-20
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-32
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0326		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	32.5		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0197		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00806		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00129		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.50		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00202		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000527		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	3.97		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	139		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.224		mg/L			19-MAR-19
Sulfur (S)-Dissolved	49.8		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00603		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00155		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	951		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	21.3		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	362		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-20
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-32
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH300
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-33
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	426		mg/L			25-MAR-19
Carbonate (CO3)	2.28		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.036		mg/L	10		21-MAR-19
pH						
pH	8.30		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	591		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	147		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0048		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.032		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	215		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.535		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0010		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00020		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00047		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0151		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.150		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	32.1		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00075		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00022		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH300
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-33
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0327		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	32.7		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0199		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00774		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00115		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.41		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00197		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000450		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	3.99		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	141		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.219		mg/L			19-MAR-19
Sulfur (S)-Dissolved	49.9		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00595		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00145		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	945		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	21.3		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	353		mg/L			23-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH300
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-33
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12B
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-34
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	452		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	8.29		pH units			23-MAR-19
Turbidity						
*Turbidity	676		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	481		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	81.8		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	425		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.573		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0048		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00075		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00071		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0197		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.167		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000147		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	57.6		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00267		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00324		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12B
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-34
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0432		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	68.2		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0753		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00812		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00284		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.049		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.82		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00151		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000216		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	7.08		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	31.1		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.307		mg/L			19-MAR-19
Sulfur (S)-Dissolved	27.9		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000033		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00035		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.0573		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00416		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0289		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000226		mg/L			19-MAR-19
Conductivity						
Conductivity	791		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.6		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	371		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-12B
Sampled By:
Date Collected: 14-MAR-19
Lab Sample ID: L2245232-34
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-35
Matrix: WATER

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	575		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.052		mg/L	10		21-MAR-19
pH						
pH	7.95		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	521		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	22.9		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0044		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.047		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	623		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.183		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.838		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00122		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0816		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.103		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000301		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	129		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000049		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00153		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00195		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00353		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.934		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.00166		mg/L	0.01		19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-35
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0186		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	73.1		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.390		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000866		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00356		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.102		mg/L			19-MAR-19
Potassium (K)-Dissolved	2.63		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00265		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	8.20		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	8.26		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.177		mg/L			19-MAR-19
Sulfur (S)-Dissolved	8.21		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	0.000029		mg/L			19-MAR-19
Thorium (Th)-Dissolved	0.00014		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00024		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.0205		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00041		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.0101		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	0.00259		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0103		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000878		mg/L			19-MAR-19
Conductivity						
Conductivity	809		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.31		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	472		mg/L			23-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-16B
Sampled By:
Date Collected: 09-MAR-19
Lab Sample ID: L2245232-35
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-08
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-36
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	416		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0060		mg/L	10		21-MAR-19
pH						
pH	8.19		pH units			23-MAR-19
Turbidity						
*Turbidity	267		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	347		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	22.1		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0060		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	352		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.237		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0047		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00020		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0602		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.102		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	58.3		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00019		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.062		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-08
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-36
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0172		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	50.2		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0261		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000317		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.13		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00252		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.85		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	7.17		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.161		mg/L			19-MAR-19
Sulfur (S)-Dissolved	7.63		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000262		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0036		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	600		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.07		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	341		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-08
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-36
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-37
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	335		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0317		mg/L	10		21-MAR-19
pH						
pH	8.23		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	440		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	121		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0045		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0272		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	316		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	1.15		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0042		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00206		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0164		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.412		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	56.2		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000022		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00014		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.044		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-37
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0311		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	42.6		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0163		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00464		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00091		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	5.88		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00419		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000142		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.29		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	39.4		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.291		mg/L			19-MAR-19
Sulfur (S)-Dissolved	33.0		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00015		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00197		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000908		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000061		mg/L			19-MAR-19
Conductivity						
Conductivity	732		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.93		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	275		mg/L			23-MAR-19

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Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-11
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-37
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-18
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-38
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	789		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	7.77		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	607		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	3.00		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	637		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.181		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0023		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	0.00031		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00101		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0975		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.093		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	114		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00086		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00048		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.213		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-18
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-38
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0400		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	85.4		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0478		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.00526		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00259		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	2.88		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00226		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000111		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	10.7		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	12.3		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.308		mg/L			19-MAR-19
Sulfur (S)-Dissolved	2.38		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00101		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000459		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0099		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000108		mg/L			19-MAR-19
Conductivity						
Conductivity	1040		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.26		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	646		mg/L			23-MAR-19

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Project Ref: 18-0300-05
Sample ID: TH19-KGS-18
Sampled By:
Date Collected: 11-MAR-19
Lab Sample ID: L2245232-38
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-14
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-39
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	425		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		21-MAR-19
pH						
pH	8.15		pH units			23-MAR-19
Turbidity						
*Turbidity	2840		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	380		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	41.0		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	363		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.266		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0017		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00027		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0371		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.136		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	60.5		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00013		mg/L			19-MAR-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.034		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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Project Ref: 18-0300-05
Sample ID: TH19-KGS-14
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-39
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0233		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	51.4		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0209		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000275		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	<0.030		mg/L			19-MAR-19
Potassium (K)-Dissolved	4.00		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00281		mg/L			19-MAR-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	4.72		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	12.6		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.162		mg/L			19-MAR-19
Sulfur (S)-Dissolved	14.7		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	0.00013		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000199		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0014		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			19-MAR-19
Conductivity						
Conductivity	650		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.60		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	348		mg/L			23-MAR-19

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Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-14
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-39
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-03A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-40
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	439		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	0.0502		mg/L	10		21-MAR-19
pH						
pH	8.05		pH units			23-MAR-19
Turbidity						
*Turbidity	>4000		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	373		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	11.1		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0060		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0442		mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	367		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.199		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0143		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00089		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0364		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.028		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	0.0000055		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	73.0		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00020		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00049		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00071		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.756		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.01		19-MAR-19

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-03A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-40
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0129		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	44.9		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.0770		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000905		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	0.00072		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.092		mg/L			19-MAR-19
Potassium (K)-Dissolved	0.634		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00116		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000107		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	6.06		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	14.0		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.125		mg/L			19-MAR-19
Sulfur (S)-Dissolved	3.43		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	0.00023		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.00116		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	0.0048		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000172		mg/L			19-MAR-19
Conductivity						
Conductivity	650		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.6		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	360		mg/L			23-MAR-19

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Date: 29-MAR-19
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Project Ref: 18-0300-05
Sample ID: TH19-KGS-03A
Sampled By:
Date Collected: 08-MAR-19
Lab Sample ID: L2245232-40
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-100
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-41
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	562		mg/L			25-MAR-19
Carbonate (CO3)	<0.60		mg/L			25-MAR-19
Hydroxide (OH)	<0.34		mg/L			25-MAR-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		21-MAR-19
pH						
pH	7.62		pH units			23-MAR-19
Turbidity						
*Turbidity	307		NTU			16-MAR-19
TDS calculated						
TDS (Calculated)	439		mg/L		500	25-MAR-19
Sulfate in Water by IC						
Sulfate (SO4)	1.71		mg/L		500	16-MAR-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0044		mg/L	1		16-MAR-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	450		mg/L		500	20-MAR-19
Fluoride in Water by IC						
Fluoride (F)	0.208		mg/L	1.5		16-MAR-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-MAR-19
Aluminum (Al)-Dissolved	0.0101		mg/L		0.1	19-MAR-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-MAR-19
Arsenic (As)-Dissolved	0.00082		mg/L	0.01		19-MAR-19
Barium (Ba)-Dissolved	0.0507		mg/L	1		19-MAR-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-MAR-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-MAR-19
Boron (B)-Dissolved	0.056		mg/L	5		19-MAR-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-MAR-19
Calcium (Ca)-Dissolved	81.0		mg/L			19-MAR-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-MAR-19
Chromium (Cr)-Dissolved	0.00019		mg/L	0.05		19-MAR-19
Cobalt (Co)-Dissolved	0.00022		mg/L			19-MAR-19
Copper (Cu)-Dissolved	0.00128		mg/L	2.0	1.0	19-MAR-19
Iron (Fe)-Dissolved	0.420		mg/L		0.3	19-MAR-19
Lead (Pb)-Dissolved	0.000053		mg/L	0.01		19-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-100
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-41
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0181		mg/L			19-MAR-19
Magnesium (Mg)-Dissolved	60.3		mg/L			19-MAR-19
Manganese (Mn)-Dissolved	0.139		mg/L		0.05	19-MAR-19
Molybdenum (Mo)-Dissolved	0.000134		mg/L			19-MAR-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-MAR-19
Phosphorus (P)-Dissolved	0.129		mg/L			19-MAR-19
Potassium (K)-Dissolved	0.532		mg/L			19-MAR-19
Rubidium (Rb)-Dissolved	0.00061		mg/L			19-MAR-19
Selenium (Se)-Dissolved	0.000159		mg/L	0.05		19-MAR-19
Silicon (Si)-Dissolved	9.96		mg/L			19-MAR-19
Silver (Ag)-Dissolved	<0.000010		mg/L			19-MAR-19
Sodium (Na)-Dissolved	12.5		mg/L		200	19-MAR-19
Strontium (Sr)-Dissolved	0.203		mg/L			19-MAR-19
Sulfur (S)-Dissolved	3.60		mg/L			19-MAR-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-MAR-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-MAR-19
Thorium (Th)-Dissolved	<0.00010		mg/L			19-MAR-19
Tin (Sn)-Dissolved	<0.00010		mg/L			19-MAR-19
Titanium (Ti)-Dissolved	0.00036		mg/L			19-MAR-19
Tungsten (W)-Dissolved	<0.00010		mg/L			19-MAR-19
Uranium (U)-Dissolved	0.000316		mg/L	0.02		19-MAR-19
Vanadium (V)-Dissolved	<0.00050		mg/L			19-MAR-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-MAR-19
Zirconium (Zr)-Dissolved	0.000182		mg/L			19-MAR-19
Conductivity						
Conductivity	767		umhos/cm			23-MAR-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.32		mg/L		250	16-MAR-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	461		mg/L			23-MAR-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: ERIC LEVAY

Date: 29-MAR-19
PO No.:
WO No.: L2245232
Project Ref: 18-0300-05
Sample ID: TH19-KGS-100
Sampled By:
Date Collected: 07-MAR-19
Lab Sample ID: L2245232-41
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**MAY 2018**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: ERIC LEVAY

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4573259								
WG3010024-10 DUP		**L2245232-2**						
Alkalinity, Total (as CaCO3)		377	377		mg/L	0.0	20	19-MAR-19
WG3010024-14 LCS								
Alkalinity, Total (as CaCO3)			104.6		%		85-115	19-MAR-19
WG3010024-9 LCS								
Alkalinity, Total (as CaCO3)			105.6		%		85-115	19-MAR-19
WG3010024-11 MB								
Alkalinity, Total (as CaCO3)			1.0		mg/L		1	19-MAR-19
WG3010024-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	19-MAR-19
Batch R4580551								
WG3013045-10 DUP		**L2245232-40**						
Alkalinity, Total (as CaCO3)		360	352		mg/L	2.3	20	23-MAR-19
WG3013045-5 DUP		**L2245232-36**						
Alkalinity, Total (as CaCO3)		341	339		mg/L	0.5	20	23-MAR-19
WG3013045-4 LCS								
Alkalinity, Total (as CaCO3)			106.1		%		85-115	23-MAR-19
WG3013045-9 LCS								
Alkalinity, Total (as CaCO3)			106.2		%		85-115	23-MAR-19
WG3013045-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	23-MAR-19
WG3013045-6 MB								
Alkalinity, Total (as CaCO3)			1.0		mg/L		1	23-MAR-19
CL-L-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-11 DUP		**L2245232-39**						
Chloride (Cl)		1.60	1.61		mg/L	0.5	20	16-MAR-19
WG3008313-10 LCS								
Chloride (Cl)			99.4		%		90-110	16-MAR-19
WG3008313-2 LCS								
Chloride (Cl)			99.4		%		90-110	16-MAR-19
WG3008313-6 LCS								
Chloride (Cl)			99.6		%		90-110	16-MAR-19
WG3008313-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	16-MAR-19
WG3008313-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	16-MAR-19
WG3008313-9 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-L-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	16-MAR-19
WG3008313-12 MS		**L2245232-39**						
Chloride (Cl)			106.9		%		75-125	16-MAR-19
EC-WP	**Water**							
Batch R4573259								
WG3010024-10 DUP		**L2245232-2**						
Conductivity		737	737		umhos/cm	0.0	10	19-MAR-19
WG3010024-13 LCS								
Conductivity			96.6		%		90-110	19-MAR-19
WG3010024-8 LCS								
Conductivity			96.3		%		90-110	19-MAR-19
WG3010024-11 MB								
Conductivity			<1.0		umhos/cm		1	19-MAR-19
WG3010024-6 MB								
Conductivity			<1.0		umhos/cm		1	19-MAR-19
Batch R4580551								
WG3013045-10 DUP		**L2245232-40**						
Conductivity		650	637		umhos/cm	2.0	10	23-MAR-19
WG3013045-5 DUP		**L2245232-36**						
Conductivity		600	599		umhos/cm	0.2	10	23-MAR-19
WG3013045-3 LCS								
Conductivity			100.9		%		90-110	23-MAR-19
WG3013045-8 LCS								
Conductivity			101.2		%		90-110	23-MAR-19
WG3013045-1 MB								
Conductivity			<1.0		umhos/cm		1	23-MAR-19
WG3013045-6 MB								
Conductivity			<1.0		umhos/cm		1	23-MAR-19
F-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-11 DUP		**L2245232-39**						
Fluoride (F)		0.266	0.263		mg/L	0.9	20	16-MAR-19
WG3008313-10 LCS								
Fluoride (F)			97.8		%		90-110	16-MAR-19
WG3008313-2 LCS								
Fluoride (F)			98.7		%		90-110	16-MAR-19
WG3008313-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-6 LCS								
Fluoride (F)			99.4		%		90-110	16-MAR-19
WG3008313-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	16-MAR-19
WG3008313-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	16-MAR-19
WG3008313-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	16-MAR-19
WG3008313-12 MS		**L2245232-39**						
Fluoride (F)			112.8		%		75-125	16-MAR-19
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009599-2 LCS								
Aluminum (Al)-Dissolved			102.5		%		80-120	19-MAR-19
Antimony (Sb)-Dissolved			97.3		%		80-120	19-MAR-19
Arsenic (As)-Dissolved			97.6		%		80-120	19-MAR-19
Barium (Ba)-Dissolved			98.0		%		80-120	19-MAR-19
Beryllium (Be)-Dissolved			100.5		%		80-120	19-MAR-19
Bismuth (Bi)-Dissolved			96.6		%		80-120	19-MAR-19
Boron (B)-Dissolved			100.2		%		80-120	19-MAR-19
Cadmium (Cd)-Dissolved			99.1		%		80-120	19-MAR-19
Calcium (Ca)-Dissolved			98.2		%		80-120	19-MAR-19
Cesium (Cs)-Dissolved			95.9		%		80-120	19-MAR-19
Chromium (Cr)-Dissolved			98.6		%		80-120	19-MAR-19
Cobalt (Co)-Dissolved			98.0		%		80-120	19-MAR-19
Copper (Cu)-Dissolved			97.0		%		80-120	19-MAR-19
Iron (Fe)-Dissolved			89.3		%		80-120	19-MAR-19
Lead (Pb)-Dissolved			94.8		%		80-120	19-MAR-19
Lithium (Li)-Dissolved			101.1		%		80-120	19-MAR-19
Magnesium (Mg)-Dissolved			113.3		%		80-120	19-MAR-19
Manganese (Mn)-Dissolved			99.5		%		80-120	19-MAR-19
Molybdenum (Mo)-Dissolved			98.9		%		80-120	19-MAR-19
Nickel (Ni)-Dissolved			97.0		%		80-120	19-MAR-19
Phosphorus (P)-Dissolved			106.3		%		80-120	19-MAR-19
Potassium (K)-Dissolved			89.2		%		80-120	19-MAR-19
Rubidium (Rb)-Dissolved			96.0		%		80-120	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009599-2 LCS								
Selenium (Se)-Dissolved			98.9		%		80-120	19-MAR-19
Silicon (Si)-Dissolved			101.2		%		80-120	19-MAR-19
Silver (Ag)-Dissolved			95.5		%		80-120	19-MAR-19
Sodium (Na)-Dissolved			99.5		%		80-120	19-MAR-19
Strontium (Sr)-Dissolved			96.0		%		80-120	19-MAR-19
Sulfur (S)-Dissolved			95.1		%		80-120	19-MAR-19
Tellurium (Te)-Dissolved			102.6		%		80-120	19-MAR-19
Thallium (Tl)-Dissolved			94.6		%		80-120	19-MAR-19
Thorium (Th)-Dissolved			94.7		%		80-120	19-MAR-19
Tin (Sn)-Dissolved			98.1		%		80-120	19-MAR-19
Titanium (Ti)-Dissolved			98.8		%		80-120	19-MAR-19
Tungsten (W)-Dissolved			96.8		%		80-120	19-MAR-19
Uranium (U)-Dissolved			97.2		%		80-120	19-MAR-19
Vanadium (V)-Dissolved			99.0		%		80-120	19-MAR-19
Zinc (Zn)-Dissolved			99.3		%		80-120	19-MAR-19
Zirconium (Zr)-Dissolved			92.8		%		80-120	19-MAR-19
WG3009601-2 LCS								
Aluminum (Al)-Dissolved			100.2		%		80-120	19-MAR-19
Antimony (Sb)-Dissolved			98.3		%		80-120	19-MAR-19
Arsenic (As)-Dissolved			95.2		%		80-120	19-MAR-19
Barium (Ba)-Dissolved			96.8		%		80-120	19-MAR-19
Beryllium (Be)-Dissolved			100.5		%		80-120	19-MAR-19
Bismuth (Bi)-Dissolved			95.0		%		80-120	19-MAR-19
Boron (B)-Dissolved			101.1		%		80-120	19-MAR-19
Cadmium (Cd)-Dissolved			97.7		%		80-120	19-MAR-19
Calcium (Ca)-Dissolved			97.0		%		80-120	19-MAR-19
Cesium (Cs)-Dissolved			96.6		%		80-120	19-MAR-19
Chromium (Cr)-Dissolved			97.1		%		80-120	19-MAR-19
Cobalt (Co)-Dissolved			95.4		%		80-120	19-MAR-19
Copper (Cu)-Dissolved			95.9		%		80-120	19-MAR-19
Iron (Fe)-Dissolved			87.2		%		80-120	19-MAR-19
Lead (Pb)-Dissolved			94.0		%		80-120	19-MAR-19
Lithium (Li)-Dissolved			100.7		%		80-120	19-MAR-19
Magnesium (Mg)-Dissolved			106.2		%		80-120	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch	**R4572208**							
WG3009601-2	**LCS**							
Manganese (Mn)-Dissolved			96.1		%		80-120	19-MAR-19
Molybdenum (Mo)-Dissolved			99.5		%		80-120	19-MAR-19
Nickel (Ni)-Dissolved			95.3		%		80-120	19-MAR-19
Phosphorus (P)-Dissolved			106.7		%		80-120	19-MAR-19
Potassium (K)-Dissolved			88.6		%		80-120	19-MAR-19
Rubidium (Rb)-Dissolved			95.3		%		80-120	19-MAR-19
Selenium (Se)-Dissolved			96.1		%		80-120	19-MAR-19
Silicon (Si)-Dissolved			99.2		%		80-120	19-MAR-19
Silver (Ag)-Dissolved			95.5		%		80-120	19-MAR-19
Sodium (Na)-Dissolved			101.2		%		80-120	19-MAR-19
Strontium (Sr)-Dissolved			97.0		%		80-120	19-MAR-19
Sulfur (S)-Dissolved			113.2		%		80-120	19-MAR-19
Tellurium (Te)-Dissolved			99.4		%		80-120	19-MAR-19
Thallium (Tl)-Dissolved			95.6		%		80-120	19-MAR-19
Thorium (Th)-Dissolved			93.2		%		80-120	19-MAR-19
Tin (Sn)-Dissolved			97.7		%		80-120	19-MAR-19
Titanium (Ti)-Dissolved			96.3		%		80-120	19-MAR-19
Tungsten (W)-Dissolved			95.3		%		80-120	19-MAR-19
Uranium (U)-Dissolved			91.4		%		80-120	19-MAR-19
Vanadium (V)-Dissolved			97.0		%		80-120	19-MAR-19
Zinc (Zn)-Dissolved			96.0		%		80-120	19-MAR-19
Zirconium (Zr)-Dissolved			92.3		%		80-120	19-MAR-19
WG3009603-2	**LCS**							
Aluminum (Al)-Dissolved			102.6		%		80-120	19-MAR-19
Antimony (Sb)-Dissolved			97.3		%		80-120	19-MAR-19
Arsenic (As)-Dissolved			97.7		%		80-120	19-MAR-19
Barium (Ba)-Dissolved			97.4		%		80-120	19-MAR-19
Beryllium (Be)-Dissolved			100.4		%		80-120	19-MAR-19
Bismuth (Bi)-Dissolved			97.5		%		80-120	19-MAR-19
Boron (B)-Dissolved			100.5		%		80-120	19-MAR-19
Cadmium (Cd)-Dissolved			98.6		%		80-120	19-MAR-19
Calcium (Ca)-Dissolved			97.1		%		80-120	19-MAR-19
Cesium (Cs)-Dissolved			94.4		%		80-120	19-MAR-19
Chromium (Cr)-Dissolved			98.3		%		80-120	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009603-2 LCS								
Cobalt (Co)-Dissolved			98.6		%		80-120	19-MAR-19
Copper (Cu)-Dissolved			98.9		%		80-120	19-MAR-19
Iron (Fe)-Dissolved			88.7		%		80-120	19-MAR-19
Lead (Pb)-Dissolved			99.0		%		80-120	19-MAR-19
Lithium (Li)-Dissolved			100.2		%		80-120	19-MAR-19
Magnesium (Mg)-Dissolved			112.2		%		80-120	19-MAR-19
Manganese (Mn)-Dissolved			98.6		%		80-120	19-MAR-19
Molybdenum (Mo)-Dissolved			99.8		%		80-120	19-MAR-19
Nickel (Ni)-Dissolved			97.3		%		80-120	19-MAR-19
Phosphorus (P)-Dissolved			108.6		%		80-120	19-MAR-19
Potassium (K)-Dissolved			91.6		%		80-120	19-MAR-19
Rubidium (Rb)-Dissolved			98.1		%		80-120	19-MAR-19
Selenium (Se)-Dissolved			98.5		%		80-120	19-MAR-19
Silicon (Si)-Dissolved			103.3		%		80-120	19-MAR-19
Silver (Ag)-Dissolved			95.6		%		80-120	19-MAR-19
Sodium (Na)-Dissolved			102.5		%		80-120	19-MAR-19
Strontium (Sr)-Dissolved			96.1		%		80-120	19-MAR-19
Sulfur (S)-Dissolved			101.8		%		80-120	19-MAR-19
Tellurium (Te)-Dissolved			97.0		%		80-120	19-MAR-19
Thallium (Tl)-Dissolved			101.2		%		80-120	19-MAR-19
Thorium (Th)-Dissolved			96.2		%		80-120	19-MAR-19
Tin (Sn)-Dissolved			98.5		%		80-120	19-MAR-19
Titanium (Ti)-Dissolved			99.5		%		80-120	19-MAR-19
Tungsten (W)-Dissolved			101.5		%		80-120	19-MAR-19
Uranium (U)-Dissolved			99.0		%		80-120	19-MAR-19
Vanadium (V)-Dissolved			100.5		%		80-120	19-MAR-19
Zinc (Zn)-Dissolved			99.9		%		80-120	19-MAR-19
Zirconium (Zr)-Dissolved			95.0		%		80-120	19-MAR-19
WG3009599-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009599-1 MB								
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	19-MAR-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	19-MAR-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-MAR-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	19-MAR-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	19-MAR-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009601-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	19-MAR-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	19-MAR-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-MAR-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	19-MAR-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009601-1 MB								
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	19-MAR-19
WG3009603-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	19-MAR-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-MAR-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	19-MAR-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-MAR-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	19-MAR-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	19-MAR-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4572208								
WG3009603-1 MB								
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	19-MAR-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-MAR-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	19-MAR-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-MAR-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	19-MAR-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	19-MAR-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	19-MAR-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	19-MAR-19
NO2-L-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-11 DUP		**L2245232-39**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	16-MAR-19
WG3008313-10 LCS								
Nitrite (as N)			96.1		%		90-110	16-MAR-19
WG3008313-2 LCS								
Nitrite (as N)			96.5		%		90-110	16-MAR-19
WG3008313-6 LCS								
Nitrite (as N)			96.3		%		90-110	16-MAR-19
WG3008313-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	16-MAR-19
WG3008313-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	16-MAR-19
WG3008313-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	16-MAR-19
WG3008313-12 MS		**L2245232-39**						
Nitrite (as N)			98.3		%		75-125	16-MAR-19
NO3-L-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-11 DUP		**L2245232-39**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	16-MAR-19
WG3008313-10 LCS								
Nitrate (as N)			99.2		%		90-110	16-MAR-19
WG3008313-2 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-2 LCS								
Nitrate (as N)			99.1		%		90-110	16-MAR-19
WG3008313-6 LCS								
Nitrate (as N)			99.1		%		90-110	16-MAR-19
WG3008313-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	16-MAR-19
WG3008313-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	16-MAR-19
WG3008313-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	16-MAR-19
WG3008313-12 MS		**L2245232-39**						
Nitrate (as N)			106.3		%		75-125	16-MAR-19
PH-WP	**Water**							
Batch R4573259								
WG3010024-10 DUP		**L2245232-2**						
pH		7.98	7.98	J	pH units	0.00	0.2	19-MAR-19
WG3010024-12 LCS								
pH			7.36		pH units		7.3-7.5	19-MAR-19
WG3010024-7 LCS								
pH			7.36		pH units		7.3-7.5	19-MAR-19
Batch R4580551								
WG3013045-10 DUP		**L2245232-40**						
pH		8.05	7.92	J	pH units	0.13	0.2	23-MAR-19
WG3013045-5 DUP		**L2245232-36**						
pH		8.19	8.17	J	pH units	0.02	0.2	23-MAR-19
WG3013045-2 LCS								
pH			7.37		pH units		7.3-7.5	23-MAR-19
WG3013045-7 LCS								
pH			7.39		pH units		7.3-7.5	23-MAR-19
SO4-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-11 DUP		**L2245232-39**						
Sulfate (SO4)		41.0	41.1		mg/L	0.1	20	16-MAR-19
WG3008313-10 LCS								
Sulfate (SO4)			99.5		%		90-110	16-MAR-19
WG3008313-2 LCS								
Sulfate (SO4)			99.6		%		90-110	16-MAR-19
WG3008313-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R4575596								
WG3008313-6 LCS								
Sulfate (SO4)			99.6		%		90-110	16-MAR-19
WG3008313-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	16-MAR-19
WG3008313-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	16-MAR-19
WG3008313-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	16-MAR-19
WG3008313-12 MS		**L2245232-39**						
Sulfate (SO4)			103.9		%		75-125	16-MAR-19
TC,EC-QT51-WP	**Water**							
Batch R4568563								
WG3008474-1 MB								
Total Coliforms			0		MPN/100mL		1	16-MAR-19
Escherichia Coli			0		MPN/100mL		1	16-MAR-19
TURBIDITY-WP	**Water**							
Batch R4576108								
WG3011364-17 DUP		**L2245232-1**						
Turbidity		3970	3980		NTU	0.3	15	16-MAR-19
WG3011364-20 DUP		**L2245232-26**						
Turbidity		233	236		NTU	1.3	15	16-MAR-19
WG3011364-23 DUP		**L2245232-5**						
Turbidity		>4000	>4000		NTU	0.0	15	16-MAR-19
WG3011364-18 LCS								
Turbidity			101.0		%		85-115	16-MAR-19
WG3011364-21 LCS								
Turbidity			100.5		%		85-115	16-MAR-19
WG3011364-24 LCS								
Turbidity			100.5		%		85-115	16-MAR-19
WG3011364-16 MB								
Turbidity			<0.10		NTU		0.1	16-MAR-19
WG3011364-19 MB								
Turbidity			<0.10		NTU		0.1	16-MAR-19
WG3011364-22 MB								
Turbidity			<0.10		NTU		0.1	16-MAR-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	1	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	2	12-MAR-19	16-MAR-19 15:00	3	4	days	EHTR
	3	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	4	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	5	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	6	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	7	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	9	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	10	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	11	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	12	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	15	10-MAR-19	16-MAR-19 15:00	3	6	days	EHTR
	16	11-MAR-19	16-MAR-19 15:00	3	5	days	EHTR
	17	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	18	11-MAR-19	16-MAR-19 15:00	3	5	days	EHTR
	19	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
	20	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	21	10-MAR-19	16-MAR-19 15:00	3	6	days	EHTR
	22	11-MAR-19	16-MAR-19 15:00	3	5	days	EHTR
	23	10-MAR-19	16-MAR-19 15:00	3	6	days	EHTR
	28	12-MAR-19	16-MAR-19 15:00	3	4	days	EHTR
	29	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	30	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	31	11-MAR-19	16-MAR-19 15:00	3	5	days	EHTR
	35	09-MAR-19	16-MAR-19 15:00	3	7	days	EHTR
	36	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	37	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	38	11-MAR-19	16-MAR-19 15:00	3	5	days	EHTR
	39	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	40	08-MAR-19	16-MAR-19 15:00	3	8	days	EHTR
	41	07-MAR-19	16-MAR-19 15:00	3	9	days	EHTR
pH							
	1	07-MAR-19	19-MAR-19 12:00	0.25	288	hours	EHTR-FM
	2	12-MAR-19	19-MAR-19 12:00	0.25	168	hours	EHTR-FM
	3	07-MAR-19	19-MAR-19 12:00	0.25	288	hours	EHTR-FM
	4	08-MAR-19	19-MAR-19 12:00	0.25	264	hours	EHTR-FM
	5	09-MAR-19	19-MAR-19 12:00	0.25	240	hours	EHTR-FM
	6	08-MAR-19	19-MAR-19 12:00	0.25	264	hours	EHTR-FM
	7	09-MAR-19	19-MAR-19 12:00	0.25	240	hours	EHTR-FM
	8	Not provided	19-MAR-19 12:00	0.25	74	hours	EHTR-FM
	9	08-MAR-19	19-MAR-19 12:00	0.25	264	hours	EHTR-FM
	10	07-MAR-19	19-MAR-19 12:00	0.25	288	hours	EHTR-FM
	11	07-MAR-19	19-MAR-19 12:00	0.25	288	hours	EHTR-FM
	12	09-MAR-19	19-MAR-19 12:00	0.25	240	hours	EHTR-FM
	13	15-MAR-19	19-MAR-19 12:00	0.25	96	hours	EHTR-FM
	14	15-MAR-19	19-MAR-19 12:00	0.25	96	hours	EHTR-FM
	15	10-MAR-19	19-MAR-19 12:00	0.25	216	hours	EHTR-FM
	16	11-MAR-19	19-MAR-19 12:00	0.25	192	hours	EHTR-FM
	17	07-MAR-19	19-MAR-19 12:00	0.25	288	hours	EHTR-FM
	18	11-MAR-19	23-MAR-19 12:00	0.25	288	hours	EHTR-FM
	19	07-MAR-19	23-MAR-19 12:00	0.25	384	hours	EHTR-FM
	20	08-MAR-19	23-MAR-19 12:00	0.25	360	hours	EHTR-FM
	21	10-MAR-19	23-MAR-19 12:00	0.25	312	hours	EHTR-FM
	22	11-MAR-19	23-MAR-19 12:00	0.25	288	hours	EHTR-FM
	23	10-MAR-19	23-MAR-19 12:00	0.25	312	hours	EHTR-FM
	24	14-MAR-19	23-MAR-19 12:00	0.25	216	hours	EHTR-FM
	25	14-MAR-19	23-MAR-19 12:00	0.25	216	hours	EHTR-FM

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	26	13-MAR-19	23-MAR-19 12:00	0.25	240	hours	EHTR-FM
	27	13-MAR-19	23-MAR-19 12:00	0.25	240	hours	EHTR-FM
	28	12-MAR-19	23-MAR-19 12:00	0.25	264	hours	EHTR-FM
	29	09-MAR-19	23-MAR-19 12:00	0.25	336	hours	EHTR-FM
	30	09-MAR-19	23-MAR-19 12:00	0.25	336	hours	EHTR-FM
	31	11-MAR-19	23-MAR-19 12:00	0.25	288	hours	EHTR-FM
	32	14-MAR-19	23-MAR-19 12:00	0.25	216	hours	EHTR-FM
	33	14-MAR-19	23-MAR-19 12:00	0.25	216	hours	EHTR-FM
	34	14-MAR-19	23-MAR-19 12:00	0.25	216	hours	EHTR-FM
	35	09-MAR-19	23-MAR-19 12:00	0.25	336	hours	EHTR-FM
	36	08-MAR-19	23-MAR-19 12:00	0.25	360	hours	EHTR-FM
	37	08-MAR-19	23-MAR-19 12:00	0.25	360	hours	EHTR-FM
	38	11-MAR-19	23-MAR-19 12:00	0.25	288	hours	EHTR-FM
	39	08-MAR-19	23-MAR-19 12:00	0.25	360	hours	EHTR-FM
	40	08-MAR-19	23-MAR-19 12:00	0.25	360	hours	EHTR-FM
	41	07-MAR-19	23-MAR-19 12:00	0.25	384	hours	EHTR-FM
Anions and Nutrients							
Alkalinity, Total (as CaCO3)							
	19	07-MAR-19	23-MAR-19 12:00	14	16	days	EHT
	20	08-MAR-19	23-MAR-19 12:00	14	15	days	EHT
	36	08-MAR-19	23-MAR-19 12:00	14	15	days	EHT
	37	08-MAR-19	23-MAR-19 12:00	14	15	days	EHT
	39	08-MAR-19	23-MAR-19 12:00	14	15	days	EHT
	40	08-MAR-19	23-MAR-19 12:00	14	15	days	EHT
	41	07-MAR-19	23-MAR-19 12:00	14	16	days	EHT
Nitrate in Water by IC (Low Level)							
	1	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	2	12-MAR-19	16-MAR-19 11:30	3	4	days	EHTR
	3	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	4	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	5	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	6	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	7	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	9	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	10	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	11	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	12	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	15	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	16	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	17	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	18	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	19	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	20	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	21	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	22	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	23	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	28	12-MAR-19	16-MAR-19 11:30	3	4	days	EHTR
	29	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	30	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	31	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	35	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	36	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	37	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	38	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	39	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	40	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	41	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrite in Water by IC (Low Level)							
	1	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	2	12-MAR-19	16-MAR-19 11:30	3	4	days	EHTR
	3	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	4	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	5	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	6	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	7	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	9	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	10	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	11	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	12	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	15	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	16	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	17	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	18	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	19	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
	20	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	21	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	22	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	23	10-MAR-19	16-MAR-19 11:30	3	6	days	EHTR
	28	12-MAR-19	16-MAR-19 11:30	3	4	days	EHTR
	29	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	30	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	31	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	35	09-MAR-19	16-MAR-19 11:30	3	7	days	EHTR
	36	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	37	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	38	11-MAR-19	16-MAR-19 11:30	3	5	days	EHTR
	39	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	40	08-MAR-19	16-MAR-19 11:30	3	8	days	EHTR
	41	07-MAR-19	16-MAR-19 11:30	3	9	days	EHTR
Bacteriological Tests							
Total Coliform and E.coli							
	24	14-MAR-19	16-MAR-19 14:25	30	50	hours	EHTR
	26	13-MAR-19	16-MAR-19 14:25	30	74	hours	EHTR
	27	13-MAR-19	16-MAR-19 14:25	30	74	hours	EHTR
	28	12-MAR-19	16-MAR-19 14:25	30	98	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2245232 were received on 16-MAR-19 09:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

Quality Control Report

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2245232-COFC

COC Number: 17 - 747302

Page of

Report To	Contact and company name below will appear on the final report
Company:	KGS Group
Contact:	Eric Levay
Phone:	204-229-1136
Company address below will appear on the final report	
Street:	3rd Floor 865 Waverley
City/Province:	Wpg / MB
Postal Code:	R3T 5P4
Invoice To	Same as Report To YES NO
	Copy of Invoice with Report YES NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	PDF EXCEL EDD (DIGITAL)
Quality Control (QC) Report with Report	YES NO
Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	EMAIL MAIL FAX
Email 1 or Fax	ELevay@kgsgroup.com
Email 2	PLindell@kgsgroup.com
Email 3	

Invoice Distribution	
Select Invoice Distribution:	EMAIL MAIL FAX
Email 1 or Fax	
Email 2	

Project Information	
ALS Account # / Quote #:	Q58403
Job #:	18-0300-05
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler:

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] 3 day [P3-25%] 2 day [P2-50%]

EMERGENCY: 1 Business day [E - 100%] Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)]

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	RDL4W-met-D-L	TC, EC-QT51	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
1	TH19-KGS-13	07-03-19		Water	2	X			
2	TH19-KGS-09	12-03-19		"	2	X			
3	Field	07-03-19		"	2	X			
4	TH15-04	08-03-19		"					
5	TH19-KGS-10	09-03-19		"	2	X			
6	TH15-05	08-03-19		"		X			
7	TH19-KGS-04	09-03-19		"	2	X			
8	Trip Blank	0		"	3	X	X		
9	TH19-KGS-14A	08-03-19		"	2	X			
10	TH19-KGS-07A	07-03-19		"	2	X			
11	TH19-KGS-07	07-03-19		"	2	X			
12	TH19-KGS-01B	09-03-19		"	2	X			

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? YES NO

Are samples for human consumption/ use? YES NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

All metals samples are field filtered + preserved.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen SIF Observations Yes No

Ice Packs Ice Cubes Custody seal intact Yes No

Cooling Initiated 6.3

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			

SHIPMENT RELEASE (client use)		
Released by:	Date: 15-03-19	Time: 18:15

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: 16 Mar 19	Time: 9:50

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2245232-COFC

COC Number: 17 - 747304

Page of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: PDF [X] EXCEL [ ] EDD (DIGITAL)	Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report [ ] YES [ ] NO	PRIORITY (Business Days): 4 day [P4-20%] [ ]; 3 day [P3-25%] [ ]; 2 day [P2-50%] [ ] — EMERGENCY: 1 Business day [E - 100%] [ ]; Same Day, Weekend or Statutory holiday [E2 -200%] (Laboratory opening fees may apply)] [ ]
Phone:	204-896-1209	[ ] Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: [X] EMAIL [ ] MAIL [ ] FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	3rd Floor, 865 Waverley St	Email 1 or Fax: PLindell@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Wpg, MB	Email 2: ELevay@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3	

Invoice To		Invoice Distribution	
	Same as Report To [X] YES [ ] NO	Select Invoice Distribution: [ ] EMAIL [X] MAIL [ ] FAX	
	Copy of Invoice with Report [X] YES [ ] NO	Email 1 or Fax	
Company:	KGS Group	Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	18-00300-05	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ROU4W-met-D-L	TC,EC-GTSI	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
13	TH19-KGS-500	15-03-19		Water	2	X			
14	TH19-KGS-16	15-03-19		"	2	X			
15	TH19-KGS-17B	10-03-19		"	2	X			
16	TH19-KGS-19A	11-03-19		"	2	X			
17	TH19-KGS-13A	07-03-19		"	2	X			
18	TH19-KGS-02B	11-03-19		"	2	X			
19	TH19-KGS-12	07-03-19		"	2	X			
20	TH19-KGS-11A	08-03-19		"	2	X			
21	TH19-KGS-17A	10-03-19		"	2	X			
22	TH19-KGS-18A	11-03-19		"	2	X			
23	TH19-KGS-17	10-03-19		"	2	X			
24	PW19-KGS-03	14-03-19		"	3	X	X		

Potential 500mL bottle

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? [ ] YES [X] NO	All metal samples are field filtered + preserved
Are samples for human consumption/ use? [ ] YES [X] NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ]	SIF Observations	Yes [ ]	No [ ]		
Ice Packs [ ]	Ice Cubes [ ]	Custody seal intact	Yes [ ]	No [ ]	
Cooling Initiated [ ]					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	15-03-19	18:00	SGM	16 Mar 19	9:50			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2245232-COFC

COC Number: 17 - 747305

Page of

Report To	Contact and company name below will appear on the final report	Report Fo	Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Eric Leroy	Quality Control (QC) Report with Report ☐ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ 3 day [P3-25%] ☐ 2 day [P2-50%] ☐
Phone:	204-229-1136	☐ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] ☐ Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	3rd Floor 865 Waverley St	Email 1 or Fax: ELeroy@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Wpg, MB	Email 2: PLindell@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3	
Invoice To	Same as Report To ☒ YES ☐ NO	Invoice Distribution	
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☐ EMAIL ☒ MAIL ☐ FAX	
Company:		Email 1 or Fax	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	18-0300-005	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact:	Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	RQU4W-met-D-L	TC, EC-QT51	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
25	PW19-KGS-04	14-03-19		Water	2	X	X	- No bacteria for this sample location	
26	PW19-KGS-02	13-03-19		"	3	X	X		
27	PW19-KGS-05	13-03-19		"	3	X	X		
28	PW19-KGS-01	12-03-19		"	3	X	X		
29	TH19-KGS-15	09-03-19		"	2	X			
30	TH200	09-03-19		"	2	X			
31	TH19-KGS-19	11-03-19		"	2	X			
32	TH19-KGS-20	14-03-19		"	2	X			
33	TH300	14-03-19		"	2	X			
34	TH19-KGS-12B	14-03-19		"	2	X			
35	TH19-KGS-16B	09-03-19		"	2	X			
36	TH19-KGS-08	08-03-19		"	2	X			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☒ NO	All metals samples field filtered + preserved.
Are samples for human consumption/ use? ☐ YES ☒ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice Packs	☐ Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 15-03-19	Time: 18:00	Received by: SQK	Date: 16 Nov 19	Time: 9:50	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2015 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2245232-COFC

COC Number: 17 - 747303

Page of

Report To	Contact and company name below will appear on the final report
Company:	KGS Group
Contact:	Eric Levay
Phone:	204-229-1136
	Company address below will appear on the final report
Street:	3rd Floor 865 Waverley St
City/Province:	Wpg. MB
Postal Code:	R3T 5P4

Report Format / Distribution	
Select Report Format:	PDF EXCEL EDD (DIGITAL)
Quality Control (QC) Report with Report	YES NO
Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	EMAIL MAIL FAX
Email 1 or Fax	ELevay@kgsgroup.com
Email 2	PLindell@kgsgroup.com
Email 3	

Invoice To		
	Same as Report To	YES NO
	Copy of Invoice with Report	YES NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	EMAIL MAIL FAX
Email 1 or Fax	
Email 2	

Project Information	
ALS Account # / Quote #:	Q58403
Job #:	18-0300-05
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only):	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	Sampler:

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] 3 day [P3-25%] 2 day [P2-50%]

EMERGENCY: 1 Business day [E - 100%] Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)]

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	R2U4W-wet-D-L	TC; EC-QTSI	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
37	TH19-KGS-11	08-03-19		Water	2	X			
38	TH19-KGS-18	11-03-19		"	2	X			
39	TH19-KGS-14	08-03-19		"	2	X			
40	TH19-KGS-03A	08-03-19		"	2	X			
41	TH19-KGS-100	07-03-19		"	2	X			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? YES NO	Metal samples field filtered + preserved.
Are samples for human consumption/ use? YES NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen SIF Observations Yes No

Ice Packs Ice Cubes Custody seal intact Yes No

Cooling Initiated 9-3

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)		
Released by:	Date: 15-03-19	Time: 18:10

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: 16 Mar 19	Time: 9:50

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	412		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	7.65		pH units			13-JUN-19
Turbidity						
*Turbidity	1.12		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	428		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	77.0		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	353		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.263		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00049		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0254		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.133		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	51.9		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00024		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.051		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

KGS Group Consultants (Winnipeg)
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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0247		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	54.3		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.00673		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.00106		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00065		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	4.91		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00139		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	5.81		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	27.9		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.214		mg/L			14-JUN-19
Sulfur (S)-Dissolved	26.7		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.00184		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0013		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	705		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.05		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	338		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	PEHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	PEHT	MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	399		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	7.79		pH units			13-JUN-19
Turbidity						
*Turbidity	2.57		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	449		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	89.0		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	362		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.317		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00161		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0250		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.129		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	55.1		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	0.000012		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00016		mg/L			14-JUN-19
Copper (Cu)-Dissolved	0.00122		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.112		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	0.000057		mg/L	0.005		14-JUN-19

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Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0253		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	54.6		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.00503		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.000424		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	4.71		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00241		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	5.80		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	35.7		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.202		mg/L			14-JUN-19
Sulfur (S)-Dissolved	30.6		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000996		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0040		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	735		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.1		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	327		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	PEHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	PEHT	MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	402		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	7.71		pH units			13-JUN-19
Turbidity						
*Turbidity	2.16		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	349		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	31.3		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	344		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.175		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00037		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0538		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.092		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	56.4		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00056		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.216		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0194		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	49.4		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.0711		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.000131		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00097		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	4.30		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00257		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	5.46		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	8.58		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.149		mg/L			14-JUN-19
Sulfur (S)-Dissolved	11.3		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000491		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0011		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	606		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.12		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	330		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	MBHT	MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-200
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	406		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	7.71		pH units			13-JUN-19
Turbidity						
*Turbidity	2.33		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	352		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	31.8		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	348		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.176		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00037		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0527		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.091		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	56.8		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00058		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.202		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-200
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0197		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	50.2		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.0694		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.000118		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00094		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	4.28		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00258		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	5.41		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	8.60		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.147		mg/L			14-JUN-19
Sulfur (S)-Dissolved	11.1		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000481		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	609		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	1.15		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	333		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	MBHT	MPN/100mL	0		13-JUN-19

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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: PW19-KGS-200
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-12
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	505		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	7.85		pH units			13-JUN-19
Turbidity						
*Turbidity	>4000		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	475		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	71.5		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	402		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.292		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0011		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	0.00024		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00041		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0602		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.115		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	48.5		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00088		mg/L			14-JUN-19
Copper (Cu)-Dissolved	0.00022		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	1.82		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

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Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-12
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0361		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	68.2		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.246		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.0164		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00373		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	4.55		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00208		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	5.81		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	30.1		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.234		mg/L			14-JUN-19
Sulfur (S)-Dissolved	24.1		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	0.00048		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000106		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0016		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	777		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.20		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	414		mg/L			13-JUN-19
Total and E. coli, 1:10 dilution by QT97						
Total Coliforms	<10		MPN/100mL	0		13-JUN-19
Escherichia Coli	<10		MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-12
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-17
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	405		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	0.0089		mg/L	10		19-JUN-19
pH						
pH	7.71		pH units			13-JUN-19
Turbidity						
*Turbidity	860		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	365		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	42.2		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0089		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	342		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.214		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0045		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	0.00015		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00270		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0429		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.085		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	49.8		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00025		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.063		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

KGS Group Consultants (Winnipeg)
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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-17
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0170		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	53.0		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.0341		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.0101		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00087		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	3.47		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00227		mg/L			14-JUN-19
Selenium (Se)-Dissolved	0.000912		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	4.66		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	16.0		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.146		mg/L			14-JUN-19
Sulfur (S)-Dissolved	16.8		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	0.00038		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000263		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	622		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.96		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			13-JUN-19
Total and E. coli, 1:10 dilution by QT97						
Total Coliforms	<10	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	<10	MBHT	MPN/100mL	0		13-JUN-19

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865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-17
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-18
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	764		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.010		mg/L	10		19-JUN-19
pH						
pH	7.14		pH units			13-JUN-19
Turbidity						
*Turbidity	>4000		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	587		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	<0.60	DLM	mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	620		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.135		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0018		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	0.00011		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00190		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.154		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.052		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	116		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00154		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	1.08		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-18
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0357		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	80.1		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.209		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.00167		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00461		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	2.22		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00167		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	10.6		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	11.3		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.290		mg/L			14-JUN-19
Sulfur (S)-Dissolved	<0.50		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	0.00016		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.000586		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0047		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	0.000193		mg/L			14-JUN-19
Conductivity						
Conductivity	989		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.83		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	627		mg/L			13-JUN-19
Total and E. coli, 1:10 dilution by QT97						
Total Coliforms	<10	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	<10	MBHT	MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-18
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-19
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	646		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	0.016		mg/L	10		19-JUN-19
pH						
pH	8.29		pH units			13-JUN-19
Turbidity						
*Turbidity	>4000		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	633		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	110		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.016		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	489		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.288		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0128		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	0.00027		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.0167		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0881		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	0.00014		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.097		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	0.0000097		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	66.7		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	0.000051		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	0.00035		mg/L			14-JUN-19
Copper (Cu)-Dissolved	0.00101		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	0.000068		mg/L	0.005		14-JUN-19

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Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-19
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0351		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	78.2		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.139		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.00524		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00216		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	5.01		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00370		mg/L			14-JUN-19
Selenium (Se)-Dissolved	0.000281		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	8.02		mg/L			14-JUN-19
Silver (Ag)-Dissolved	0.000021		mg/L			14-JUN-19
Sodium (Na)-Dissolved	48.5		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.921		mg/L			14-JUN-19
Sulfur (S)-Dissolved	30.9		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	0.000119		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	0.00061		mg/L			14-JUN-19
Tungsten (W)-Dissolved	0.0293		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.00203		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	0.00135		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0026		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	0.000287		mg/L			14-JUN-19
Conductivity						
Conductivity	902		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	7.08		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	529		mg/L			13-JUN-19
Total and E. coli, 1:10 dilution by QT97						
Total Coliforms	10	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	<10	MBHT	MPN/100mL	0		13-JUN-19

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Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TH19-KGS-19
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TRIP BLANK
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	2.0		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	5.70		pH units			13-JUN-19
Turbidity						
*Turbidity	0.44		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Hardness Calculated						
Hardness (as CaCO3)	0.40		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	<0.00010		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	<0.010		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	0.141		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			14-JUN-19
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19
Lithium (Li)-Dissolved	<0.0010		mg/L			14-JUN-19
Magnesium (Mg)-	0.0120		mg/L			14-JUN-19

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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TRIP BLANK
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Dissolved Manganese (Mn)-Dissolved	<0.00010		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	<0.050		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	<0.00020		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	<0.050		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	<0.050		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	<0.00010		mg/L			14-JUN-19
Sulfur (S)-Dissolved	<0.50		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	<1.0		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	1.6		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	PEHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	PEHT	MPN/100mL	0		13-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: TRIP BLANK
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	290		mg/L			14-JUN-19
Carbonate (CO3)	14.0		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	8.57		pH units			13-JUN-19
Turbidity						
*Turbidity	6.93		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	267		mg/L		500	20-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	16.8		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	269		mg/L		500	20-JUN-19
Fluoride in Water by IC						
Fluoride (F)	0.159		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0044		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	0.00083		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.0380		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	0.048		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	38.3		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			14-JUN-19
Copper (Cu)-Dissolved	0.00199		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	0.012		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19

KGS Group Consultants (Winnipeg)
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ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0145		mg/L			14-JUN-19
Magnesium (Mg)-Dissolved	42.1		mg/L			14-JUN-19
Manganese (Mn)-Dissolved	0.00547		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	0.000564		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	0.00068		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	3.38		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	0.00174		mg/L			14-JUN-19
Selenium (Se)-Dissolved	0.000055		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	0.707		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	6.84		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.111		mg/L			14-JUN-19
Sulfur (S)-Dissolved	6.46		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	0.00177		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	0.00057		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0020		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	0.000098		mg/L			14-JUN-19
Conductivity						
Conductivity	456		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.97		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	262		mg/L			13-JUN-19
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.263		mg/L		0.1	19-JUN-19
Antimony (Sb)-Total	<0.00010		mg/L	0.006		19-JUN-19
Arsenic (As)-Total	0.00098		mg/L	0.01		19-JUN-19
Barium (Ba)-Total	0.0396		mg/L	1		19-JUN-19
Beryllium (Be)-Total	<0.00010		mg/L			19-JUN-19
Bismuth (Bi)-Total	<0.000050		mg/L			19-JUN-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Metals in Water by CRC ICPMS						
Boron (B)-Total	0.040		mg/L	5		19-JUN-19
Cadmium (Cd)-Total	<0.0000050		mg/L	0.005		19-JUN-19
Calcium (Ca)-Total	40.0		mg/L			19-JUN-19
Cesium (Cs)-Total	0.000032		mg/L			19-JUN-19
Chromium (Cr)-Total	0.00046		mg/L	0.05		19-JUN-19
Cobalt (Co)-Total	0.00019		mg/L			19-JUN-19
Copper (Cu)-Total	0.00164		mg/L	2.0	1.0	19-JUN-19
Iron (Fe)-Total	0.294		mg/L		0.3	19-JUN-19
Lead (Pb)-Total	0.000149		mg/L	0.005		19-JUN-19
Lithium (Li)-Total	0.0143		mg/L			19-JUN-19
Magnesium (Mg)-Total	42.0		mg/L			19-JUN-19
Manganese (Mn)-Total	0.0210		mg/L	0.12	0.02	19-JUN-19
Molybdenum (Mo)-Total	0.000566		mg/L			19-JUN-19
Nickel (Ni)-Total	0.00105		mg/L			19-JUN-19
Potassium (K)-Total	3.48		mg/L			19-JUN-19
Phosphorus (P)-Total	<0.030		mg/L			19-JUN-19
Rubidium (Rb)-Total	0.00220		mg/L			19-JUN-19
Selenium (Se)-Total	0.000066		mg/L	0.05		19-JUN-19
Silicon (Si)-Total	1.33		mg/L			19-JUN-19
Silver (Ag)-Total	<0.000010		mg/L			19-JUN-19
Sodium (Na)-Total	6.85		mg/L		200	19-JUN-19
Strontium (Sr)-Total	0.117		mg/L			19-JUN-19
Sulfur (S)-Total	6.31		mg/L			19-JUN-19
Tellurium (Te)-Total	<0.00020		mg/L			19-JUN-19
Thallium (Tl)-Total	0.000011		mg/L			19-JUN-19
Thorium (Th)-Total	<0.00010		mg/L			19-JUN-19
Tin (Sn)-Total	<0.00010		mg/L			19-JUN-19
Titanium (Ti)-Total	0.0106		mg/L			19-JUN-19
Tungsten (W)-Total	<0.00010		mg/L			19-JUN-19
Uranium (U)-Total	0.00191		mg/L	0.02		19-JUN-19
Vanadium (V)-Total	0.00120		mg/L			19-JUN-19
Zinc (Zn)-Total	<0.0030		mg/L		5.0	19-JUN-19
Zirconium (Zr)-Total	0.00029		mg/L			19-JUN-19

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Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL
Date Collected: 11-JUN-19
Lab Sample ID: L2290890-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 24-JUN-19
PO No.:
WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: FIELD BLANK
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-11
Matrix: WTP

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	2.1		mg/L			14-JUN-19
Carbonate (CO3)	<0.60		mg/L			14-JUN-19
Hydroxide (OH)	<0.34		mg/L			14-JUN-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		19-JUN-19
pH						
pH	6.12		pH units			13-JUN-19
Turbidity						
*Turbidity	0.17		NTU			15-JUN-19
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	17-JUN-19
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	13-JUN-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		13-JUN-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		13-JUN-19
Hardness Calculated						
Hardness (as CaCO3)	0.40		mg/L		500	17-JUN-19
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		13-JUN-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					14-JUN-19
Aluminum (Al)-Dissolved	0.0025		mg/L		0.1	14-JUN-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		14-JUN-19
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		14-JUN-19
Barium (Ba)-Dissolved	0.00018		mg/L	1		14-JUN-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			14-JUN-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			14-JUN-19
Boron (B)-Dissolved	<0.010		mg/L	5		14-JUN-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		14-JUN-19
Calcium (Ca)-Dissolved	0.106		mg/L			14-JUN-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			14-JUN-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		14-JUN-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			14-JUN-19
Copper (Cu)-Dissolved	0.00091		mg/L	2.0	1.0	14-JUN-19
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	14-JUN-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		14-JUN-19
Lithium (Li)-Dissolved	<0.0010		mg/L			14-JUN-19
Magnesium (Mg)-	0.0325		mg/L			14-JUN-19

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Project Ref: 18-0300-005
Sample ID: FIELD BLANK
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-11
Matrix: WTP

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Dissolved						
Manganese (Mn)-Dissolved	0.00027		mg/L	0.12	0.02	14-JUN-19
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			14-JUN-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			14-JUN-19
Phosphorus (P)-Dissolved	<0.030		mg/L			14-JUN-19
Potassium (K)-Dissolved	0.078		mg/L			14-JUN-19
Rubidium (Rb)-Dissolved	<0.00020		mg/L			14-JUN-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		14-JUN-19
Silicon (Si)-Dissolved	<0.050		mg/L			14-JUN-19
Silver (Ag)-Dissolved	<0.000010		mg/L			14-JUN-19
Sodium (Na)-Dissolved	0.123		mg/L		200	14-JUN-19
Strontium (Sr)-Dissolved	0.00012		mg/L			14-JUN-19
Sulfur (S)-Dissolved	0.54		mg/L			14-JUN-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			14-JUN-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			14-JUN-19
Thorium (Th)-Dissolved	<0.00010		mg/L			14-JUN-19
Tin (Sn)-Dissolved	<0.00010		mg/L			14-JUN-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			14-JUN-19
Tungsten (W)-Dissolved	<0.00010		mg/L			14-JUN-19
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		14-JUN-19
Vanadium (V)-Dissolved	<0.00050		mg/L			14-JUN-19
Zinc (Zn)-Dissolved	0.0033		mg/L		5.0	14-JUN-19
Zirconium (Zr)-Dissolved	<0.000060		mg/L			14-JUN-19
Conductivity						
Conductivity	<1.0		umhos/cm			13-JUN-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	13-JUN-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	1.7		mg/L			13-JUN-19
Total Coliform and E.coli						
Total Coliforms	0	MBHT	MPN/100mL	0		13-JUN-19
Escherichia Coli	0	MBHT	MPN/100mL	0		13-JUN-19

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WO No.: L2290890
Project Ref: 18-0300-005
Sample ID: FIELD BLANK
Sampled By: PJL
Date Collected: 12-JUN-19
Lab Sample ID: L2290890-11
Matrix: WTP

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
MBHT	The APHA 30 hour hold time was exceeded for microbiological testing. Samples processed within 48 hours from time of sampling may

	be valid in some cases (refer to Health Canada guidance).
PEHT	Parameter Exceeded Recommended Holding Time Prior to Analysis
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2290890 Report Date: 24-JUN-19

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4669808								
WG3077144-20 DUP		**L2290890-8**						
Alkalinity, Total (as CaCO3)		529	547		mg/L	3.4	20	13-JUN-19
WG3077144-14 LCS								
Alkalinity, Total (as CaCO3)			103.7		%		85-115	13-JUN-19
WG3077144-19 LCS								
Alkalinity, Total (as CaCO3)			104.5		%		85-115	13-JUN-19
WG3077144-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	13-JUN-19
WG3077144-16 MB								
Alkalinity, Total (as CaCO3)			1.0		mg/L		1	13-JUN-19
CL-L-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-3 DUP		**L2290890-1**						
Chloride (Cl)		9.05	9.09		mg/L	0.5	20	13-JUN-19
WG3076575-2 LCS								
Chloride (Cl)			99.98		%		90-110	13-JUN-19
WG3076575-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	13-JUN-19
WG3076575-4 MS		**L2290890-1**						
Chloride (Cl)			103.1		%		75-125	13-JUN-19
EC-WP	**Water**							
Batch R4669808								
WG3077144-20 DUP		**L2290890-8**						
Conductivity		902	907		umhos/cm	0.6	10	13-JUN-19
WG3077144-13 LCS								
Conductivity			98.2		%		90-110	13-JUN-19
WG3077144-18 LCS								
Conductivity			98.4		%		90-110	13-JUN-19
WG3077144-11 MB								
Conductivity			<1.0		umhos/cm		1	13-JUN-19
WG3077144-16 MB								
Conductivity			<1.0		umhos/cm		1	13-JUN-19
F-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-3 DUP		**L2290890-1**						
Fluoride (F)		0.263	0.261		mg/L	0.8	20	13-JUN-19
WG3076575-2 LCS								
Fluoride (F)			99.4		%		90-110	13-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	13-JUN-19
WG3076575-4 MS		**L2290890-1**						
Fluoride (F)			97.8		%		75-125	13-JUN-19
MET-D-CCMS-WP	**Water**							
Batch R4671275								
WG3077972-2 LCS								
Aluminum (Al)-Dissolved			102.7		%		80-120	14-JUN-19
Antimony (Sb)-Dissolved			99.2		%		80-120	14-JUN-19
Arsenic (As)-Dissolved			101.0		%		80-120	14-JUN-19
Barium (Ba)-Dissolved			100.0		%		80-120	14-JUN-19
Beryllium (Be)-Dissolved			99.8		%		80-120	14-JUN-19
Bismuth (Bi)-Dissolved			103.1		%		80-120	14-JUN-19
Boron (B)-Dissolved			95.8		%		80-120	14-JUN-19
Cadmium (Cd)-Dissolved			98.3		%		80-120	14-JUN-19
Calcium (Ca)-Dissolved			97.7		%		80-120	14-JUN-19
Cesium (Cs)-Dissolved			99.4		%		80-120	14-JUN-19
Chromium (Cr)-Dissolved			99.8		%		80-120	14-JUN-19
Cobalt (Co)-Dissolved			98.4		%		80-120	14-JUN-19
Copper (Cu)-Dissolved			100.2		%		80-120	14-JUN-19
Iron (Fe)-Dissolved			92.2		%		80-120	14-JUN-19
Lead (Pb)-Dissolved			101.4		%		80-120	14-JUN-19
Lithium (Li)-Dissolved			101.4		%		80-120	14-JUN-19
Magnesium (Mg)-Dissolved			107.6		%		80-120	14-JUN-19
Manganese (Mn)-Dissolved			98.3		%		80-120	14-JUN-19
Molybdenum (Mo)-Dissolved			102.2		%		80-120	14-JUN-19
Nickel (Ni)-Dissolved			97.1		%		80-120	14-JUN-19
Phosphorus (P)-Dissolved			108.8		%		80-120	14-JUN-19
Potassium (K)-Dissolved			98.8		%		80-120	14-JUN-19
Rubidium (Rb)-Dissolved			100.6		%		80-120	14-JUN-19
Selenium (Se)-Dissolved			102.5		%		80-120	14-JUN-19
Silicon (Si)-Dissolved			101.0		%		80-120	14-JUN-19
Silver (Ag)-Dissolved			100.5		%		80-120	14-JUN-19
Sodium (Na)-Dissolved			99.97		%		80-120	14-JUN-19
Strontium (Sr)-Dissolved			100.1		%		80-120	14-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4671275								
WG3077972-2 LCS								
Sulfur (S)-Dissolved			97.6		%		80-120	14-JUN-19
Tellurium (Te)-Dissolved			95.3		%		80-120	14-JUN-19
Thallium (Tl)-Dissolved			99.5		%		80-120	14-JUN-19
Thorium (Th)-Dissolved			100.6		%		80-120	14-JUN-19
Tin (Sn)-Dissolved			99.7		%		80-120	14-JUN-19
Titanium (Ti)-Dissolved			97.5		%		80-120	14-JUN-19
Tungsten (W)-Dissolved			100.6		%		80-120	14-JUN-19
Uranium (U)-Dissolved			103.0		%		80-120	14-JUN-19
Vanadium (V)-Dissolved			100.8		%		80-120	14-JUN-19
Zinc (Zn)-Dissolved			101.6		%		80-120	14-JUN-19
Zirconium (Zr)-Dissolved			99.3		%		80-120	14-JUN-19
WG3077977-2 LCS								
Aluminum (Al)-Dissolved			102.9		%		80-120	14-JUN-19
Antimony (Sb)-Dissolved			98.3		%		80-120	14-JUN-19
Arsenic (As)-Dissolved			101.1		%		80-120	14-JUN-19
Barium (Ba)-Dissolved			99.5		%		80-120	14-JUN-19
Beryllium (Be)-Dissolved			104.7		%		80-120	14-JUN-19
Bismuth (Bi)-Dissolved			101.3		%		80-120	14-JUN-19
Boron (B)-Dissolved			103.4		%		80-120	14-JUN-19
Cadmium (Cd)-Dissolved			100.2		%		80-120	14-JUN-19
Calcium (Ca)-Dissolved			100.7		%		80-120	14-JUN-19
Cesium (Cs)-Dissolved			98.3		%		80-120	14-JUN-19
Chromium (Cr)-Dissolved			99.4		%		80-120	14-JUN-19
Cobalt (Co)-Dissolved			98.8		%		80-120	14-JUN-19
Copper (Cu)-Dissolved			99.9		%		80-120	14-JUN-19
Iron (Fe)-Dissolved			93.2		%		80-120	14-JUN-19
Lead (Pb)-Dissolved			99.9		%		80-120	14-JUN-19
Lithium (Li)-Dissolved			105.6		%		80-120	14-JUN-19
Magnesium (Mg)-Dissolved			114.2		%		80-120	14-JUN-19
Manganese (Mn)-Dissolved			99.2		%		80-120	14-JUN-19
Molybdenum (Mo)-Dissolved			102.5		%		80-120	14-JUN-19
Nickel (Ni)-Dissolved			97.4		%		80-120	14-JUN-19
Phosphorus (P)-Dissolved			105.0		%		80-120	14-JUN-19
Potassium (K)-Dissolved			101.9		%		80-120	14-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4671275								
WG3077977-2 LCS								
Rubidium (Rb)-Dissolved			98.9		%		80-120	14-JUN-19
Selenium (Se)-Dissolved			101.6		%		80-120	14-JUN-19
Silicon (Si)-Dissolved			107.5		%		80-120	14-JUN-19
Silver (Ag)-Dissolved			101.9		%		80-120	14-JUN-19
Sodium (Na)-Dissolved			103.5		%		80-120	14-JUN-19
Strontium (Sr)-Dissolved			99.8		%		80-120	14-JUN-19
Sulfur (S)-Dissolved			98.0		%		80-120	14-JUN-19
Tellurium (Te)-Dissolved			94.0		%		80-120	14-JUN-19
Thallium (Tl)-Dissolved			100.1		%		80-120	14-JUN-19
Thorium (Th)-Dissolved			99.1		%		80-120	14-JUN-19
Tin (Sn)-Dissolved			100.4		%		80-120	14-JUN-19
Titanium (Ti)-Dissolved			100.8		%		80-120	14-JUN-19
Tungsten (W)-Dissolved			99.5		%		80-120	14-JUN-19
Uranium (U)-Dissolved			101.8		%		80-120	14-JUN-19
Vanadium (V)-Dissolved			101.4		%		80-120	14-JUN-19
Zinc (Zn)-Dissolved			99.9		%		80-120	14-JUN-19
Zirconium (Zr)-Dissolved			96.2		%		80-120	14-JUN-19
WG3077972-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	14-JUN-19
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	14-JUN-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	14-JUN-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch	**R4671275**							
WG3077972-1	**MB**							
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	14-JUN-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	14-JUN-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	14-JUN-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	14-JUN-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	14-JUN-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	14-JUN-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	14-JUN-19
WG3077977-1	**MB**							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	14-JUN-19
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	14-JUN-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch	**R4671275**							
WG3077977-1	**MB**							
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	14-JUN-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	14-JUN-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	14-JUN-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	14-JUN-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	14-JUN-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	14-JUN-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	14-JUN-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	14-JUN-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	14-JUN-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	14-JUN-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	14-JUN-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	14-JUN-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	14-JUN-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	14-JUN-19
MET-T-CCMS-WP	**Water**							
Batch	**R4676666**							
WG3081705-2	**LCS**							
Aluminum (Al)-Total			102.9		%		80-120	19-JUN-19
Antimony (Sb)-Total			101.3		%		80-120	19-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4676666								
WG3081705-2 LCS								
Arsenic (As)-Total			99.4		%		80-120	19-JUN-19
Barium (Ba)-Total			100.6		%		80-120	19-JUN-19
Beryllium (Be)-Total			93.5		%		80-120	19-JUN-19
Bismuth (Bi)-Total			96.8		%		80-120	19-JUN-19
Boron (B)-Total			84.1		%		80-120	19-JUN-19
Cadmium (Cd)-Total			100.8		%		80-120	19-JUN-19
Calcium (Ca)-Total			98.9		%		80-120	19-JUN-19
Cesium (Cs)-Total			103.1		%		80-120	19-JUN-19
Chromium (Cr)-Total			97.2		%		80-120	19-JUN-19
Cobalt (Co)-Total			96.7		%		80-120	19-JUN-19
Copper (Cu)-Total			97.1		%		80-120	19-JUN-19
Iron (Fe)-Total			96.6		%		80-120	19-JUN-19
Lead (Pb)-Total			99.6		%		80-120	19-JUN-19
Lithium (Li)-Total			96.4		%		80-120	19-JUN-19
Magnesium (Mg)-Total			107.4		%		80-120	19-JUN-19
Manganese (Mn)-Total			100.4		%		80-120	19-JUN-19
Molybdenum (Mo)-Total			99.0		%		80-120	19-JUN-19
Nickel (Ni)-Total			97.1		%		80-120	19-JUN-19
Potassium (K)-Total			101.6		%		80-120	19-JUN-19
Phosphorus (P)-Total			104.0		%		80-120	19-JUN-19
Rubidium (Rb)-Total			100.4		%		80-120	19-JUN-19
Selenium (Se)-Total			102.6		%		80-120	19-JUN-19
Silicon (Si)-Total			103.7		%		80-120	19-JUN-19
Silver (Ag)-Total			98.8		%		80-120	19-JUN-19
Sodium (Na)-Total			96.1		%		80-120	19-JUN-19
Strontium (Sr)-Total			101.9		%		80-120	19-JUN-19
Sulfur (S)-Total			96.8		%		80-120	19-JUN-19
Tellurium (Te)-Total			95.6		%		80-120	19-JUN-19
Thallium (Tl)-Total			99.9		%		80-120	19-JUN-19
Thorium (Th)-Total			98.0		%		80-120	19-JUN-19
Tin (Sn)-Total			99.7		%		80-120	19-JUN-19
Titanium (Ti)-Total			96.4		%		80-120	19-JUN-19
Tungsten (W)-Total			100.6		%		80-120	19-JUN-19
Uranium (U)-Total			103.2		%		80-120	19-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4676666								
WG3081705-2 LCS								
Vanadium (V)-Total			98.4		%		80-120	19-JUN-19
Zinc (Zn)-Total			97.4		%		80-120	19-JUN-19
Zirconium (Zr)-Total			97.3		%		80-120	19-JUN-19
WG3081705-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	19-JUN-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	19-JUN-19
Boron (B)-Total			<0.010		mg/L		0.01	19-JUN-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	19-JUN-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	19-JUN-19
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	19-JUN-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Copper (Cu)-Total			<0.00050		mg/L		0.0005	19-JUN-19
Iron (Fe)-Total			<0.010		mg/L		0.01	19-JUN-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	19-JUN-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	19-JUN-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	19-JUN-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	19-JUN-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	19-JUN-19
Potassium (K)-Total			<0.050		mg/L		0.05	19-JUN-19
Phosphorus (P)-Total			<0.030		mg/L		0.03	19-JUN-19
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	19-JUN-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	19-JUN-19
Silicon (Si)-Total			<0.10		mg/L		0.1	19-JUN-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	19-JUN-19
Sodium (Na)-Total			<0.050		mg/L		0.05	19-JUN-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	19-JUN-19
Sulfur (S)-Total			<0.50		mg/L		0.5	19-JUN-19
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	19-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4676666								
WG3081705-1 MB								
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	19-JUN-19
Thorium (Th)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	19-JUN-19
Tungsten (W)-Total			<0.00010		mg/L		0.0001	19-JUN-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	19-JUN-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	19-JUN-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	19-JUN-19
Zirconium (Zr)-Total			<0.00020		mg/L		0.0002	19-JUN-19
NO2-L-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-3 DUP		**L2290890-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	13-JUN-19
WG3076575-2 LCS								
Nitrite (as N)			101.3		%		90-110	13-JUN-19
WG3076575-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	13-JUN-19
WG3076575-4 MS		**L2290890-1**						
Nitrite (as N)			106.0		%		75-125	13-JUN-19
NO3-L-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-3 DUP		**L2290890-1**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	13-JUN-19
WG3076575-2 LCS								
Nitrate (as N)			100.1		%		90-110	13-JUN-19
WG3076575-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	13-JUN-19
WG3076575-4 MS		**L2290890-1**						
Nitrate (as N)			103.1		%		75-125	13-JUN-19
PH-WP	**Water**							
Batch R4669808								
WG3077144-20 DUP		**L2290890-8**						
pH		8.29	8.31	J	pH units	0.02	0.2	13-JUN-19
WG3077144-12 LCS								
pH			7.37		pH units		7.3-7.5	13-JUN-19
WG3077144-17 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R4669808								
WG3077144-17 LCS								
pH			7.37		pH units		7.3-7.5	13-JUN-19
SO4-IC-N-WP	**Water**							
Batch R4673647								
WG3076575-3 DUP		**L2290890-1**						
Sulfate (SO4)		77.0	76.6		mg/L	0.6	20	13-JUN-19
WG3076575-2 LCS								
Sulfate (SO4)			100.7		%		90-110	13-JUN-19
WG3076575-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	13-JUN-19
WG3076575-4 MS		**L2290890-1**						
Sulfate (SO4)			101.6		%		75-125	13-JUN-19
TC,EC-QT51-WP	**Water**							
Batch R4669890								
WG3076370-4 DUP		**L2290890-11**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-5 DUP		**L2290890-9**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-6 DUP		**L2290890-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-7 DUP		**L2290890-3**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-8 DUP		**L2290890-2**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-9 DUP		**L2290890-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	13-JUN-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	13-JUN-19
WG3076370-1 MB								
Total Coliforms			0		MPN/100mL		1	13-JUN-19
Escherichia Coli			0		MPN/100mL		1	13-JUN-19
WG3076370-2 MB								
Total Coliforms			0		MPN/100mL		1	13-JUN-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R4669890								
WG3076370-2 MB								
Escherichia Coli			0		MPN/100mL		1	13-JUN-19
WG3076370-3 MB								
Total Coliforms			0		MPN/100mL		1	13-JUN-19
Escherichia Coli			0		MPN/100mL		1	13-JUN-19
TC,EC10-QT97-WP	**Water**							
Batch R4670080								
WG3077524-2 DUP		**L2290890-5**						
Total Coliforms		<10	<10	RPD-NA	MPN/100mL	N/A	65	13-JUN-19
Escherichia Coli		<10	<10	RPD-NA	MPN/100mL	N/A	65	13-JUN-19
WG3077524-1 MB								
Total Coliforms			<1		MPN/100mL		1	13-JUN-19
Escherichia Coli			<1		MPN/100mL		1	13-JUN-19
TURBIDITY-WP	**Water**							
Batch R4670937								
WG3077331-5 LCS								
Turbidity			105.5		%		85-115	15-JUN-19
WG3077331-4 MB								
Turbidity			<0.10		NTU		0.1	15-JUN-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	1	11-JUN-19 09:40	15-JUN-19 10:00	3	4	days	EHTL
	2	11-JUN-19 11:50	15-JUN-19 10:00	3	4	days	EHT
	3	11-JUN-19 16:20	15-JUN-19 10:00	3	4	days	EHT
	4	11-JUN-19 20:00	15-JUN-19 10:00	3	4	days	EHT
	9	11-JUN-19 08:00	15-JUN-19 10:00	3	4	days	EHTL
	10	11-JUN-19 14:00	15-JUN-19 10:00	3	4	days	EHT
pH							
	1	11-JUN-19 09:40	13-JUN-19 12:00	0.25	50	hours	EHTR-FM
	2	11-JUN-19 11:50	13-JUN-19 12:00	0.25	48	hours	EHTR-FM
	3	11-JUN-19 16:20	13-JUN-19 12:00	0.25	44	hours	EHTR-FM
	4	11-JUN-19 20:00	13-JUN-19 12:00	0.25	40	hours	EHTR-FM
	5	12-JUN-19 13:30	13-JUN-19 12:00	0.25	23	hours	EHTR-FM
	6	12-JUN-19 08:40	13-JUN-19 12:00	0.25	27	hours	EHTR-FM
	7	12-JUN-19 10:20	13-JUN-19 12:00	0.25	26	hours	EHTR-FM
	8	12-JUN-19 09:50	13-JUN-19 12:00	0.25	26	hours	EHTR-FM
	9	11-JUN-19 08:00	13-JUN-19 12:00	0.25	52	hours	EHTR-FM
	10	11-JUN-19 14:00	13-JUN-19 12:00	0.25	46	hours	EHTR-FM
	11	12-JUN-19 08:20	13-JUN-19 12:00	0.25	28	hours	EHTR-FM
Bacteriological Tests							
Total Coliform and E.coli							
	1	11-JUN-19 09:40	13-JUN-19 14:40	30	53	hours	EHTR
	2	11-JUN-19 11:50	13-JUN-19 14:40	30	51	hours	EHTR
	3	11-JUN-19 16:20	13-JUN-19 14:40	30	46	hours	EHTR
	4	11-JUN-19 20:00	13-JUN-19 14:40	30	43	hours	EHTR
	9	11-JUN-19 08:00	13-JUN-19 14:40	30	55	hours	EHTR
Total and E. coli, 1:10 dilution by QT97							
	6	12-JUN-19 08:40	13-JUN-19 17:35	30	33	hours	EHTL
	7	12-JUN-19 10:20	13-JUN-19 17:35	30	31	hours	EHTL
	8	12-JUN-19 09:50	13-JUN-19 17:35	30	32	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2290890 were received on 13-JUN-19 10:10.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2290890-COFC

COC Number: 17 - 747657

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: PDF ☑ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report ☐ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Phone:	204-896-1209	☐ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	865 Waverley	Email 1 or Fax plindell@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Winnipeg, MB	Email 2 soffman@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3	
Invoice To	Same as Report To ☐ YES ☐ NO	**Invoice Distribution**	**Analysis Request**
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax Payables@kgsgroup.com	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#:
Job #:	18-0300-005	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Judy D	Sampler: PJL

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	F/P	ROU4W-Met-DL	TC,Ec-QT57	Metals-Total	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
1	PW19-KGS-01	11-Jun-19	09:40	GW	3		X	X			
2	PW19-KGS-02	11-Jun-19	11:50		3						
3	PW19-KGS-03	11-Jun-19	16:20		3						
4	PW19-KGS-200	11-Jun-19	20:00		3						
5	TH19-KGS-12	12-Jun-19	13:30		3						
6	TH19-KGS-17	11/12-Jun-19	18:25 QR 08:40		3						
7	TH19-KGS-18	12-Jun-19	10:20		3						
8	TH19-KGS-19	12-Jun-19	09:50		3						
9	(Trip)Blank	11-Jun-19	08:00	WTR	3						
10	R3-SW	12-Jun-19	14:00	SW	4				X		
11	Field Blank	12-Jun-19	08:20	WTR	3		X	X			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	TH19-KGS-17 → Bact & Rou Bottles - Jun 11/19 18:25; Metals → Jun 12/19 08:40
Are samples for human consumption/ use? ☐ YES ☑ NO	If Bottle time differs from COC, please use Bottle time.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No	☐
Ice Packs	☐ Ice Cubes ☐	Custody seal intact	Yes ☐	No	☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
6.4	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	June 13/19	11:10	AAL	13/06/19	10:16			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

KGS Group Consultants (Winnipeg)
ATTN: ERIC LEVAY
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 28-SEP-19
Report Date: 30-SEP-19 10:25 (MT)
Version: DRAFT

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L2356084

Project P.O. #: NOT SUBMITTED
Job Reference: 18-0300-05
C of C Numbers:
Legal Site Desc:

DRAFT

Judy Dalmaijer
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2356084-1 SEUTINEL WELL #2							
Sampled By: CLIENT on 27-SEP-19 @ 10:50							
Matrix: WATER							
Total Coliform and E.coli							
Total Coliforms	4		0	MPN/100mL		28-SEP-19	R4850289
Escherichia Coli	0		0	MPN/100mL		28-SEP-19	R4850289
ROU4W Dissolved							
L2356084-2 SEUTINEL WELL #3							
Sampled By: CLIENT on 27-SEP-19 @ 14:50							
Matrix: WATER							
Total Coliform and E.coli							
Total Coliforms	6		0	MPN/100mL		28-SEP-19	R4850289
Escherichia Coli	0		0	MPN/100mL		28-SEP-19	R4850289
ROU4W Dissolved							

DRAFT

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TC,EC-QT51-WP	Water	Total Coliform and E.coli	APHA 9223B QT51

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

DRAFT

Quality Control Report

Workorder: L2356084 Report Date: 30-SEP-19

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: ERIC LEVAY

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R4850289								
WG3176010-2 DUP		**L2356084-1**						
Total Coliforms		4	2	DUP-H	MPN/100mL	2	2	28-SEP-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	28-SEP-19
WG3176010-3 DUP		**L2356084-2**						
Total Coliforms		6	5		MPN/100mL	18	65	28-SEP-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	28-SEP-19
WG3176010-1 MB								
Total Coliforms			0		MPN/100mL		1	28-SEP-19
Escherichia Coli			0		MPN/100mL		1	28-SEP-19

DRAFT

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

DRAFT

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L2356084

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2356084-COFC

COC Number: 17 - 752000

Page of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Turnaround Time (TAT) Requested - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: ☐ PDF ☐ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Eric Levay	Quality Control (QC) Report with Report ☐ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Phone:	204-229-1136	☐ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	865 Waverley St	Email 1 or Fax ~~eric~~, elevay@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Wpg, MB	Email 2	
Postal Code:	R3J	Email 3	
Invoice To	Same as Report To ☒ YES ☐ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☒ NO	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	18-0300-05	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ROU4W-met-D-L	TC,EC-QTS1	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	Sentinel Well #2	27-Sep-19	10:50	Water	3	X	X		
	Sentinel Well #3	27-Sep-19	14:50	Water	3	X	X		

Metals Not Filtered or Preserved

Please provide metals results for dissolved metals?

Thank You

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	
Are samples for human consumption/use? ☐ YES ☐ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐	SIF Observations	Yes ☐	No ☐
Ice Packs ☐ Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated ☐			

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
3.3C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Eric Levay	Sept 27/19	19:35	MPM	28 Sep 19	06:50			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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JUNE 2018 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS Group Consultants (Winnipeg)
ATTN: PAUL LINDELL
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 24-OCT-19
Report Date: 07-NOV-19 10:41 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L2371438

Project P.O. #: NOT SUBMITTED
Job Reference: 18-0300-005
C of C Numbers:
Legal Site Desc:

Comments: Note: Ground Water samples Frac -2 &-3 were too turbid to run for TC,EC-QT51 - had to do 1:10 Dilution and run by TC,EC10-QT97-WP. Frac -4 was still too turbid after 1:10 dilution and had to be run by multiple serial diultions to End Point (TC,EC-QT97-ENDPT)

Hua Wo
Chemistry Laboratory Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-1 TH19-KGS-19							
Sampled By: CLIENT on 23-OCT-19 @ 16:40							
Matrix: GW							
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	620		1.2	mg/L		29-OCT-19	
Alkalinity, Carbonate							
Carbonate (CO3)	3.48		0.60	mg/L		29-OCT-19	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		29-OCT-19	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	514		1.0	mg/L		28-OCT-19	R4888741
Chloride in Water by IC (Low Level)							
Chloride (Cl)	4.32		0.10	mg/L		25-OCT-19	R4886074
Conductivity							
Conductivity	841		1.0	umhos/cm		28-OCT-19	R4888741
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					31-OCT-19	R4891430
Aluminum (Al)-Dissolved	0.0060		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Arsenic (As)-Dissolved	0.00629		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Barium (Ba)-Dissolved	0.0983		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Boron (B)-Dissolved	0.097		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Calcium (Ca)-Dissolved	34.4		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cobalt (Co)-Dissolved	0.00018		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Iron (Fe)-Dissolved	0.018		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Lithium (Li)-Dissolved	0.0331		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Magnesium (Mg)-Dissolved	76.2		0.0050	mg/L	31-OCT-19	01-NOV-19	R4898393
Manganese (Mn)-Dissolved	0.189		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Molybdenum (Mo)-Dissolved	0.00790		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Nickel (Ni)-Dissolved	0.00089		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	31-OCT-19	01-NOV-19	R4898393
Potassium (K)-Dissolved	3.10		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Rubidium (Rb)-Dissolved	0.00167		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Selenium (Se)-Dissolved	0.000101		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silicon (Si)-Dissolved	7.92		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sodium (Na)-Dissolved	43.1		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Strontium (Sr)-Dissolved	0.511		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sulfur (S)-Dissolved	24.7		0.50	mg/L	31-OCT-19	01-NOV-19	R4898393
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Tin (Sn)-Dissolved	0.00092		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	31-OCT-19	01-NOV-19	R4898393
Tungsten (W)-Dissolved	0.0172		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Uranium (U)-Dissolved	0.00186		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-1 TH19-KGS-19							
Sampled By: CLIENT on 23-OCT-19 @ 16:40							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Zinc (Zn)-Dissolved	0.0014		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Zirconium (Zr)-Dissolved	0.00023		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Fluoride in Water by IC							
Fluoride (F)	0.325		0.020	mg/L		25-OCT-19	R4886074
Hardness Calculated							
Hardness (as CaCO3)	400		0.20	mg/L		05-NOV-19	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.136		0.0050	mg/L		25-OCT-19	R4886074
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.140		0.0051	mg/L		29-OCT-19	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0042		0.0010	mg/L		25-OCT-19	R4886074
Sulfate in Water by IC							
Sulfate (SO4)	71.4		0.30	mg/L		25-OCT-19	R4886074
TDS calculated							
TDS (Calculated)	541		5.0	mg/L		05-NOV-19	
Turbidity							
Turbidity	37.7		0.10	NTU		24-OCT-19	R4883808
pH							
pH	8.30		0.10	pH units		28-OCT-19	R4888741
L2371438-2 TH19-KGS-18							
Sampled By: CLIENT on 23-OCT-19 @ 11:45							
Matrix: GW							
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	823		1.2	mg/L		29-OCT-19	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		29-OCT-19	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		29-OCT-19	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	675		1.0	mg/L		28-OCT-19	R4888741
Chloride in Water by IC (Low Level)							
Chloride (Cl)	0.22		0.20	mg/L		25-OCT-19	R4886074
Conductivity							
Conductivity	913		1.0	umhos/cm		28-OCT-19	R4888741
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					31-OCT-19	R4891430
Aluminum (Al)-Dissolved	0.0100		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Arsenic (As)-Dissolved	0.00099		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Barium (Ba)-Dissolved	0.154		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Boron (B)-Dissolved	0.060		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Calcium (Ca)-Dissolved	119		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Cesium (Cs)-Dissolved	0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cobalt (Co)-Dissolved	0.00073		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Copper (Cu)-Dissolved	0.00035		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-2 TH19-KGS-18							
Sampled By: CLIENT on 23-OCT-19 @ 11:45							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Iron (Fe)-Dissolved	1.71		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Lead (Pb)-Dissolved	0.000134		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Lithium (Li)-Dissolved	0.0323		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Magnesium (Mg)-Dissolved	73.3		0.0050	mg/L	31-OCT-19	01-NOV-19	R4898393
Manganese (Mn)-Dissolved	0.0643		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Molybdenum (Mo)-Dissolved	0.000785		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Nickel (Ni)-Dissolved	0.00177		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	31-OCT-19	01-NOV-19	R4898393
Potassium (K)-Dissolved	1.98		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Rubidium (Rb)-Dissolved	0.00147		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Selenium (Se)-Dissolved	0.000095		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silicon (Si)-Dissolved	9.86		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silver (Ag)-Dissolved	0.000022		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sodium (Na)-Dissolved	11.2		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Strontium (Sr)-Dissolved	0.305		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sulfur (S)-Dissolved	<0.50		0.50	mg/L	31-OCT-19	01-NOV-19	R4898393
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Titanium (Ti)-Dissolved	0.00047		0.00030	mg/L	31-OCT-19	01-NOV-19	R4898393
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Uranium (U)-Dissolved	0.000294		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Zinc (Zn)-Dissolved	0.0014		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Fluoride in Water by IC							
Fluoride (F)	0.123		0.040	mg/L		25-OCT-19	R4886074
Hardness Calculated							
Hardness (as CaCO3)	600		0.20	mg/L		05-NOV-19	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.011		0.010	mg/L		25-OCT-19	R4886074
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.011		0.010	mg/L		29-OCT-19	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0020	DLM	0.0020	mg/L		25-OCT-19	R4886074
Sulfate in Water by IC							
Sulfate (SO4)	<0.60	DLM	0.60	mg/L		25-OCT-19	R4886074
TDS calculated							
TDS (Calculated)	611		5.0	mg/L		05-NOV-19	
Turbidity							
Turbidity	2370		0.10	NTU		24-OCT-19	R4883808
pH							
pH	7.86		0.10	pH units		28-OCT-19	R4888741
L2371438-3 TH19-KGS-17							
Sampled By: CLIENT on 23-OCT-19 @ 12:40							
Matrix: GW							
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	446		1.2	mg/L		29-OCT-19	
Alkalinity, Carbonate							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-3 TH19-KGS-17							
Sampled By: CLIENT on 23-OCT-19 @ 12:40							
Matrix: GW							
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		29-OCT-19	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		29-OCT-19	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	365		1.0	mg/L		28-OCT-19	R4888741
Chloride in Water by IC (Low Level)							
Chloride (Cl)	0.92		0.10	mg/L		25-OCT-19	R4886074
Conductivity							
Conductivity	591		1.0	umhos/cm		28-OCT-19	R4888741
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					31-OCT-19	R4891430
Aluminum (Al)-Dissolved	0.0015		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Arsenic (As)-Dissolved	0.00137		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Barium (Ba)-Dissolved	0.0428		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Boron (B)-Dissolved	0.082		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Calcium (Ca)-Dissolved	53.9		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cobalt (Co)-Dissolved	0.00011		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Copper (Cu)-Dissolved	0.00033		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Iron (Fe)-Dissolved	0.159		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Lithium (Li)-Dissolved	0.0174		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Magnesium (Mg)-Dissolved	52.2		0.0050	mg/L	31-OCT-19	01-NOV-19	R4898393
Manganese (Mn)-Dissolved	0.0405		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Molybdenum (Mo)-Dissolved	0.000591		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	31-OCT-19	01-NOV-19	R4898393
Potassium (K)-Dissolved	3.18		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Rubidium (Rb)-Dissolved	0.00192		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silicon (Si)-Dissolved	4.35		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sodium (Na)-Dissolved	9.11		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Strontium (Sr)-Dissolved	0.166		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sulfur (S)-Dissolved	13.6		0.50	mg/L	31-OCT-19	01-NOV-19	R4898393
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	31-OCT-19	01-NOV-19	R4898393
Tungsten (W)-Dissolved	0.00012		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Uranium (U)-Dissolved	0.000137		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Fluoride in Water by IC							
Fluoride (F)	0.237		0.020	mg/L		25-OCT-19	R4886074

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-3 TH19-KGS-17							
Sampled By: CLIENT on 23-OCT-19 @ 12:40							
Matrix: GW							
Hardness Calculated							
Hardness (as CaCO3)	350		0.20	mg/L		05-NOV-19	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0067		0.0050	mg/L		25-OCT-19	R4886074
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0080		0.0051	mg/L		29-OCT-19	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0013		0.0010	mg/L		25-OCT-19	R4886074
Sulfate in Water by IC							
Sulfate (SO4)	40.6		0.30	mg/L		25-OCT-19	R4886074
TDS calculated							
TDS (Calculated)	379		5.0	mg/L		05-NOV-19	
Turbidity							
Turbidity	2000		0.10	NTU		24-OCT-19	R4883808
pH							
pH	8.23		0.10	pH units		28-OCT-19	R4888741
L2371438-4 TH19-KGS-12							
Sampled By: CLIENT on 23-OCT-19 @ 16:15							
Matrix: GW							
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	567		1.2	mg/L		29-OCT-19	
Alkalinity, Carbonate							
Carbonate (CO3)	6.36		0.60	mg/L		29-OCT-19	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		29-OCT-19	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	475		1.0	mg/L		28-OCT-19	R4888741
Chloride in Water by IC (Low Level)							
Chloride (Cl)	5.27		0.10	mg/L		25-OCT-19	R4886074
Conductivity							
Conductivity	715		1.0	umhos/cm		28-OCT-19	R4888741
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					31-OCT-19	R4891430
Aluminum (Al)-Dissolved	0.0057		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Antimony (Sb)-Dissolved	0.00063		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Arsenic (As)-Dissolved	0.00109		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Barium (Ba)-Dissolved	0.0919		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Boron (B)-Dissolved	0.109		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Calcium (Ca)-Dissolved	37.5		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Chromium (Cr)-Dissolved	0.00017		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Cobalt (Co)-Dissolved	0.00071		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Copper (Cu)-Dissolved	0.00058		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Iron (Fe)-Dissolved	0.422		0.010	mg/L	31-OCT-19	01-NOV-19	R4898393
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Lithium (Li)-Dissolved	0.0327		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Magnesium (Mg)-Dissolved	57.9		0.0050	mg/L	31-OCT-19	01-NOV-19	R4898393
Manganese (Mn)-Dissolved	0.0686		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2371438-4 TH19-KGS-12							
Sampled By: CLIENT on 23-OCT-19 @ 16:15							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Molybdenum (Mo)-Dissolved	0.0470		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Nickel (Ni)-Dissolved	0.00573		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	31-OCT-19	01-NOV-19	R4898393
Potassium (K)-Dissolved	4.57		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Rubidium (Rb)-Dissolved	0.00213		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Selenium (Se)-Dissolved	0.000098		0.000050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silicon (Si)-Dissolved	5.22		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sodium (Na)-Dissolved	51.2		0.050	mg/L	31-OCT-19	01-NOV-19	R4898393
Strontium (Sr)-Dissolved	0.222		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Sulfur (S)-Dissolved	20.8		0.50	mg/L	31-OCT-19	01-NOV-19	R4898393
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Tin (Sn)-Dissolved	0.00019		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	31-OCT-19	01-NOV-19	R4898393
Tungsten (W)-Dissolved	0.00138		0.00010	mg/L	31-OCT-19	01-NOV-19	R4898393
Uranium (U)-Dissolved	0.000043		0.000010	mg/L	31-OCT-19	01-NOV-19	R4898393
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	31-OCT-19	01-NOV-19	R4898393
Zinc (Zn)-Dissolved	0.0013		0.0010	mg/L	31-OCT-19	01-NOV-19	R4898393
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	31-OCT-19	01-NOV-19	R4898393
Fluoride in Water by IC							
Fluoride (F)	0.356		0.020	mg/L		25-OCT-19	R4886074
Hardness Calculated							
Hardness (as CaCO3)	332		0.20	mg/L		05-NOV-19	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0152		0.0050	mg/L		25-OCT-19	R4886074
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0183		0.0051	mg/L		29-OCT-19	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0031		0.0010	mg/L		25-OCT-19	R4886074
Sulfate in Water by IC							
Sulfate (SO4)	65.9		0.30	mg/L		25-OCT-19	R4886074
TDS calculated							
TDS (Calculated)	508		5.0	mg/L		05-NOV-19	
Turbidity							
Turbidity	>4000		0.10	NTU		25-OCT-19	R4886035
pH							
pH	8.37		0.10	pH units		28-OCT-19	R4888741

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-WP	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020B (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4888741								
WG3204356-5 DUP		**L2371438-1**						
Alkalinity, Total (as CaCO3)		514	502		mg/L	2.3	20	28-OCT-19
WG3204356-4 LCS								
Alkalinity, Total (as CaCO3)			113.1		%		85-115	28-OCT-19
WG3204356-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	28-OCT-19
CL-L-IC-N-WP	**Water**							
Batch R4886074								
WG3201699-2 LCS								
Chloride (Cl)			98.3		%		90-110	25-OCT-19
WG3201699-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	25-OCT-19
EC-WP	**Water**							
Batch R4888741								
WG3204356-5 DUP		**L2371438-1**						
Conductivity		841	842		umhos/cm	0.1	10	28-OCT-19
WG3204356-3 LCS								
Conductivity			97.6		%		90-110	28-OCT-19
WG3204356-1 MB								
Conductivity			<1.0		umhos/cm		1	28-OCT-19
F-IC-N-WP	**Water**							
Batch R4886074								
WG3201699-2 LCS								
Fluoride (F)			98.1		%		90-110	25-OCT-19
WG3201699-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	25-OCT-19
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207155-2 LCS								
Aluminum (Al)-Dissolved			99.2		%		80-120	01-NOV-19
Antimony (Sb)-Dissolved			97.3		%		80-120	01-NOV-19
Arsenic (As)-Dissolved			96.5		%		80-120	01-NOV-19
Barium (Ba)-Dissolved			98.2		%		80-120	01-NOV-19
Beryllium (Be)-Dissolved			97.5		%		80-120	01-NOV-19
Bismuth (Bi)-Dissolved			96.8		%		80-120	01-NOV-19
Boron (B)-Dissolved			93.5		%		80-120	01-NOV-19
Cadmium (Cd)-Dissolved			95.0		%		80-120	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207155-2 LCS								
Calcium (Ca)-Dissolved			97.7		%		80-120	01-NOV-19
Cesium (Cs)-Dissolved			101.4		%		80-120	01-NOV-19
Chromium (Cr)-Dissolved			98.4		%		80-120	01-NOV-19
Cobalt (Co)-Dissolved			97.7		%		80-120	01-NOV-19
Copper (Cu)-Dissolved			97.1		%		80-120	01-NOV-19
Iron (Fe)-Dissolved			90.3		%		80-120	01-NOV-19
Lead (Pb)-Dissolved			97.1		%		80-120	01-NOV-19
Lithium (Li)-Dissolved			100.3		%		80-120	01-NOV-19
Magnesium (Mg)-Dissolved			98.4		%		80-120	01-NOV-19
Manganese (Mn)-Dissolved			98.4		%		80-120	01-NOV-19
Molybdenum (Mo)-Dissolved			99.3		%		80-120	01-NOV-19
Nickel (Ni)-Dissolved			95.1		%		80-120	01-NOV-19
Phosphorus (P)-Dissolved			103.6		%		80-120	01-NOV-19
Potassium (K)-Dissolved			93.1		%		80-120	01-NOV-19
Rubidium (Rb)-Dissolved			101.7		%		80-120	01-NOV-19
Selenium (Se)-Dissolved			96.7		%		80-120	01-NOV-19
Silicon (Si)-Dissolved			99.0		%		80-120	01-NOV-19
Silver (Ag)-Dissolved			97.7		%		80-120	01-NOV-19
Sodium (Na)-Dissolved			102.4		%		80-120	01-NOV-19
Strontium (Sr)-Dissolved			102.0		%		80-120	01-NOV-19
Sulfur (S)-Dissolved			100.6		%		80-120	01-NOV-19
Tellurium (Te)-Dissolved			97.3		%		80-120	01-NOV-19
Thallium (Tl)-Dissolved			96.3		%		80-120	01-NOV-19
Thorium (Th)-Dissolved			95.2		%		80-120	01-NOV-19
Tin (Sn)-Dissolved			98.7		%		80-120	01-NOV-19
Titanium (Ti)-Dissolved			95.9		%		80-120	01-NOV-19
Tungsten (W)-Dissolved			98.4		%		80-120	01-NOV-19
Uranium (U)-Dissolved			96.8		%		80-120	01-NOV-19
Vanadium (V)-Dissolved			98.0		%		80-120	01-NOV-19
Zinc (Zn)-Dissolved			100.1		%		80-120	01-NOV-19
Zirconium (Zr)-Dissolved			94.7		%		80-120	01-NOV-19
WG3207155-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207155-1 MB								
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-NOV-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	01-NOV-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-NOV-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-NOV-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	01-NOV-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-NOV-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-NOV-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207155-1 MB								
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
NO2-L-IC-N-WP	**Water**							
Batch R4886074								
WG3201699-2 LCS								
Nitrite (as N)			100.0		%		90-110	25-OCT-19
WG3201699-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-OCT-19
NO3-L-IC-N-WP	**Water**							
Batch R4886074								
WG3201699-2 LCS								
Nitrate (as N)			98.4		%		90-110	25-OCT-19
WG3201699-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-OCT-19
PH-WP	**Water**							
Batch R4888741								
WG3204356-5 DUP		**L2371438-1**						
pH		8.30	8.29	J	pH units	0.01	0.2	28-OCT-19
WG3204356-2 LCS								
pH			7.37		pH units		7.3-7.5	28-OCT-19
SO4-IC-N-WP	**Water**							
Batch R4886074								
WG3201699-2 LCS								
Sulfate (SO4)			99.99		%		90-110	25-OCT-19
WG3201699-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	25-OCT-19
TURBIDITY-WP	**Water**							
Batch R4883808								
WG3201155-2 LCS								
Turbidity			102.5		%		85-115	24-OCT-19
WG3201155-1 MB								
Turbidity			<0.10		NTU		0.1	24-OCT-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R4886035								
WG3201869-2 LCS								
Turbidity			104.5		%		85-115	25-OCT-19
WG3201869-1 MB								
Turbidity			<0.10		NTU		0.1	25-OCT-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	23-OCT-19 16:40	28-OCT-19 12:00	0.25	115	hours	EHTR-FM
	2	23-OCT-19 11:45	28-OCT-19 12:00	0.25	120	hours	EHTR-FM
	3	23-OCT-19 12:40	28-OCT-19 12:00	0.25	119	hours	EHTR-FM
	4	23-OCT-19 16:15	28-OCT-19 12:00	0.25	116	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2371438 were received on 24-OCT-19 14:55.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2371438-COFC

COC Number: 17 - 781639

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Turnaround Time (TAT) Requested - Please indicate below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: PDF, EXCEL, EDD (DIGITAL)	Regular [R]: Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report: YES / NO	PRIORITY (Business Days): 4 day [P4-20%]; 3 day [P3-25%]; 2 day [P2-50%]
Phone:	204-896-1209	Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%]; Same Day, Weekend or Statutory holiday [E2 -200%] (Laboratory opening fees may apply)]
	Company address below will appear on the final report	Select Distribution: EMAIL / MAIL / FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	865 Waverley st.	Email 1 or Fax: plindell@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Wpg / MB	Email 2: sofman@kgsgroup.com	
Postal Code:	R4T 0A6	Email 3: jmann@kgsgroup.com	
Invoice To	Same as Report To: YES / NO	**Invoice Distribution**	
	Copy of Invoice with Report: YES / NO	Select Invoice Distribution: EMAIL / MAIL / FAX	
Company:		Email 1 or Fax: payables@kgsgroup.com	
Contact:	payables@kgsgroup.com	Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#:
Job #:	18-0300-005	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Jodi D	Sampler: PJL/NB

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Analysis Request: Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below: RQU4W-Met-VL	TC,EC-QT57	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	TH19-KGS-19	23-Oct-19	16:40	GW	3	X	X		
	TH19-KGS-18	↓	11:45	↓	3	X	X		
	TH19-KGS-17		12:40		3	X	X		
	TH19-KGS-12		16:15		4	X	X		

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)	SAMPLE CONDITION AS RECEIVED (lab use only)
Are samples taken from a Regulated DW System? YES / NO (X)	please use times on this C.O.C. if times on bottles differ.	Frozen; SIF Observations Yes / No; Ice Packs; Ice Cubes; Custody seal intact Yes / No; Cooling Initiated
Are samples for human consumption/ use? YES / NO (X)		INITIAL COOLER TEMPERATURES °C: 3.2 — FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: AK	Date: 10/24	Time: 2:55	Received by:	Date: OCT 24 2019	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-1
Matrix: GW

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	443		mg/L			29-OCT-19
Carbonate (CO3)	<0.60		mg/L			29-OCT-19
Hydroxide (OH)	<0.34		mg/L			29-OCT-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-OCT-19
pH						
pH	8.18		pH units			28-OCT-19
Turbidity						
*Turbidity	78.3		NTU			25-OCT-19
TDS calculated						
TDS (Calculated)	467		mg/L		500	05-NOV-19
Sulfate in Water by IC						
Sulfate (SO4)	78.6		mg/L		500	25-OCT-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		25-OCT-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		25-OCT-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	420		mg/L		500	05-NOV-19
Fluoride in Water by IC						
Fluoride (F)	0.305		mg/L	1.5		25-OCT-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					31-OCT-19
Aluminum (Al)-Dissolved	0.206		mg/L		0.1	01-NOV-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Dissolved	0.00063		mg/L	0.01		01-NOV-19
Barium (Ba)-Dissolved	0.0290		mg/L	1		01-NOV-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-NOV-19
Boron (B)-Dissolved	0.142		mg/L	5		01-NOV-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-NOV-19
Calcium (Ca)-Dissolved	66.6		mg/L			01-NOV-19
Cesium (Cs)-Dissolved	0.000054		mg/L			01-NOV-19
Chromium (Cr)-Dissolved	0.00060		mg/L	0.05		01-NOV-19
Cobalt (Co)-Dissolved	0.00049		mg/L			01-NOV-19
Copper (Cu)-Dissolved	0.00186		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Dissolved	0.390		mg/L		0.3	01-NOV-19
Lead (Pb)-Dissolved	0.00122		mg/L	0.005		01-NOV-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0242		mg/L			01-NOV-19
Magnesium (Mg)-Dissolved	61.5		mg/L			01-NOV-19
Manganese (Mn)-Dissolved	0.0226		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Dissolved	0.000894		mg/L			01-NOV-19
Nickel (Ni)-Dissolved	0.00141		mg/L			01-NOV-19
Phosphorus (P)-Dissolved	0.037		mg/L			01-NOV-19
Potassium (K)-Dissolved	4.93		mg/L			01-NOV-19
Rubidium (Rb)-Dissolved	0.00202		mg/L			01-NOV-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-NOV-19
Silicon (Si)-Dissolved	6.14		mg/L			01-NOV-19
Silver (Ag)-Dissolved	<0.000010		mg/L			01-NOV-19
Sodium (Na)-Dissolved	28.0		mg/L		200	01-NOV-19
Strontium (Sr)-Dissolved	0.222		mg/L	7		01-NOV-19
Sulfur (S)-Dissolved	25.9		mg/L			01-NOV-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Dissolved	0.000014		mg/L			01-NOV-19
Thorium (Th)-Dissolved	0.00021		mg/L			01-NOV-19
Tin (Sn)-Dissolved	<0.00010		mg/L			01-NOV-19
Titanium (Ti)-Dissolved	0.0130		mg/L			01-NOV-19
Tungsten (W)-Dissolved	<0.00010		mg/L			01-NOV-19
Uranium (U)-Dissolved	0.00211		mg/L	0.02		01-NOV-19
Vanadium (V)-Dissolved	0.00056		mg/L			01-NOV-19
Zinc (Zn)-Dissolved	0.0042		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Dissolved	0.00026		mg/L			01-NOV-19
Conductivity						
Conductivity	694		umhos/cm			28-OCT-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.35		mg/L		250	25-OCT-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	363		mg/L			28-OCT-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		25-OCT-19
Escherichia Coli	0		MPN/100mL	0		25-OCT-19

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-01
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	446		mg/L			29-OCT-19
Carbonate (CO3)	<0.60		mg/L			29-OCT-19
Hydroxide (OH)	<0.34		mg/L			29-OCT-19
*Nitrate and Nitrite as N	0.0082		mg/L	10		29-OCT-19
pH						
pH	8.22		pH units			28-OCT-19
Turbidity						
*Turbidity	1.33		NTU			25-OCT-19
TDS calculated						
TDS (Calculated)	471		mg/L		500	05-NOV-19
Sulfate in Water by IC						
Sulfate (SO4)	93.1		mg/L		500	25-OCT-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		25-OCT-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0082		mg/L	10		25-OCT-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	371		mg/L		500	05-NOV-19
Fluoride in Water by IC						
Fluoride (F)	0.339		mg/L	1.5		25-OCT-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					31-OCT-19
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	01-NOV-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Dissolved	0.00125		mg/L	0.01		01-NOV-19
Barium (Ba)-Dissolved	0.0258		mg/L	1		01-NOV-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-NOV-19
Boron (B)-Dissolved	0.137		mg/L	5		01-NOV-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-NOV-19
Calcium (Ca)-Dissolved	57.2		mg/L			01-NOV-19
Cesium (Cs)-Dissolved	0.000016		mg/L			01-NOV-19
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		01-NOV-19
Cobalt (Co)-Dissolved	0.00015		mg/L			01-NOV-19
Copper (Cu)-Dissolved	0.00079		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Dissolved	0.116		mg/L		0.3	01-NOV-19
Lead (Pb)-Dissolved	0.000070		mg/L	0.005		01-NOV-19

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ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0245		mg/L			01-NOV-19
Magnesium (Mg)-Dissolved	55.5		mg/L			01-NOV-19
Manganese (Mn)-Dissolved	0.00436		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Dissolved	0.000343		mg/L			01-NOV-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			01-NOV-19
Phosphorus (P)-Dissolved	<0.030		mg/L			01-NOV-19
Potassium (K)-Dissolved	5.06		mg/L			01-NOV-19
Rubidium (Rb)-Dissolved	0.00281		mg/L			01-NOV-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-NOV-19
Silicon (Si)-Dissolved	5.50		mg/L			01-NOV-19
Silver (Ag)-Dissolved	<0.000010		mg/L			01-NOV-19
Sodium (Na)-Dissolved	31.9		mg/L		200	01-NOV-19
Strontium (Sr)-Dissolved	0.207		mg/L	7		01-NOV-19
Sulfur (S)-Dissolved	30.7		mg/L			01-NOV-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-NOV-19
Thorium (Th)-Dissolved	<0.00010		mg/L			01-NOV-19
Tin (Sn)-Dissolved	<0.00010		mg/L			01-NOV-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-NOV-19
Tungsten (W)-Dissolved	<0.00010		mg/L			01-NOV-19
Uranium (U)-Dissolved	0.000727		mg/L	0.02		01-NOV-19
Vanadium (V)-Dissolved	<0.00050		mg/L			01-NOV-19
Zinc (Zn)-Dissolved	0.0019		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Dissolved	<0.00020		mg/L			01-NOV-19
Conductivity						
Conductivity	729		umhos/cm			28-OCT-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	8.52		mg/L		250	25-OCT-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	366		mg/L			28-OCT-19
Total Coliform and E.coli						
Total Coliforms	3		MPN/100mL	0		25-OCT-19
Escherichia Coli	0		MPN/100mL	0		25-OCT-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-02
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	403		mg/L			29-OCT-19
Carbonate (CO3)	<0.60		mg/L			29-OCT-19
Hydroxide (OH)	<0.34		mg/L			29-OCT-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-OCT-19
pH						
pH	8.11		pH units			28-OCT-19
Turbidity						
*Turbidity	1.06		NTU			25-OCT-19
TDS calculated						
TDS (Calculated)	344		mg/L		500	05-NOV-19
Sulfate in Water by IC						
Sulfate (SO4)	31.8		mg/L		500	25-OCT-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		25-OCT-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		25-OCT-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	327		mg/L		500	05-NOV-19
Fluoride in Water by IC						
Fluoride (F)	0.181		mg/L	1.5		25-OCT-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					31-OCT-19
Aluminum (Al)-Dissolved	0.0090		mg/L		0.1	01-NOV-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Dissolved	0.00110		mg/L	0.01		01-NOV-19
Barium (Ba)-Dissolved	0.0619		mg/L	1		01-NOV-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-NOV-19
Boron (B)-Dissolved	0.068		mg/L	5		01-NOV-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-NOV-19
Calcium (Ca)-Dissolved	68.3		mg/L			01-NOV-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			01-NOV-19
Chromium (Cr)-Dissolved	0.00010		mg/L	0.05		01-NOV-19
Cobalt (Co)-Dissolved	0.00198		mg/L			01-NOV-19
Copper (Cu)-Dissolved	0.00041		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Dissolved	1.25		mg/L		0.3	01-NOV-19
Lead (Pb)-Dissolved	0.000065		mg/L	0.005		01-NOV-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0124		mg/L			01-NOV-19
Magnesium (Mg)-Dissolved	38.0		mg/L			01-NOV-19
Manganese (Mn)-Dissolved	0.276		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Dissolved	0.000440		mg/L			01-NOV-19
Nickel (Ni)-Dissolved	0.00505		mg/L			01-NOV-19
Phosphorus (P)-Dissolved	<0.030		mg/L			01-NOV-19
Potassium (K)-Dissolved	2.51		mg/L			01-NOV-19
Rubidium (Rb)-Dissolved	0.00179		mg/L			01-NOV-19
Selenium (Se)-Dissolved	0.000067		mg/L	0.05		01-NOV-19
Silicon (Si)-Dissolved	5.22		mg/L			01-NOV-19
Silver (Ag)-Dissolved	0.000011		mg/L			01-NOV-19
Sodium (Na)-Dissolved	3.76		mg/L		200	01-NOV-19
Strontium (Sr)-Dissolved	0.123		mg/L	7		01-NOV-19
Sulfur (S)-Dissolved	10.5		mg/L			01-NOV-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-NOV-19
Thorium (Th)-Dissolved	<0.00010		mg/L			01-NOV-19
Tin (Sn)-Dissolved	0.00075		mg/L			01-NOV-19
Titanium (Ti)-Dissolved	0.00035		mg/L			01-NOV-19
Tungsten (W)-Dissolved	<0.00010		mg/L			01-NOV-19
Uranium (U)-Dissolved	0.00221		mg/L	0.02		01-NOV-19
Vanadium (V)-Dissolved	0.00117		mg/L			01-NOV-19
Zinc (Zn)-Dissolved	0.0013		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Dissolved	0.00060		mg/L			01-NOV-19
Conductivity						
Conductivity	550		umhos/cm			28-OCT-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.91		mg/L		250	25-OCT-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	331		mg/L			28-OCT-19
Total Coliform and E.coli						
Total Coliforms	130		MPN/100mL	0		25-OCT-19
Escherichia Coli	0		MPN/100mL	0		25-OCT-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW19-KGS-03
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW-200
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	436		mg/L			29-OCT-19
Carbonate (CO3)	<0.60		mg/L			29-OCT-19
Hydroxide (OH)	<0.34		mg/L			29-OCT-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-OCT-19
pH						
pH	8.21		pH units			28-OCT-19
Turbidity						
*Turbidity	81.2		NTU			25-OCT-19
TDS calculated						
TDS (Calculated)	469		mg/L		500	05-NOV-19
Sulfate in Water by IC						
Sulfate (SO4)	79.3		mg/L		500	25-OCT-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		25-OCT-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		25-OCT-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	431		mg/L		500	05-NOV-19
Fluoride in Water by IC						
Fluoride (F)	0.302		mg/L	1.5		25-OCT-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					31-OCT-19
Aluminum (Al)-Dissolved	0.212		mg/L		0.1	01-NOV-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Dissolved	0.00064		mg/L	0.01		01-NOV-19
Barium (Ba)-Dissolved	0.0295		mg/L	1		01-NOV-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-NOV-19
Boron (B)-Dissolved	0.144		mg/L	5		01-NOV-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-NOV-19
Calcium (Ca)-Dissolved	68.0		mg/L			01-NOV-19
Cesium (Cs)-Dissolved	0.000055		mg/L			01-NOV-19
Chromium (Cr)-Dissolved	0.00063		mg/L	0.05		01-NOV-19
Cobalt (Co)-Dissolved	0.00051		mg/L			01-NOV-19
Copper (Cu)-Dissolved	0.00153		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Dissolved	0.412		mg/L		0.3	01-NOV-19
Lead (Pb)-Dissolved	0.00118		mg/L	0.005		01-NOV-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW-200
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0243		mg/L			01-NOV-19
Magnesium (Mg)-Dissolved	63.4		mg/L			01-NOV-19
Manganese (Mn)-Dissolved	0.0228		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Dissolved	0.000916		mg/L			01-NOV-19
Nickel (Ni)-Dissolved	0.00143		mg/L			01-NOV-19
Phosphorus (P)-Dissolved	<0.030		mg/L			01-NOV-19
Potassium (K)-Dissolved	5.05		mg/L			01-NOV-19
Rubidium (Rb)-Dissolved	0.00210		mg/L			01-NOV-19
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		01-NOV-19
Silicon (Si)-Dissolved	6.14		mg/L			01-NOV-19
Silver (Ag)-Dissolved	<0.000010		mg/L			01-NOV-19
Sodium (Na)-Dissolved	29.0		mg/L		200	01-NOV-19
Strontium (Sr)-Dissolved	0.228		mg/L	7		01-NOV-19
Sulfur (S)-Dissolved	25.9		mg/L			01-NOV-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Dissolved	0.000014		mg/L			01-NOV-19
Thorium (Th)-Dissolved	0.00023		mg/L			01-NOV-19
Tin (Sn)-Dissolved	<0.00010		mg/L			01-NOV-19
Titanium (Ti)-Dissolved	0.0128		mg/L			01-NOV-19
Tungsten (W)-Dissolved	<0.00010		mg/L			01-NOV-19
Uranium (U)-Dissolved	0.00212		mg/L	0.02		01-NOV-19
Vanadium (V)-Dissolved	0.00055		mg/L			01-NOV-19
Zinc (Zn)-Dissolved	0.0026		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Dissolved	0.00028		mg/L			01-NOV-19
Conductivity						
Conductivity	697		umhos/cm			28-OCT-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.87		mg/L		250	25-OCT-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	357		mg/L			28-OCT-19
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		25-OCT-19
Escherichia Coli	0		MPN/100mL	0		25-OCT-19

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: PW-200
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	131		mg/L			29-OCT-19
Carbonate (CO3)	<0.60		mg/L			29-OCT-19
Hydroxide (OH)	<0.34		mg/L			29-OCT-19
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-OCT-19
pH						
pH	8.02		pH units			28-OCT-19
Turbidity						
*Turbidity	1.20		NTU			25-OCT-19
TDS calculated						
TDS (Calculated)	103		mg/L		500	05-NOV-19
Sulfate in Water by IC						
Sulfate (SO4)	1.52		mg/L		500	25-OCT-19
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		25-OCT-19
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		25-OCT-19
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	106		mg/L		500	05-NOV-19
Fluoride in Water by IC						
Fluoride (F)	0.044		mg/L	1.5		25-OCT-19
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					31-OCT-19
Aluminum (Al)-Dissolved	0.0048		mg/L		0.1	01-NOV-19
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Dissolved	0.00064		mg/L	0.01		01-NOV-19
Barium (Ba)-Dissolved	0.00618		mg/L	1		01-NOV-19
Beryllium (Be)-Dissolved	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Dissolved	<0.000050		mg/L			01-NOV-19
Boron (B)-Dissolved	0.012		mg/L	5		01-NOV-19
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		01-NOV-19
Calcium (Ca)-Dissolved	20.8		mg/L			01-NOV-19
Cesium (Cs)-Dissolved	<0.000010		mg/L			01-NOV-19
Chromium (Cr)-Dissolved	0.00011		mg/L	0.05		01-NOV-19
Cobalt (Co)-Dissolved	<0.00010		mg/L			01-NOV-19
Copper (Cu)-Dissolved	0.00070		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Dissolved	0.014		mg/L		0.3	01-NOV-19
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		01-NOV-19

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ATTN: PAUL LINDELL

Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0021		mg/L			01-NOV-19
Magnesium (Mg)-Dissolved	13.1		mg/L			01-NOV-19
Manganese (Mn)-Dissolved	0.00141		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Dissolved	0.000081		mg/L			01-NOV-19
Nickel (Ni)-Dissolved	<0.00050		mg/L			01-NOV-19
Phosphorus (P)-Dissolved	<0.030		mg/L			01-NOV-19
Potassium (K)-Dissolved	2.02		mg/L			01-NOV-19
Rubidium (Rb)-Dissolved	0.00356		mg/L			01-NOV-19
Selenium (Se)-Dissolved	0.000100		mg/L	0.05		01-NOV-19
Silicon (Si)-Dissolved	4.04		mg/L			01-NOV-19
Silver (Ag)-Dissolved	<0.000010		mg/L			01-NOV-19
Sodium (Na)-Dissolved	0.916		mg/L		200	01-NOV-19
Strontium (Sr)-Dissolved	0.0223		mg/L	7		01-NOV-19
Sulfur (S)-Dissolved	<0.50		mg/L			01-NOV-19
Tellurium (Te)-Dissolved	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Dissolved	<0.000010		mg/L			01-NOV-19
Thorium (Th)-Dissolved	<0.00010		mg/L			01-NOV-19
Tin (Sn)-Dissolved	<0.00010		mg/L			01-NOV-19
Titanium (Ti)-Dissolved	<0.00030		mg/L			01-NOV-19
Tungsten (W)-Dissolved	<0.00010		mg/L			01-NOV-19
Uranium (U)-Dissolved	0.000057		mg/L	0.02		01-NOV-19
Vanadium (V)-Dissolved	<0.00050		mg/L			01-NOV-19
Zinc (Zn)-Dissolved	0.0016		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Dissolved	<0.00020		mg/L			01-NOV-19
Conductivity						
Conductivity	176		umhos/cm			28-OCT-19
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.66		mg/L		250	25-OCT-19
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	107		mg/L			28-OCT-19
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	0.0342		mg/L		0.1	01-NOV-19
Antimony (Sb)-Total	<0.00010		mg/L	0.006		01-NOV-19
Arsenic (As)-Total	0.00068		mg/L	0.01		01-NOV-19
Barium (Ba)-Total	0.00697		mg/L	1		01-NOV-19
Beryllium (Be)-Total	<0.00010		mg/L			01-NOV-19
Bismuth (Bi)-Total	<0.000050		mg/L			01-NOV-19

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Date: 05-NOV-19
PO No.:
WO No.: L2371920
Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Metals in Water by CRC ICPMS						
Boron (B)-Total	<0.010		mg/L	5		01-NOV-19
Cadmium (Cd)-Total	0.0000128		mg/L	0.005		01-NOV-19
Calcium (Ca)-Total	21.5		mg/L			01-NOV-19
Cesium (Cs)-Total	<0.000010		mg/L			01-NOV-19
Chromium (Cr)-Total	0.00016		mg/L	0.05		01-NOV-19
Cobalt (Co)-Total	<0.00010		mg/L			01-NOV-19
Copper (Cu)-Total	<0.00050		mg/L	2.0	1.0	01-NOV-19
Iron (Fe)-Total	0.035		mg/L		0.3	01-NOV-19
Lead (Pb)-Total	<0.000050		mg/L	0.005		01-NOV-19
Lithium (Li)-Total	0.0023		mg/L			01-NOV-19
Magnesium (Mg)-Total	13.5		mg/L			01-NOV-19
Manganese (Mn)-Total	0.00204		mg/L	0.12	0.02	01-NOV-19
Molybdenum (Mo)-Total	0.000085		mg/L			01-NOV-19
Nickel (Ni)-Total	<0.00050		mg/L			01-NOV-19
Potassium (K)-Total	2.00		mg/L			01-NOV-19
Phosphorus (P)-Total	<0.030		mg/L			01-NOV-19
Rubidium (Rb)-Total	0.00355		mg/L			01-NOV-19
Selenium (Se)-Total	0.000108		mg/L	0.05		01-NOV-19
Silicon (Si)-Total	4.17		mg/L			01-NOV-19
Silver (Ag)-Total	<0.000010		mg/L			01-NOV-19
Sodium (Na)-Total	1.03		mg/L		200	01-NOV-19
Strontium (Sr)-Total	0.0233		mg/L	7		01-NOV-19
Sulfur (S)-Total	1.27		mg/L			01-NOV-19
Tellurium (Te)-Total	<0.00020		mg/L			01-NOV-19
Thallium (Tl)-Total	<0.000010		mg/L			01-NOV-19
Thorium (Th)-Total	<0.00010		mg/L			01-NOV-19
Tin (Sn)-Total	<0.00010		mg/L			01-NOV-19
Titanium (Ti)-Total	0.00117		mg/L			01-NOV-19
Tungsten (W)-Total	<0.00010		mg/L			01-NOV-19
Uranium (U)-Total	0.000061		mg/L	0.02		01-NOV-19
Vanadium (V)-Total	<0.00050		mg/L			01-NOV-19
Zinc (Zn)-Total	<0.0030		mg/L		5.0	01-NOV-19
Zirconium (Zr)-Total	<0.00020		mg/L			01-NOV-19
Total Coliform and E.coli						
Total Coliforms	>200		MPN/100mL	0		25-OCT-19
Escherichia Coli	1		MPN/100mL	0		25-OCT-19

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Project Ref: 18-0300-005
Sample ID: R3-SW
Sampled By: PJL/NB
Date Collected: 24-OCT-19
Lab Sample ID: L2371920-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.
Manganese*	Criteria limit is 0.12 mg/L. Possible neurological effects in infants.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2371920 Report Date: 05-NOV-19

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4888741								
WG3204356-19 LCS								
Alkalinity, Total (as CaCO3)			114.1		%		85-115	28-OCT-19
WG3204356-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	28-OCT-19
CL-L-IC-N-WP	**Water**							
Batch R4885628								
WG3202025-2 LCS								
Chloride (Cl)			99.1		%		90-110	25-OCT-19
WG3202025-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	25-OCT-19
EC-WP	**Water**							
Batch R4888741								
WG3204356-18 LCS								
Conductivity			98.0		%		90-110	28-OCT-19
WG3204356-16 MB								
Conductivity			<1.0		umhos/cm		1	28-OCT-19
F-IC-N-WP	**Water**							
Batch R4885628								
WG3202025-2 LCS								
Fluoride (F)			94.1		%		90-110	25-OCT-19
WG3202025-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	25-OCT-19
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207162-2 LCS								
Aluminum (Al)-Dissolved			102.7		%		80-120	01-NOV-19
Antimony (Sb)-Dissolved			103.2		%		80-120	01-NOV-19
Arsenic (As)-Dissolved			102.7		%		80-120	01-NOV-19
Barium (Ba)-Dissolved			102.4		%		80-120	01-NOV-19
Beryllium (Be)-Dissolved			104.2		%		80-120	01-NOV-19
Bismuth (Bi)-Dissolved			101.6		%		80-120	01-NOV-19
Boron (B)-Dissolved			101.0		%		80-120	01-NOV-19
Cadmium (Cd)-Dissolved			103.1		%		80-120	01-NOV-19
Calcium (Ca)-Dissolved			102.0		%		80-120	01-NOV-19
Cesium (Cs)-Dissolved			105.8		%		80-120	01-NOV-19
Chromium (Cr)-Dissolved			99.9		%		80-120	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207162-2 LCS								
Cobalt (Co)-Dissolved			100.4		%		80-120	01-NOV-19
Copper (Cu)-Dissolved			101.7		%		80-120	01-NOV-19
Iron (Fe)-Dissolved			92.6		%		80-120	01-NOV-19
Lead (Pb)-Dissolved			102.1		%		80-120	01-NOV-19
Lithium (Li)-Dissolved			102.1		%		80-120	01-NOV-19
Magnesium (Mg)-Dissolved			114.4		%		80-120	01-NOV-19
Manganese (Mn)-Dissolved			104.3		%		80-120	01-NOV-19
Molybdenum (Mo)-Dissolved			100.8		%		80-120	01-NOV-19
Nickel (Ni)-Dissolved			101.4		%		80-120	01-NOV-19
Phosphorus (P)-Dissolved			102.8		%		80-120	01-NOV-19
Potassium (K)-Dissolved			95.8		%		80-120	01-NOV-19
Rubidium (Rb)-Dissolved			105.8		%		80-120	01-NOV-19
Selenium (Se)-Dissolved			103.0		%		80-120	01-NOV-19
Silicon (Si)-Dissolved			102.9		%		80-120	01-NOV-19
Silver (Ag)-Dissolved			100.7		%		80-120	01-NOV-19
Sodium (Na)-Dissolved			102.6		%		80-120	01-NOV-19
Strontium (Sr)-Dissolved			99.9		%		80-120	01-NOV-19
Sulfur (S)-Dissolved			93.1		%		80-120	01-NOV-19
Tellurium (Te)-Dissolved			104.0		%		80-120	01-NOV-19
Thallium (Tl)-Dissolved			95.9		%		80-120	01-NOV-19
Thorium (Th)-Dissolved			104.0		%		80-120	01-NOV-19
Tin (Sn)-Dissolved			101.8		%		80-120	01-NOV-19
Titanium (Ti)-Dissolved			101.5		%		80-120	01-NOV-19
Tungsten (W)-Dissolved			104.5		%		80-120	01-NOV-19
Uranium (U)-Dissolved			106.6		%		80-120	01-NOV-19
Vanadium (V)-Dissolved			103.2		%		80-120	01-NOV-19
Zinc (Zn)-Dissolved			101.2		%		80-120	01-NOV-19
Zirconium (Zr)-Dissolved			100.7		%		80-120	01-NOV-19
WG3207162-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R4898393								
WG3207162-1 MB								
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-NOV-19
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	01-NOV-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-NOV-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-NOV-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-19
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	01-NOV-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-NOV-19
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-NOV-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-NOV-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-NOV-19
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4898393								
WG3204244-2 LCS								
Aluminum (Al)-Total			104.4		%		80-120	01-NOV-19
Antimony (Sb)-Total			104.7		%		80-120	01-NOV-19
Arsenic (As)-Total			104.6		%		80-120	01-NOV-19
Barium (Ba)-Total			105.0		%		80-120	01-NOV-19
Beryllium (Be)-Total			101.2		%		80-120	01-NOV-19
Bismuth (Bi)-Total			104.6		%		80-120	01-NOV-19
Boron (B)-Total			101.8		%		80-120	01-NOV-19
Cadmium (Cd)-Total			102.7		%		80-120	01-NOV-19
Calcium (Ca)-Total			101.3		%		80-120	01-NOV-19
Cesium (Cs)-Total			106.4		%		80-120	01-NOV-19
Chromium (Cr)-Total			104.5		%		80-120	01-NOV-19
Cobalt (Co)-Total			102.2		%		80-120	01-NOV-19
Copper (Cu)-Total			102.8		%		80-120	01-NOV-19
Iron (Fe)-Total			97.1		%		80-120	01-NOV-19
Lead (Pb)-Total			104.9		%		80-120	01-NOV-19
Lithium (Li)-Total			99.0		%		80-120	01-NOV-19
Magnesium (Mg)-Total			113.4		%		80-120	01-NOV-19
Manganese (Mn)-Total			103.4		%		80-120	01-NOV-19
Molybdenum (Mo)-Total			103.2		%		80-120	01-NOV-19
Nickel (Ni)-Total			103.1		%		80-120	01-NOV-19
Potassium (K)-Total			98.0		%		80-120	01-NOV-19
Phosphorus (P)-Total			106.1		%		80-120	01-NOV-19
Rubidium (Rb)-Total			103.6		%		80-120	01-NOV-19
Selenium (Se)-Total			102.0		%		80-120	01-NOV-19
Silicon (Si)-Total			105.8		%		80-120	01-NOV-19
Silver (Ag)-Total			99.99		%		80-120	01-NOV-19
Sodium (Na)-Total			106.4		%		80-120	01-NOV-19
Strontium (Sr)-Total			104.6		%		80-120	01-NOV-19
Sulfur (S)-Total			115.6		%		80-120	01-NOV-19
Tellurium (Te)-Total			101.4		%		80-120	01-NOV-19
Thallium (Tl)-Total			104.7		%		80-120	01-NOV-19
Thorium (Th)-Total			108.1		%		80-120	01-NOV-19
Tin (Sn)-Total			104.0		%		80-120	01-NOV-19
Titanium (Ti)-Total			101.9		%		80-120	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4898393								
WG3204244-2 LCS								
Tungsten (W)-Total			104.8		%		80-120	01-NOV-19
Uranium (U)-Total			115.6		%		80-120	01-NOV-19
Vanadium (V)-Total			103.9		%		80-120	01-NOV-19
Zinc (Zn)-Total			105.0		%		80-120	01-NOV-19
Zirconium (Zr)-Total			101.2		%		80-120	01-NOV-19
WG3204244-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	01-NOV-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	01-NOV-19
Boron (B)-Total			<0.010		mg/L		0.01	01-NOV-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	01-NOV-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	01-NOV-19
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	01-NOV-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Copper (Cu)-Total			<0.00050		mg/L		0.0005	01-NOV-19
Iron (Fe)-Total			<0.010		mg/L		0.01	01-NOV-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	01-NOV-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	01-NOV-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	01-NOV-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	01-NOV-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	01-NOV-19
Potassium (K)-Total			<0.050		mg/L		0.05	01-NOV-19
Phosphorus (P)-Total			<0.030		mg/L		0.03	01-NOV-19
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	01-NOV-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	01-NOV-19
Silicon (Si)-Total			<0.10		mg/L		0.1	01-NOV-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	01-NOV-19
Sodium (Na)-Total			<0.050		mg/L		0.05	01-NOV-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	01-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4898393								
WG3204244-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	01-NOV-19
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	01-NOV-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	01-NOV-19
Thorium (Th)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	01-NOV-19
Tungsten (W)-Total			<0.00010		mg/L		0.0001	01-NOV-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	01-NOV-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	01-NOV-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	01-NOV-19
Zirconium (Zr)-Total			<0.00020		mg/L		0.0002	01-NOV-19
NO2-L-IC-N-WP	**Water**							
Batch R4885628								
WG3202025-2 LCS								
Nitrite (as N)			99.4		%		90-110	25-OCT-19
WG3202025-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-OCT-19
NO3-L-IC-N-WP	**Water**							
Batch R4885628								
WG3202025-2 LCS								
Nitrate (as N)			99.7		%		90-110	25-OCT-19
WG3202025-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-OCT-19
PH-WP	**Water**							
Batch R4888741								
WG3204356-17 LCS								
pH			7.37		pH units		7.3-7.5	28-OCT-19
SO4-IC-N-WP	**Water**							
Batch R4885628								
WG3202025-2 LCS								
Sulfate (SO4)			99.3		%		90-110	25-OCT-19
WG3202025-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	25-OCT-19
TC,EC-QT51-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R4885887								
WG3201991-5 DUP		**L2371920-5**						
Total Coliforms		>200	>200		MPN/100mL	0.0	65	25-OCT-19
Escherichia Coli		1	1		MPN/100mL	0.0	65	25-OCT-19
WG3201991-6 DUP		**L2371920-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	25-OCT-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	25-OCT-19
WG3201991-7 DUP		**L2371920-3**						
Total Coliforms		130	118		MPN/100mL	9.7	65	25-OCT-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	25-OCT-19
WG3201991-8 DUP		**L2371920-2**						
Total Coliforms		3	0	DUPM	MPN/100mL	3	2	25-OCT-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	25-OCT-19
WG3201991-9 DUP		**L2371920-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	25-OCT-19
Escherichia Coli		0	0		MPN/100mL	0.0	65	25-OCT-19
WG3201991-1 MB								
Total Coliforms			0		MPN/100mL		1	25-OCT-19
Escherichia Coli			0		MPN/100mL		1	25-OCT-19
WG3201991-2 MB								
Total Coliforms			0		MPN/100mL		1	25-OCT-19
Escherichia Coli			0		MPN/100mL		1	25-OCT-19
WG3201991-3 MB								
Total Coliforms			0		MPN/100mL		1	25-OCT-19
Escherichia Coli			0		MPN/100mL		1	25-OCT-19
TURBIDITY-WP	**Water**							
Batch R4886035								
WG3201869-6 DUP		**L2371920-4**						
Turbidity		81.2	81.4		NTU	0.2	15	25-OCT-19
WG3201869-5 LCS								
Turbidity			102.5		%		85-115	25-OCT-19
WG3201869-4 MB								
Turbidity			<0.10		NTU		0.1	25-OCT-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	24-OCT-19 14:20	28-OCT-19 12:00	0.25	94	hours	EHTR-FM
	2	24-OCT-19 16:20	28-OCT-19 12:00	0.25	92	hours	EHTR-FM
	3	24-OCT-19 11:20	28-OCT-19 12:00	0.25	97	hours	EHTR-FM
	4	24-OCT-19 11:50	28-OCT-19 12:00	0.25	96	hours	EHTR-FM
	5	24-OCT-19	28-OCT-19 12:00	0.25	96	hours	EHTR-FM
Bacteriological Tests							
Total Coliform and E.coli							
	3	24-OCT-19 11:20	25-OCT-19 18:15	30	31	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2371920 were received on 25-OCT-19 11:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2371920-COFC

COC Number: 17 - 781791

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Distribution		Turnaround Time (TAT) Requested (please see below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format:	PDF ✓ EXCEL ✓ EDD (DIGITAL)	Regular [R] ✓ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report	YES NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐ — EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
Phone:	204-896-1209	Compare Results to Criteria on Report - provide details below if box checked		Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Company address below will appear on the final report		Select Distribution:	EMAIL MAIL FAX	For tests that can not be performed according to the service level selected, you will be contacted.
Street:	865 Waverley St.	Email 1 or Fax	plindell@kgsgroup.com	
City/Province:	WPG/MB	Email 2	soffman@kgsgroup.com	
Postal Code:	R4A 2A6	Email 3	elevay@kgsgroup.com	
Invoice To	Same as Report To ☐ YES ☐ NO	**Invoice Distribution**		
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution:	EMAIL MAIL FAX	
Company:		Email 1 or Fax	payables@kgsgroup.com	
Contact:		Email 2		

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#:
Job #:	18-0300-005	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Judy D.	Sampler: PJL/NB

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below: F/P: Routine Water-Met-D-L	P: TC,EC-QT51	P: total Metals	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	PW19-KGS-01	24-Oct-19	14:20	GW	3	X	X			
	PW19-KGS-02		16:20		3	X	X			
	PW19-KGS-03		11:20		3	X	X			
	PW-200		11:50		3	X	X			
	R3-SW			SW	4	X	X	X		

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ✓ NO	
Are samples for human consumption/ use? ☐ YES ✓ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice Packs	☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
5.5							

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
P Lindell	Oct 25/19	11:45		Oct 25	1150			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-18
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	404		mg/L			22-JUN-20
Carbonate (CO3)	<0.60		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		23-JUN-20
pH						
pH	7.41		pH units			19-JUN-20
Turbidity						
*Turbidity	821		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	323		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	5.69		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	333		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.127		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0163		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	0.00014		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00163		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0434		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.028		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	77.6		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	0.00047		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00065		mg/L			19-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	1.78		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		19-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-18
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0089		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	33.9		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.112		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.000534		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	0.00174		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	0.616		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00131		mg/L			19-JUN-20
Selenium (Se)-Dissolved	0.000918		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	6.99		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	6.56		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.108		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	9.68		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	0.00081		mg/L			19-JUN-20
Tungsten (W)-Dissolved	0.00013		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.000545		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	0.00102		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	0.00053		mg/L			19-JUN-20
Conductivity						
Conductivity	566		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.38		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	331		mg/L			19-JUN-20
Total Coliform and E.coli						
Total Coliforms	1	MBHT	MPN/100mL	0		18-JUN-20
Escherichia Coli	0	MBHT	MPN/100mL	0		18-JUN-20

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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-18
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-17
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-2
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	394		mg/L			22-JUN-20
Carbonate (CO3)	<0.60		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		23-JUN-20
pH						
pH	8.12		pH units			19-JUN-20
Turbidity						
*Turbidity	>4000	TMV	NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	361		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	43.9		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	365		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.275		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0030		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00120		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0414		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.087		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	55.5		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	<0.00010		mg/L			19-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.140		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		19-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-17
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-2
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0177		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	55.0		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.0204		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.000557		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	3.34		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00187		mg/L			19-JUN-20
Selenium (Se)-Dissolved	0.000140		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	4.29		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	9.00		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.163		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	13.9		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.000116		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			19-JUN-20
Conductivity						
Conductivity	617		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.86		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	323		mg/L			19-JUN-20
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1	MBHT	MPN/100mL	0		18-JUN-20
Escherichia Coli	<1	MBHT	MPN/100mL	0		18-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-17
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-2
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-12
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-3
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	463		mg/L			22-JUN-20
Carbonate (CO3)	<0.60		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	0.0121		mg/L	10		23-JUN-20
pH						
pH	8.24		pH units			19-JUN-20
Turbidity						
*Turbidity	3020		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	429		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	46.9		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0121		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	402		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.391		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0010		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	0.00011		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00121		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0783		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.126		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	45.5		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00057		mg/L			19-JUN-20
Copper (Cu)-Dissolved	0.00041		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.597		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		19-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-12
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-3
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0359		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	70.1		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.209		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.00380		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	0.00167		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	4.50		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00203		mg/L			19-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	6.17		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	29.3		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.244		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	19.1		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	0.00022		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	0.00018		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.000235		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	0.0034		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			19-JUN-20
Conductivity						
Conductivity	717		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.39		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	380		mg/L			19-JUN-20
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1	MBHT	MPN/100mL	0		18-JUN-20
Escherichia Coli	<1	MBHT	MPN/100mL	0		18-JUN-20

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Date: 30-JUN-20
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WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-12
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-3
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-02
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-4
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	399		mg/L			22-JUN-20
Carbonate (CO3)	3.96		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		23-JUN-20
pH						
pH	8.32		pH units			19-JUN-20
Turbidity						
*Turbidity	1.13		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	453		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	89.6		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	378		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.310		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00129		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0246		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.144		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	57.8		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00015		mg/L			19-JUN-20
Copper (Cu)-Dissolved	0.00050		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.138		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	0.000055		mg/L	0.005		19-JUN-20

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Date: 30-JUN-20
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WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-02
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-4
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0253		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	56.7		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.00495		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.000406		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	4.73		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00266		mg/L			19-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	5.39		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	32.9		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.205		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	28.8		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.000739		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			19-JUN-20
Conductivity						
Conductivity	736		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	10.9		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	334		mg/L			19-JUN-20
Total Coliform and E.coli						
Total Coliforms	0	MBHT	MPN/100mL	0		18-JUN-20
Escherichia Coli	0	MBHT	MPN/100mL	0		18-JUN-20

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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-02
Sampled By: PL/SB
Date Collected: 16-JUN-20
Lab Sample ID: L2462330-4
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-03
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-5
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	365		mg/L			22-JUN-20
Carbonate (CO3)	<0.60		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		23-JUN-20
pH						
pH	8.24		pH units			19-JUN-20
Turbidity						
*Turbidity	2.10		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	313		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	25.8		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	314		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.199		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0018		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00072		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0487		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.077		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	55.6		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00094		mg/L			19-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.243		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		19-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-03
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-5
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0139		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	42.4		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.119		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.000318		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	0.00214		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	2.83		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00170		mg/L			19-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	4.51		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	5.83		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.128		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	8.60		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	0.000015		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.00179		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			19-JUN-20
Conductivity						
Conductivity	536		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.86		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	300		mg/L			19-JUN-20
Total Coliform and E.coli						
Total Coliforms	200		MPN/100mL	0		18-JUN-20
Escherichia Coli	0		MPN/100mL	0		18-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-03
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-5
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-300
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-6
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	363		mg/L			22-JUN-20
Carbonate (CO3)	<0.60		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		23-JUN-20
pH						
pH	8.23		pH units			19-JUN-20
Turbidity						
*Turbidity	1.37		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	312		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	25.9		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	315		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.198		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0019		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00067		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.0492		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.076		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	55.2		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	0.000011		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00090		mg/L			19-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.248		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	0.000074		mg/L	0.005		19-JUN-20

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Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-300
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-6
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0139		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	42.9		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.119		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.000335		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	0.00215		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	2.83		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00173		mg/L			19-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	4.55		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	5.72		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.130		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	8.82		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	0.000015		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.00179		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			19-JUN-20
Conductivity						
Conductivity	535		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.87		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	298		mg/L			19-JUN-20
Total Coliform and E.coli						
Total Coliforms	165		MPN/100mL	0		18-JUN-20
Escherichia Coli	0		MPN/100mL	0		18-JUN-20

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Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-300
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-6
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-19
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-7
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	566		mg/L			22-JUN-20
Carbonate (CO3)	7.20		mg/L			22-JUN-20
Hydroxide (OH)	<0.34		mg/L			22-JUN-20
*Nitrate and Nitrite as N	<0.010		mg/L	10		23-JUN-20
pH						
pH	8.34		pH units			19-JUN-20
Turbidity						
*Turbidity	36.3		NTU			18-JUN-20
TDS calculated						
TDS (Calculated)	533		mg/L		500	22-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	68.2		mg/L		500	19-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		19-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		19-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	487		mg/L		500	22-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.275		mg/L	1.5		19-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					19-JUN-20
Aluminum (Al)-Dissolved	0.0025		mg/L		0.1	19-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		19-JUN-20
Arsenic (As)-Dissolved	0.00520		mg/L	0.01		19-JUN-20
Barium (Ba)-Dissolved	0.265		mg/L	2		19-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			19-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			19-JUN-20
Boron (B)-Dissolved	0.112		mg/L	5		19-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		19-JUN-20
Calcium (Ca)-Dissolved	50.3		mg/L			19-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			19-JUN-20
Chromium (Cr)-Dissolved	0.00012		mg/L	0.05		19-JUN-20
Cobalt (Co)-Dissolved	0.00108		mg/L			19-JUN-20
Copper (Cu)-Dissolved	0.00048		mg/L	2.0	1.0	19-JUN-20
Iron (Fe)-Dissolved	0.015		mg/L		0.3	19-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		19-JUN-20

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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-19
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-7
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0335		mg/L			19-JUN-20
Magnesium (Mg)-Dissolved	87.7		mg/L			19-JUN-20
Manganese (Mn)-Dissolved	0.406		mg/L	0.12	0.02	19-JUN-20
Molybdenum (Mo)-Dissolved	0.00415		mg/L			19-JUN-20
Nickel (Ni)-Dissolved	0.00311		mg/L			19-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			19-JUN-20
Potassium (K)-Dissolved	4.20		mg/L			19-JUN-20
Rubidium (Rb)-Dissolved	0.00146		mg/L			19-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		19-JUN-20
Silicon (Si)-Dissolved	7.21		mg/L			19-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			19-JUN-20
Sodium (Na)-Dissolved	34.6		mg/L		200	19-JUN-20
Strontium (Sr)-Dissolved	0.920		mg/L	7		19-JUN-20
Sulfur (S)-Dissolved	22.2		mg/L			19-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			19-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			19-JUN-20
Tin (Sn)-Dissolved	0.00019		mg/L			19-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			19-JUN-20
Tungsten (W)-Dissolved	0.00355		mg/L			19-JUN-20
Uranium (U)-Dissolved	0.00146		mg/L	0.02		19-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			19-JUN-20
Zinc (Zn)-Dissolved	0.0030		mg/L		5.0	19-JUN-20
Zirconium (Zr)-Dissolved	0.00021		mg/L			19-JUN-20
Conductivity						
Conductivity	860		umhos/cm			19-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.30		mg/L		250	19-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	476		mg/L			19-JUN-20
Total Coliform and E.coli						
Total Coliforms	1		MPN/100mL	0		18-JUN-20
Escherichia Coli	0		MPN/100mL	0		18-JUN-20

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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: TH19-KGS-19
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-7
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: SW-R3
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	107.3		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	93.2		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		23-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	0.55		mg/L			22-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		19-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		19-JUN-20
Phosphorus (P)-Total Dissolved	0.0084		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0171		mg/L			22-JUN-20
Ammonia, Total (as N)	0.012		mg/L			23-JUN-20
Total Nitrogen	0.55		mg/L			23-JUN-20
Total Suspended Solids	8.0		mg/L			24-JUN-20
*Turbidity	16.1		NTU			18-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: SW-R3
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: LSMOC-OUTLET1
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	107.7		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	91.5		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		23-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	0.52		mg/L			22-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		19-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		19-JUN-20
Phosphorus (P)-Total Dissolved	0.0105		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0207		mg/L			22-JUN-20
Ammonia, Total (as N)	<0.010		mg/L			23-JUN-20
Total Nitrogen	0.52		mg/L			23-JUN-20
Total Suspended Solids	<3.0		mg/L			24-JUN-20
*Turbidity	4.38		NTU			18-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: LSMOC-OUTLET1
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: CR3-1
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	105.9		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	91.4		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		23-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	0.64		mg/L			22-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		19-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		19-JUN-20
Phosphorus (P)-Total Dissolved	0.0053		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0073		mg/L			26-JUN-20
Ammonia, Total (as N)	<0.010		mg/L			23-JUN-20
Total Nitrogen	0.64		mg/L			23-JUN-20
Total Suspended Solids	<3.0		mg/L			24-JUN-20
*Turbidity	0.16		NTU			18-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: CR3-1
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: CR3-2
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-11
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			25-JUN-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			20-JUN-20
	F3 (C16-C34)	<0.25		mg/L			20-JUN-20
	F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr:	2-Bromobenzotrifluoride	108.0		%			20-JUN-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		23-JUN-20
	Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
	o-Xylene	<0.00050		mg/L			23-JUN-20
	m+p-Xylenes	<0.00040		mg/L			23-JUN-20
	F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr:	4-Bromofluorobenzene (SS)	92.9		%			23-JUN-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		23-JUN-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.63		mg/L			22-JUN-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		19-JUN-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		19-JUN-20
	Phosphorus (P)-Total Dissolved	0.0065		mg/L			24-JUN-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					25-JUN-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
	Phosphorus (P)-Total	0.0093		mg/L			22-JUN-20
	Ammonia, Total (as N)	0.013		mg/L			23-JUN-20
	Total Nitrogen	0.63		mg/L			23-JUN-20
	Total Suspended Solids	4.6		mg/L			24-JUN-20
	*Turbidity	3.68		NTU			18-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2462330
Project Ref: 18-0300-005.2302.04
Sample ID: CR3-2
Sampled By: PL/SB
Date Collected: 17-JUN-20
Lab Sample ID: L2462330-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
MBHT	The APHA 30 hour hold time was exceeded for microbiological testing. Samples processed within 48 hours from time of sampling may

	be valid in some cases (refer to Health Canada guidance).
TMV	Turbidity exceeded upper limit of the nephelometric method. Minimum value reported.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.
Manganese*	Criteria limit is 0.12 mg/L. Possible neurological effects in infants.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2462330 Report Date: 30-JUN-20

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R5126860								
WG3346888-14 LCS								
Alkalinity, Total (as CaCO3)			104.1		%		85-115	19-JUN-20
WG3346888-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	19-JUN-20
BTEXS+F1-HSMS-WP	**Water**							
Batch R5131240								
WG3347130-2 LCS								
Benzene			104.4		%		70-130	22-JUN-20
Toluene			101.9		%		70-130	22-JUN-20
Ethyl benzene			101.2		%		70-130	22-JUN-20
o-Xylene			108.4		%		70-130	22-JUN-20
m+p-Xylenes			104.2		%		70-130	22-JUN-20
WG3347130-3 LCS								
F1 (C6-C10)			108.2		%		70-130	22-JUN-20
WG3347130-1 MB								
Benzene			<0.00050		mg/L		0.0005	22-JUN-20
Toluene			<0.0010		mg/L		0.001	22-JUN-20
Ethyl benzene			<0.00050		mg/L		0.0005	22-JUN-20
o-Xylene			<0.00050		mg/L		0.0005	22-JUN-20
m+p-Xylenes			<0.00040		mg/L		0.0004	22-JUN-20
F1 (C6-C10)			<0.10		mg/L		0.1	22-JUN-20
Surrogate: 4-Bromofluorobenzene (SS)			96.1		%		70-130	22-JUN-20
CL-L-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Chloride (Cl)			103.1		%		90-110	19-JUN-20
WG3346282-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	19-JUN-20
EC-WP	**Water**							
Batch R5126860								
WG3346888-13 LCS								
Conductivity			99.2		%		90-110	19-JUN-20
WG3346888-11 MB								
Conductivity			<1.0		umhos/cm		1	19-JUN-20
F-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Fluoride (F)			104.1		%		90-110	19-JUN-20
WG3346282-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	19-JUN-20
F2-F4-FID-WP	**Water**							
Batch R5128566								
WG3346557-4 LCS								
F2 (C10-C16)			106.6		%		70-130	20-JUN-20
F3 (C16-C34)			96.5		%		70-130	20-JUN-20
F4 (C34-C50)			105.3		%		70-130	20-JUN-20
WG3346557-3 MB								
F2 (C10-C16)			<0.10		mg/L		0.1	20-JUN-20
F3 (C16-C34)			<0.25		mg/L		0.25	20-JUN-20
F4 (C34-C50)			<0.25		mg/L		0.25	20-JUN-20
Surrogate: 2-Bromobenzotrifluoride			103.5		%		60-140	20-JUN-20
HG-D-CVAA-WP	**Water**							
Batch R5138697								
WG3353190-3 DUP		**L2462330-8**						
Mercury (Hg)-Dissolved		<0.0000050	<0.000005C	RPD-NA	mg/L	N/A	20	30-JUN-20
WG3353190-2 LCS								
Mercury (Hg)-Dissolved			107.0		%		80-120	30-JUN-20
WG3353190-1 MB								
Mercury (Hg)-Dissolved			<0.000005C		mg/L		0.000005	30-JUN-20
WG3353190-4 MS		**L2462330-9**						
Mercury (Hg)-Dissolved			100.0		%		70-130	30-JUN-20
HG-T-CVAA-WP	**Water**							
Batch R5138801								
WG3353244-3 DUP		**L2462330-9**						
Mercury (Hg)-Total		<0.0000050	<0.000005C	RPD-NA	mg/L	N/A	20	30-JUN-20
WG3353182-2 LCS								
Mercury (Hg)-Total			107.0		%		80-120	30-JUN-20
WG3353244-2 LCS								
Mercury (Hg)-Total			107.0		%		80-120	30-JUN-20
WG3353182-1 MB								
Mercury (Hg)-Total			<0.000005C		mg/L		0.000005	30-JUN-20
WG3353244-1 MB								
Mercury (Hg)-Total			<0.000005C		mg/L		0.000005	30-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-T-CVAA-WP	**Water**							
Batch R5138801								
WG3353244-4 MS		**L2462330-10**						
Mercury (Hg)-Total			102.0		%		70-130	30-JUN-20
MET-D-CCMS-WP	**Water**							
Batch R5126483								
WG3346153-2 LCS								
Aluminum (Al)-Dissolved			99.6		%		80-120	19-JUN-20
Antimony (Sb)-Dissolved			99.0		%		80-120	19-JUN-20
Arsenic (As)-Dissolved			102.3		%		80-120	19-JUN-20
Barium (Ba)-Dissolved			101.0		%		80-120	19-JUN-20
Beryllium (Be)-Dissolved			100.8		%		80-120	19-JUN-20
Bismuth (Bi)-Dissolved			96.3		%		80-120	19-JUN-20
Boron (B)-Dissolved			95.6		%		80-120	19-JUN-20
Cadmium (Cd)-Dissolved			103.0		%		80-120	19-JUN-20
Calcium (Ca)-Dissolved			100.0		%		80-120	19-JUN-20
Cesium (Cs)-Dissolved			101.2		%		80-120	19-JUN-20
Chromium (Cr)-Dissolved			101.0		%		80-120	19-JUN-20
Cobalt (Co)-Dissolved			100.9		%		80-120	19-JUN-20
Copper (Cu)-Dissolved			101.5		%		80-120	19-JUN-20
Iron (Fe)-Dissolved			92.1		%		80-120	19-JUN-20
Lead (Pb)-Dissolved			97.3		%		80-120	19-JUN-20
Lithium (Li)-Dissolved			100.7		%		80-120	19-JUN-20
Magnesium (Mg)-Dissolved			102.0		%		80-120	19-JUN-20
Manganese (Mn)-Dissolved			101.9		%		80-120	19-JUN-20
Molybdenum (Mo)-Dissolved			100.7		%		80-120	19-JUN-20
Nickel (Ni)-Dissolved			100.4		%		80-120	19-JUN-20
Phosphorus (P)-Dissolved			106.0		%		80-120	19-JUN-20
Potassium (K)-Dissolved			101.7		%		80-120	19-JUN-20
Rubidium (Rb)-Dissolved			103.8		%		80-120	19-JUN-20
Selenium (Se)-Dissolved			100.3		%		80-120	19-JUN-20
Silicon (Si)-Dissolved			103.4		%		80-120	19-JUN-20
Silver (Ag)-Dissolved			99.8		%		80-120	19-JUN-20
Sodium (Na)-Dissolved			103.3		%		80-120	19-JUN-20
Strontium (Sr)-Dissolved			102.1		%		80-120	19-JUN-20
Sulfur (S)-Dissolved			101.5		%		80-120	19-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5126483								
WG3346153-2 LCS								
Tellurium (Te)-Dissolved			93.0		%		80-120	19-JUN-20
Thallium (Tl)-Dissolved			97.3		%		80-120	19-JUN-20
Thorium (Th)-Dissolved			92.5		%		80-120	19-JUN-20
Tin (Sn)-Dissolved			99.5		%		80-120	19-JUN-20
Titanium (Ti)-Dissolved			95.7		%		80-120	19-JUN-20
Tungsten (W)-Dissolved			97.3		%		80-120	19-JUN-20
Uranium (U)-Dissolved			97.9		%		80-120	19-JUN-20
Vanadium (V)-Dissolved			101.9		%		80-120	19-JUN-20
Zinc (Zn)-Dissolved			101.3		%		80-120	19-JUN-20
Zirconium (Zr)-Dissolved			96.5		%		80-120	19-JUN-20
WG3346153-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	19-JUN-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	19-JUN-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-JUN-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	19-JUN-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-JUN-20
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	19-JUN-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-JUN-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-JUN-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	19-JUN-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	19-JUN-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	19-JUN-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	19-JUN-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	19-JUN-20
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-JUN-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	19-JUN-20
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5126483								
WG3346153-1 MB								
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	19-JUN-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	19-JUN-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	19-JUN-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	19-JUN-20
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	19-JUN-20
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-JUN-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	19-JUN-20
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	19-JUN-20
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-JUN-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	19-JUN-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	19-JUN-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	19-JUN-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	19-JUN-20
N-TOTKJ-WP	**Water**							
Batch R5127098								
WG3344867-2 LCS								
Total Kjeldahl Nitrogen			103.1		%		75-125	22-JUN-20
WG3344867-1 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	22-JUN-20
NH3-COL-WP	**Water**							
Batch R5131205								
WG3348980-10 LCS								
Ammonia, Total (as N)			105.3		%		85-115	23-JUN-20
WG3348980-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	23-JUN-20
NO2-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Nitrite (as N)			103.6		%		90-110	19-JUN-20
WG3346282-6 LCS								
Nitrite (as N)			103.4		%		90-110	19-JUN-20
WG3346282-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	19-JUN-20
WG3346282-5 MB								
Nitrite (as N)			<0.010		mg/L		0.01	19-JUN-20
NO2-L-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Nitrite (as N)			103.6		%		90-110	19-JUN-20
WG3346282-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-20
NO3-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Nitrate (as N)			102.8		%		90-110	19-JUN-20
WG3346282-6 LCS								
Nitrate (as N)			103.9		%		90-110	19-JUN-20
WG3346282-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	19-JUN-20
WG3346282-5 MB								
Nitrate (as N)			<0.020		mg/L		0.02	19-JUN-20
NO3-L-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Nitrate (as N)			102.8		%		90-110	19-JUN-20
WG3346282-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-20
P-T-COL-WP	**Water**							
Batch R5127191								
WG3346931-18 LCS								
Phosphorus (P)-Total			98.0		%		80-120	22-JUN-20
WG3346931-17 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	22-JUN-20
P-T-L-COL-WP	**Water**							
Batch R5135492								
WG3351878-2 LCS								
Phosphorus (P)-Total			95.7		%		80-120	26-JUN-20
WG3351878-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-L-COL-WP	**Water**							
Batch R5135492								
WG3351878-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	26-JUN-20
P-TD-COL-WP	**Water**							
Batch R5131182								
WG3348693-2 LCS								
Phosphorus (P)-Total	Dissolved		98.4		%		80-120	24-JUN-20
WG3348693-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0030		mg/L		0.003	24-JUN-20
PH-WP	**Water**							
Batch R5126860								
WG3346888-12 LCS								
pH			7.38		pH units		7.3-7.5	19-JUN-20
SO4-IC-N-WP	**Water**							
Batch R5129756								
WG3346282-2 LCS								
Sulfate (SO4)			103.6		%		90-110	19-JUN-20
WG3346282-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-JUN-20
SOLIDS-TOTSUS-WP	**Water**							
Batch R5132616								
WG3348929-2 LCS								
Total Suspended Solids			86.7		%		85-115	24-JUN-20
WG3348929-1 MB								
Total Suspended Solids			<3.0		mg/L		3	24-JUN-20
TC,EC-QT51-WP	**Water**							
Batch R5126072								
WG3344904-2 DUP		**L2462330-7**						
Total Coliforms		1	0	J	MPN/100mL	1	2	18-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-JUN-20
WG3344904-3 DUP		**L2462330-6**						
Total Coliforms		165	165		MPN/100mL	0.0	65	18-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-JUN-20
WG3344904-4 DUP		**L2462330-5**						
Total Coliforms		200	200		MPN/100mL	0.0	65	18-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R5126072								
WG3344904-5 DUP		**L2462330-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	18-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-JUN-20
WG3344904-6 DUP		**L2462330-1**						
Total Coliforms		1	1		MPN/100mL	0.0	65	18-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-JUN-20
WG3344904-1 MB								
Total Coliforms			0		MPN/100mL		1	18-JUN-20
Escherichia Coli			0		MPN/100mL		1	18-JUN-20
TC,EC-QT97-WP	**Water**							
Batch R5126098								
WG3345194-2 DUP		**L2462330-2**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	18-JUN-20
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	18-JUN-20
WG3345194-1 MB								
Total Coliforms			<1		MPN/100mL		1	18-JUN-20
Escherichia Coli			<1		MPN/100mL		1	18-JUN-20
TURBIDITY-WP	**Water**							
Batch R5125843								
WG3345751-6 DUP		**L2462330-8**						
Turbidity		16.1	16.0		NTU	0.6	15	18-JUN-20
WG3345751-2 LCS								
Turbidity			102.0		%		85-115	18-JUN-20
WG3345751-5 LCS								
Turbidity			101.5		%		85-115	18-JUN-20
WG3345751-1 MB								
Turbidity			<0.10		NTU		0.1	18-JUN-20
WG3345751-4 MB								
Turbidity			<0.10		NTU		0.1	18-JUN-20

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	16-JUN-20 11:00	19-JUN-20 12:00	0.25	73	hours	EHTR-FM
	2	16-JUN-20 12:15	19-JUN-20 12:00	0.25	72	hours	EHTR-FM
	3	16-JUN-20 14:45	19-JUN-20 12:00	0.25	69	hours	EHTR-FM
	4	16-JUN-20 17:30	19-JUN-20 12:00	0.25	66	hours	EHTR-FM
	5	17-JUN-20 10:00	19-JUN-20 12:00	0.25	50	hours	EHTR-FM
	6	17-JUN-20 12:00	19-JUN-20 12:00	0.25	48	hours	EHTR-FM
	7	17-JUN-20 13:12	19-JUN-20 12:00	0.25	47	hours	EHTR-FM
Bacteriological Tests							
Total Coliform and E.coli							
	1	16-JUN-20 11:00	18-JUN-20 10:45	30	48	hours	EHTR
	4	16-JUN-20 17:30	18-JUN-20 10:45	30	41	hours	EHTR
Total Coliform and E.coli by MPN QT97							
	2	16-JUN-20 12:15	18-JUN-20 12:10	30	48	hours	EHTR
	3	16-JUN-20 14:45	18-JUN-20 12:10	30	45	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2462330 were received on 18-JUN-20 07:50.

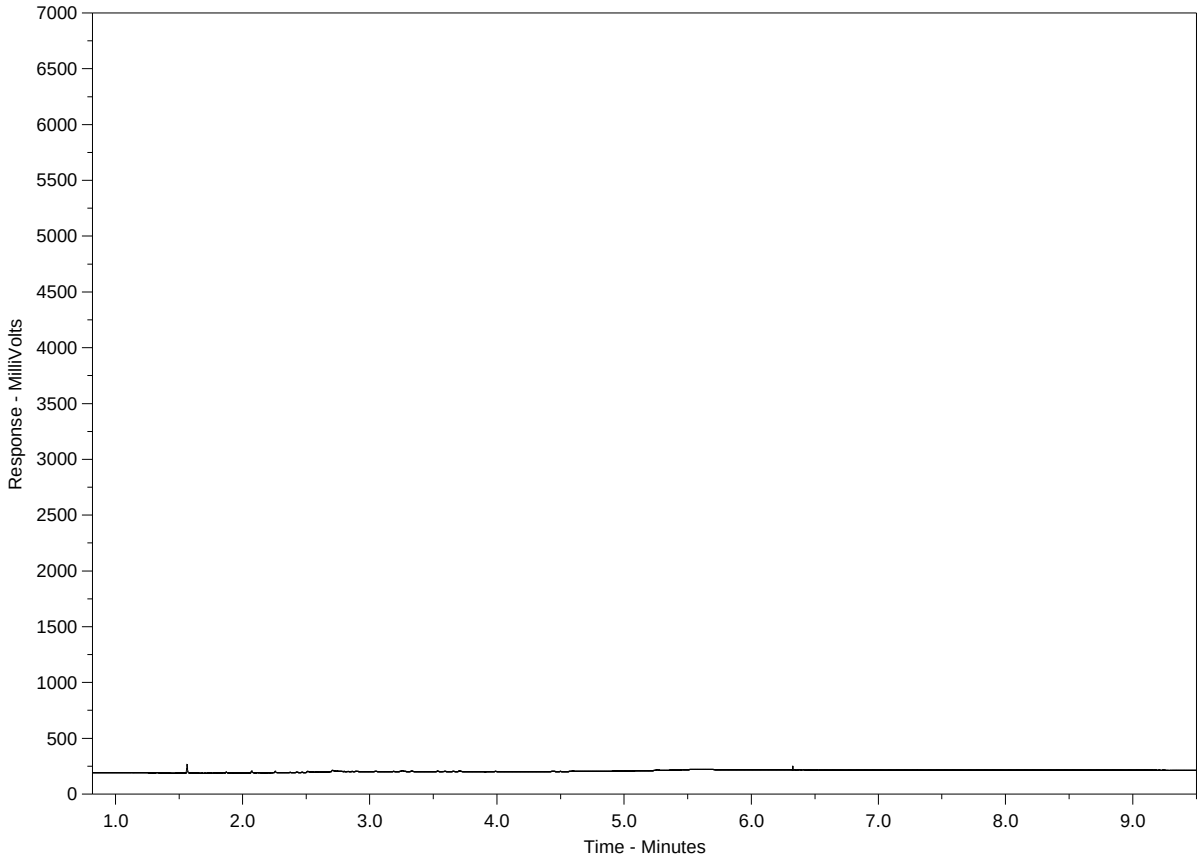
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

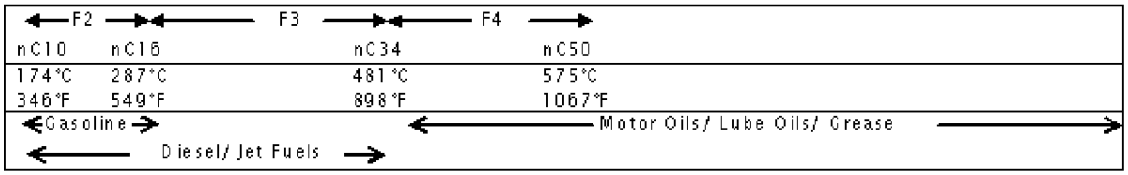
The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2462330-8
Client Sample ID: SW-R3





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

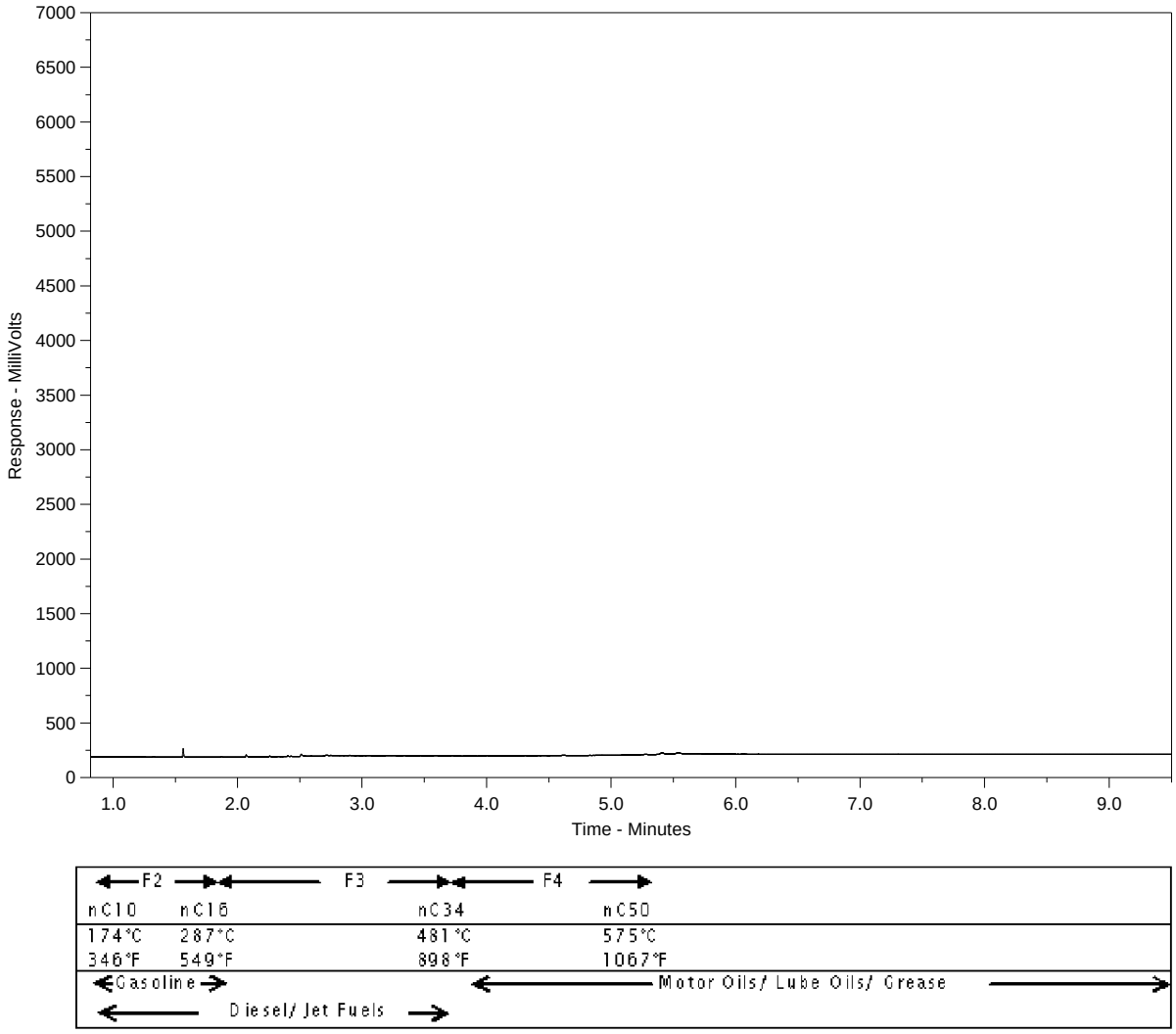
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2462330-9
Client Sample ID: LSMOC-OUTLET1



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

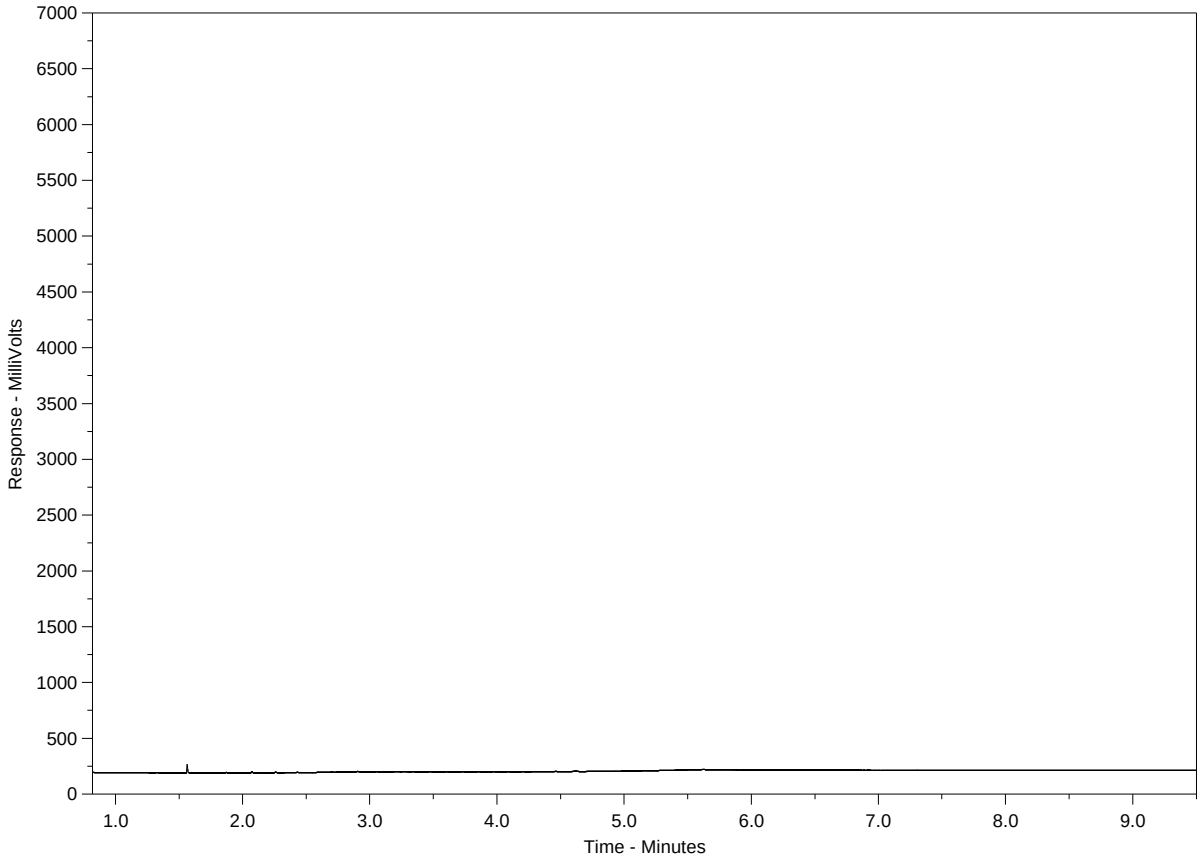
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

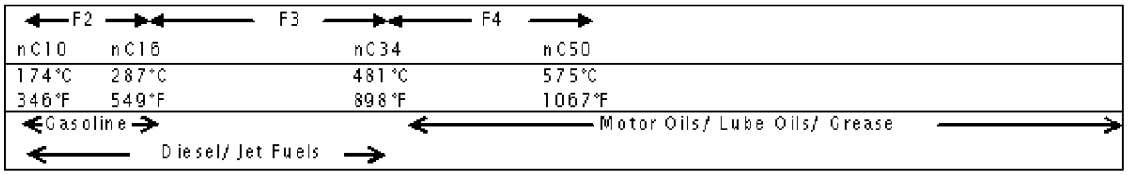
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2462330-10
Client Sample ID: CR3-1





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

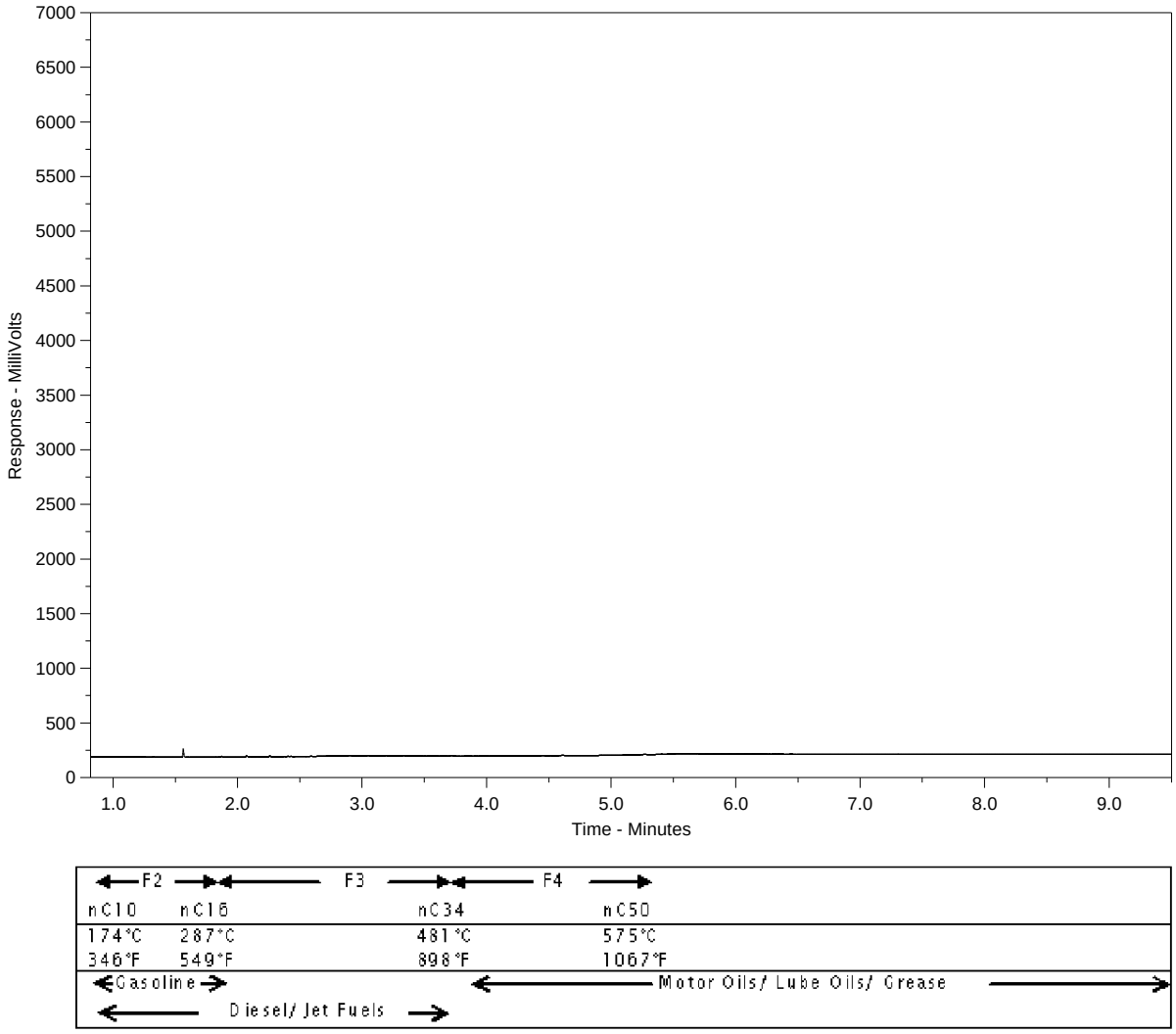
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2462330-11
Client Sample ID: CR3-2



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2462330-COFC

COC Number: 17 - 750820

Page 1 of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report ☐ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐ — EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
Phone:	204-896-1209	☐ Compare Results to Criteria on Report - provide details below if box checked	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	For tests that can not be performed according to the service level selected, you will be contacted.
Street:	865 WAVERLEY ST	Email 1 plindell@kgsgroup.com	
City/Province:	WPG, MB	Email 2 soffman@kgsgroup.com	
Postal Code:	R3J 3P4	Email 3	
Invoice To	Same as Report To ☐ YES ☐ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax payables@kgsgroup	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#
Job #:	18-0300-005.2302.04	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Judy D.	Sampler: P. LINDELL S. BEAUDRY

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	F/P	Rou4W-met-D-L	TC, EC-QT51	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
1	TH19-KGS-18	16-Jun-20	11:00	Groundwater	3		X	X		
2	TH19-KGS-17		12:15		3		X	X		
3	TH19-KGS-12		14:45		3		X	X		
4	PW19-KGS-02		17:30		3		X	X		
5	PW19-KGS-03	17-Jun-20	10:00	GW	3		X	X		
6	PW19-KGS-300		12:00	GW	3		X	X		
7	TH19-KGS 19		13:12	GW	3		X	X		
8	SW-R3		12:03	Surface Water	10					
9	LSMOC-Outlet 1		13:26	SW	10					
10	CR3-1		13:55	SW	10					
11	CR3-2		14:10	SW	10					

AS PER QUOTE

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☒ NO	METALS BOTTLE(S) F/P.
Are samples for human consumption/ use? ☐ YES ☒ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice Packs ☐ Ice Cubes ☐		Custody seal intact	Yes ☐	No ☐	
Cooling Initiated ☐					

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
0-2	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	JUN 17	20:00		JUN 18 2020				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	461		mg/L			23-JUN-20
Carbonate (CO3)	<0.60		mg/L			23-JUN-20
Hydroxide (OH)	<0.34		mg/L			23-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-JUN-20
pH						
pH	7.89		pH units			22-JUN-20
Turbidity						
*Turbidity	3.20		NTU			19-JUN-20
TDS calculated						
TDS (Calculated)	515		mg/L		500	24-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	87.5		mg/L		500	22-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	396		mg/L		500	24-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.339		mg/L	1.5		22-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					23-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	23-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		23-JUN-20
Arsenic (As)-Dissolved	0.00036		mg/L	0.01		23-JUN-20
Barium (Ba)-Dissolved	0.0282		mg/L	2		23-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			23-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			23-JUN-20
Boron (B)-Dissolved	0.180		mg/L	5		23-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		23-JUN-20
Calcium (Ca)-Dissolved	61.3		mg/L			23-JUN-20
Cesium (Cs)-Dissolved	0.000010		mg/L			23-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		23-JUN-20
Cobalt (Co)-Dissolved	0.00016		mg/L			23-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	23-JUN-20
Iron (Fe)-Dissolved	0.134		mg/L		0.3	23-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		23-JUN-20

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Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0312		mg/L			23-JUN-20
Magnesium (Mg)-Dissolved	59.1		mg/L			23-JUN-20
Manganese (Mn)-Dissolved	0.0162		mg/L	0.12	0.02	23-JUN-20
Molybdenum (Mo)-Dissolved	0.00149		mg/L			23-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			23-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			23-JUN-20
Potassium (K)-Dissolved	6.44		mg/L			23-JUN-20
Rubidium (Rb)-Dissolved	0.00338		mg/L			23-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		23-JUN-20
Silicon (Si)-Dissolved	4.50		mg/L			23-JUN-20
Silver (Ag)-Dissolved	0.000010		mg/L			23-JUN-20
Sodium (Na)-Dissolved	45.4		mg/L		200	23-JUN-20
Strontium (Sr)-Dissolved	0.227		mg/L	7		23-JUN-20
Sulfur (S)-Dissolved	25.3		mg/L			23-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			23-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			23-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			23-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			23-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			23-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			23-JUN-20
Uranium (U)-Dissolved	0.000875		mg/L	0.02		23-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			23-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	23-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			23-JUN-20
Conductivity						
Conductivity	866		umhos/cm			22-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	29.0		mg/L		250	22-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	378		mg/L			22-JUN-20
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		19-JUN-20
Escherichia Coli	0		MPN/100mL	0		19-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: PW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	400		mg/L			24-JUN-20
Carbonate (CO3)	1.08		mg/L			24-JUN-20
Hydroxide (OH)	<0.34		mg/L			24-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-JUN-20
pH						
pH	8.29		pH units			23-JUN-20
Turbidity						
*Turbidity	0.52		NTU			19-JUN-20
TDS calculated						
TDS (Calculated)	432		mg/L		500	24-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	80.4		mg/L		500	22-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	368		mg/L		500	24-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.273		mg/L	1.5		22-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					23-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	23-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		23-JUN-20
Arsenic (As)-Dissolved	0.00050		mg/L	0.01		23-JUN-20
Barium (Ba)-Dissolved	0.0245		mg/L	2		23-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			23-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			23-JUN-20
Boron (B)-Dissolved	0.143		mg/L	5		23-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		23-JUN-20
Calcium (Ca)-Dissolved	58.6		mg/L			23-JUN-20
Cesium (Cs)-Dissolved	0.000012		mg/L			23-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		23-JUN-20
Cobalt (Co)-Dissolved	0.00022		mg/L			23-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	23-JUN-20
Iron (Fe)-Dissolved	0.072		mg/L		0.3	23-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		23-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0253		mg/L			23-JUN-20
Magnesium (Mg)-Dissolved	53.8		mg/L			23-JUN-20
Manganese (Mn)-Dissolved	0.00547		mg/L	0.12	0.02	23-JUN-20
Molybdenum (Mo)-Dissolved	0.00117		mg/L			23-JUN-20
Nickel (Ni)-Dissolved	0.00053		mg/L			23-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			23-JUN-20
Potassium (K)-Dissolved	4.52		mg/L			23-JUN-20
Rubidium (Rb)-Dissolved	0.00125		mg/L			23-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		23-JUN-20
Silicon (Si)-Dissolved	6.02		mg/L			23-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			23-JUN-20
Sodium (Na)-Dissolved	27.3		mg/L		200	23-JUN-20
Strontium (Sr)-Dissolved	0.230		mg/L	7		23-JUN-20
Sulfur (S)-Dissolved	26.4		mg/L			23-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			23-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			23-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			23-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			23-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			23-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			23-JUN-20
Uranium (U)-Dissolved	0.00195		mg/L	0.02		23-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			23-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	23-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			23-JUN-20
Conductivity						
Conductivity	700		umhos/cm			23-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.60		mg/L		250	22-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	330		mg/L			23-JUN-20
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		19-JUN-20
Escherichia Coli	0		MPN/100mL	0		19-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-01
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-02
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	421		mg/L			24-JUN-20
Carbonate (CO3)	<0.60		mg/L			24-JUN-20
Hydroxide (OH)	<0.34		mg/L			24-JUN-20
*Nitrate and Nitrite as N	<0.010		mg/L	10		25-JUN-20
pH						
pH	8.26		pH units			23-JUN-20
Turbidity						
*Turbidity	0.91		NTU			19-JUN-20
TDS calculated						
TDS (Calculated)	759		mg/L		500	24-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	204		mg/L		500	22-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		22-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		22-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	449		mg/L		500	24-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.284		mg/L	1.5		22-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					23-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	23-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		23-JUN-20
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		23-JUN-20
Barium (Ba)-Dissolved	0.0124		mg/L	2		23-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			23-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			23-JUN-20
Boron (B)-Dissolved	0.190		mg/L	5		23-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		23-JUN-20
Calcium (Ca)-Dissolved	70.1		mg/L			23-JUN-20
Cesium (Cs)-Dissolved	0.000020		mg/L			23-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		23-JUN-20
Cobalt (Co)-Dissolved	0.00017		mg/L			23-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	23-JUN-20
Iron (Fe)-Dissolved	0.099		mg/L		0.3	23-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		23-JUN-20

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-02
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0381		mg/L			23-JUN-20
Magnesium (Mg)-Dissolved	66.6		mg/L			23-JUN-20
Manganese (Mn)-Dissolved	0.00999		mg/L	0.12	0.02	23-JUN-20
Molybdenum (Mo)-Dissolved	0.000083		mg/L			23-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			23-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			23-JUN-20
Potassium (K)-Dissolved	7.43		mg/L			23-JUN-20
Rubidium (Rb)-Dissolved	0.00401		mg/L			23-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		23-JUN-20
Silicon (Si)-Dissolved	4.02		mg/L			23-JUN-20
Silver (Ag)-Dissolved	0.000023		mg/L			23-JUN-20
Sodium (Na)-Dissolved	107		mg/L		200	23-JUN-20
Strontium (Sr)-Dissolved	0.248		mg/L	7		23-JUN-20
Sulfur (S)-Dissolved	56.3		mg/L			23-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			23-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			23-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			23-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			23-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			23-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			23-JUN-20
Uranium (U)-Dissolved	0.000200		mg/L	0.02		23-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			23-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	23-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			23-JUN-20
Conductivity						
Conductivity	1180		umhos/cm			23-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	97.2		mg/L		250	22-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	345		mg/L			23-JUN-20
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		19-JUN-20
Escherichia Coli	0		MPN/100mL	0		19-JUN-20

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-02
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-03
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	447		mg/L			24-JUN-20
Carbonate (CO3)	3.96		mg/L			24-JUN-20
Hydroxide (OH)	<0.34		mg/L			24-JUN-20
*Nitrate and Nitrite as N	<0.010		mg/L	10		25-JUN-20
pH						
pH	8.33		pH units			23-JUN-20
Turbidity						
*Turbidity	1.29		NTU			19-JUN-20
TDS calculated						
TDS (Calculated)	576		mg/L		500	24-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	22-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		22-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		22-JUN-20
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	420		mg/L		500	24-JUN-20
Fluoride in Water by IC						
Fluoride (F)	0.308		mg/L	1.5		22-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					23-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	23-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		23-JUN-20
Arsenic (As)-Dissolved	0.00019		mg/L	0.01		23-JUN-20
Barium (Ba)-Dissolved	0.0175		mg/L	2		23-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			23-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			23-JUN-20
Boron (B)-Dissolved	0.190		mg/L	5		23-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		23-JUN-20
Calcium (Ca)-Dissolved	64.8		mg/L			23-JUN-20
Cesium (Cs)-Dissolved	0.000019		mg/L			23-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		23-JUN-20
Cobalt (Co)-Dissolved	0.00023		mg/L			23-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	23-JUN-20
Iron (Fe)-Dissolved	0.110		mg/L		0.3	23-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		23-JUN-20

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ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-03
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Lithium (Li)-Dissolved	0.0339		mg/L			23-JUN-20
Magnesium (Mg)-Dissolved	62.8		mg/L			23-JUN-20
Manganese (Mn)-Dissolved	0.0146		mg/L	0.12	0.02	23-JUN-20
Molybdenum (Mo)-Dissolved	0.000182		mg/L			23-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			23-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			23-JUN-20
Potassium (K)-Dissolved	6.56		mg/L			23-JUN-20
Rubidium (Rb)-Dissolved	0.00342		mg/L			23-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		23-JUN-20
Silicon (Si)-Dissolved	4.75		mg/L			23-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			23-JUN-20
Sodium (Na)-Dissolved	58.5		mg/L		200	23-JUN-20
Strontium (Sr)-Dissolved	0.241		mg/L	7		23-JUN-20
Sulfur (S)-Dissolved	36.6		mg/L			23-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			23-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			23-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			23-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			23-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			23-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			23-JUN-20
Uranium (U)-Dissolved	0.000175		mg/L	0.02		23-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			23-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	23-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			23-JUN-20
Conductivity						
Conductivity	930		umhos/cm			23-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	42.4		mg/L		250	22-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	373		mg/L			23-JUN-20
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		19-JUN-20
Escherichia Coli	0		MPN/100mL	0		19-JUN-20

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: SW19-KGS-03
Sampled By: PJL/SGB
Date Collected: 18-JUN-20
Lab Sample ID: L2463404-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: LSMOC-INLET-1A
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	135.0		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	94.6		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		25-JUN-20
Total Nitrogen	0.84		mg/L			25-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	0.84		mg/L			24-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		22-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		22-JUN-20
Phosphorus (P)-Total Dissolved	0.0055		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0275		mg/L			26-JUN-20
Ammonia, Total (as N)	0.025		mg/L			26-JUN-20
Total Suspended Solids	8.4		mg/L			24-JUN-20
*Turbidity	4.85		NTU			19-JUN-20

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Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: LSMOC-INLET-1A
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: BC-05
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	107.6		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	93.1		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		25-JUN-20
Total Nitrogen	1.30		mg/L			25-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	1.30		mg/L			24-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		22-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		22-JUN-20
Phosphorus (P)-Total Dissolved	0.0089		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0486		mg/L			26-JUN-20
Ammonia, Total (as N)	0.016		mg/L			26-JUN-20
Total Suspended Solids	35.0		mg/L			24-JUN-20
*Turbidity	26.3		NTU			19-JUN-20

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Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: BC-05
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: BC-02
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4						
Xylenes (Total)	<0.00064		mg/L	0.09	0.02	25-JUN-20
CCME Total Hydrocarbons						
F1-BTEX	<0.10		mg/L			25-JUN-20
Total Hydrocarbons (C6-C50)	<0.38		mg/L			25-JUN-20
CCME PHC F2-F4 in Water						
F2 (C10-C16)	<0.10		mg/L			20-JUN-20
F3 (C16-C34)	<0.25		mg/L			20-JUN-20
F4 (C34-C50)	<0.25		mg/L			20-JUN-20
Surr: 2-Bromobenzotrifluoride	107.9		%			20-JUN-20
BTX plus F1 by GCMS						
Benzene	<0.00050		mg/L	0.005		23-JUN-20
Toluene	<0.0010		mg/L	0.06	0.024	23-JUN-20
Ethyl benzene	<0.00050		mg/L	0.14	0.0016	23-JUN-20
o-Xylene	<0.00050		mg/L			23-JUN-20
m+p-Xylenes	<0.00040		mg/L			23-JUN-20
F1 (C6-C10)	<0.10		mg/L			23-JUN-20
Surr: 4-Bromofluorobenzene (SS)	92.0		%			23-JUN-20
Nitrogen Total						
*Nitrate and Nitrite as N	<0.070		mg/L	10		30-JUN-20
Total Nitrogen	1.14		mg/L			30-JUN-20
Total Kjeldahl Nitrogen						
Total Kjeldahl Nitrogen	1.14		mg/L			24-JUN-20
Nitrite in Water by IC						
*Nitrite (as N)	<0.010		mg/L	1		26-JUN-20
Nitrate in Water by IC						
*Nitrate (as N)	<0.020		mg/L	10		26-JUN-20
Phosphorus (P)-Total Dissolved	0.0085		mg/L			24-JUN-20
Mercury Dissolved						
Dissolved Mercury Filtration Location	FIELD					25-JUN-20
Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		30-JUN-20
Mercury (Hg)-Total	<0.0000050		mg/L	0.001		30-JUN-20
Phosphorus (P)-Total	0.0551		mg/L			26-JUN-20
Ammonia, Total (as N)	0.029		mg/L			26-JUN-20
Total Suspended Solids	3.2		mg/L			26-JUN-20
*Turbidity	2.12		NTU			26-JUN-20

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ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: BC-02
Sampled By: PJL/SGB
Date Collected: 17-JUN-20
Lab Sample ID: L2463404-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: TRIP
Sampled By: PJL/SGB
Date Collected:
Lab Sample ID: L2463404-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	<1.2		mg/L			25-JUN-20
Carbonate (CO3)	<0.60		mg/L			25-JUN-20
Hydroxide (OH)	<0.34		mg/L			25-JUN-20
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-JUN-20
pH						
pH	5.55		pH units			24-JUN-20
Turbidity						
*Turbidity	<0.10		NTU			19-JUN-20
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	29-JUN-20
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	22-JUN-20
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-JUN-20
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-JUN-20
Hardness Calculated						
Hardness (as CaCO3)	<0.20		mg/L		500	29-JUN-20
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		22-JUN-20
Dissolved Metals in Water by CRC ICPMS						
Dissolved Metals Filtration Location	FIELD					23-JUN-20
Aluminum (Al)-Dissolved	<0.0010		mg/L		0.1	23-JUN-20
Antimony (Sb)-Dissolved	<0.00010		mg/L	0.006		23-JUN-20
Arsenic (As)-Dissolved	<0.00010		mg/L	0.01		23-JUN-20
Barium (Ba)-Dissolved	<0.00010		mg/L	2		23-JUN-20
Beryllium (Be)-Dissolved	<0.00010		mg/L			23-JUN-20
Bismuth (Bi)-Dissolved	<0.000050		mg/L			23-JUN-20
Boron (B)-Dissolved	<0.010		mg/L	5		23-JUN-20
Cadmium (Cd)-Dissolved	<0.0000050		mg/L	0.005		23-JUN-20
Calcium (Ca)-Dissolved	<0.050		mg/L			26-JUN-20
Cesium (Cs)-Dissolved	<0.000010		mg/L			23-JUN-20
Chromium (Cr)-Dissolved	<0.00010		mg/L	0.05		23-JUN-20
Cobalt (Co)-Dissolved	<0.00010		mg/L			23-JUN-20
Copper (Cu)-Dissolved	<0.00020		mg/L	2.0	1.0	23-JUN-20
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	23-JUN-20
Lead (Pb)-Dissolved	<0.000050		mg/L	0.005		23-JUN-20
Lithium (Li)-Dissolved	<0.0010		mg/L			23-JUN-20
Magnesium (Mg)-	<0.0050		mg/L			26-JUN-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: TRIP
Sampled By: PJL/SGB
Date Collected:
Lab Sample ID: L2463404-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals in Water by CRC ICPMS						
Dissolved						
Manganese (Mn)-Dissolved	<0.00010		mg/L	0.12	0.02	23-JUN-20
Molybdenum (Mo)-Dissolved	<0.000050		mg/L			23-JUN-20
Nickel (Ni)-Dissolved	<0.00050		mg/L			23-JUN-20
Phosphorus (P)-Dissolved	<0.030		mg/L			23-JUN-20
Potassium (K)-Dissolved	<0.050		mg/L			23-JUN-20
Rubidium (Rb)-Dissolved	<0.00020		mg/L			23-JUN-20
Selenium (Se)-Dissolved	<0.000050		mg/L	0.05		23-JUN-20
Silicon (Si)-Dissolved	<0.050		mg/L			23-JUN-20
Silver (Ag)-Dissolved	<0.000010		mg/L			23-JUN-20
Sodium (Na)-Dissolved	<0.050		mg/L		200	23-JUN-20
Strontium (Sr)-Dissolved	<0.00010		mg/L	7		26-JUN-20
Sulfur (S)-Dissolved	<0.50		mg/L			23-JUN-20
Tellurium (Te)-Dissolved	<0.00020		mg/L			23-JUN-20
Thallium (Tl)-Dissolved	<0.000010		mg/L			23-JUN-20
Thorium (Th)-Dissolved	<0.00010		mg/L			23-JUN-20
Tin (Sn)-Dissolved	<0.00010		mg/L			23-JUN-20
Titanium (Ti)-Dissolved	<0.00030		mg/L			23-JUN-20
Tungsten (W)-Dissolved	<0.00010		mg/L			23-JUN-20
Uranium (U)-Dissolved	<0.000010		mg/L	0.02		23-JUN-20
Vanadium (V)-Dissolved	<0.00050		mg/L			23-JUN-20
Zinc (Zn)-Dissolved	<0.0010		mg/L		5.0	23-JUN-20
Zirconium (Zr)-Dissolved	<0.00020		mg/L			23-JUN-20
Conductivity						
Conductivity	<1.0		umhos/cm			24-JUN-20
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	22-JUN-20
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	<1.0		mg/L			24-JUN-20
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		19-JUN-20
Escherichia Coli	0		MPN/100mL	0		19-JUN-20

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ATTN: P. LINDELL

Date: 30-JUN-20
PO No.:
WO No.: L2463404
Project Ref: 18-0300-005.2302.04
Sample ID: TRIP
Sampled By: PJL/SGB
Date Collected:
Lab Sample ID: L2463404-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.
Manganese*	Criteria limit is 0.12 mg/L. Possible neurological effects in infants.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: P. LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R5129241								
WG3347902-19 LCS								
Alkalinity, Total (as CaCO3)			103.2		%		85-115	22-JUN-20
WG3347902-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	22-JUN-20
Batch R5131095								
WG3348907-10 DUP		**L2463404-2**						
Alkalinity, Total (as CaCO3)		330	328		mg/L	0.5	20	23-JUN-20
WG3348907-4 LCS								
Alkalinity, Total (as CaCO3)			101.4		%		85-115	23-JUN-20
WG3348907-9 LCS								
Alkalinity, Total (as CaCO3)			101.4		%		85-115	23-JUN-20
WG3348907-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	23-JUN-20
WG3348907-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	23-JUN-20
Batch R5131733								
WG3349652-4 LCS								
Alkalinity, Total (as CaCO3)			100.7		%		85-115	24-JUN-20
WG3349652-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	24-JUN-20
BTEXS+F1-HSMS-WP	**Water**							
Batch R5131240								
WG3347130-2 LCS								
Benzene			104.4		%		70-130	22-JUN-20
Toluene			101.9		%		70-130	22-JUN-20
Ethyl benzene			101.2		%		70-130	22-JUN-20
o-Xylene			108.4		%		70-130	22-JUN-20
m+p-Xylenes			104.2		%		70-130	22-JUN-20
WG3347130-3 LCS								
F1 (C6-C10)			108.2		%		70-130	22-JUN-20
WG3347130-1 MB								
Benzene			<0.00050		mg/L		0.0005	22-JUN-20
Toluene			<0.0010		mg/L		0.001	22-JUN-20
Ethyl benzene			<0.00050		mg/L		0.0005	22-JUN-20
o-Xylene			<0.00050		mg/L		0.0005	22-JUN-20
m+p-Xylenes			<0.00040		mg/L		0.0004	22-JUN-20
F1 (C6-C10)			<0.10		mg/L		0.1	22-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BTEXS+F1-HSMS-WP	**Water**							
Batch R5131240								
WG3347130-1 MB								
Surrogate: 4-Bromofluorobenzene (SS)			96.1		%		70-130	22-JUN-20
CL-L-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Chloride (Cl)			104.6		%		90-110	22-JUN-20
WG3346559-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	22-JUN-20
EC-WP	**Water**							
Batch R5129241								
WG3347902-18 LCS								
Conductivity			99.4		%		90-110	22-JUN-20
WG3347902-16 MB								
Conductivity			<1.0		umhos/cm		1	22-JUN-20
Batch R5131095								
WG3348907-10 DUP		**L2463404-2**						
Conductivity		700	696		umhos/cm	0.6	10	23-JUN-20
WG3348907-3 LCS								
Conductivity			98.8		%		90-110	23-JUN-20
WG3348907-8 LCS								
Conductivity			98.5		%		90-110	23-JUN-20
WG3348907-1 MB								
Conductivity			<1.0		umhos/cm		1	23-JUN-20
Batch R5131733								
WG3349652-3 LCS								
Conductivity			98.3		%		90-110	24-JUN-20
WG3349652-1 MB								
Conductivity			<1.0		umhos/cm		1	24-JUN-20
F-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Fluoride (F)			102.8		%		90-110	22-JUN-20
WG3346559-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	22-JUN-20
F2-F4-FID-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F2-F4-FID-WP	**Water**							
Batch R5128566								
WG3346557-4 LCS								
F2 (C10-C16)			106.6		%		70-130	20-JUN-20
F3 (C16-C34)			96.5		%		70-130	20-JUN-20
F4 (C34-C50)			105.3		%		70-130	20-JUN-20
WG3346557-3 MB								
F2 (C10-C16)			<0.10		mg/L		0.1	20-JUN-20
F3 (C16-C34)			<0.25		mg/L		0.25	20-JUN-20
F4 (C34-C50)			<0.25		mg/L		0.25	20-JUN-20
Surrogate: 2-Bromobenzotrifluoride			103.5		%		60-140	20-JUN-20
HG-D-CVAA-WP	**Water**							
Batch R5138697								
WG3353190-2 LCS								
Mercury (Hg)-Dissolved			107.0		%		80-120	30-JUN-20
WG3353190-1 MB								
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	30-JUN-20
HG-T-CVAA-WP	**Water**							
Batch R5138801								
WG3353182-2 LCS								
Mercury (Hg)-Total			107.0		%		80-120	30-JUN-20
WG3353182-1 MB								
Mercury (Hg)-Total			<0.000005		mg/L		0.000005	30-JUN-20
MET-D-CCMS-WP	**Water**							
Batch R5131179								
WG3348148-2 LCS								
Aluminum (Al)-Dissolved			98.9		%		80-120	23-JUN-20
Antimony (Sb)-Dissolved			103.4		%		80-120	23-JUN-20
Arsenic (As)-Dissolved			97.6		%		80-120	23-JUN-20
Barium (Ba)-Dissolved			99.99		%		80-120	23-JUN-20
Beryllium (Be)-Dissolved			105.6		%		80-120	23-JUN-20
Bismuth (Bi)-Dissolved			106.8		%		80-120	23-JUN-20
Boron (B)-Dissolved			93.4		%		80-120	23-JUN-20
Cadmium (Cd)-Dissolved			98.3		%		80-120	23-JUN-20
Calcium (Ca)-Dissolved			108.7		%		80-120	23-JUN-20
Cesium (Cs)-Dissolved			108.2		%		80-120	23-JUN-20
Chromium (Cr)-Dissolved			98.8		%		80-120	23-JUN-20
Cobalt (Co)-Dissolved			99.0		%		80-120	23-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5131179								
WG3348148-2 LCS								
Copper (Cu)-Dissolved			100.6		%		80-120	23-JUN-20
Iron (Fe)-Dissolved			92.4		%		80-120	23-JUN-20
Lead (Pb)-Dissolved			107.1		%		80-120	23-JUN-20
Lithium (Li)-Dissolved			108.3		%		80-120	23-JUN-20
Magnesium (Mg)-Dissolved			110.6		%		80-120	23-JUN-20
Manganese (Mn)-Dissolved			97.1		%		80-120	23-JUN-20
Molybdenum (Mo)-Dissolved			106.0		%		80-120	23-JUN-20
Nickel (Ni)-Dissolved			98.6		%		80-120	23-JUN-20
Phosphorus (P)-Dissolved			95.4		%		80-120	23-JUN-20
Potassium (K)-Dissolved			100.8		%		80-120	23-JUN-20
Rubidium (Rb)-Dissolved			99.3		%		80-120	23-JUN-20
Selenium (Se)-Dissolved			109.3		%		80-120	23-JUN-20
Silicon (Si)-Dissolved			111.9		%		80-120	23-JUN-20
Silver (Ag)-Dissolved			103.8		%		80-120	23-JUN-20
Sodium (Na)-Dissolved			104.3		%		80-120	23-JUN-20
Strontium (Sr)-Dissolved			107.8		%		80-120	23-JUN-20
Sulfur (S)-Dissolved			113.9		%		80-120	23-JUN-20
Tellurium (Te)-Dissolved			104.3		%		80-120	23-JUN-20
Thallium (Tl)-Dissolved			107.4		%		80-120	23-JUN-20
Thorium (Th)-Dissolved			107.1		%		80-120	23-JUN-20
Tin (Sn)-Dissolved			98.7		%		80-120	23-JUN-20
Titanium (Ti)-Dissolved			94.9		%		80-120	23-JUN-20
Tungsten (W)-Dissolved			106.0		%		80-120	23-JUN-20
Uranium (U)-Dissolved			107.2		%		80-120	23-JUN-20
Vanadium (V)-Dissolved			99.4		%		80-120	23-JUN-20
Zinc (Zn)-Dissolved			96.8		%		80-120	23-JUN-20
Zirconium (Zr)-Dissolved			102.7		%		80-120	23-JUN-20
WG3348148-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	23-JUN-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	23-JUN-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5131179								
WG3348148-1 MB								
Boron (B)-Dissolved			<0.010		mg/L		0.01	23-JUN-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	23-JUN-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	23-JUN-20
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	23-JUN-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	23-JUN-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	23-JUN-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	23-JUN-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	23-JUN-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	23-JUN-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	23-JUN-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	23-JUN-20
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	23-JUN-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	23-JUN-20
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	23-JUN-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	23-JUN-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	23-JUN-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	23-JUN-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	23-JUN-20
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	23-JUN-20
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	23-JUN-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	23-JUN-20
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	23-JUN-20
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	23-JUN-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	23-JUN-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	23-JUN-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	23-JUN-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	23-JUN-20
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R5131171								
WG3347032-6 LCS								
Total Kjeldahl Nitrogen			95.2		%		75-125	24-JUN-20
WG3347032-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	24-JUN-20
NH3-COL-WP	**Water**							
Batch R5135765								
WG3351968-2 LCS								
Ammonia, Total (as N)			97.9		%		85-115	26-JUN-20
WG3351968-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	26-JUN-20
NO2-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Nitrite (as N)			103.1		%		90-110	22-JUN-20
WG3346559-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	22-JUN-20
NO2-L-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Nitrite (as N)			103.1		%		90-110	22-JUN-20
WG3346559-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	22-JUN-20
NO3-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Nitrate (as N)			104.9		%		90-110	22-JUN-20
WG3346559-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	22-JUN-20
NO3-L-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Nitrate (as N)			104.9		%		90-110	22-JUN-20
WG3346559-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	22-JUN-20
P-T-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-WP	**Water**							
Batch R5133944								
WG3350549-2 LCS								
Phosphorus (P)-Total			101.1		%		80-120	26-JUN-20
WG3350549-1 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	26-JUN-20
P-TD-COL-WP	**Water**							
Batch R5131182								
WG3348693-6 LCS								
Phosphorus (P)-Total	Dissolved		97.7		%		80-120	24-JUN-20
WG3348693-5 MB								
Phosphorus (P)-Total	Dissolved		<0.0030		mg/L		0.003	24-JUN-20
PH-WP	**Water**							
Batch R5129241								
WG3347902-17 LCS								
pH			7.34		pH units		7.3-7.5	22-JUN-20
Batch R5131095								
WG3348907-10 DUP		**L2463404-2**						
pH		8.29	8.31	J	pH units	0.02	0.2	23-JUN-20
WG3348907-2 LCS								
pH			7.33		pH units		7.3-7.5	23-JUN-20
WG3348907-7 LCS								
pH			7.31		pH units		7.3-7.5	23-JUN-20
Batch R5131733								
WG3349652-2 LCS								
pH			7.35		pH units		7.3-7.5	24-JUN-20
SO4-IC-N-WP	**Water**							
Batch R5131382								
WG3346559-2 LCS								
Sulfate (SO4)			105.6		%		90-110	22-JUN-20
WG3346559-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	22-JUN-20
SOLIDS-TOTSUS-WP	**Water**							
Batch R5132616								
WG3348929-2 LCS								
Total Suspended Solids			86.7		%		85-115	24-JUN-20
WG3348929-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TOTSUS-WP	**Water**							
Batch R5132616								
WG3348929-1 MB								
Total Suspended Solids			<3.0		mg/L		3	24-JUN-20
Batch R5137800								
WG3350740-2 LCS								
Total Suspended Solids			91.0		%		85-115	26-JUN-20
WG3350740-1 MB								
Total Suspended Solids			<3.0		mg/L		3	26-JUN-20
TC,EC-QT51-WP	**Water**							
Batch R5126494								
WG3346218-2 DUP		**L2463404-8**						
Total Coliforms		0	0		MPN/100mL	0.0	65	19-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	19-JUN-20
WG3346218-3 DUP		**L2463404-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	19-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	19-JUN-20
WG3346218-4 DUP		**L2463404-3**						
Total Coliforms		0	0		MPN/100mL	0.0	65	19-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	19-JUN-20
WG3346218-5 DUP		**L2463404-2**						
Total Coliforms		0	0		MPN/100mL	0.0	65	19-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	19-JUN-20
WG3346218-6 DUP		**L2463404-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	19-JUN-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	19-JUN-20
WG3346218-1 MB								
Total Coliforms			0		MPN/100mL		1	19-JUN-20
Escherichia Coli			0		MPN/100mL		1	19-JUN-20
TURBIDITY-WP	**Water**							
Batch R5126854								
WG3346878-9 DUP		**L2463404-6**						
Turbidity		26.3	26.0		NTU	1.1	15	19-JUN-20
WG3346878-5 LCS								
Turbidity			101.5		%		85-115	19-JUN-20
WG3346878-8 LCS								
Turbidity			102.5		%		85-115	19-JUN-20
WG3346878-4 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R5126854								
WG3346878-4 MB								
Turbidity			<0.10		NTU		0.1	19-JUN-20
WG3346878-7 MB								
Turbidity			<0.10		NTU		0.1	19-JUN-20
Batch R5136957								
WG3352105-2 LCS								
Turbidity			103.5		%		85-115	26-JUN-20
WG3352105-1 MB								
Turbidity			<0.10		NTU		0.1	26-JUN-20

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Total Suspended Solids							
	7	17-JUN-20 17:35	26-JUN-20 12:30	7	9	days	EHT
Turbidity							
	7	17-JUN-20 17:35	26-JUN-20 07:00	3	9	days	EHT
pH							
	1	17-JUN-20 16:30	22-JUN-20 12:00	0.25	115	hours	EHTR-FM
	2	18-JUN-20 11:25	23-JUN-20 12:00	0.25	120	hours	EHTR-FM
	3	18-JUN-20 15:15	23-JUN-20 12:00	0.25	117	hours	EHTR-FM
	4	18-JUN-20 13:50	23-JUN-20 12:00	0.25	118	hours	EHTR-FM
	8	Not provided	24-JUN-20 12:00	0.25	119	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC							
	5	17-JUN-20 17:00	22-JUN-20 13:00	3	5	days	EHT
	6	17-JUN-20 17:25	22-JUN-20 13:00	3	5	days	EHT
	7	17-JUN-20 17:35	26-JUN-20 13:00	3	9	days	EHT
Nitrate in Water by IC (Low Level)							
	1	17-JUN-20 16:30	22-JUN-20 13:00	3	5	days	EHT
	2	18-JUN-20 11:25	22-JUN-20 13:00	3	4	days	EHT
	3	18-JUN-20 15:15	22-JUN-20 13:00	3	4	days	EHT
	4	18-JUN-20 13:50	22-JUN-20 13:00	3	4	days	EHT
Nitrite in Water by IC							
	5	17-JUN-20 17:00	22-JUN-20 13:00	3	5	days	EHT
	6	17-JUN-20 17:25	22-JUN-20 13:00	3	5	days	EHT
	7	17-JUN-20 17:35	26-JUN-20 13:00	3	9	days	EHT
Nitrite in Water by IC (Low Level)							
	1	17-JUN-20 16:30	22-JUN-20 13:00	3	5	days	EHT
	2	18-JUN-20 11:25	22-JUN-20 13:00	3	4	days	EHT
	3	18-JUN-20 15:15	22-JUN-20 13:00	3	4	days	EHT
	4	18-JUN-20 13:50	22-JUN-20 13:00	3	4	days	EHT
Bacteriological Tests							
Total Coliform and E.coli							
	1	17-JUN-20 16:30	19-JUN-20 16:55	30	48	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2463404 were received on 19-JUN-20 13:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

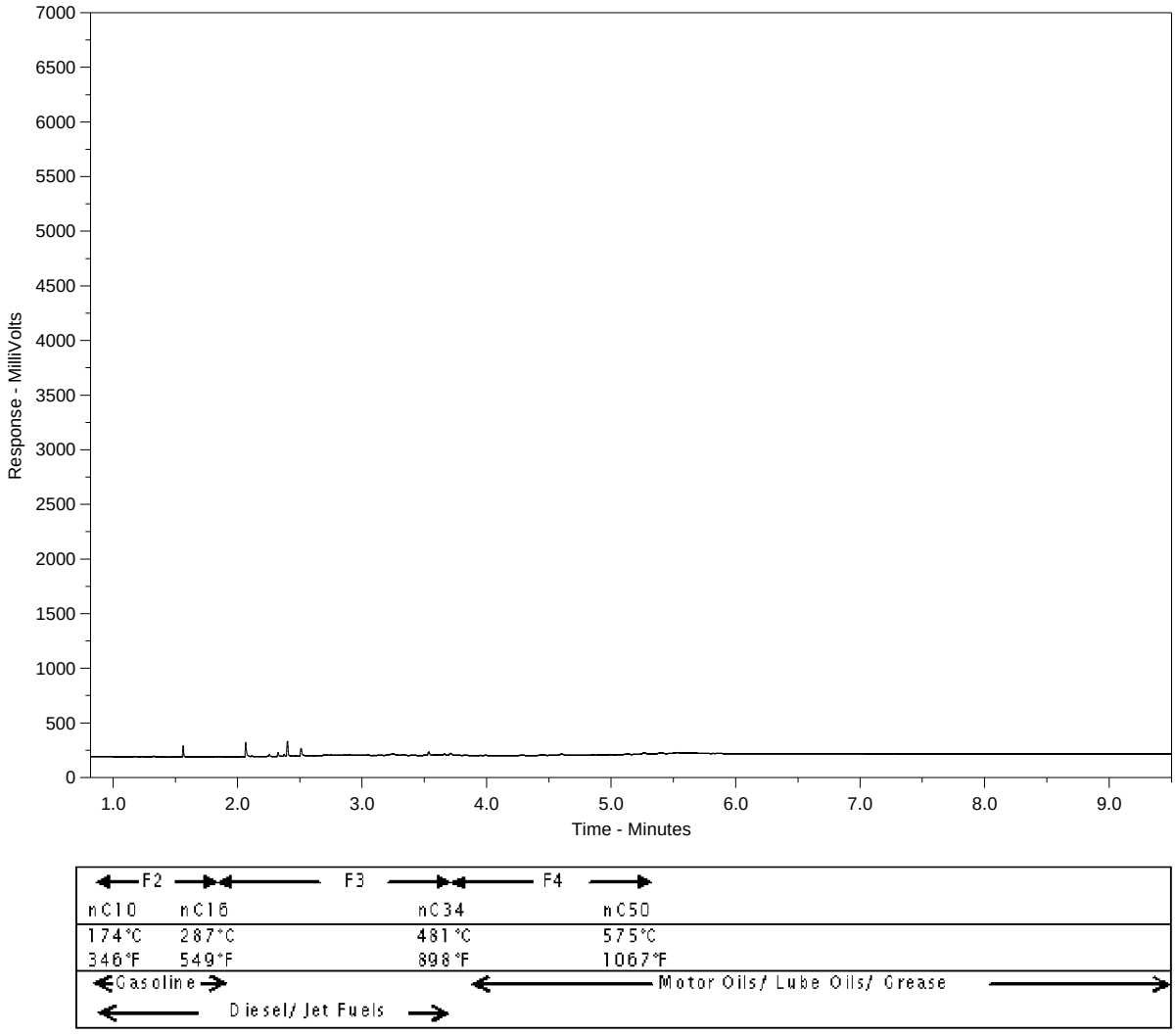
Quality Control Report

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2463404-5
Client Sample ID: LSMOC-INLET-1A



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

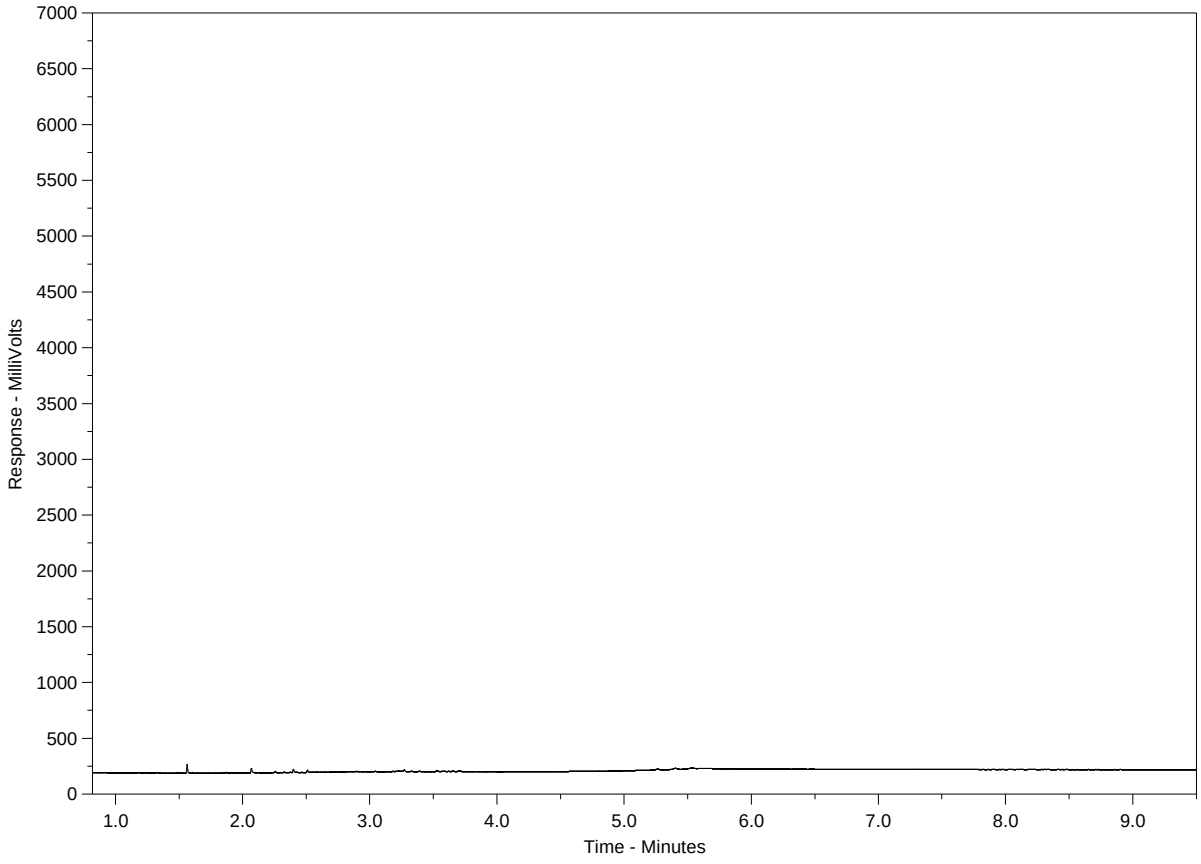
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

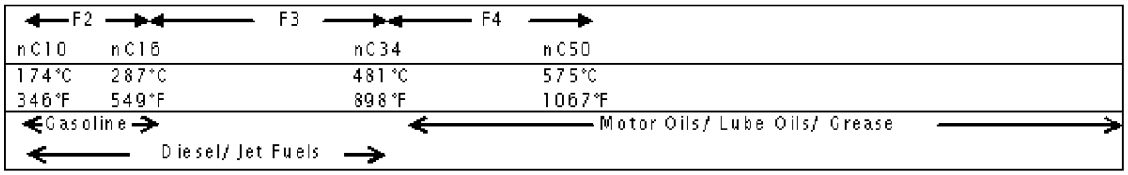
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2463404-6
Client Sample ID: BC-05





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

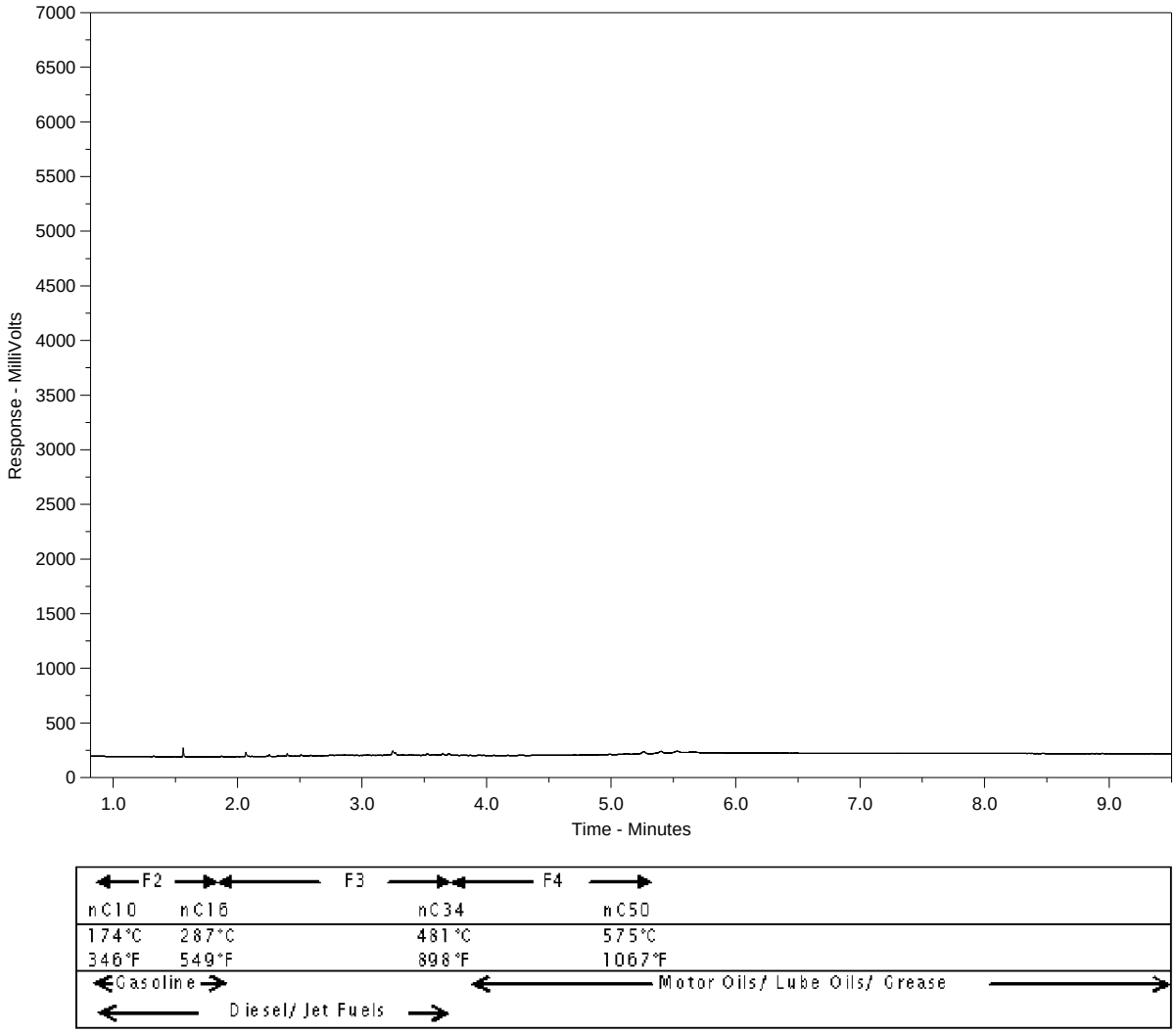
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2463404-7
Client Sample ID: BC-02



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2463404-COFC

COC Number: 17 - 751102

Page of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: [X] PDF [X] EXCEL [ ] EDD (DIGITAL)	Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	P. Lindell	Quality Control (QC) Report with Report [ ] YES [ ] NO	PRIORITY (Business Days): 4 day [P4-20%] [ ] / 3 day [P3-25%] [ ] / 2 day [P2-50%] [ ]
Phone:	204-803-0720	[ ] Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] [ ] / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] [ ]
	Company address below will appear on the final report	Select Distribution: [X] EMAIL [ ] MAIL [ ] FAX	
Street:	865 Waverley St.	Email 1 or Fax: plindell@kgsgroup.com	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
City/Province:	Wpg, MB	Email 2: soffman@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
Postal Code:	R3T 5P4	Email 3:	
Invoice To	Same as Report To [ ] YES [ ] NO	Invoice Distribution	Analysis Request
	Copy of Invoice with Report [ ] YES [ ] NO	Select Invoice Distribution: [✓] EMAIL [ ] MAIL [ ] FAX	
Company:		Email 1 or Fax: payables@kgsgroup.com	
Contact:		Email 2:	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q58403	AFE/Cost Center:	PO#:
Job #:	18-0300-005.6302.04	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Judy D	Sampler: PDL/SGB

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	BTEX, F1-F4	Conductivity Screening Only	Tot. Nitrogen Calculated	Mercury Dissolved	Mercury Total	Ammonia by Colour	Nitrogen, Total	Phosphorus, Total Dissolved	Phosphorus, Total	RSKHW Dissolved	Total Suspended Solids	[illegible]	Turbidity	TSS, EC, DTS	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
															F/P						
	PW19-KGS-01	17-Jun-20	16:30	GW	2										X			X	X		
	SW19-KGS-01	18-Jun-20	11:25		4										X				X		
	SW19-KGS-02		15:15		3										X				X		
	SW19-KGS-03		13:50		3										X				X		
	LSMOC-INLET-1A	17-Jun-20	17:00	SW	15	X	X	X	X	X	X	X	X	X		X		X			
	BC-05		17:25		10	↓	↓	↓	↓	↓	↓	↓	↓	↓		↓		↓			
	BC-02		17:35		10	↓	↓	↓	↓	↓	↓	↓	↓	↓		↓		↓			
	TRIP BLANK				3										X				X		

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? [ ] YES [X] NO	GW - Metals bottle - F/P
Are samples for human consumption/ use? [ ] YES [X] NO	SW - [illegible]/Mercury & [illegible] Amber - F/P
	TRIP - Water from Lab.

SAMPLE CONDITION AS RECEIVED (lab use only)			
Frozen [ ]	SIF Observations	Yes [ ]	No [ ]
Ice Packs [ ] Ice Cubes [ ]	Custody seal intact	Yes [ ]	No [ ]
Cooling Initiated [ ]			
INITIAL COOLER TEMPERATURES °C: 3.9		FINAL COOLER TEMPERATURES °C:	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
[signature]	Jun 19/20	11:50	[signature]	19 Jun	1100			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2015 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS Group Consultants (Winnipeg)
ATTN: PAUL LINDELL
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

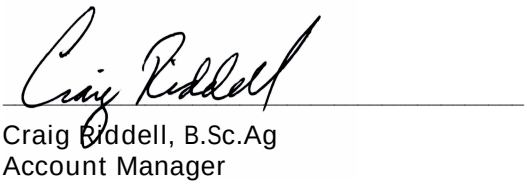
Date Received: 29-OCT-20
Report Date: 05-NOV-20 14:10 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L2523514

Project P.O. #: NOT SUBMITTED
Job Reference: 18-0300-005.2302.04
C of C Numbers:
Legal Site Desc:



Craig Riddell, B.Sc.Ag
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-1 PW19-KGS-01							
Sampled By: PJL/NB on 27-OCT-20 @ 10:00							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	398		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	327		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	9.46		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	726		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00078		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0243		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.145		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	51.7		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00019		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.152		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0227		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	50.2		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.00596		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.00106		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	4.40		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00128		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	5.72		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	26.9		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.222		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	25.9		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-1 PW19-KGS-01							
Sampled By: PJL/NB on 27-OCT-20 @ 10:00							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.00162		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.251		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	336		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	70.5		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	409		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	1.91		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.26		0.10	pH units		30-OCT-20	R5272787
L2523514-2 PW19-KGS-02							
Sampled By: PJL/NB on 28-OCT-20 @ 17:30							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0		0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	401		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	329		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	16.9		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	787		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00185		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0245		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.139		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-2 PW19-KGS-02							
Sampled By: PJL/NB on 28-OCT-20 @ 17:30							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	54.2		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00015		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.191		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0240		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	50.6		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.00685		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000503		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	4.50		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00253		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	5.69		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	34.5		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.218		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	29.1		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000935		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.330		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	344		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	85.5		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	444		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	2.96		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.24		0.10	pH units		30-OCT-20	R5272787

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-3 PW19-KGS-03							
Sampled By: PJL/NB on 27-OCT-20 @ 17:10							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0	PEHT	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHT	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	388		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	318		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	0.99		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	608		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00091		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0546		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.094		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	56.2		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00082		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.362		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0160		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	43.1		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.126		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000355		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	0.00140		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	3.32		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00210		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	5.10		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	7.05		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.148		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	9.81		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-3 PW19-KGS-03							
Sampled By: PJL/NB on 27-OCT-20 @ 17:10							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.00145		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.202		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	318		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	27.1		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	329		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	0.82		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.21		0.10	pH units		30-OCT-20	R5272787
L2523514-4 TH19-KGS-12							
Sampled By: PJL/NB on 28-OCT-20 @ 12:50							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0		0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	502		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	412		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	3.06		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	775		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	0.0062		0.0010	mg/L	02-NOV-20	03-NOV-20	R5278083
Antimony (Sb)-Dissolved	0.00025		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00214		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.107		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.135		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-4 TH19-KGS-12							
Sampled By: PJL/NB on 28-OCT-20 @ 12:50							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	45.3		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	0.00020		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00168		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	0.00030		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.423		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0353		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	64.1		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.227		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.00605		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	0.00540		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	4.55		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00200		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	6.07		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	26.4		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.261		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	20.7		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295
Tungsten (W)-Dissolved	0.00024		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000273		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	0.0013		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.319		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	377		0.20	mg/L		04-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0101		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0101		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	59.2		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	450		5.0	mg/L		04-NOV-20	
Turbidity							
Turbidity	3240		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.20		0.10	pH units		30-OCT-20	R5272787

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-5 TH19-KGS-17							
Sampled By: PJL/NB on 27-OCT-20 @ 15:10							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	393		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	322		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	0.92		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	637		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	1.25		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00134		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0607		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	0.00012		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.094		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	0.0000064		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	67.7		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	0.000298		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	0.00224		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00119		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	0.00168		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	1.35		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	0.00282		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0192		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	60.5		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.0417		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000300		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	0.00344		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	0.094		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	3.84		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00528		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	6.22		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	8.63		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.169		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	15.9		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	0.000020		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	0.00081		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	0.0471		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-5 TH19-KGS-17							
Sampled By: PJL/NB on 27-OCT-20 @ 15:10							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000232		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	0.00216		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	0.0071		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	0.00189		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.245		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	418		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	42.7		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	378		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	>4000	TMV	0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.20		0.10	pH units		30-OCT-20	R5272787
L2523514-6 TH19-KGS-18							
Sampled By: PJL/NB on 27-OCT-20 @ 13:40							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	655		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	537		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	0.17		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	908		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272875
Aluminum (Al)-Dissolved	0.0030		0.0010	mg/L	02-NOV-20	03-NOV-20	R5278083
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00163		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0871		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.063		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-6 TH19-KGS-18							
Sampled By: PJL/NB on 27-OCT-20 @ 13:40							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	108		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	0.00020		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00042		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	1.53		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0227		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	55.2		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.0492		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000614		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	0.00136		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	1.14		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00157		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.000063		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	8.64		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	9.36		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.227		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	2.14		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000475		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	0.00046		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.143		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	498		0.20	mg/L		04-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	1.20		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	498		5.0	mg/L		04-NOV-20	
Turbidity							
Turbidity	1880		0.10	NTU		30-OCT-20	R5275126
pH							
pH	7.81		0.10	pH units		30-OCT-20	R5272787

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-7 TH19-KGS-19							
Sampled By: PJL/NB on 27-OCT-20 @ 11:40							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	1	PEHR	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	568		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	466		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	1.88		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	890		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272878
Aluminum (Al)-Dissolved	0.0094		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00352		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.195		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.112		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	62.7		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	0.00012		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.026		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0341		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	81.2		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.469		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000099		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	4.15		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00144		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.000337		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	8.12		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	23.4		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.711		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	65.2		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	0.00016		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	0.00032		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-7 TH19-KGS-19							
Sampled By: PJL/NB on 27-OCT-20 @ 11:40							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	0.00189		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000842		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	0.00031		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.242		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	491		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0166		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0166		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	68.5		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	521		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	32.4		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.21		0.10	pH units		30-OCT-20	R5272787
L2523514-8 PW-100							
Sampled By: PJL/NB on 28-OCT-20 @ 17:35							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0		0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	398		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	326		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	16.8		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	790		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272878
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00182		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0248		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.139		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-8 PW-100							
Sampled By: PJL/NB on 28-OCT-20 @ 17:35							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	55.4		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	0.000023		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00016		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.202		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0249		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	51.4		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.00694		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000502		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	4.53		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00244		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.00151		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	5.74		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	35.7		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.222		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	30.2		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000952		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.344		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	350		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	85.4		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	445		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	2.47		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.08		0.10	pH units		30-OCT-20	R5272787

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-9 SW19-KGS-02							
Sampled By: PJL/NB on 29-OCT-20 @ 12:25							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0		0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	415		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	340		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	89.0		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	1240		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272878
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0122		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.203		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	65.0		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	0.000014		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00017		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.102		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0364		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	63.5		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.0103		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000102		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	7.39		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00408		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.000791		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	4.37		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	106		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.246		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	65.9		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-9 SW19-KGS-02							
Sampled By: PJL/NB on 29-OCT-20 @ 12:25							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000183		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.291		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	424		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	187		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	722		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	1.17		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.06		0.10	pH units		30-OCT-20	R5272787
L2523514-10 SW19-KGS-03							
Sampled By: PJL/NB on 29-OCT-20 @ 11:00							
Matrix: GW							
Total Coliform and E.coli							
Total Coliforms	2		0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0		0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	456		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	374		1.0	mg/L		30-OCT-20	R5272787
Chloride in Water by IC (Low Level)							
Chloride (Cl)	39.3		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	979		1.0	umhos/cm		30-OCT-20	R5272787
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272878
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	0.00022		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	0.0180		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	0.206		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-10 SW19-KGS-03							
Sampled By: PJL/NB on 29-OCT-20 @ 11:00							
Matrix: GW							
Dissolved Metals in Water by CRC ICPMS							
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	60.2		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	0.000020		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	0.00024		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	0.116		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	0.0326		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	62.4		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	0.0152		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	0.000188		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	6.74		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	0.00356		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.000544		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	4.74		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	59.8		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	0.240		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	38.1		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	0.000164		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	0.319		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	407		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	109		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	562		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	1.44		0.10	NTU		30-OCT-20	R5275126
pH							
pH	8.03		0.10	pH units		30-OCT-20	R5272787

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-11 TRIP BLANK							
Sampled By: PJL/NB on 26-OCT-20							
Matrix:							
Total Coliform and E.coli							
Total Coliforms	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
Escherichia Coli	0	PEHR	0	MPN/100mL		29-OCT-20	R5271879
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	<1.2		1.2	mg/L		02-NOV-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		02-NOV-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		02-NOV-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	<1.0		1.0	mg/L		02-NOV-20	R5273180
Chloride in Water by IC (Low Level)							
Chloride (Cl)	<0.10		0.10	mg/L		31-OCT-20	R5278767
Conductivity							
Conductivity	<1.0		1.0	umhos/cm		02-NOV-20	R5273180
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	FIELD					02-NOV-20	R5272878
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Arsenic (As)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Barium (Ba)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Boron (B)-Dissolved	<0.010		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cadmium (Cd)-Dissolved	<0.0000050		0.0000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Calcium (Ca)-Dissolved	<0.050		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Cesium (Cs)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Cobalt (Co)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Iron (Fe)-Dissolved	<0.010		0.010	mg/L	02-NOV-20	02-NOV-20	R5275295
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Lithium (Li)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Magnesium (Mg)-Dissolved	<0.0050		0.0050	mg/L	02-NOV-20	02-NOV-20	R5275295
Manganese (Mn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Molybdenum (Mo)-Dissolved	<0.000050		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Nickel (Ni)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	02-NOV-20	02-NOV-20	R5275295
Potassium (K)-Dissolved	<0.050		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Rubidium (Rb)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Selenium (Se)-Dissolved	0.000090		0.000050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silicon (Si)-Dissolved	<0.050		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sodium (Na)-Dissolved	<0.050		0.050	mg/L	02-NOV-20	02-NOV-20	R5275295
Strontium (Sr)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Sulfur (S)-Dissolved	<0.50		0.50	mg/L	02-NOV-20	02-NOV-20	R5275295
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Thallium (Tl)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	02-NOV-20	02-NOV-20	R5275295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2523514-11 TRIP BLANK							
Sampled By: PJL/NB on 26-OCT-20							
Matrix:							
Dissolved Metals in Water by CRC ICPMS							
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	02-NOV-20	02-NOV-20	R5275295
Uranium (U)-Dissolved	<0.000010		0.000010	mg/L	02-NOV-20	02-NOV-20	R5275295
Vanadium (V)-Dissolved	<0.00050		0.00050	mg/L	02-NOV-20	02-NOV-20	R5275295
Zinc (Zn)-Dissolved	<0.0010		0.0010	mg/L	02-NOV-20	02-NOV-20	R5275295
Zirconium (Zr)-Dissolved	<0.00020		0.00020	mg/L	02-NOV-20	02-NOV-20	R5275295
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		31-OCT-20	R5278767
Hardness Calculated							
Hardness (as CaCO3)	<0.20		0.20	mg/L		03-NOV-20	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		31-OCT-20	R5278767
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-NOV-20	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		31-OCT-20	R5278767
Sulfate in Water by IC							
Sulfate (SO4)	<0.30		0.30	mg/L		31-OCT-20	R5278767
TDS calculated							
TDS (Calculated)	<5.0		5.0	mg/L		03-NOV-20	
Turbidity							
Turbidity	<0.10		0.10	NTU		30-OCT-20	R5275126
pH							
pH	5.57		0.10	pH units		02-NOV-20	R5273180

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.
PEHT	Parameter Exceeded Recommended Holding Time Prior to Analysis
TMV	Turbidity exceeded upper limit of the nephelometric method. Minimum value reported.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-WP	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020B (mod)

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TC,EC-QT51-WP	Water	Total Coliform and E.coli	APHA 9223B QT51
This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 +/- 0.5 degrees C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2523514 Report Date: 05-NOV-20

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R5272787								
WG3436899-15 DUP		**L2523514-8**						
Alkalinity, Total (as CaCO3)		326	326		mg/L	0.0	20	30-OCT-20
WG3436899-14 LCS								
Alkalinity, Total (as CaCO3)			96.3		%		85-115	30-OCT-20
WG3436899-24 LCS								
Alkalinity, Total (as CaCO3)			98.3		%		85-115	30-OCT-20
WG3436899-11 MB								
Alkalinity, Total (as CaCO3)			1.1	B	mg/L		1	30-OCT-20
WG3436899-21 MB								
Alkalinity, Total (as CaCO3)			1.5	B	mg/L		1	30-OCT-20
Batch R5273180								
WG3437150-4 LCS								
Alkalinity, Total (as CaCO3)			98.5		%		85-115	02-NOV-20
WG3437150-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-20
CL-L-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-10 LCS								
Chloride (Cl)			96.6		%		90-110	31-OCT-20
WG3436253-6 LCS								
Chloride (Cl)			96.7		%		90-110	31-OCT-20
WG3436253-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-OCT-20
WG3436253-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-OCT-20
EC-WP	**Water**							
Batch R5272787								
WG3436899-15 DUP		**L2523514-8**						
Conductivity		790	788		umhos/cm	0.3	10	30-OCT-20
WG3436899-13 LCS								
Conductivity			102.4		%		90-110	30-OCT-20
WG3436899-23 LCS								
Conductivity			103.0		%		90-110	30-OCT-20
WG3436899-11 MB								
Conductivity			<1.0		umhos/cm		1	30-OCT-20
WG3436899-21 MB								
Conductivity			1.6	B	umhos/cm		1	30-OCT-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WP	**Water**							
Batch R5273180								
WG3437150-3 LCS								
Conductivity			100.2		%		90-110	02-NOV-20
WG3437150-1 MB								
Conductivity			<1.0		umhos/cm		1	02-NOV-20
F-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-10 LCS								
Fluoride (F)			98.1		%		90-110	31-OCT-20
WG3436253-6 LCS								
Fluoride (F)			98.0		%		90-110	31-OCT-20
WG3436253-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	31-OCT-20
WG3436253-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	31-OCT-20
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436937-4 DUP		**L2523514-7**						
Aluminum (Al)-Dissolved		0.0094	0.0115	DUP-H	mg/L	21	20	02-NOV-20
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-20
Arsenic (As)-Dissolved		0.00352	0.00356		mg/L	1.1	20	02-NOV-20
Barium (Ba)-Dissolved		0.195	0.196		mg/L	0.7	20	02-NOV-20
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-20
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	02-NOV-20
Boron (B)-Dissolved		0.112	0.116		mg/L	3.0	20	02-NOV-20
Cadmium (Cd)-Dissolved		<0.0000050	<0.000005(	RPD-NA	mg/L	N/A	20	02-NOV-20
Calcium (Ca)-Dissolved		62.7	64.4		mg/L	2.7	20	02-NOV-20
Cesium (Cs)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	02-NOV-20
Chromium (Cr)-Dissolved		0.00012	0.00011		mg/L	10	20	02-NOV-20
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-20
Copper (Cu)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	02-NOV-20
Iron (Fe)-Dissolved		0.026	0.026		mg/L	0.7	20	02-NOV-20
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	02-NOV-20
Lithium (Li)-Dissolved		0.0341	0.0341		mg/L	0.0	20	02-NOV-20
Magnesium (Mg)-Dissolved		81.2	81.4		mg/L	0.3	20	02-NOV-20
Manganese (Mn)-Dissolved		0.469	0.462		mg/L	1.5	20	02-NOV-20
Molybdenum (Mo)-Dissolved		0.000099	0.000102		mg/L	3.1	20	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436937-4 DUP		**L2523514-7**						
Nickel (Ni)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-20
Phosphorus (P)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	02-NOV-20
Potassium (K)-Dissolved		4.15	4.12		mg/L	0.8	20	02-NOV-20
Rubidium (Rb)-Dissolved		0.00144	0.00139		mg/L	3.5	20	02-NOV-20
Selenium (Se)-Dissolved		0.000337	0.000398		mg/L	17	20	02-NOV-20
Silicon (Si)-Dissolved		8.12	7.97		mg/L	1.9	20	02-NOV-20
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	02-NOV-20
Sodium (Na)-Dissolved		23.4	23.2		mg/L	0.8	20	02-NOV-20
Strontium (Sr)-Dissolved		0.711	0.707		mg/L	0.6	20	02-NOV-20
Sulfur (S)-Dissolved		65.2	72.1		mg/L	10	20	02-NOV-20
Tellurium (Te)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	02-NOV-20
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	02-NOV-20
Thorium (Th)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-20
Tin (Sn)-Dissolved		0.00016	0.00016		mg/L	2.9	20	02-NOV-20
Titanium (Ti)-Dissolved		0.00032	0.00042	J	mg/L	0.00010	0.0006	02-NOV-20
Tungsten (W)-Dissolved		0.00189	0.00194		mg/L	2.8	20	02-NOV-20
Uranium (U)-Dissolved		0.000842	0.000872		mg/L	3.5	20	02-NOV-20
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-20
Zinc (Zn)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	02-NOV-20
Zirconium (Zr)-Dissolved		0.00031	0.00031		mg/L	1.8	20	02-NOV-20
WG3436936-2 LCS								
Aluminum (Al)-Dissolved			103.1		%		80-120	02-NOV-20
Antimony (Sb)-Dissolved			99.1		%		80-120	02-NOV-20
Arsenic (As)-Dissolved			101.0		%		80-120	02-NOV-20
Barium (Ba)-Dissolved			100.1		%		80-120	02-NOV-20
Beryllium (Be)-Dissolved			102.2		%		80-120	02-NOV-20
Bismuth (Bi)-Dissolved			99.6		%		80-120	02-NOV-20
Boron (B)-Dissolved			101.8		%		80-120	02-NOV-20
Cadmium (Cd)-Dissolved			101.4		%		80-120	02-NOV-20
Calcium (Ca)-Dissolved			99.98		%		80-120	02-NOV-20
Cesium (Cs)-Dissolved			100.2		%		80-120	02-NOV-20
Chromium (Cr)-Dissolved			101.6		%		80-120	02-NOV-20
Cobalt (Co)-Dissolved			100.7		%		80-120	02-NOV-20
Copper (Cu)-Dissolved			101.8		%		80-120	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436936-2 LCS								
Iron (Fe)-Dissolved			97.3		%		80-120	02-NOV-20
Lead (Pb)-Dissolved			99.3		%		80-120	02-NOV-20
Lithium (Li)-Dissolved			104.4		%		80-120	02-NOV-20
Magnesium (Mg)-Dissolved			108.0		%		80-120	02-NOV-20
Manganese (Mn)-Dissolved			102.3		%		80-120	02-NOV-20
Molybdenum (Mo)-Dissolved			101.3		%		80-120	02-NOV-20
Nickel (Ni)-Dissolved			100.3		%		80-120	02-NOV-20
Phosphorus (P)-Dissolved			101.0		%		80-120	02-NOV-20
Potassium (K)-Dissolved			102.5		%		80-120	02-NOV-20
Rubidium (Rb)-Dissolved			99.9		%		80-120	02-NOV-20
Selenium (Se)-Dissolved			100.4		%		80-120	02-NOV-20
Silicon (Si)-Dissolved			98.9		%		80-120	02-NOV-20
Silver (Ag)-Dissolved			101.4		%		80-120	02-NOV-20
Sodium (Na)-Dissolved			102.5		%		80-120	02-NOV-20
Strontium (Sr)-Dissolved			101.3		%		80-120	02-NOV-20
Sulfur (S)-Dissolved			103.8		%		80-120	02-NOV-20
Tellurium (Te)-Dissolved			100.8		%		80-120	02-NOV-20
Thallium (Tl)-Dissolved			99.7		%		80-120	02-NOV-20
Thorium (Th)-Dissolved			93.6		%		80-120	02-NOV-20
Tin (Sn)-Dissolved			99.2		%		80-120	02-NOV-20
Titanium (Ti)-Dissolved			96.4		%		80-120	02-NOV-20
Tungsten (W)-Dissolved			97.5		%		80-120	02-NOV-20
Uranium (U)-Dissolved			95.4		%		80-120	02-NOV-20
Vanadium (V)-Dissolved			102.0		%		80-120	02-NOV-20
Zinc (Zn)-Dissolved			101.2		%		80-120	02-NOV-20
Zirconium (Zr)-Dissolved			93.5		%		80-120	02-NOV-20
WG3436937-2 LCS								
Aluminum (Al)-Dissolved			101.8		%		80-120	02-NOV-20
Antimony (Sb)-Dissolved			98.0		%		80-120	02-NOV-20
Arsenic (As)-Dissolved			99.1		%		80-120	02-NOV-20
Barium (Ba)-Dissolved			101.4		%		80-120	02-NOV-20
Beryllium (Be)-Dissolved			95.6		%		80-120	02-NOV-20
Bismuth (Bi)-Dissolved			96.7		%		80-120	02-NOV-20
Boron (B)-Dissolved			99.0		%		80-120	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436937-2 LCS								
Cadmium (Cd)-Dissolved			102.1		%		80-120	02-NOV-20
Calcium (Ca)-Dissolved			98.4		%		80-120	02-NOV-20
Cesium (Cs)-Dissolved			100.3		%		80-120	02-NOV-20
Chromium (Cr)-Dissolved			98.7		%		80-120	02-NOV-20
Cobalt (Co)-Dissolved			97.7		%		80-120	02-NOV-20
Copper (Cu)-Dissolved			97.5		%		80-120	02-NOV-20
Iron (Fe)-Dissolved			93.6		%		80-120	02-NOV-20
Lead (Pb)-Dissolved			97.4		%		80-120	02-NOV-20
Lithium (Li)-Dissolved			101.7		%		80-120	02-NOV-20
Magnesium (Mg)-Dissolved			104.3		%		80-120	02-NOV-20
Manganese (Mn)-Dissolved			100.6		%		80-120	02-NOV-20
Molybdenum (Mo)-Dissolved			101.3		%		80-120	02-NOV-20
Nickel (Ni)-Dissolved			96.4		%		80-120	02-NOV-20
Phosphorus (P)-Dissolved			103.0		%		80-120	02-NOV-20
Potassium (K)-Dissolved			101.8		%		80-120	02-NOV-20
Rubidium (Rb)-Dissolved			104.9		%		80-120	02-NOV-20
Selenium (Se)-Dissolved			96.6		%		80-120	02-NOV-20
Silicon (Si)-Dissolved			96.5		%		80-120	02-NOV-20
Silver (Ag)-Dissolved			99.0		%		80-120	02-NOV-20
Sodium (Na)-Dissolved			99.2		%		80-120	02-NOV-20
Strontium (Sr)-Dissolved			102.7		%		80-120	02-NOV-20
Sulfur (S)-Dissolved			101.8		%		80-120	02-NOV-20
Tellurium (Te)-Dissolved			94.2		%		80-120	02-NOV-20
Thallium (Tl)-Dissolved			97.8		%		80-120	02-NOV-20
Thorium (Th)-Dissolved			93.6		%		80-120	02-NOV-20
Tin (Sn)-Dissolved			97.9		%		80-120	02-NOV-20
Titanium (Ti)-Dissolved			95.4		%		80-120	02-NOV-20
Tungsten (W)-Dissolved			97.2		%		80-120	02-NOV-20
Uranium (U)-Dissolved			93.5		%		80-120	02-NOV-20
Vanadium (V)-Dissolved			99.6		%		80-120	02-NOV-20
Zinc (Zn)-Dissolved			101.6		%		80-120	02-NOV-20
Zirconium (Zr)-Dissolved			95.9		%		80-120	02-NOV-20
WG3436936-1 MB								
Aluminum (Al)-Dissolved			0.0046	B	mg/L		0.001	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436936-1 MB								
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	02-NOV-20
Cadmium (Cd)-Dissolved			<0.000005(		mg/L		0.000005	02-NOV-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	02-NOV-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	02-NOV-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	02-NOV-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	02-NOV-20
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	02-NOV-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	02-NOV-20
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	02-NOV-20
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436936-1 MB								
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	02-NOV-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	02-NOV-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
WG3436937-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	02-NOV-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	02-NOV-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	02-NOV-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	02-NOV-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	02-NOV-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	02-NOV-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	02-NOV-20
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	02-NOV-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	02-NOV-20
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436937-1 MB								
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	02-NOV-20
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	02-NOV-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	02-NOV-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	02-NOV-20
WG3436937-5 MS		**L2523514-7**						
Aluminum (Al)-Dissolved			92.0		%		70-130	02-NOV-20
Antimony (Sb)-Dissolved			91.8		%		70-130	02-NOV-20
Arsenic (As)-Dissolved			93.4		%		70-130	02-NOV-20
Barium (Ba)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Beryllium (Be)-Dissolved			87.1		%		70-130	02-NOV-20
Bismuth (Bi)-Dissolved			70.0		%		70-130	02-NOV-20
Boron (B)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Cadmium (Cd)-Dissolved			88.6		%		70-130	02-NOV-20
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Cesium (Cs)-Dissolved			90.6		%		70-130	02-NOV-20
Chromium (Cr)-Dissolved			87.5		%		70-130	02-NOV-20
Cobalt (Co)-Dissolved			85.3		%		70-130	02-NOV-20
Copper (Cu)-Dissolved			81.7		%		70-130	02-NOV-20
Iron (Fe)-Dissolved			86.5		%		70-130	02-NOV-20
Lead (Pb)-Dissolved			83.7		%		70-130	02-NOV-20
Lithium (Li)-Dissolved			93.0		%		70-130	02-NOV-20
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Molybdenum (Mo)-Dissolved			92.1		%		70-130	02-NOV-20
Nickel (Ni)-Dissolved			83.6		%		70-130	02-NOV-20
Phosphorus (P)-Dissolved			96.2		%		70-130	02-NOV-20
Potassium (K)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Rubidium (Rb)-Dissolved			89.0		%		70-130	02-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WP	**Water**							
Batch R5275295								
WG3436937-5 MS		**L2523514-7**						
Selenium (Se)-Dissolved			62.4	MES	%		70-130	02-NOV-20
Silicon (Si)-Dissolved			81.9		%		70-130	02-NOV-20
Silver (Ag)-Dissolved			76.1		%		70-130	02-NOV-20
Sodium (Na)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Sulfur (S)-Dissolved			N/A	MS-B	%		-	02-NOV-20
Tellurium (Te)-Dissolved			75.5		%		70-130	02-NOV-20
Thallium (Tl)-Dissolved			83.2		%		70-130	02-NOV-20
Thorium (Th)-Dissolved			87.8		%		70-130	02-NOV-20
Tin (Sn)-Dissolved			88.6		%		70-130	02-NOV-20
Titanium (Ti)-Dissolved			88.4		%		70-130	02-NOV-20
Tungsten (W)-Dissolved			87.6		%		70-130	02-NOV-20
Uranium (U)-Dissolved			87.5		%		70-130	02-NOV-20
Vanadium (V)-Dissolved			91.0		%		70-130	02-NOV-20
Zinc (Zn)-Dissolved			86.6		%		70-130	02-NOV-20
Zirconium (Zr)-Dissolved			93.4		%		70-130	02-NOV-20
NO2-L-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-10 LCS								
Nitrite (as N)			97.1		%		90-110	31-OCT-20
WG3436253-6 LCS								
Nitrite (as N)			96.4		%		90-110	31-OCT-20
WG3436253-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	31-OCT-20
WG3436253-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	31-OCT-20
NO3-L-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-10 LCS								
Nitrate (as N)			96.9		%		90-110	31-OCT-20
WG3436253-6 LCS								
Nitrate (as N)			96.9		%		90-110	31-OCT-20
WG3436253-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	31-OCT-20
WG3436253-9 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	31-OCT-20
PH-WP	**Water**							
Batch R5272787								
WG3436899-15 DUP		**L2523514-8**						
pH		8.08	8.11	J	pH units	0.03	0.2	30-OCT-20
WG3436899-12 LCS								
pH			7.36		pH units		7.3-7.5	30-OCT-20
WG3436899-22 LCS								
pH			7.35		pH units		7.3-7.5	30-OCT-20
Batch R5273180								
WG3437150-2 LCS								
pH			7.34		pH units		7.3-7.5	02-NOV-20
SO4-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-10 LCS								
Sulfate (SO4)			97.4		%		90-110	31-OCT-20
WG3436253-6 LCS								
Sulfate (SO4)			97.4		%		90-110	31-OCT-20
WG3436253-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	31-OCT-20
WG3436253-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	31-OCT-20
TC,EC-QT51-WP	**Water**							
Batch R5271879								
WG3435308-7 DUP		**L2523514-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	29-OCT-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	29-OCT-20
WG3435308-8 DUP		**L2523514-3**						
Total Coliforms		0	0		MPN/100mL	0.0	65	29-OCT-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	29-OCT-20
WG3435308-1 MB								
Total Coliforms			0		MPN/100mL		1	29-OCT-20
Escherichia Coli			0		MPN/100mL		1	29-OCT-20
WG3435308-2 MB								
Total Coliforms			0		MPN/100mL		1	29-OCT-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R5271879								
WG3435308-2 MB								
Escherichia Coli			0		MPN/100mL		1	29-OCT-20
WG3435308-3 MB								
Total Coliforms			0		MPN/100mL		1	29-OCT-20
Escherichia Coli			0		MPN/100mL		1	29-OCT-20
WG3435308-4 MB								
Total Coliforms			0		MPN/100mL		1	29-OCT-20
Escherichia Coli			0		MPN/100mL		1	29-OCT-20
TURBIDITY-WP	**Water**							
Batch R5275126								
WG3436977-2 LCS								
Turbidity			99.5		%		85-115	30-OCT-20
WG3436977-5 LCS								
Turbidity			98.5		%		85-115	30-OCT-20
WG3436977-1 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-20
WG3436977-4 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-20

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
J	Duplicate results and limits are expressed in terms of absolute difference.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	11	26-OCT-20	30-OCT-20 12:00	3	4	days	EHTR
pH							
	1	27-OCT-20 10:00	30-OCT-20 12:00	0.25	74	hours	EHTR-FM
	2	28-OCT-20 17:30	30-OCT-20 12:00	0.25	42	hours	EHTR-FM
	3	27-OCT-20 17:10	30-OCT-20 12:00	0.25	67	hours	EHTR-FM
	4	28-OCT-20 12:50	30-OCT-20 12:00	0.25	47	hours	EHTR-FM
	5	27-OCT-20 15:10	30-OCT-20 12:00	0.25	69	hours	EHTR-FM
	6	27-OCT-20 13:40	30-OCT-20 12:00	0.25	70	hours	EHTR-FM
	7	27-OCT-20 11:40	30-OCT-20 12:00	0.25	72	hours	EHTR-FM
	8	28-OCT-20 17:35	30-OCT-20 12:00	0.25	42	hours	EHTR-FM
	9	29-OCT-20 12:25	30-OCT-20 12:00	0.25	24	hours	EHTR-FM
	10	29-OCT-20 11:00	30-OCT-20 12:00	0.25	25	hours	EHTR-FM
	11	26-OCT-20	02-NOV-20 12:00	0.25	168	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	27-OCT-20 10:00	31-OCT-20 05:30	3	4	days	EHTL
	3	27-OCT-20 17:10	31-OCT-20 05:30	3	4	days	EHT
	5	27-OCT-20 15:10	31-OCT-20 05:30	3	4	days	EHTL
	6	27-OCT-20 13:40	31-OCT-20 05:30	3	4	days	EHTL
	7	27-OCT-20 11:40	31-OCT-20 05:30	3	4	days	EHTL
	11	26-OCT-20	31-OCT-20 05:30	3	5	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	27-OCT-20 10:00	31-OCT-20 05:30	3	4	days	EHTL
	3	27-OCT-20 17:10	31-OCT-20 05:30	3	4	days	EHT
	5	27-OCT-20 15:10	31-OCT-20 05:30	3	4	days	EHTL
	6	27-OCT-20 13:40	31-OCT-20 05:30	3	4	days	EHTL
	7	27-OCT-20 11:40	31-OCT-20 05:30	3	4	days	EHTL
	11	26-OCT-20	31-OCT-20 05:30	3	5	days	EHTR
Bacteriological Tests							
Total Coliform and E.coli							
	1	27-OCT-20 10:00	29-OCT-20 18:10	30	56	hours	EHTR
	3	27-OCT-20 17:10	29-OCT-20 18:10	30	49	hours	EHTR
	5	27-OCT-20 15:10	29-OCT-20 18:10	30	51	hours	EHTR
	6	27-OCT-20 13:40	29-OCT-20 18:10	30	53	hours	EHTR
	7	27-OCT-20 11:40	29-OCT-20 18:10	30	54	hours	EHTR
	11	26-OCT-20	29-OCT-20 18:10	30	78	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2523514 were received on 29-OCT-20 16:40.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

Quality Control Report

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2523514-COFC

COC Number: 17 - 781643

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Turnaround Time (TAT) Requested - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	KGS Group	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Paul Lindell	Quality Control (QC) Report with Report ☐ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Phone:	204-896-1209	☐ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E - 100%] ☐ / Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	865 Waverley St.	Email 1 or Fax plindell@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Winnipeg / MB	Email 2 soffman@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3	
Invoice To	Same as Report To ☐ YES ☐ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax payables@kgsgroup.com	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	18-0300-005.2302.04	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Judy D.	Sampler: PJL / NB

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ROUTINE-D	TCLEC-QT51	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	PW19-KGS-01	27-Oct-20	10:00	GW	3	X	X		
	PW19-KGS-02	28-Oct-20	17:30	GW	3	X	X		
	PW19-KGS-03	27-Oct-20	16:00		3	X	X		
	TH19-KGS-12	28-Oct-20	12:50		3	X	X		
	TH19-KGS-17	27-Oct-20	15:10		3	X	X		
	TH19-KGS-18	27-Oct-20	13:40		3	X	X		
	TH19-KGS-19	27-Oct-20	11:40		3	X	X		
	PW-100	28-Oct-20	17:35		3	X	X		
	SW19-KGS-02	29-Oct-20	12:25		3	X	X		
	SW19-KGS-03	29-Oct-20	11:00		3	X	X		
	TRIP BLANK	26-Oct-20	00:00	X	3	X	X		

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☒ NO	Metals bottles Field Filtered & Preserved
Are samples for human consumption/ use? ☐ YES ☒ NO	Please use times shown on C.O.C. if different from Bottles.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
			2.8				

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	Oct 29/20	16:25	DSV	Oct 29	4:40PM			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: LSMDC-INLET-1A
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-1
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	104.0		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	77.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	1.21		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	1.21		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0078		mg/L			05-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		04-NOV-20
	Phosphorus (P)-Total	0.0204		mg/L			03-NOV-20
	Ammonia, Total (as N)	0.047		mg/L			03-NOV-20
	Total Suspended Solids	5.8		mg/L			03-NOV-20
	*Turbidity	4.46		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: LSMDC-INLET-1A
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: LSMDC-OUTLET-1A
Sampled By: PJL/NB
Date Collected: 27-OCT-20
Lab Sample ID: L2523516-2
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	100.3		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	78.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	0.48		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.48		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	0.051		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0313		mg/L			05-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0670		mg/L			03-NOV-20
	Ammonia, Total (as N)	0.031		mg/L			03-NOV-20
	Total Suspended Solids	11.4		mg/L			30-OCT-20
	*Turbidity	14.1		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: LSMDC-OUTLET-1A
Sampled By: PJL/NB
Date Collected: 27-OCT-20
Lab Sample ID: L2523516-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: BC-02
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-3
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	101.2		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	79.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	1.28		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	1.28		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0189		mg/L			05-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0162		mg/L			03-NOV-20
	Ammonia, Total (as N)	0.026		mg/L			05-NOV-20
	Total Suspended Solids	8.6		mg/L			03-NOV-20
	*Turbidity	5.25		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: BC-02
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: BC-05
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-4
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	100.6		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	80.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	1.07		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	1.07		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0064		mg/L			05-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0223		mg/L			03-NOV-20
	Ammonia, Total (as N)	0.016		mg/L			03-NOV-20
	Total Suspended Solids	10.8		mg/L			03-NOV-20
	*Turbidity	5.19		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: BC-05
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: CR3-1
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-5
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	100.0		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	76.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	0.50		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.50		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0029		mg/L			10-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0051		mg/L			03-NOV-20
	Ammonia, Total (as N)	<0.010		mg/L			03-NOV-20
	Total Suspended Solids	<3.0		mg/L			03-NOV-20
	*Turbidity	0.16		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: CR3-1
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: CR3-2
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-6
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	100.7		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	79.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	0.53		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.53		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	0.064		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0050		mg/L			05-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0104		mg/L			03-NOV-20
	Ammonia, Total (as N)	0.017		mg/L			03-NOV-20
	Total Suspended Solids	<3.0		mg/L			03-NOV-20
	*Turbidity	0.89		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: CR3-2
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: SW-R3
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-7
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	102.5		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		04-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	04-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	04-NOV-20
	o-Xylene	<0.00050		mg/L			04-NOV-20
	m+p-Xylenes	<0.00040		mg/L			04-NOV-20
	F1 (C6-C10)	<0.10		mg/L			04-NOV-20
Surr:	4-Bromofluorobenzene (SS)	79.0		%			04-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	0.49		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.49		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0028		mg/L			10-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0052		mg/L			05-NOV-20
	Ammonia, Total (as N)	<0.010		mg/L			03-NOV-20
	Total Suspended Solids	<3.0		mg/L			03-NOV-20
	*Turbidity	1.58		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: SW-R3
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: SW-100
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-8
Matrix: SW

Test Description		Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
BTEX plus F1-F4							
	Xylenes (Total)	<0.00064		mg/L	0.09	0.02	09-NOV-20
CCME Total Hydrocarbons							
	F1-BTEX	<0.10		mg/L			10-NOV-20
	Total Hydrocarbons (C6-C50)	<0.38		mg/L			10-NOV-20
CCME PHC F2-F4 in Water							
	F2 (C10-C16)	<0.10		mg/L			07-NOV-20
	F3 (C16-C34)	<0.25		mg/L			07-NOV-20
	F4 (C34-C50)	<0.25		mg/L			07-NOV-20
Surr:	2-Bromobenzotrifluoride	100.7		%			07-NOV-20
BTX plus F1 by GCMS							
	Benzene	<0.00050		mg/L	0.005		05-NOV-20
	Toluene	<0.0010		mg/L	0.06	0.024	05-NOV-20
	Ethyl benzene	<0.00050		mg/L	0.14	0.0016	05-NOV-20
	o-Xylene	<0.00050		mg/L			05-NOV-20
	m+p-Xylenes	<0.00040		mg/L			05-NOV-20
	F1 (C6-C10)	<0.10		mg/L			05-NOV-20
Surr:	4-Bromofluorobenzene (SS)	78.0		%			05-NOV-20
Nitrogen Total							
	*Nitrate and Nitrite as N	<0.070		mg/L	10		04-NOV-20
	Total Nitrogen	0.48		mg/L			05-NOV-20
Total Kjeldahl Nitrogen							
	Total Kjeldahl Nitrogen	0.48		mg/L			05-NOV-20
Nitrite in Water by IC							
	*Nitrite (as N)	<0.010		mg/L	1		31-OCT-20
Nitrate in Water by IC							
	*Nitrate (as N)	<0.020		mg/L	10		31-OCT-20
	Phosphorus (P)-Total Dissolved	0.0034		mg/L			10-NOV-20
Mercury Dissolved							
	Dissolved Mercury Filtration Location	FIELD					05-NOV-20
	Mercury (Hg)-Dissolved	<0.0000050		mg/L	0.001		06-NOV-20
	Mercury (Hg)-Total	<0.0000050		mg/L	0.001		06-NOV-20
	Phosphorus (P)-Total	0.0045		mg/L			05-NOV-20
	Ammonia, Total (as N)	0.013		mg/L			03-NOV-20
	Total Suspended Solids	<3.0		mg/L			03-NOV-20
	*Turbidity	1.54		NTU			30-OCT-20

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: PAUL LINDELL

Date: 10-NOV-20
PO No.:
WO No.: L2523516
Project Ref: 18-0300-005.2302.004
Sample ID: SW-100
Sampled By: PJL/NB
Date Collected: 28-OCT-20
Lab Sample ID: L2523516-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**JUNE 2019**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.
Manganese*	Criteria limit is 0.12 mg/L. Possible neurological effects in infants.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: PAUL LINDELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BTEXS+F1-HSMS-WP	**Water**							
Batch R5281357								
WG3438951-4 DUP		**L2523516-1**						
Benzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	04-NOV-20
Toluene		<0.0010	<0.0010	RPD-NA	mg/L	N/A	30	04-NOV-20
Ethyl benzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	04-NOV-20
o-Xylene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	04-NOV-20
m+p-Xylenes		<0.00040	<0.00040	RPD-NA	mg/L	N/A	30	04-NOV-20
F1 (C6-C10)		<0.10	<0.10	RPD-NA	mg/L	N/A	30	04-NOV-20
WG3438951-2 LCS								
Benzene			113.0		%		70-130	04-NOV-20
Toluene			80.0		%		70-130	04-NOV-20
Ethyl benzene			83.4		%		70-130	04-NOV-20
o-Xylene			101.8		%		70-130	04-NOV-20
m+p-Xylenes			112.4		%		70-130	04-NOV-20
WG3438951-3 LCS								
F1 (C6-C10)			122.4		%		70-130	04-NOV-20
WG3438951-1 MB								
Benzene			<0.00050		mg/L		0.0005	04-NOV-20
Toluene			<0.0010		mg/L		0.001	04-NOV-20
Ethyl benzene			<0.00050		mg/L		0.0005	04-NOV-20
o-Xylene			<0.00050		mg/L		0.0005	04-NOV-20
m+p-Xylenes			<0.00040		mg/L		0.0004	04-NOV-20
F1 (C6-C10)			<0.10		mg/L		0.1	04-NOV-20
Surrogate: 4-Bromofluorobenzene (SS)			80.0		%		70-130	04-NOV-20
WG3438951-5 MS		**L2523516-2**						
Benzene			101.3		%		50-150	04-NOV-20
Toluene			84.9		%		50-150	04-NOV-20
Ethyl benzene			89.8		%		50-150	04-NOV-20
o-Xylene			107.5		%		50-150	04-NOV-20
m+p-Xylenes			107.6		%		50-150	04-NOV-20
WG3438951-6 MS		**L2523516-3**						
F1 (C6-C10)			103.8		%		50-150	04-NOV-20
F2-F4-FID-WP	**Water**							
Batch R5283401								
WG3440738-2 LCS								
F2 (C10-C16)			92.6		%		70-130	07-NOV-20
F3 (C16-C34)			88.8		%		70-130	07-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F2-F4-FID-WP	**Water**							
Batch R5283401								
WG3440738-2 LCS								
F4 (C34-C50)			93.5		%		70-130	07-NOV-20
WG3440738-1 MB								
F2 (C10-C16)			<0.10		mg/L		0.1	07-NOV-20
F3 (C16-C34)			<0.25		mg/L		0.25	07-NOV-20
F4 (C34-C50)			<0.25		mg/L		0.25	07-NOV-20
Surrogate: 2-Bromobenzotrifluoride			106.2		%		60-140	07-NOV-20
HG-D-CVAA-WP	**Water**							
Batch R5281894								
WG3440773-2 LCS								
Mercury (Hg)-Dissolved			98.8		%		80-120	06-NOV-20
WG3440773-1 MB								
Mercury (Hg)-Dissolved			<0.000005C		mg/L		0.000005	06-NOV-20
HG-T-CVAA-WP	**Water**							
Batch R5280436								
WG3439608-2 LCS								
Mercury (Hg)-Total			100.5		%		80-120	04-NOV-20
WG3439608-1 MB								
Mercury (Hg)-Total			<0.000005C		mg/L		0.000005	04-NOV-20
Batch R5281894								
WG3440770-3 DUP		**L2523516-2**						
Mercury (Hg)-Total		<0.0000050	<0.000005C	RPD-NA	mg/L	N/A	20	06-NOV-20
WG3440770-2 LCS								
Mercury (Hg)-Total			98.3		%		80-120	06-NOV-20
WG3440770-1 MB								
Mercury (Hg)-Total			<0.000005C		mg/L		0.000005	06-NOV-20
WG3440770-4 MS		**L2523516-3**						
Mercury (Hg)-Total			78.9		%		70-130	06-NOV-20
N-TOTKJ-WP	**Water**							
Batch R5281040								
WG3435825-2 LCS								
Total Kjeldahl Nitrogen			102.1		%		75-125	05-NOV-20
WG3435825-1 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	05-NOV-20
NH3-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-WP	**Water**							
Batch R5278600								
WG3438910-6 LCS								
Ammonia, Total (as N)			100.1		%		85-115	03-NOV-20
WG3438910-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	03-NOV-20
Batch R5280713								
WG3439701-2 LCS								
Ammonia, Total (as N)			102.4		%		85-115	05-NOV-20
WG3439701-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	05-NOV-20
NO2-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-7 DUP		**L2523516-2**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	31-OCT-20
WG3436253-10 LCS								
Nitrite (as N)			97.1		%		90-110	31-OCT-20
WG3436253-6 LCS								
Nitrite (as N)			96.4		%		90-110	31-OCT-20
WG3436253-5 MB								
Nitrite (as N)			<0.010		mg/L		0.01	31-OCT-20
WG3436253-9 MB								
Nitrite (as N)			<0.010		mg/L		0.01	31-OCT-20
WG3436253-8 MS		**L2523516-2**						
Nitrite (as N)			107.1		%		75-125	31-OCT-20
NO3-IC-N-WP	**Water**							
Batch R5278767								
WG3436253-7 DUP		**L2523516-2**						
Nitrate (as N)		0.051	0.052		mg/L	1.3	20	31-OCT-20
WG3436253-10 LCS								
Nitrate (as N)			96.9		%		90-110	31-OCT-20
WG3436253-6 LCS								
Nitrate (as N)			96.9		%		90-110	31-OCT-20
WG3436253-5 MB								
Nitrate (as N)			<0.020		mg/L		0.02	31-OCT-20
WG3436253-9 MB								
Nitrate (as N)			<0.020		mg/L		0.02	31-OCT-20
WG3436253-8 MS		**L2523516-2**						
Nitrate (as N)			109.5		%		75-125	31-OCT-20
P-T-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-WP	**Water**							
Batch R5275487								
WG3437482-15 DUP		**L2523516-1**						
Phosphorus (P)-Total		0.0204	0.0204		mg/L	0.0	20	03-NOV-20
WG3437482-14 LCS								
Phosphorus (P)-Total			95.5		%		80-120	03-NOV-20
WG3437482-13 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	03-NOV-20
WG3437482-16 MS		**L2523516-2**						
Phosphorus (P)-Total			102.0		%		70-130	03-NOV-20
P-T-L-COL-WP	**Water**							
Batch R5279660								
WG3439015-2 LCS								
Phosphorus (P)-Total			82.1		%		80-120	05-NOV-20
WG3439015-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	05-NOV-20
P-TD-COL-WP	**Water**							
Batch R5281504								
WG3439016-2 LCS								
Phosphorus (P)-Total	Dissolved		96.1		%		80-120	05-NOV-20
WG3439016-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0030		mg/L		0.003	05-NOV-20
P-TD-L-COL-WP	**Water**							
Batch R5283269								
WG3442294-2 LCS								
Phosphorus (P)-Total	Dissolved		87.4		%		80-120	10-NOV-20
WG3442294-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	10-NOV-20
SOLIDS-TOTSUS-WP	**Water**							
Batch R5272859								
WG3435672-5 LCS								
Total Suspended Solids			93.6		%		85-115	30-OCT-20
WG3435672-4 MB								
Total Suspended Solids			<3.0		mg/L		3	30-OCT-20
Batch R5277996								
WG3437693-2 LCS								
Total Suspended Solids			110.3		%		85-115	03-NOV-20
WG3437693-1 MB								
Total Suspended Solids			<3.0		mg/L		3	03-NOV-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R5275126								
WG3436977-5 LCS								
Turbidity			98.5		%		85-115	30-OCT-20
WG3436977-4 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-20

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC							
	2	27-OCT-20 12:45	31-OCT-20 05:30	3	4	days	EHTL
Nitrite in Water by IC							
	2	27-OCT-20 12:45	31-OCT-20 05:30	3	4	days	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2523516 were received on 29-OCT-20 16:40.

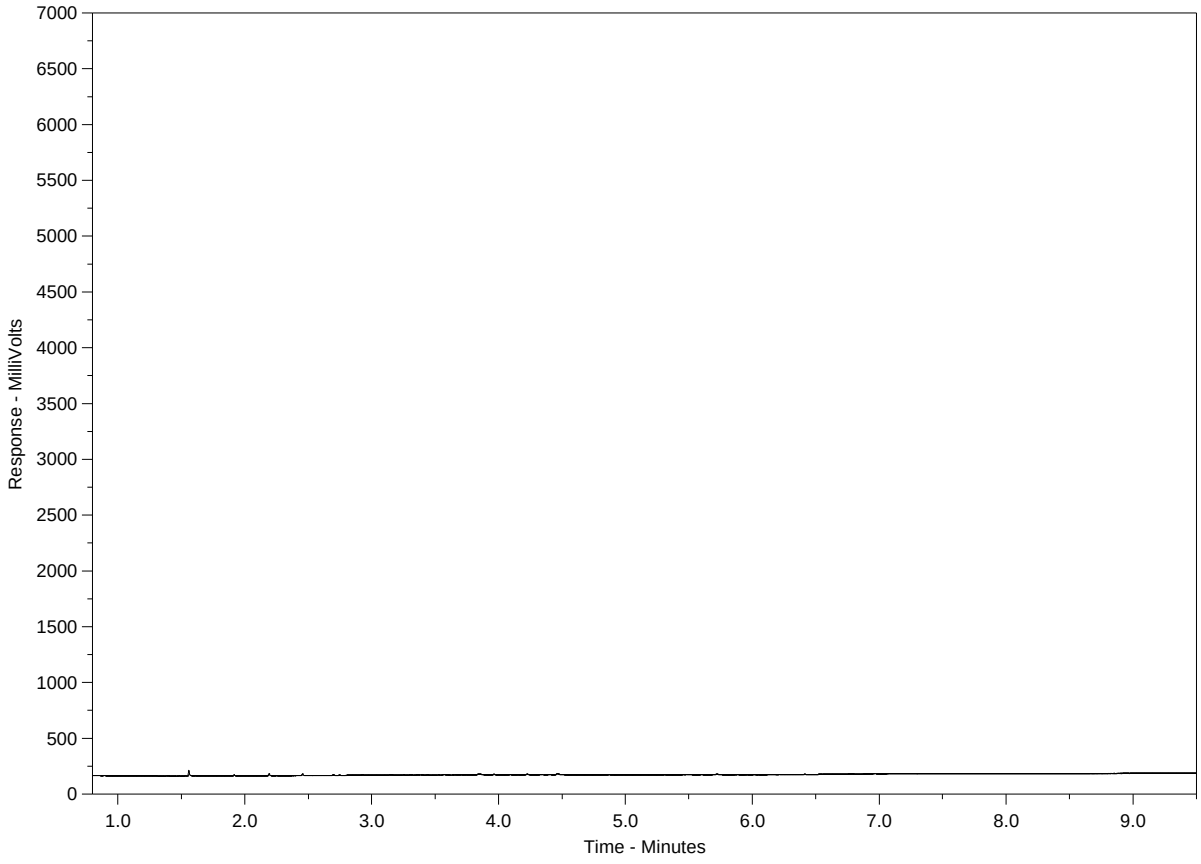
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

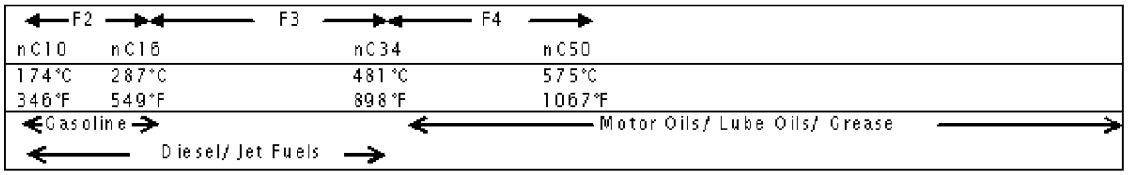
The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-1
Client Sample ID: LSMDC-INLET-1A





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

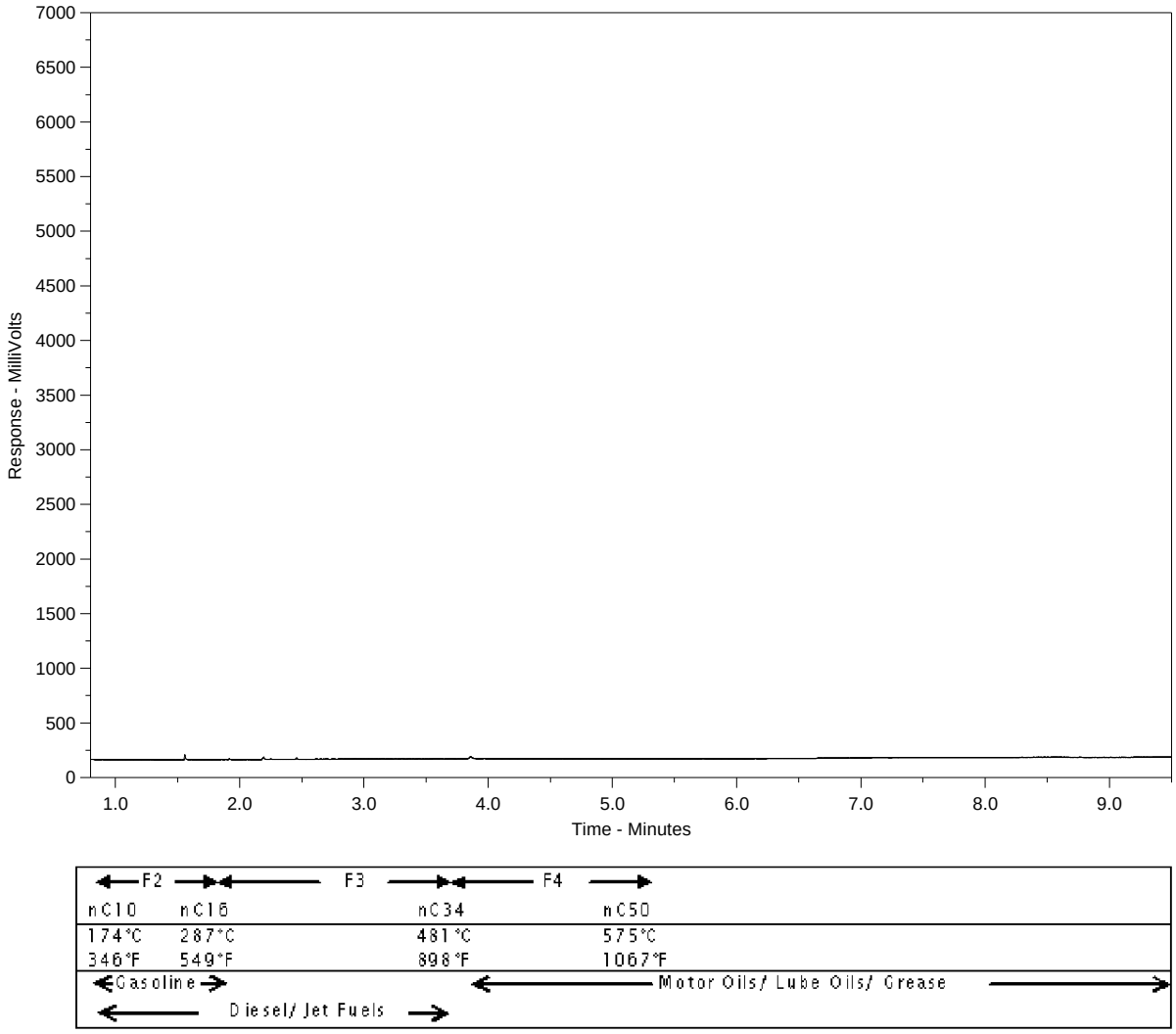
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-2
Client Sample ID: LSMDC-OUTLET-1A



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

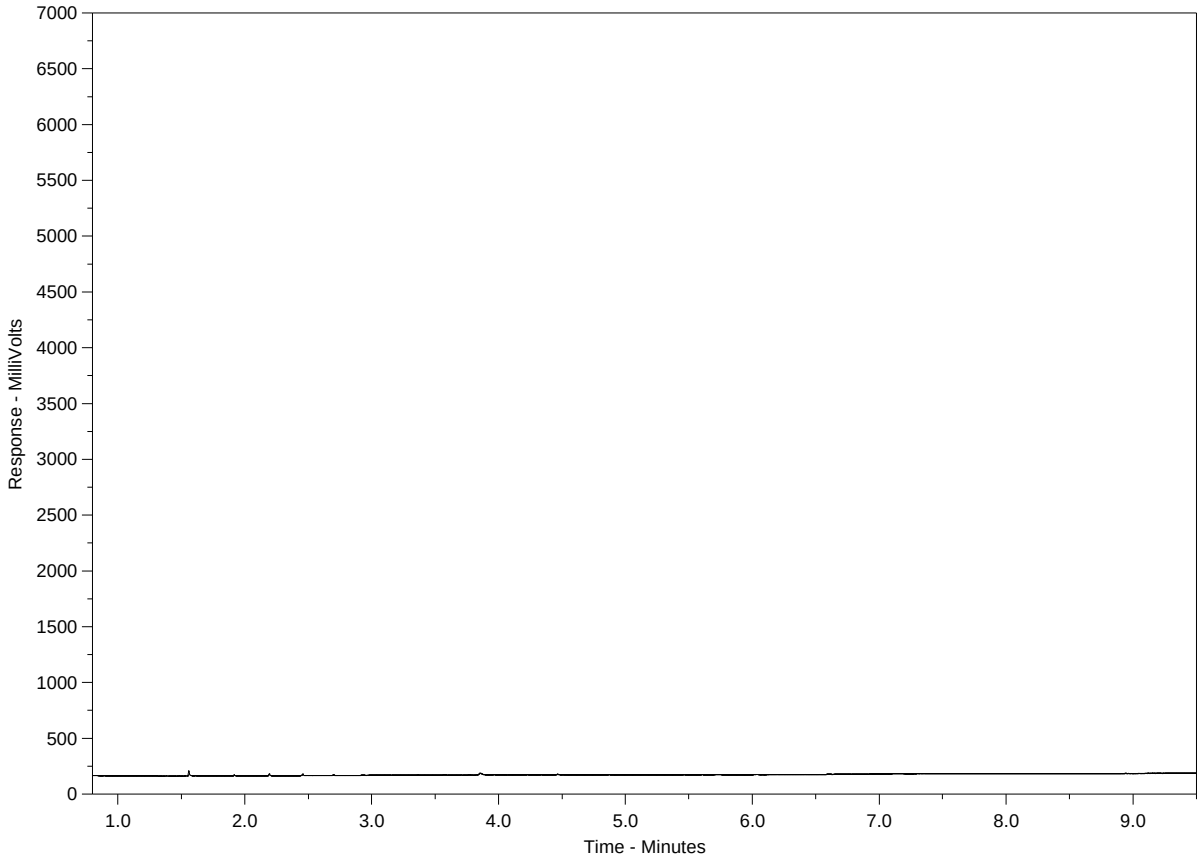
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

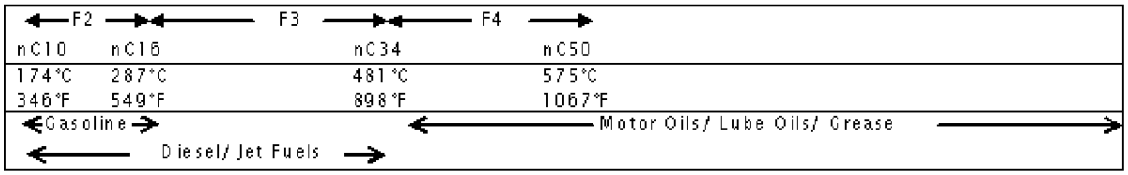
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-3
Client Sample ID: BC-02





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

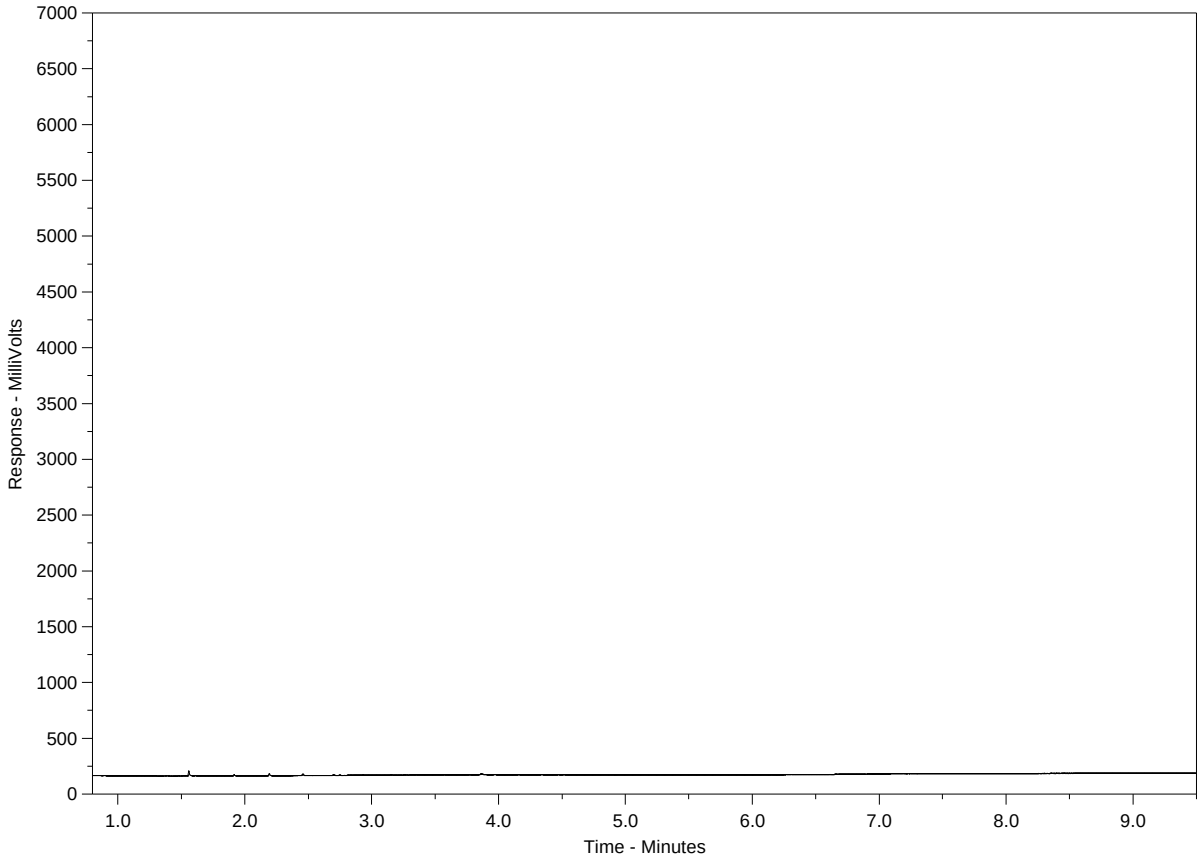
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

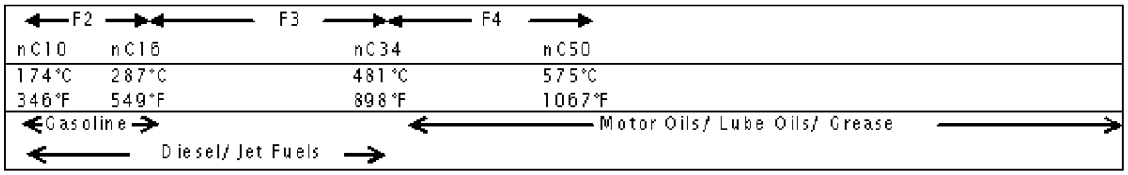
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-4
Client Sample ID: BC-05





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

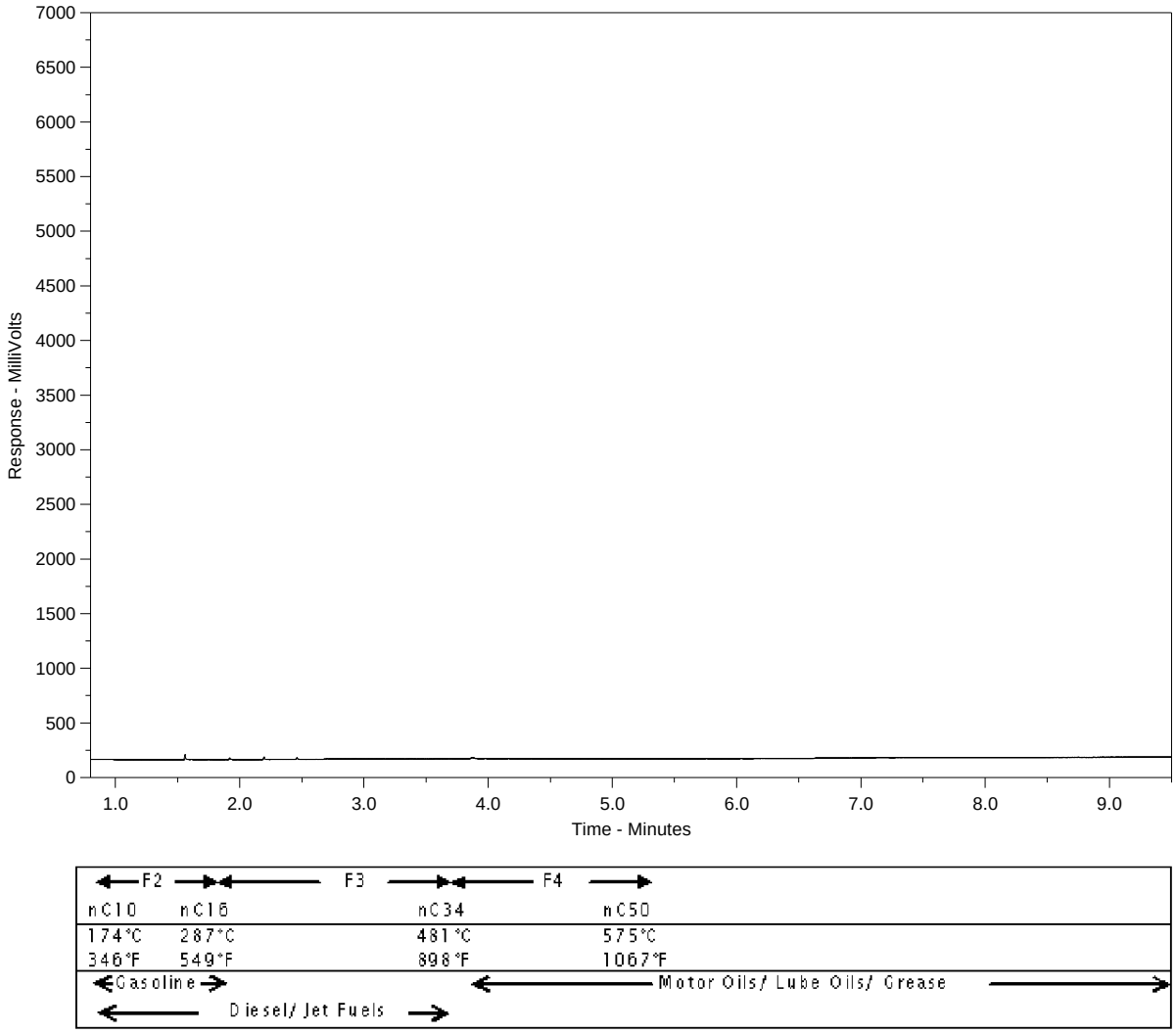
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-5
Client Sample ID: CR3-1



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

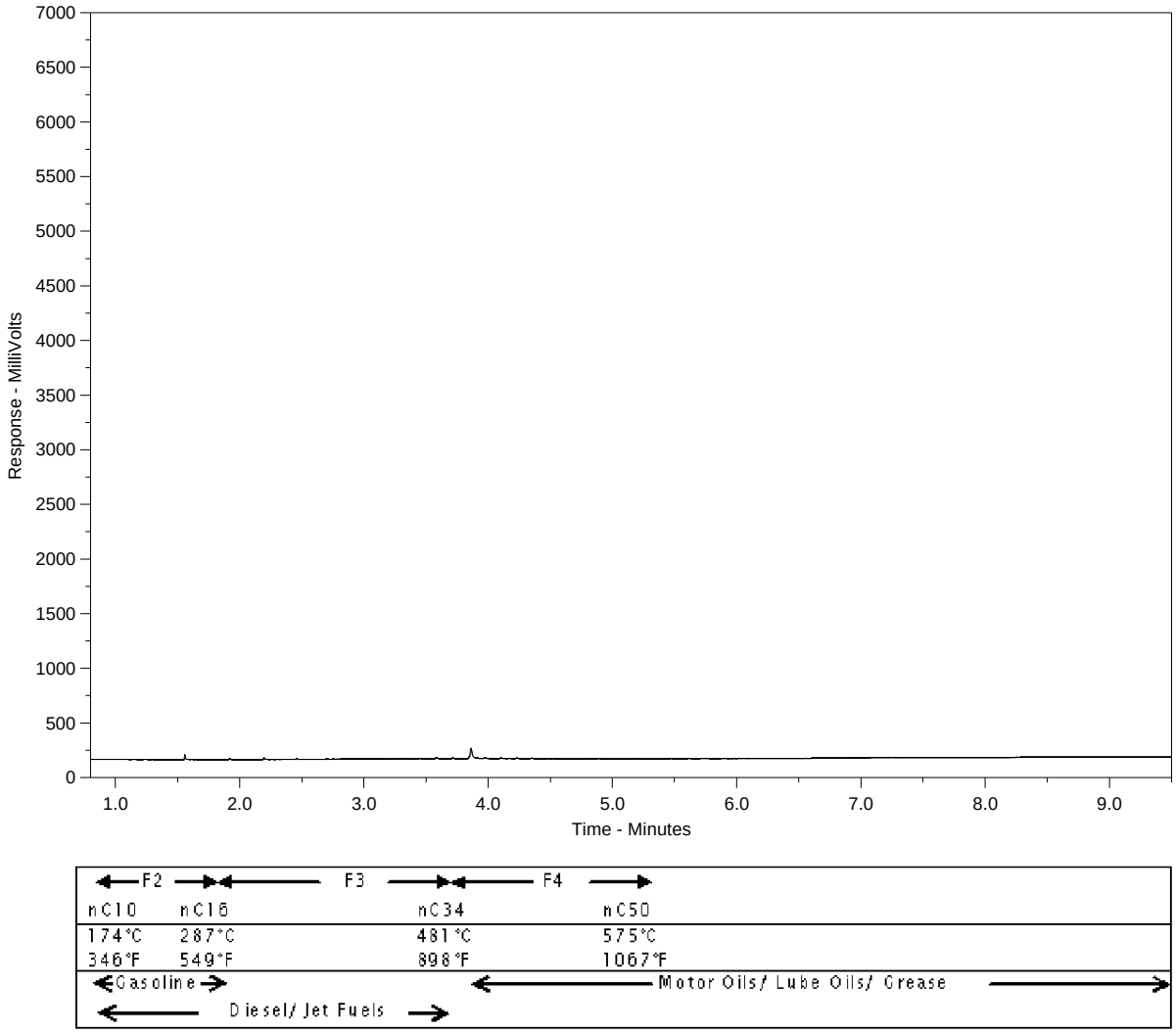
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-6
Client Sample ID: CR3-2



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

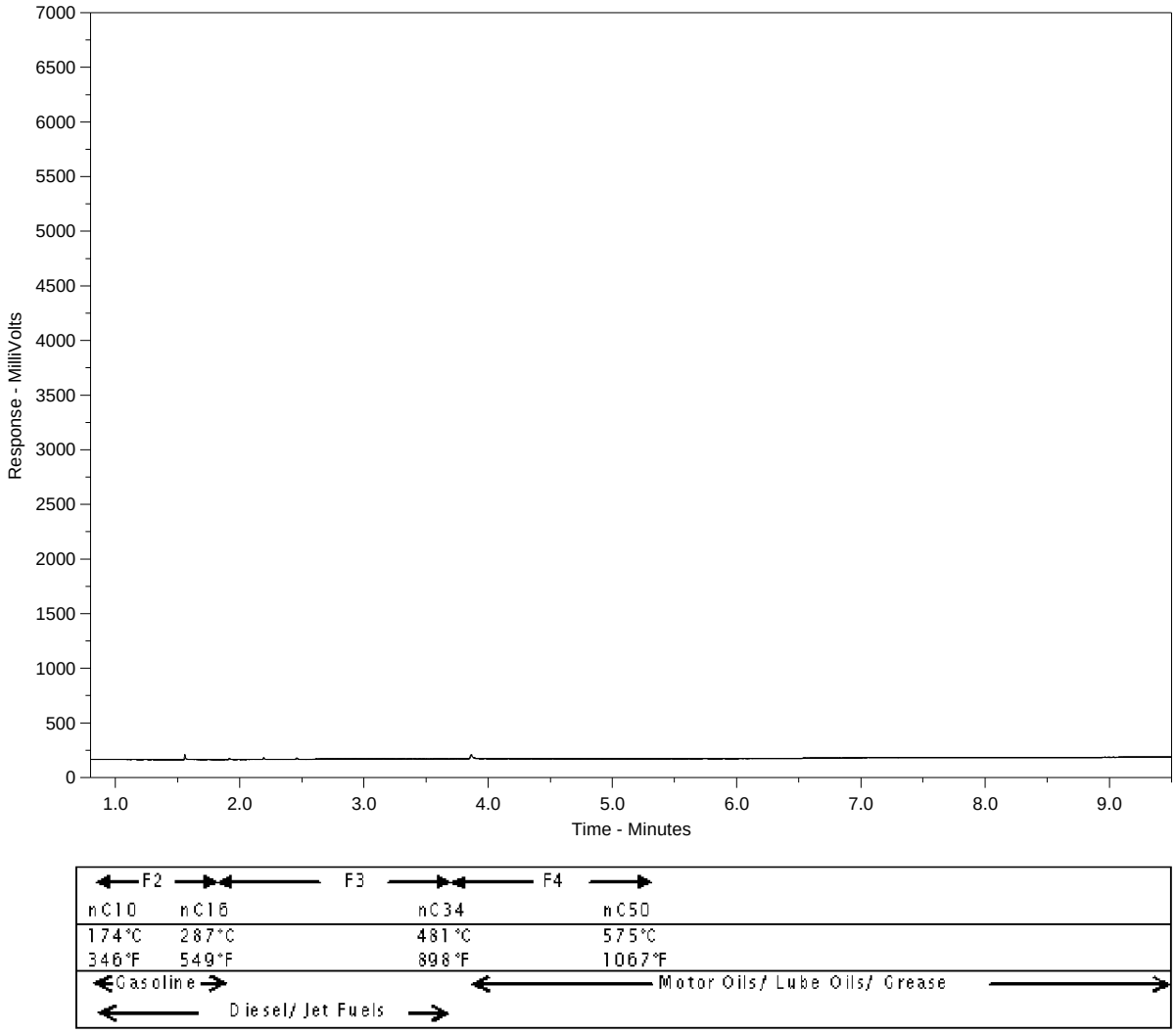
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-7
Client Sample ID: SW-R3



The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

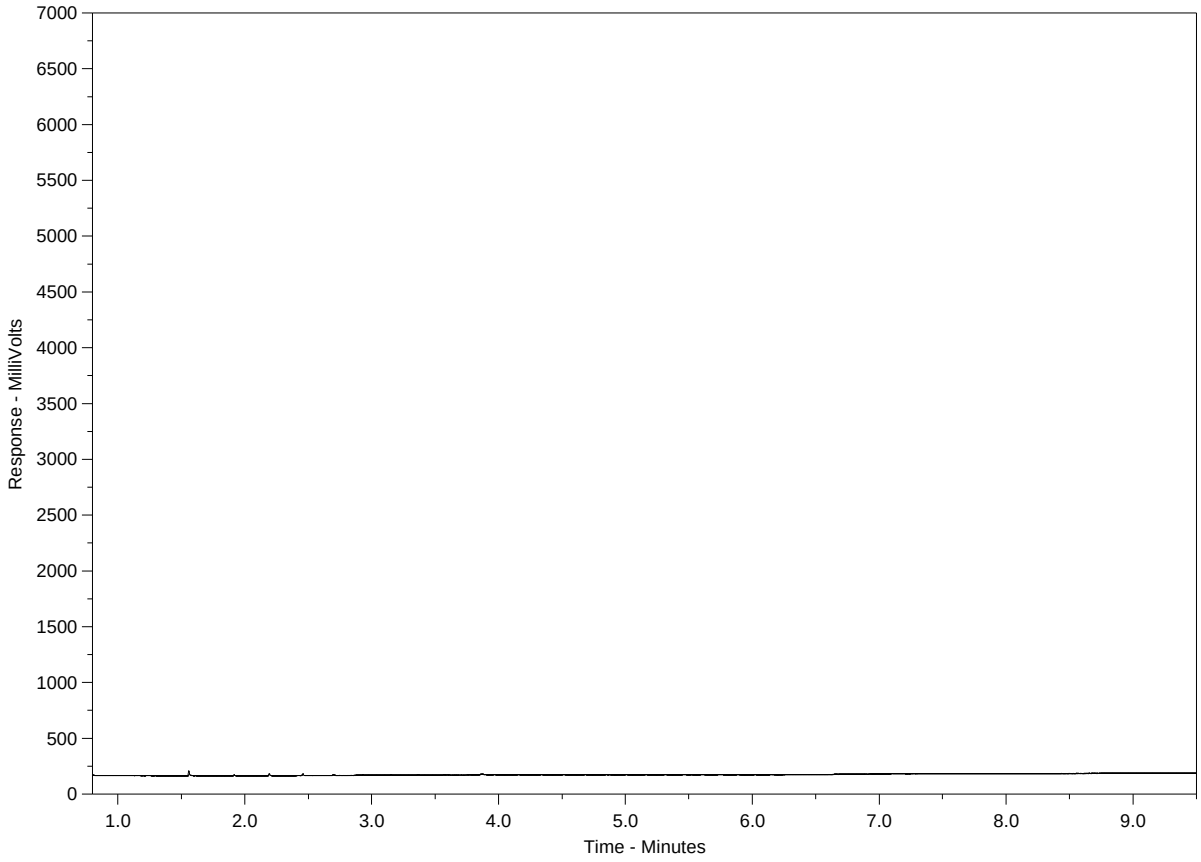
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

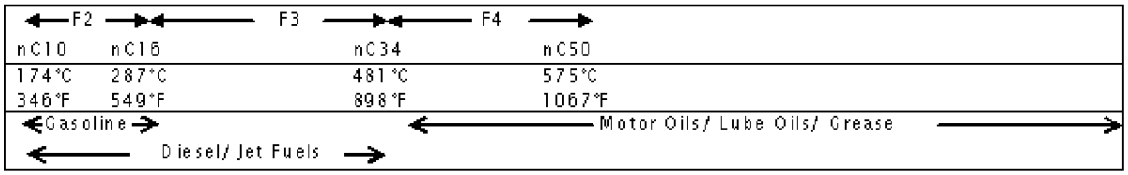
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2523516-8
Client Sample ID: SW-100





The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2523516-COFC

COC Number: 17 - 751104

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	KGS Group
Contact:	Paul Lindell
Phone:	204-803-0720
	Company address below will appear on the final report
Street:	865 Waverley St.
City/Province:	Wpg/MB
Postal Code:	R3T 5P4

Report Format / Distribution	
Select Report Format:	PDF ☑ EXCEL ☐ EDD (DIGITAL) ☐
Quality Control (QC) Report with Report	YES ☐ NO ☐
Compare Results to Criteria on Report - provide details below if box checked	☐
Select Distribution:	EMAIL ☑ MAIL ☐ FAX ☐
Email 1 or Fax	plindell@kgsgroup.com
Email 2	soffman@kgsgroup.com
Email 3	

Invoice To		
	Same as Report To	YES ☐ NO ☐
	Copy of Invoice with Report	YES ☐ NO ☐
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	EMAIL ☑ MAIL ☐ FAX ☐
Email 1 or Fax	payables@kgsgroup.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q58403
Job #:	18-0300-005.2302.004
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Judy D

Sampler: PJL/NB

Select Service Level below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4-20%] ☐
- 3 day [P3-25%] ☐
- 2 day [P2-50%] ☐

EMERGENCY
- 1 Business day [E - 100%] ☐
- Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	As Per Quote	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	LSMOC-Inlet-1A	28-Oct-20	15:25	SW	10	X		
	LSMOC-Outlet-1A	Oct27-20	12:45			X		
	BC-02	28-Oct-20	12:15			X		
	BC-05	28-Oct-20	11:45			X		
	CR3-1	28-Oct-20	11:20			X		
	CR3-2	28-Oct-20	11:00			X		
	SW-R3	28-Oct-20	10:00		10	X		
	SW-100	28-Oct-20	10:05	SW	10	X		

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? YES ☐ NO ☒

Are samples for human consumption/ use? YES ☐ NO ☒

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

please use times on COC if different from Bottle.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No	☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No	☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
			4.1				

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	26.25 Oct29/20	16:12	DJV	Oct 29	4:40 PM			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Client: Levay
KGS Group
Project: 18-0300-005

ISO# 2019187
Location:
29 for 18O+2H
9 for E3H

Environmental Isotope Lab
2019-05-27

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		± 0.8 T.U.		± 0.8 T.U.			µS/cm	
1	Sentinel Well 1	08-Mar-19	420126	X	-15.01	-15.03	X	-114.68	-113.97	X	<0.8	0.3			7.70	940	
2	PW19-KGS-02	13-Mar-19	420127	X	-14.81		X	-113.18		X	<0.8	0.3			7.90	796	
3	PW19-KGS-03	14-Mar-19	420128	X	-14.92	-14.90	X	-111.49	-111.57	X	1.7	0.4			7.80	663	
4	PW19-KGS-04	14-Mar-19	420129	X	-15.00		X	-111.60		X	1.9	0.4			7.80	663	
5	PW19-KGS-01	12-Mar-19	420130	X	-14.64	-14.60	X	-113.02	-112.81	X	<0.8	0.3			8.10	782	
6	PW19-KGS-05	13-Mar-19	420131	X	-15.19		X	-114.56		X	<0.8	0.3			7.90	796	
7	TH19-KGS-17	10-Mar-19	420132	X	-15.11		X	-112.37		X	<0.8	0.3			7.58	640	
8	TH19-KGS-18	11-Mar-19	420133	X	-14.87		X	-109.46		X	<0.8	0.3			6.70	957	
9	TH19-KGS-19	11-Mar-19	420134	X	-15.13		X	-112.49		X	<0.8	0.3	<0.8	0.5	8.76	769	
10	TH19-KGS-11	08-Mar-19	420135	X	-15.12	-15.16	X	-115.62	-115.73						6.64	786	
11	TH15-04	08-Mar-19	420136	X	-15.04		X	-112.65							7.37	536	
12	TH19-KGS-13	07-Mar-19	420137	X	-14.06	-14.10	X	-112.59	-112.80						7.08	786	
13	TH300	14-Mar-19	420138	X	-14.59		X	-114.05							7.28	1008	
14	TH19-KGS-10	09-Mar-19	420139	X	-15.21		X	-112.31							7.57	707	
15	TH19-KGS-04	09-Mar-19	420140	X	-14.83	-14.87	X	-113.99	-113.75						7.58	1018	
16	TH19-KGS-14	08-Mar-19	420141	X	-15.18		X	-113.03							6.90	592	
17	TH19-KGS-08	08-Mar-19	420142	X	-15.14		X	-112.26							6.93	546	
18	TH200	09-Mar-19	420143	X	-15.21		X	-112.80							7.57	707	
19	TH19-KGS-12	07-Mar-19	420144	X	-15.33		X	-115.76							6.79	904	
20	TH19-KGS-15	09-Mar-19	420145	X	-15.19	-15.17	X	-112.73	-112.66						7.15	768	
21	TH19-KGS-01B	09-Mar-19	420146	X	-14.62		X	-114.07							7.35	957	
22	TH19-KGS-09	12-Mar-19	420147	X	-15.21		X	-114.44							7.56	737	
23	TH19-KGS-20	14-Mar-19	420148	X	-14.76	-14.68	X	-114.41	-114.65						7.28	1008	
24	TH15-05	08-Mar-19	420149	X	-15.16		X	-112.77							6.86	531	
25	Trip	-	420150	X	-6.57	-6.58	X	-60.17	-60.04								
26	Field Blank	-	420151	X	-6.55		X	-60.19									
27	TH19-KGS-100	07-Mar-19	420152	X	-14.80		X	-108.59							6.85	756	
28	TH19-KGS-500	15-Mar-19	420153	X	-15.19		X	-112.75									
29	TH19-KGS-16	15-Mar-19	420154	X	-14.99	-15.01	X	-112.14	-112.18								
30	TH19-KGS-07	07-Mar-19	420155												7.10	688	
31	TH19-KGS-02B	11-Mar-19	420156												7.63	1888	
32	TH19-KGS-13A	07-Mar-19	420157												7.00	436	
33	TH19-KGS-12B	14-Mar-19	420158												7.82	918	
34	TH19-KGS-19A	11-Mar-19	420159												7.07	787	
35	TH19-KGS-07A	07-Mar-19	420160												6.95	852	
36	TH19-KGS-11A	08-Mar-19	420161												6.51	648	
37	TH19-KGS-03A	08-Mar-19	420162												7.02	605	
38	TH19-KGS-18A	11-Mar-19	420163												6.97	496	
39	TH19-KGS-16B	09-Mar-19	420164												6.89	889	
40	TH19-KGS-17A	10-Mar-19	420165												7.22	544	
41	TH19-KGS-14A	08-Mar-19	420166												6.84	446	
42	TH19-KGS-17B	10-Mar-19	420167												7.12	904	

Hold samples until further instructions from client.

Tritium is reported in Tritium Units.
1TU = 3.221 Picocurries/L per IAEA, 2000 Report.
1TU = 0.11919 Becquerels/L per IAEA, 2000 Report.

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To Contact uwEILAB:
519 888 4732

Client: Lindell
KGS Group
Project:18-0300-005

ISO# 2019360
Location:
9 for 18O+2H, E3H

Environmental Isotope Lab
2019-08-19

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		± 0.8 T.U.		± 0.8 T.U.			µS/cm	
1	PW19-KGS-01	11-Jun-2019	425182	X	-14.69	-14.65	X	-114.25	-114.23	X	< 0.8	0.8			7.32	688	
2	PW19-KGS-02	11-Jun-2019	425183	X	-14.76		X	-114.39		X	<0.8	0.8			7.34	724	
3	PW19-KGS-03	11-Jun-2019	425184	X	-14.68	-14.71	X	-112.66	-112.62	X	<0.8	0.8			7.3	591	
4	PW19-KGS-200	11-Jun-2019	425185	X	-14.73		X	-112.61		X	<0.8	0.8			7.3	591	
5	TH19-KGS-12	12-Jun-2019	425186	X	-15.54		X	-119.09		X	<0.8	0.8			7.48	732.6	
6	TH19-KGS-17	11-Jun-2019	425187	X	-14.17	-13.99	X	-110.08	-109.25	X	<0.8	0.8			7.54	626	
7	TH19-KGS-18	12-Jun-2019	425188	X	-14.43		X	-108.74		X	10.6	0.8			7.03	972	
8	TH19-KGS-19	12-Jun-2019	425189	X	-14.94		X	-113.71		X	<0.8	0.8			7.79	915	
9	R3-SW	11-Jun-2019	425190	X	-11.48	-11.52	X	-98.79	-98.59	X	7.3	0.8			8.58	455.5	

Tritium is reported in Tritium Units.
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Client: Levay
KGS Group
Project: 18-0300-005

ISO# 2019544
Location:
2 for 18O+2H, E3H

Environmental Isotope Lab
2019-11-22
1 of 1

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW ± 0.2‰		H_2O	VSMOW ± 0.8‰			± 0.8 T.U.		± 0.8 T.U.			µS/cm	
1	Sentinel Well 2	2019-09-27	430024	X	-15.29	-15.35	X	-116.35	-115.60	X	< 0.8	0.3			8.40	1202	
2	Sentinel Well 3	2019-09-27	430025	X	-15.21	-15.22	X	-114.63	-114.84	X	< 0.8	0.3			8.15	961	

Tritium is reported in Tritium Units.
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Client: Lindell
KGS Group
Project: 18-0300-005.2302.04

ISO# 2019633
Location:
9 for 18O+2H, E3H

Environmental Isotope Lab
2020-01-10

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW ± 0.2‰		H_2O	VSMOW ± 0.8‰			± 0.8 T.U.		± 0.8 T.U.			µS/cm	
1	PW19-KGS-01	2019-10-24	432033	X	-14.87	-14.79	X	-113.88	-113.94	X	< 0.8	0.2			7.42	717	
2	PW19-KGS-02	2019-10-24	432034	X	-15.11		X	-114.15		X	< 0.8	0.2			7.32	751	
3	PW19-KGS-03	2019-10-24	432035	X	-13.62	-13.58	X	-97.15	-97.62	X	7.3	0.6	6.3	0.5	7.25	569	
4	TH19-KGS-12	2019-10-23	432036	X	-16.17		X	-119.73		X	< 0.8	0.2			7.36	748	
5	TH19-KGS-17	2019-10-23	432037	X	-15.40		X	-113.58		X	< 0.8	0.2			7.41	633	
6	TH19-KGS-18	2019-10-23	432038	X	-14.94		X	-108.99		X	10.7	0.8			6.95	1023	
7	TH19-KGS-19	2019-10-23	432039	X	-15.39	-15.34	X	-114.44	-114.12	X	< 0.8	0.2			8.17	783	
8	PW-200	2019-10-24	432040	X	-15.09		X	-114.97		X	< 0.8	0.2			7.42	717	
9	R3-SW	2019-10-24	432041	X	-14.58	-14.56	X	-102.10	-102.51	X	8.2	0.6			8.58	456	

Tritium is reported in Tritium Units.
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#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 2σ	Repeat	± 2σ	3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		± 0.8 T.U.		± 0.8 T.U.			± 6.0 T.U.		± 6.0 T.U.			µS/cm	
1	PW19-KGS-01	17-Jun-2020	443388	X	-14.93	-14.92	X	-113.94	-114.16	X										7.20	683.8	
2	PW19-KGS-02	16-Jun-2020	443389	X	-15.22		X	-114.90		X										6.98	810	
3	PW19-KGS-03	17-Jun-2020	443390	X	-14.73		X	-108.26		X										7.12	522.6	
4	TH19-KGS-12	16-Jun-2020	443391	X	-16.27		X	-119.72		X										6.99	810	
5	TH19-KGS-17	16-Jun-2020	443392	X	-15.27	-15.23	X	-113.09	-112.77	X										7.03	685.8	
6	TH19-KGS-18	16-Jun-2020	443393	X	-14.74		X	-105.73		X										6.56	566.5	
7	TH19-KGS-19	17-Jun-2020	443394	X	-15.27		X	-113.47		X										7.83	813	
8	PW19-KGS-300	17-Jun-2020	443395	X	-14.83		X	-108.20		X										7.12	522.6	
9	R3-SW	17-Jun-2020	443396	X	-11.32		X	-87.43		X										8.04	285.7	
10	LSMOC OUTLET 1A	17-Jun-2020	443397	X	-9.46	-9.36	X	-80.35	-80.11	X										8.02	625	
11	LSMOC INLET 1A	17-Jun-2020	443398	X	-7.63		X	-69.95		X										8.50	793	
12	CR3-1	17-Jun-2020	443399	X	-12.41		X	-89.75							X					7.27	228.9	
13	CR3-2	17-Jun-2020	443400	X	-12.47		X	-89.83		X										7.75	258.3	
14	BC-02	17-Jun-2020	443401	X	-10.54		X	-82.06		X										8.42	407	
15	BC-05	17-Jun-2020	443402	X	-11.14	-11.07	X	-85.12	-85.06	X										8.35	433.9	
16	SW19-KGS-01	18-Jun-2020	443403	X	-15.62		X	-114.73		X										7.08	784	
17	SW19-KGS-02	18-Jun-2020	443404	X	-15.79		X	-117.26		X										7.01	1102	
18	SW19-KGS-03	18-Jun-2020	443405	X	-15.58	-15.57	X	-115.47	-115.91	X										6.93	874	

Tritium is reported in Tritium Units.
1TU = 3.221 Picocurries/L per IAEA, 2000 Report.
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#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	E3H	Result	± 2σ	Repeat	± 2σ	3H	Result	± 1σ	Repeat	± 1σ	pH	EC	AZD
				H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		± 0.8 T.U.		± 0.8 T.U.			± 6.0 T.U.		± 6.0 T.U.			µS/cm	
1	PW19-KGS-01	2020-10-27	446559	X	-15.00	-14.92	X	-114.41	-114.40	X										7.38	709.8	
2	PW19-KGS-02	2020-10-28	446560	X	-15.28		X	-115.47		X										7.14	794.1	
3	PW19-KGS-03	2020-10-27	446561	X	-14.93		X	-111.13		X										7.24	592.1	
4	TH19-KGS-12	2020-10-28	446562	X	-16.19		X	-120.34		X										7.47	758.7	
5	TH19-KGS-17	2020-10-27	446563	X	-15.19	-15.17	X	-113.33	-113.22	X										6.68	640.7	
6	TH19-KGS-18	2020-10-27	446564	X	-14.71		X	-108.28		X										6.51	910	
7	TH19-KGS-19	2020-10-27	446565	X	-15.19		X	-113.88		X										7.06	947	
8	PW-100	2020-10-28	446566	X	-15.23		X	-115.40		X										7.14	794.1	
9	SW-R3	2020-10-28	446567	X	-13.38		X	-100.06		X										7.29	389	
10	LSMOC OUTLET 1A	2020-10-27	446568	X	-10.17	-10.13	X	-85.85	-85.45	X										8.02	625	
11	LSMOC INLET 1A	2020-10-28	446569	X	-7.88	-7.81	X	-72.08	-72.06	X										6.48	1278	
12	CR3-1	2020-10-28	446570	X	-13.25		X	-96.67		X										6.98	281.2	
13	CR3-2	2020-10-28	446571	X	-13.09		X	-96.32		X										7.10	290.8	
14	BC-02	2020-10-28	446572	X	-10.73		X	-86.72		X										8.09	572.7	
15	BC-05	2020-10-28	446573	X	-11.75	-11.61	X	-91.79	-90.95	X										7.78	630.2	
16	SW19-KGS-02	2020-10-29	446574	X	-15.25		X	-116.37		X										7.30	1163	
17	SW19-KGS-03	2020-10-29	446575	X	-15.09		X	-114.86		X										6.97	921	
18	SW-100	2020-10-28	446576	X	-13.35	-13.33	X	-99.46	-99.38						X					7.29	389	

Tritium is reported in Tritium Units.
1TU = 3.221 Picocurries/L per IAEA, 2000 Report.
1TU = 0.11919 Becquerels/L per IAEA, 2000 Report.

*1x40ml arrived broken

ENVIRONMENTAL ISOTOPE LABORATORY



Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring, Fall 2021 - Sediment Quality

REPORT

Prepared for Manitoba Infrastructure
By North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4

Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring Fall 2021

Sediment Quality

An Updated Data Report Prepared for

Manitoba Transportation and Infrastructure

By:

North/South Consultants Inc.

May 2022

North/South Consultants Inc.
Aquatic Environment Specialists

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EXECUTIVE SUMMARY

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). Regulatory review of the EIS identified a need for sediment quality data information to properly assess potential Project effects. Although not a component of the AEMP, it was noted within the AEMP that sediment quality sampling would be conducted post-operation if total suspended solids monitoring indicated that large amounts of sediment were mobilized during channel operation. This report combines the results of sediment quality sampling conducted in 2020 (NSC 2021a) with results of sediment quality sampling conducted in fall 2021 at an additional site in Lake St. Martin. The site was added to enhance spatial coverage provided by the 2020 sampling program. Overall, sediment sampling conducted in 2020 and 2021 included 10 sites as follows: two sites in Lake Manitoba; five sites in Lake St. Martin; and three sites in Lake Winnipeg in Sturgeon Bay.

At each site, sediment samples were collected for laboratory analysis of particle size, nitrogen, carbon, metals and major ions. Samples of surficial sediment were collected using either an Ekman or Ponar grab sampler; each sample was a composite of the top 5 cm of sediment from a minimum of three grabs. Sediment characteristics, including composition, colour, odour, presence of vegetation or debris, and sample depth were recorded for each sample. Three replicate samples spaced approximately 20 m apart were collected from each site. Samples were submitted to a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory for analysis. In addition, *in situ* profiles of water quality parameters including pH, specific conductance, dissolved oxygen, turbidity, and water temperature were collected at the time of sampling.

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program including standard sampling methods and the collection of replicate samples at each sampling site.

Results were compared to the Manitoba Sediment Quality Guidelines (SQGs) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) PAL guidelines. Additionally, the Ontario SQGs and the British Columbia sediment alert concentration (BC SAC) for selenium were applied to supplement the Manitoba and CCME guidelines.

The results of the sediment sampling program indicated that the surficial sediments in Lake Manitoba, Lake St. Martin, and Sturgeon Bay are dominated by sand or silt and that clay makes up a small proportion of the sediments. Parameters with Manitoba and CCME SQGs were below PAL guidelines at all sites sampled, including: arsenic; cadmium; chromium; copper; lead; mercury; and zinc.

Total Kjeldahl nitrogen (TKN), total organic carbon (TOC), and nickel exceeded the Ontario SQGs at two or more sites sampled. TKN exceeded the Ontario Lowest Effect Level (LEL) at all but two sites (Lake Manitoba at the Fairford River and a nearshore site in Sturgeon Bay) and the Ontario Severe Effect Level (SEL) at one site (south basin of Lake St. Martin). TOC exceeded the Ontario LEL at seven of ten sites (exceptions were Lake Manitoba at the Fairford River and two sites in Sturgeon Bay near the proposed Lake St. Martin Outlet Channel) but was consistently below the Ontario SEL. Nickel exceeded the Ontario LEL at three locations (south basin of Lake St. Martin, Lake St. Martin at Dauphin River, and the offshore site in Sturgeon Bay) but was consistently below the SEL. Phosphorus, iron and manganese were below the Ontario SQGs at all sites. Selenium was below the BC SAC at all sites sampled.

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ACRONYMS

AEMP	Aquatic Effects Monitoring Program
BC	British Columbia
BCMECCS	BC Ministry of Environment and Climate Change Strategy
CCME	Canadian Council of Ministers of the Environment
DL	Analytical Detection Limit
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
FRWCS	Fairford Water Control Structure
ISQG	Interim Sediment Quality Guideline
LEL	Lowest Effect Level
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MTI	Manitoba Transportation and Infrastructure
MWS	Manitoba Water Stewardship
NSC	North/South Consultants Inc.
PAL	Protection of Freshwater Aquatic Life
PEL	Probable Effect Level
QA/QC	Quality Assurance/Quality Control
SAC	Sediment Alert Concentration
SD	Standard Deviation
SEL	Severe Effect Level
SQG	Sediment Quality Guideline
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon

1.0 INTRODUCTION

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). The proposed Project is designed to manage flood waters on Lake Manitoba and Lake St. Martin by providing a channel by which flood waters can be conveyed, in addition to the natural outflow via the Fairford and Dauphin rivers (Figure 1). The Project consists of two outlet channels that are intended to work together:

- The 24 km Lake Manitoba Outlet Channel (LMOC) will work in tandem with the existing water control structure on the Fairford River (the Fairford Water Control Structure or FRWCS) to help regulate water levels and mitigate flooding on Lake Manitoba; and
- The 24 km Lake St. Martin Outlet Channel (LSMOC) will restore a more natural water regime to Lake St. Martin and will also provide flood protection by mitigating increased inflows from operation of the FRWCS, as well as additional inflows from the planned outlet from Lake Manitoba.

An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The specific objectives of the AEMP were to:

- Verify the predicted effects presented in the surface water quality and fish and fish habitat sections of the EIS;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation measures if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted measure(s); and
- Confirm compliance with regulatory requirements relevant to surface water quality and fish and fish habitat set out in the Project approvals (e.g., Manitoba Environment Act License; Fisheries Act Authorization).

Regulatory review of the EIS identified a need for sediment quality data information to assess potential project effects (Lake Manitoba and Lake St. Martin Outlet Channels Project - Technical Review Information Requests Round 1 Package 1 – April 23, 2020; Information Request 12). Although not a component of the AEMP, it was noted within the AEMP that sediment quality monitoring would be conducted after operation if total suspended solids (TSS) monitoring indicated that large amounts of sediment were mobilized during channel operation. Collection of pre-Project sediment quality samples will enable comparison to future samples if required after operation.

This report combines the results of sediment quality sampling conducted in 2020 (NSC 2021a) with results of sediment quality sampling conducted in fall 2021 at an additional site in Lake St. Martin. The new site was added to enhance spatial coverage provided by the 2020 sampling program.

2.0 METHODS

2.1 SAMPLING DATES

Sediment sampling was initiated in mid-October 2020 to coincide with the water quality monitoring program (NSC 2021b). However, due to poor weather conditions, including strong winds and the early and rapid formation of ice, the sediment sampling program was postponed until December 2020 when ice cover was sufficient to allow safe sampling through the ice. Following completion of the 2020 sampling program, a gap was identified in the data such that one additional site (i.e., Lake St. Martin at the inlet of the Dauphin River) was sampled in October 2021. Sampling dates were as follows:

- October 13, 2020;
- December 9-11, 2020; and
- October 20, 2021.

2.2 SAMPLING SITES

The study area for the monitoring program is comprised of Lake Manitoba, the Fairford and Dauphin rivers, Lake St. Martin, and Sturgeon Bay in Lake Winnipeg. Sediment sampling was conducted at ten sites in the study area. Information on sampling locations is listed in Table 1 and illustrated in Figure 1. Sampling sites were as follows:

- Two sites in Lake Manitoba,
    - Watchorn Bay at the proposed LMOC (WHB2), and
    - at the inlet of the Fairford River (LMB-FR);
- Five sites in Lake St. Martin,
    - Birch Bay (BB-LSM),
    - at the outlet of the Fairford River (LSM-FR),
    - middle of the south basin (LSM5),
    - at the inlet of the Dauphin River (LSM-DR), and
    - the eastern bay near the proposed LSMOC (LSM3); and
- Three sites in Lake Winnipeg in Sturgeon Bay,
    - at the outlet of the Dauphin River (SB-DR),
    - nearshore at the proposed LSMOC (SB1), and
    - offshore of the proposed LSMOC (SB2).

Sediment sampling was also attempted in the middle of the north basin of Lake St. Martin near water quality monitoring site LSM1 (NSC 2021b); however, the sediments in this area of the lake were too compact to allow for sampling. As an alternative, sampling was conducted at the inlet of the Dauphin River (LSM-DR) in fall 2021.

2.3 PARAMETERS

At each site, sediment samples were collected for laboratory analysis of particle size, nitrogen, carbon, and metals and major ions (e.g., aluminum, iron, calcium). A detailed list of parameters measured at the laboratory is provided in Table 2.

In situ measurements of water quality parameters were collected at each sampling site to supplement the sediment quality information. Water quality parameters measured included dissolved oxygen (DO), water temperature, specific conductance, pH, and turbidity.

2.4 FIELD METHODS

Sampling sites were accessed by boat in October 2020 and October 2021, and by snowmobile in December 2020. Sampling date and time were noted for each site. Sample locations were recorded using a handheld Garmin GPS receiver. Total water depth was recorded using a hand-held depth sounder. In December 2020, holes were drilled through the ice with an electric auger then widened using an ice saw; snow depth and ice-thickness were recorded.

In situ measurements of water quality parameters including pH, specific conductance, DO, turbidity, and water temperature were collected. In October 2020 and October 2021, *in situ* measurements were taken using a YSI EXO™2 sonde; and, in December 2020, measurements were taken using a YSI ProPlus water quality meter and an Analite turbidity meter. At each site, *in situ* profiles were taken such that measurements were recorded near the surface (i.e., at 0.3 m) and at increments of either 0.5 m (where total water depth was less than 5 m) or 1.0 m (where total water depth was at least 5m).

Sediment was collected using either an Ekman or Ponar grab sampler. Material from the top 0-5 cm was taken from the central portion of each grab using a stainless-steel spoon and placed into a Pyrex® bowl for homogenization; care was taken to avoid sediments that may have come in contact with the sampling device. Each sample was comprised of material from at least three grabs and successive grabs were separated spatially to avoid re-sampling the same location while still collecting the grabs as close as feasible to one another. Samples were placed into glass jars and zip top bags supplied by ALS Laboratories. All equipment was site rinsed prior to sample collection. Sediment characteristics, including composition, colour, odour, presence of vegetation or debris, and sample depth were recorded for each sample. Three replicate samples spaced approximately 20 m apart were collected from each site.

After collection, samples were placed in a cooler and kept cool but not frozen (using ice packs or hot water bottles as appropriate) until submission to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory) for analysis.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program. Standard QA/QC measures were followed during sample collection including but not limited to: the use of latex gloves; the use of clean site rinsed equipment; standard labelling practices;

and meter calibration. Additionally, the sampling program incorporated the collection of triplicate samples (i.e., three separate sub-samples) at each sampling site. Replicate samples provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses.

All sediment quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as "suspect" and the laboratory was asked to verify the result.

2.6 DATA ANALYSIS

All data analyses treated censured values (i.e., values reported as below the DL) as equal to one half the analytical detection limit (DL). Mean and standard deviation (SD) were calculated for each sampling site (n=3); however, SD was not calculated in cases where the result for more than one sample was below the DL. Total Kjeldahl Nitrogen (TKN) results were converted from mg/kg as provided by the analytical laboratory to units of percent (%) in order to facilitate comparison to guidelines.

2.7 COMPARISON TO SEDIMENT QUALITY GUIDELINES

Results were compared to the Manitoba Sediment Quality Guidelines (SQGs; MWS 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) PAL guidelines (CCME 1999; updated to 2021). Manitoba includes SQGs and Probable Effect Levels (PELs) for some metals (MWS 2011) which are equivalent to the CCME Interim Sediment Quality Guidelines (ISQGs) and PELs, respectively. To supplement the Manitoba/CCME guidelines, the Ontario SQGs (Fletcher et al. 2008) and the British Columbia sediment alert concentration (SAC) for selenium (BCMECCS 2019) were also applied. Manitoba, CCME and Ontario specify two values with similar intentions: SQG/ISQG (Manitoba/CCME) and lowest effect level (LEL; Ontario) are concentrations below which adverse effects are rarely expected; and PEL (Manitoba and CCME) and severe effect level (SEL; Ontario) are concentrations above which there is a higher risk for adverse effects to occur. A summary of relevant sediment quality criteria is presented in Table 3.

3.0 RESULTS

This section describes the results of the sediment quality program conducted in 2020 and 2021. Table 4 and Figures 2-16 summarize the sediment quality data collected. Supplemental field data and raw laboratory results are provided in Appendix 1 and Appendix 2, respectively. *In situ* water quality data collected during the sediment quality program are provided in Appendix 3. The following is a summary of these results.

3.1 *IN SITU* WATER QUALITY

In general, *In situ* water quality variables including, temperature, DO, turbidity, pH, and specific conductance were consistent across depth at most sites. An exception to this occurred at the offshore site in Sturgeon Bay (SB2) and in Lake St. Martin (LSM3) where there was a slight decrease in DO at depth. Despite this, all sites remained oxygenated at the sediment water interface.

3.2 SEDIMENT TEXTURE

Surficial sediment samples at most sites were dominated by sand (Figure 2); however, silt dominated the samples collected from Lake St. Martin in the south basin, at the Dauphin River inlet, and in the eastern bay near the proposed LSMOC (LSM5, LSM-DR, and LSM3, respectively); as well as the offshore site in Sturgeon Bay (SB2). Clay constituted a small proportion of the surficial sediments at all sites sampled.

3.3 NUTRIENTS

TKN (Figure 3) exceeded the Ontario LEL (550 mg/kg) at most sites sampled but was, with two exceptions, below the SEL (4800 mg/kg); the exceptions were at the south basin of Lake St. Martin (LSM5) and at inlet to the Dauphin River (LSM-DR) where TKN exceeded the Ontario SEL. TKN was below the Ontario LEL at Lake Manitoba at the Fairford River (LMB-FR) and at the nearshore site on Sturgeon Bay (SB1).

Total organic carbon (TOC; Figure 4) exceeded the Ontario LEL (1%) at most sites sampled but was below the SEL (10%). TOC was below the DL, including Lake Manitoba at the Fairford River (LMB-FR), and both the nearshore and offshore sites on Sturgeon Bay (SB1 and SB2; Table 4).

Total phosphorus was below the Ontario LEL (600 mg/kg) and SEL (2000 mg/kg) at all sites sampled (Figure 5).

3.4 METALS

Mean concentrations of all metals for which there are Manitoba and CCME sediment quality criteria were consistently below the SQG/ISQG and PEL, including: arsenic (Figure 6); cadmium (Figure 7); chromium (Figure 8); copper (Figure 9); lead (Figure 10); mercury (Figure 11); and zinc (Figure 12). Similarly, with one exception, individual sample concentrations were within PAL guidelines. The exception was one of three

samples collected from the middle of the south basin of Lake St. Martin (LSM5) in which arsenic (5.98 mg/kg) was at the SQG/ISQG (5.9 mg/kg) but well below the PEL (17 mg/kg; Appendix 2).

Mean nickel concentrations in surficial sediments exceeded the Ontario LEL (16 mg/kg) in the south basin of Lake St. Martin (LSM5), Lake St. Martin at Dauphin River (LSM-DR), and at the offshore site in Sturgeon Bay (SB2); concentrations were below this guideline at all other sites sampled (Figure 13). Nickel was below the Ontario SEL (75 mg/kg) at all sites sampled.

Iron and manganese were below the Ontario LEL and therefore the SEL at all sites sampled (Figures 14 and 15, respectively).

Additionally, selenium was below the BC SAC (2 mg/kg) at all sites sampled (Figure 16).

4.0 SUMMARY

Surficial sediments in Lake Manitoba, Lake St. Martin and Sturgeon Bay were dominated by sand or silt; clay made up a small proportion of the surficial sediments. Sediment quality parameters with Manitoba and CCME SQGs were below PAL guidelines at all sites sampled, including: arsenic; cadmium; chromium; copper; lead; mercury; and zinc.

In addition to the Manitoba and CCME guidelines, results were compared to selected Ontario SQGs and the BC SAC for selenium. Phosphorus, iron and manganese were below the Ontario SQGs at all sites; selenium was below the BC SAC. Conversely, TKN, TOC and nickel exceeded Ontario SQGs at two or more sites sampled. TKN exceeded the Ontario LEL at all but two sites (LMB-FR and SB1) and exceeded the Ontario SEL at two sites (LSM5 and LSM-DR). TOC exceeded the Ontario LEL at seven of ten sites (exceptions were LMB-FR, SB1 and SB2) but was consistently below the Ontario SEL. Nickel exceeded the Ontario LEL at three locations (LSM5, LSM-DR, and SB2) but was consistently below the SEL.

5.0 REFERENCES

British Columbia Ministry of Environment and Climate Change Strategy (BCMECCS). 2019. British Columbia approved water quality guidelines: aquatic life, wildlife & agriculture, summary report. Water Protection and Sustainability Branch, August 2019.

Canadian Council of Ministers of the Environment (CCME). 1999 (Updated to 2021). Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Fletcher, R., P. Welsh, and T. Fletcher. 2008. Guidelines for identifying, assessing and managing contaminated sediments in Ontario: an integrated approach. Ontario Ministry of the Environment, May 2008. 107 pp.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. July 4, 2011. 68 pp.

North/South Consultants Inc. (NSC). 2021a. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Sediment Quality. A report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. vi + 41 p.

NSC. 2021b. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Water Quality. A data report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. v + 75 pp.

Table 1. Sediment quality sampling sites, 2020 and 2021.

Waterbody	Location Description	Site ID	Sampling Date	Sampling Time	UTM Coordinates		
					Zone	Easting	Northing
Lake Manitoba	Watchorn Bay at proposed LMOC	WHB2	8-Dec-20	9:20	14U	529300	5681102
	at the inlet to the Fairford River	LMB-FR	9-Dec-20	8:50	14U	516805	5713010
Lake St. Martin	Birch Bay	BB-LSM	13-Oct-20	12:20	14U	534252	5704286
	at Fairford River	LSM-FR	13-Oct-20	15:50	14U	528313	5716449
	middle of south basin	LSM5	9-Dec-20	13:25	14U	536040	5724699
	at the inlet to the Dauphin River	LSM-DR	20-Oct-21	11:30	14U	547471	5740361
	eastern bay near proposed LSMOC	LSM3	11-Dec-20	11:50	14U	555895	5737191
Lake Winnipeg	at the Dauphin River	SB-DR	10-Dec-20	15:05	14U	566731	5757355
	nearshore at proposed LSMOC	SB1	10-Dec-20	12:50	14U	573476	5751450
	offshore at proposed LSMOC	SB2	10-Dec-20	9:55	14U	576810	5753557

Table 2. Laboratory measured parameters in sediment samples collected.

Sediment Quality Parameters		
Particle Size	Metals and Major Ions	
Moisture	Aluminum (Al)	Molybdenum (Mo)
% Sand (2.0mm - 0.05mm)	Antimony (Sb)	Nickel (Ni)
% Silt (0.05mm - 2um)	Arsenic (As)	Phosphorus (P)
% Clay (<2um)	Barium (Ba)	Potassium (K)
Texture	Beryllium (Be)	Selenium (Se)
Nitrogen	Bismuth (Bi)	Silver (Ag)
Nitrate/Nitrite	Boron (B)	Sodium (Na)
Nitrate	Cadmium (Cd)	Strontium (Sr)
Nitrite	Calcium (Ca)	Sulfur (S)
Total Kjeldahl Nitrogen	Chromium (Cr)	Thallium (Tl)
Carbon	Cobalt (Co)	Tin (Sn)
Inorganic Carbon	Copper (Cu)	Titanium (Ti)
Inorganic Carbon (as $CaCO_3$ Equivalent)	Iron (Fe)	Tungsten (W)
Total Organic Carbon	Lead (Pb)	Uranium (U)
Total Carbon	Lithium (Li)	Vanadium (V)
	Magnesium (Mg)	Zinc (Zn)
	Manganese (Mn)	Zirconium (Zr)
	Mercury (Hg)	

Table 3. Summary of Manitoba (MWS 2011) and CCME (1999 updated to 2021) sediment quality guidelines, as well as supplemental guidelines from Ontario (Fletcher et al. 2008) and British Columbia (BCMECCS 2019).

		Manitoba/CCME		Ontario		British Columbia
Parameter	Units	ISQG	PEL	LEL	SEL	SAC
Total Kjeldahl Nitrogen	mg/kg	-	-	550	4800	-
Total Phosphorus	mg/kg	-	-	600	2000	-
Total Organic Carbon	%	-	-	1	10	-
Arsenic	mg/kg	5.9	17	-	-	-
Cadmium	mg/kg	0.6	3.5	-	-	-
Chromium	mg/kg	37.3	90	-	-	-
Copper	mg/kg	35.7	197	-	-	-
Iron	mg/kg	-	-	20000	40000	-
Lead	mg/kg	35	91.3	-	-	-
Manganese	mg/kg	-	-	460	1100	-
Mercury	mg/kg	0.17	0.486	-	-	-
Nickel	mg/kg	-	-	16	75	-
Selenium	mg/kg	-	-	-	-	2
Zinc	mg/kg	123	315	-	-	-

SQG = Sediment Quality Guideline; ISQG = Interim Sediment Quality Guideline; PEL = Probable Effect Level; LEL = Lowest Effect Level; SEL = Severe Effect Level; and SAC = Sediment Alert Concentration.

Table 4. Mean and standard deviation (SD) of sediment quality parameters at sampling sites in Lake Manitoba, Lake St. Martin and Lake Winnipeg, 2020-2021.

Parameter	Units	Analytical Detection Limit	Lake Manitoba				Lake St. Martin										Lake Winnipeg					
			WHB2		LMB-FR		BB-LSM		LSM-FR		LSM5		LSM-DR		LSM3		SB-DR		SB1		SB2	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Particle Size																						
Moisture	%	0.1	32	9.08	34.4	2.88	46.4	2.75	71.1	13.1	87.9	0.51	76.7	1.42	62.4	2.26	38.6	4.48	25.2	1.36	51.5	0.92
% Sand (2.0mm - 0.05mm)	%	1	91.1	3.48	95.6	1.81	88.7	3.22	60.7	17.9	3.7	2.75	8.3	1.99	33.7	5.61	79	5.15	96.6	0.12	12.2	5.01
% Silt (0.05mm - 2µm)	%	1	8.1	3.3	4.3	1.79	11.1	3.16	38.2	16.9	79.2	5.31	69.2	2.85	63.3	5.5	17.5	4.8	1.6	0.21	72.1	0.83
% Clay (<2µm)	%	1	<1.0	-	<1.0	-	<1.0	-	1.1	-	17.1	2.81	22.5	4.6	3	0.49	3.6	0.35	1.8	0.29	15.6	5.14
Nitrogen																						
Nitrate/Nitrite	mg N/kg	1	1.9	0.15	2	0	1.4	0.21	1.6	0.32	3.9	0.4	1.5	0.14	3.6	0.21	4.5	1.73	1.5	0.15	3.5	0.46
Nitrate	mg N/kg	1.1	<1.1	-	<1.1	-	<1.1	-	<1.1	-	<1.1	0.35	1.4	0.77	<1.1	-	2.8	1.57	<1.1	-	1.4	0.77
Nitrite	mg N/kg	0.4	1.19	0.182	1.59	0.032	0.91	0.186	1.03	0.272	2.82	0.437	0.94	0.272	2.75	0.28	1.63	0.272	0.97	0.099	2	0.27
Total Kjeldahl Nitrogen	mg/kg	200/400/1000	720	60.8	497	40.4	1490	131	4033	1850	7567	1097	5770	1080	2260	147	620	105	297	5.8	1400	233
Carbon																						
Inorganic Carbon	%	0.05	4.04	1.32	5.83	0.765	1.61	0.139	3.23	0.122	5.66	0.347	5.95	0.137	4.96	0.58	3.61	0.804	1.73	0.463	4.01	0.349
Inorganic Carbon (as $CaCO_3$ Equivalent)	%	0.4	33.7	11	48.6	6.37	13.4	1.13	26.9	1.01	47.2	2.9	49.6	1.16	41.3	4.85	30.1	6.7	14.4	3.9	33.4	2.9
Total Organic Carbon	%	various	2.2	1.3	<1.2	-	2.96	0.26	6.5	1.7	9.2	0.26	34	0.23	4.9	0.7	<0.93	-	<0.37	-	3.4	0.23
Total Carbon	%	0.05	6.2	0.28	6.1	0.212	4.57	0.397	9.68	1.86	14.9	0.058	8.17	0.351	9.8	0.173	4.39	0.248	1.81	0.053	7.38	0.106
Metals																						
Aluminum (Al)	mg/kg	50	2273	110	2167	85	2453	75	2570	431	7783	749	7500	741	4067	490	4317	462	2447	185	10063	469
Antimony (Sb)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	<0.10	-	0.42	0.06	0.16	0.02	<0.10	-	<0.10	-	<0.10	-	0.13	0.01
Arsenic (As)	mg/kg	0.1	1.06	0.006	0.74	0.065	0.91	0.04	1.24	0.286	5.45	0.648	3.15	0.282	1.61	0.122	1.51	0.081	0.96	0.081	2.58	0.075
Barium (Ba)	mg/kg	0.5	29.5	1.12	23.7	4.38	23.9	1.18	67.8	7.49	148	8.3	192.7	13.5	63.3	7.62	25.8	3.45	11.5	1.04	66.9	3.94
Beryllium (Be)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	0.13	0.017	0.29	0.017	0.27	0.042	0.13	0.015	0.15	0.015	<0.10	-	0.35	0.021
Bismuth (Bi)	mg/kg	0.2	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-
Boron (B)	mg/kg	5	13.8	0.95	8.5	0.95	9.2	0.4	14.4	1.63	27.7	2.01	26.7	1.45	17	2.17	10.2	0.6	6	0.26	14.4	0.4
Cadmium (Cd)	mg/kg	0.02	0.052	0.0032	0.029	0.0052	0.067	0.003	0.098	0.0366	0.289	0.0512	0.198	0.02	0.097	0.0096	0.044	0.0012	<0.020	-	0.124	0.0064
Calcium (Ca)	mg/kg	50	64700	1852	73667	8051	68300	2170	122667	8021	204667	4163	268667	10263	155000	13748	69133	5637	31100	872	88433	3092
Chromium (Cr)	mg/kg	0.5	5.2	0.194	5.27	0.286	5.66	0.45	7.1	1.4	19.6	0.666	18.1	2.12	8.69	1.1	10.6	1.04	5.62	0.397	23.9	0.76
Cobalt (Co)	mg/kg	0.1	1.35	0.021	1.22	0.11	1.61	0.066	2.18	0.535	5.32	0.252	4.18	0.364	1.94	0.195	3.31	0.226	1.48	0.104	6.2	0.23
Copper (Cu)	mg/kg	0.5	2.9	0.036	1.93	0.405	3.29	0.271	7.12	2.1	17.7	0.67	12.1	0.924	4.3	0.451	4.63	0.691	1.66	0.212	13.9	0.78
Iron (Fe)	mg/kg	50	3037	49.3	2740	252	3397	143	4410	865	10303	495	9403	671	4940	540	5803	545	3020	178	12767	252
Lead (Pb)	mg/kg	0.5	2.14	0.089	1.36	0.18	2.21	0.11	3.61	1.29	10	2.52	6.53	1.47	3.06	0.265	2.97	0.324	1.53	0.164	6.55	0.263
Lithium (Li)	mg/kg	2	3.7	0.17	3.9	0.36	4.6	0.15	5.8	1.05	11.9	0.64	13	0.47	7.2	0.95	7.7	0.7	3.9	0.25	15.7	0.69
Magnesium (Mg)	mg/kg	20	21967	1150	28433	1358	28367	1447	27833	1595	20633	252	26033	1893	51767	3696	38233	2285	17100	819	52733	1589
Manganese (Mn)	mg/kg	1	97.9	1.22	98.4	10.2	96.7	4.05	159	22	306	13.5	330	24.01	193	18.6	153	7.5	78.2	6.1	308	12.7
Mercury (Hg)	mg/kg	0.0050/0.010	0.0103	0.00015	0.0065	0.00026	0.0131	0.00118	0.0121	0.00488	0.038	0.0072	0.0147	0.00808	0.0159	0.00058	0.0109	0.00131	<0.0050	-	0.0211	0.00106
Molybdenum (Mo)	mg/kg	0.1	0.32	0.021	0.25	0.044	0.17	0.012	0.44	0.081	2.79	0.122	0.98	0.163	0.46	0.046	0.13	0.023	<0.10	-	0.22	0.012

Table 4. Continued.

Parameter	Units	Analytical Detection Limit	Lake Manitoba				Lake St. Martin										Lake Winnipeg					
			WHB2		LMB-FR		BB-LSM		LSM-FR		LSM5		LSM-DR		LSM3		SB-DR		SB1		SB2	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Nickel (Ni)	mg/kg	0.5	4.68	0.07	3.59	0.418	4.56	0.295	7.82	2.06	23.4	1.47	16.1	1.25	6.58	0.741	7.33	0.739	3.44	0.202	17.4	1.01
Phosphorus (P)	mg/kg	50	350	33.2	260	20.1	357	24.4	286	52	390	60.3	353	35.2	303	20.5	420	4	387	43.3	442	11
Potassium (K)	mg/kg	100	497	11.5	453	61.1	537	35.1	883	174	2307	188	2303	172	1037	125	943	125	403	40.4	2200	72.1
Selenium (Se)	mg/kg	0.2	<0.20	-	<0.20	-	<0.20	-	0.29	0.074	1.21	0.031	<0.20	-	0.25	0.015	<0.20	-	<0.20	-	<0.20	-
Silver (Ag)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-
Sodium (Na)	mg/kg	50	394	15.5	337	64.8	334	19.1	773	215	1773	110	1447	32.1	671	96	278	31.5	119	6.7	384	19.5
Strontium (Sr)	mg/kg	0.5	77.8	4.47	69.1	12.1	65.3	1.84	207	28.3	456	8.5	758	30.32	230	24.6	32.8	2.15	18.6	0.93	44.9	0.42
Sulfur (S)	mg/kg	1000	1267	57.7	<1000	-	1400	100	2567	379	7033	57.7	6667	586	2467	306	<1000	-	<1000	-	1200	100
Thallium (Tl)	mg/kg	0.05	0.065	0.0032	0.053	0.0026	0.083	0.0032	0.065	0.0089	0.165	0.0067	0.133	0.0036	0.074	0.0081	0.083	0.0095	<0.050	-	0.151	0.0065
Tin (Sn)	mg/kg	2	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-
Titanium (Ti)	mg/kg	1	127	4.2	137	13.6	127	4.6	123	93.9	291	32.5	314	36.3	197	24.5	269	23.3	274	20.8	448	21.8
Tungsten (W)	mg/kg	0.5	-	-	-	-	<0.50	-	<0.50	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium (U)	mg/kg	0.05	0.458	0.0275	0.373	0.0288	0.388	0.0258	0.718	0.108	2.82	0.226	1.19	0.1212	0.643	0.0594	0.467	0.0571	0.341	0.0333	0.949	0.0255
Vanadium (V)	mg/kg	0.2	5.92	0.229	5.57	0.361	6.01	0.29	7.4	1.2	24	2.27	18.8	1.94	10.3	1.24	11.8	1.21	6.68	0.496	26.3	0.89
Zinc (Zn)	mg/kg	2	9.3	0.47	6.9	0.8	11.3	1.32	16.9	5.14	44.6	3.07	36.6	2.65	16.2	1.96	14.5	1.42	6.2	0.5	32.1	0.95
Zirconium (Zr)	mg/kg	1	1.1	0.06	1.2	0.17	1.2	0	1.4	0.29	3.7	0	5.1	0.701	2	0.26	3.2	0.3	2.5	0.21	8.8	0.35

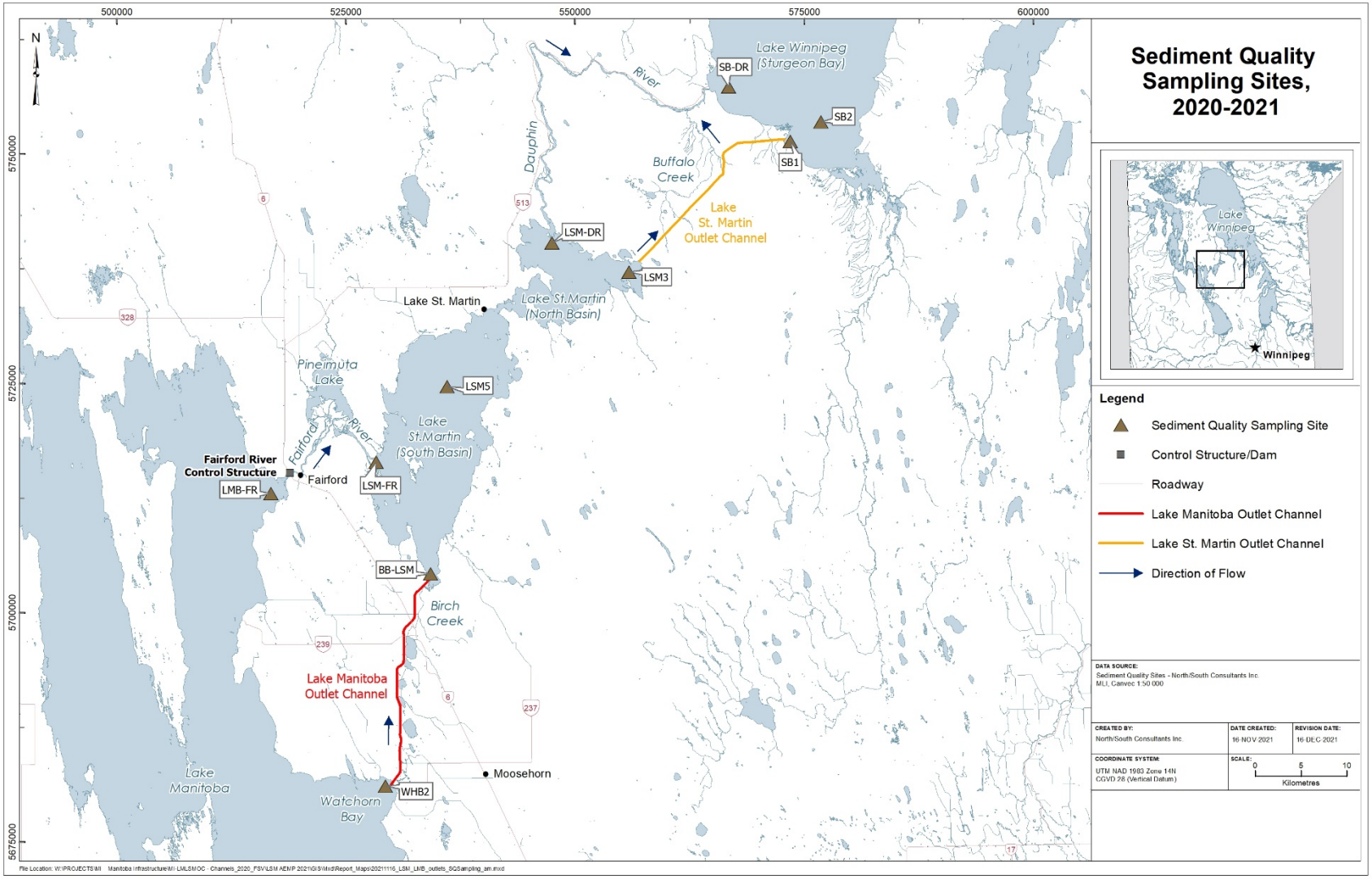


Figure 1. Sediment quality sampling locations, 2020-2021.

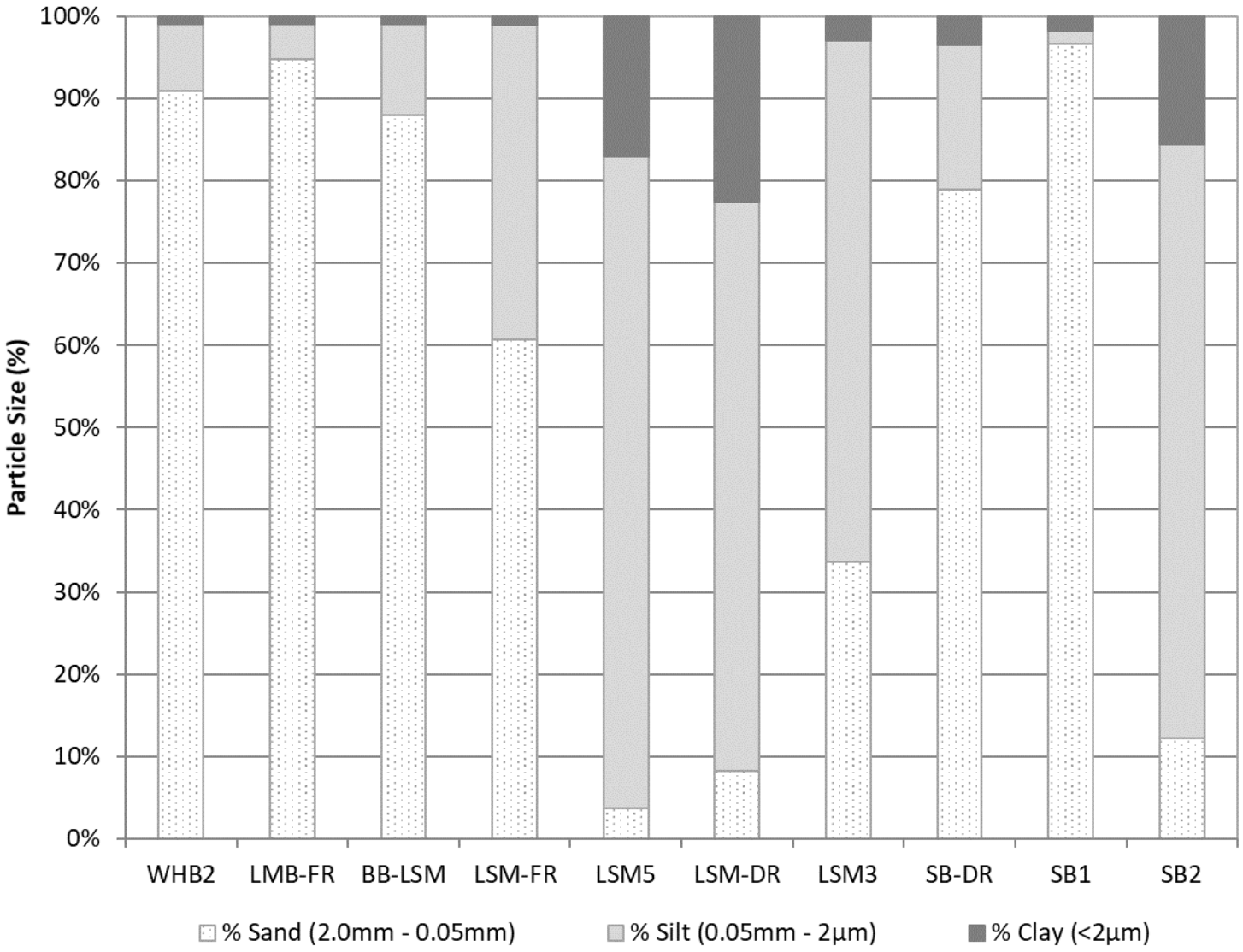


Figure 2. Particle size of surficial sediments samples (n=3) collected at sites in Lake Manitoba, Lake St. Martin and Sturgeon Bay.

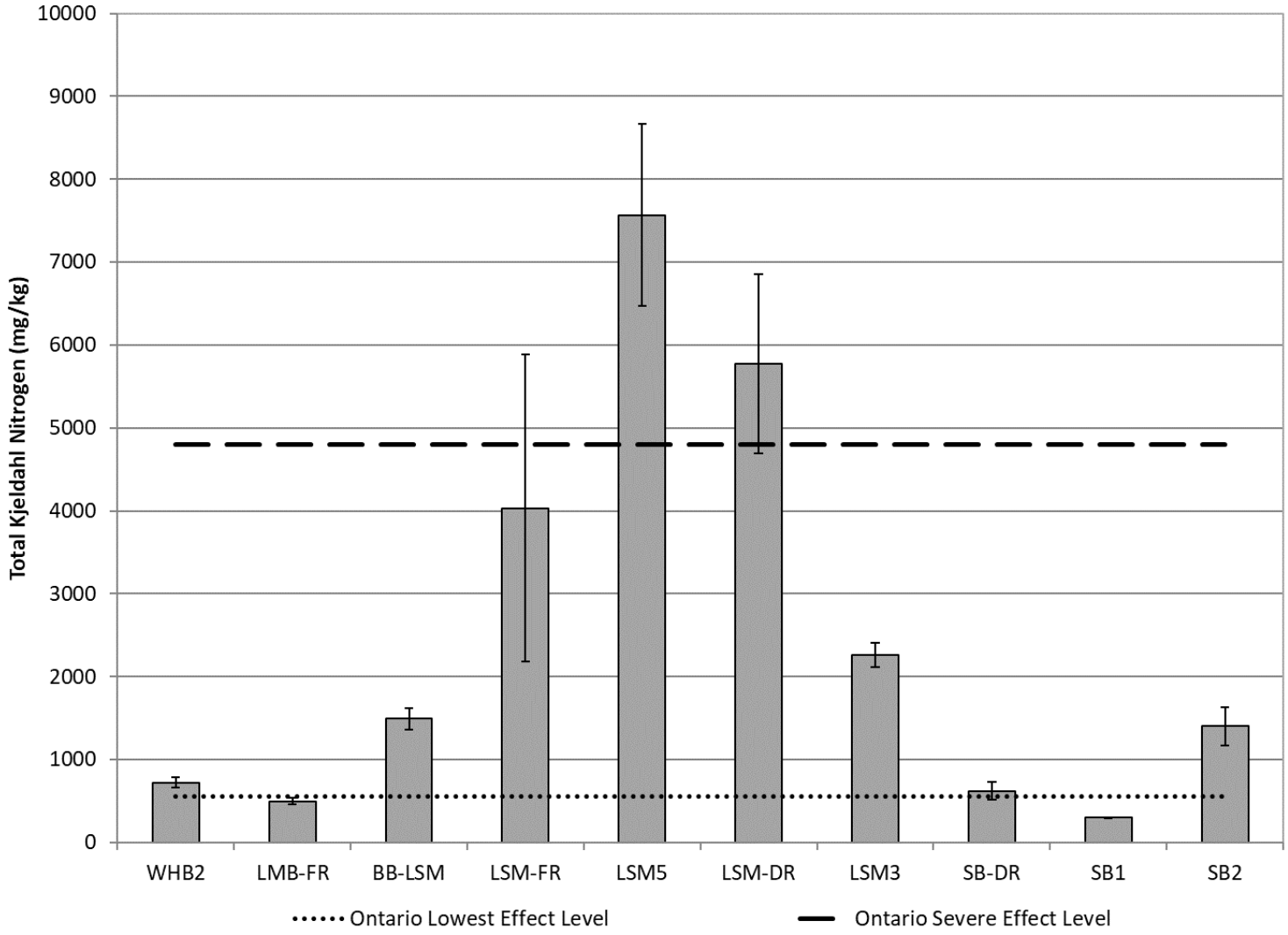


Figure 3. Mean (±SD) concentration of total Kjeldahl nitrogen in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

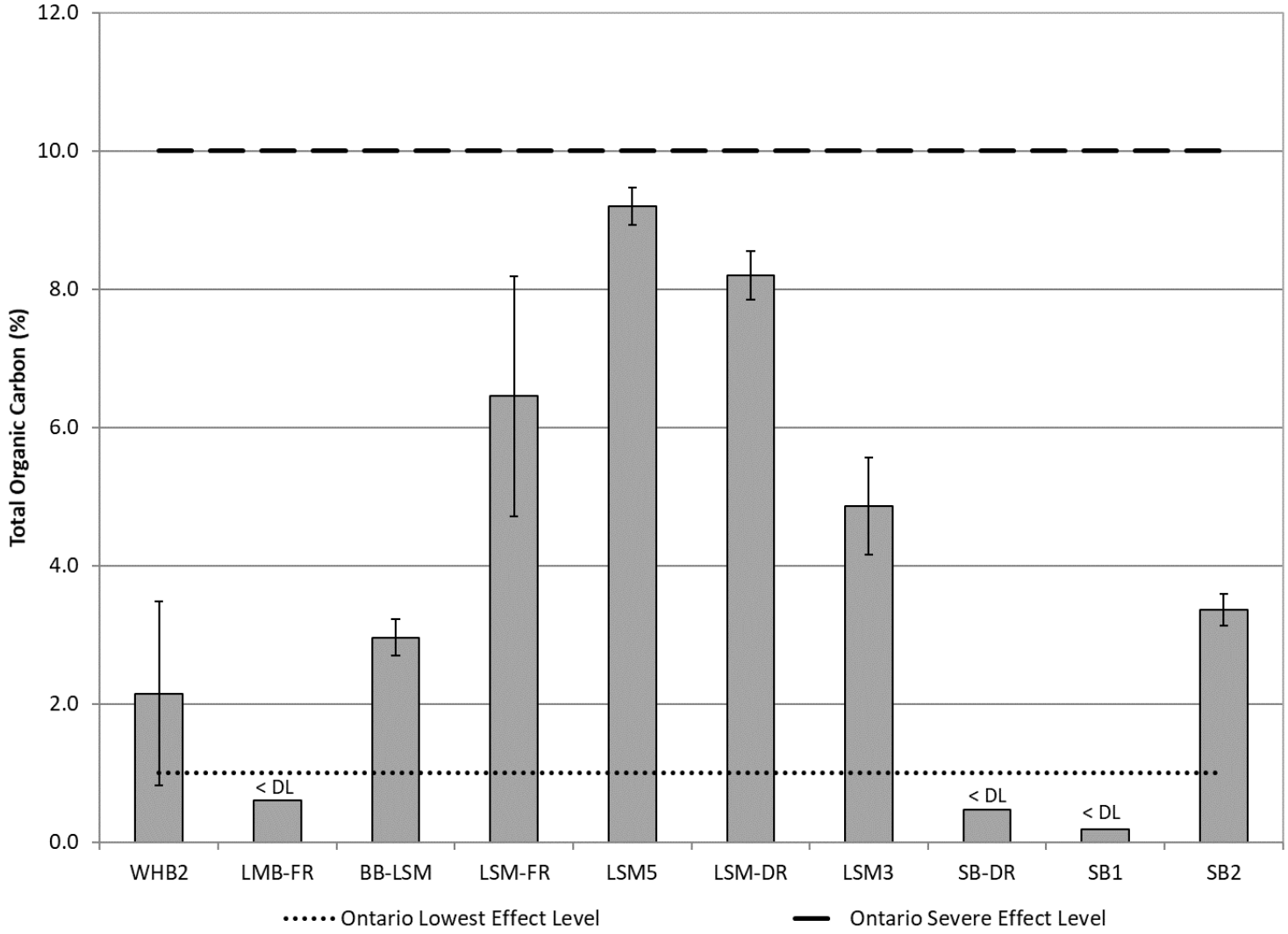


Figure 4. Mean (±SD) percent total organic carbon in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

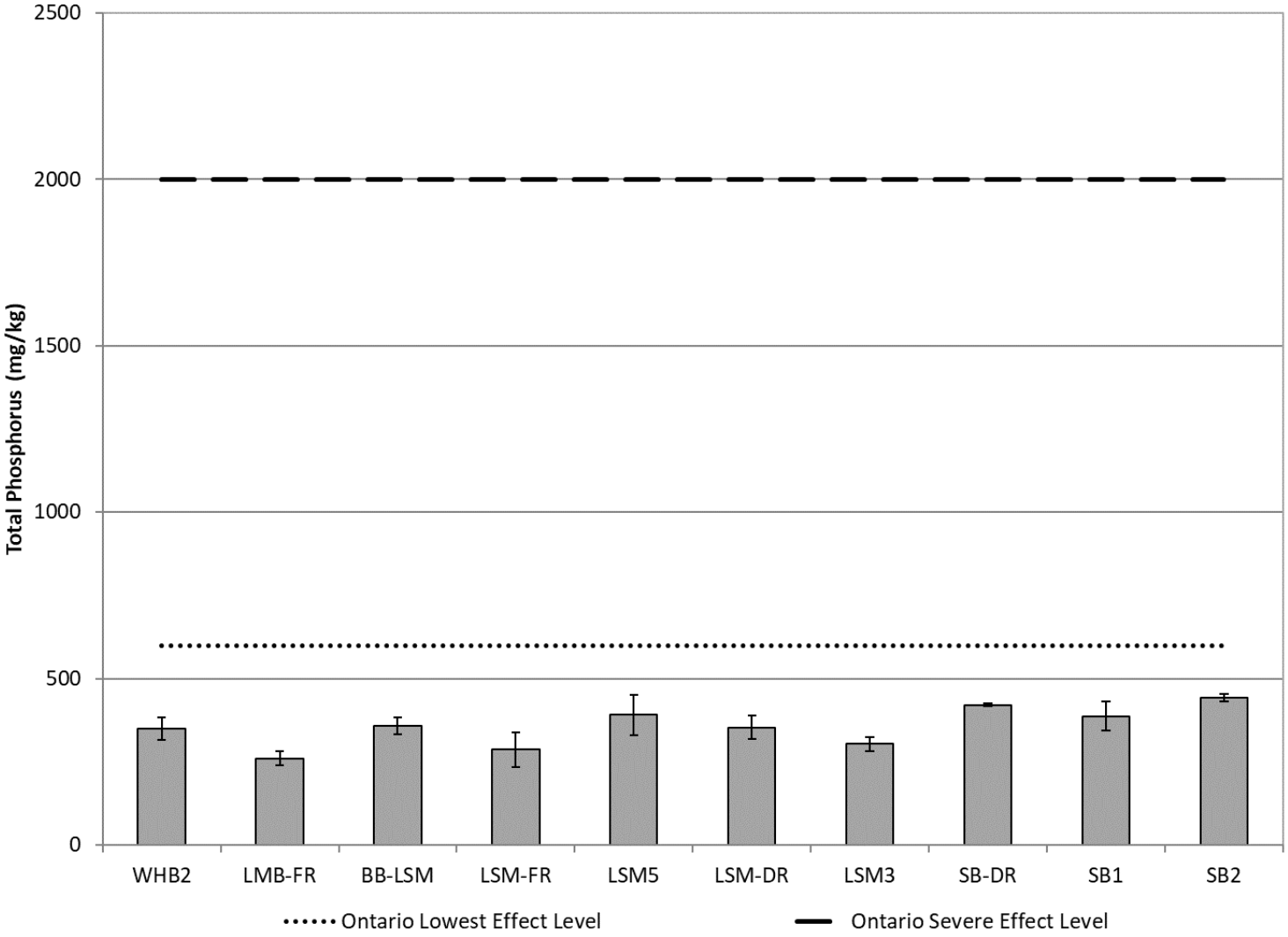


Figure 5. Mean (±SD) concentration of total phosphorus in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

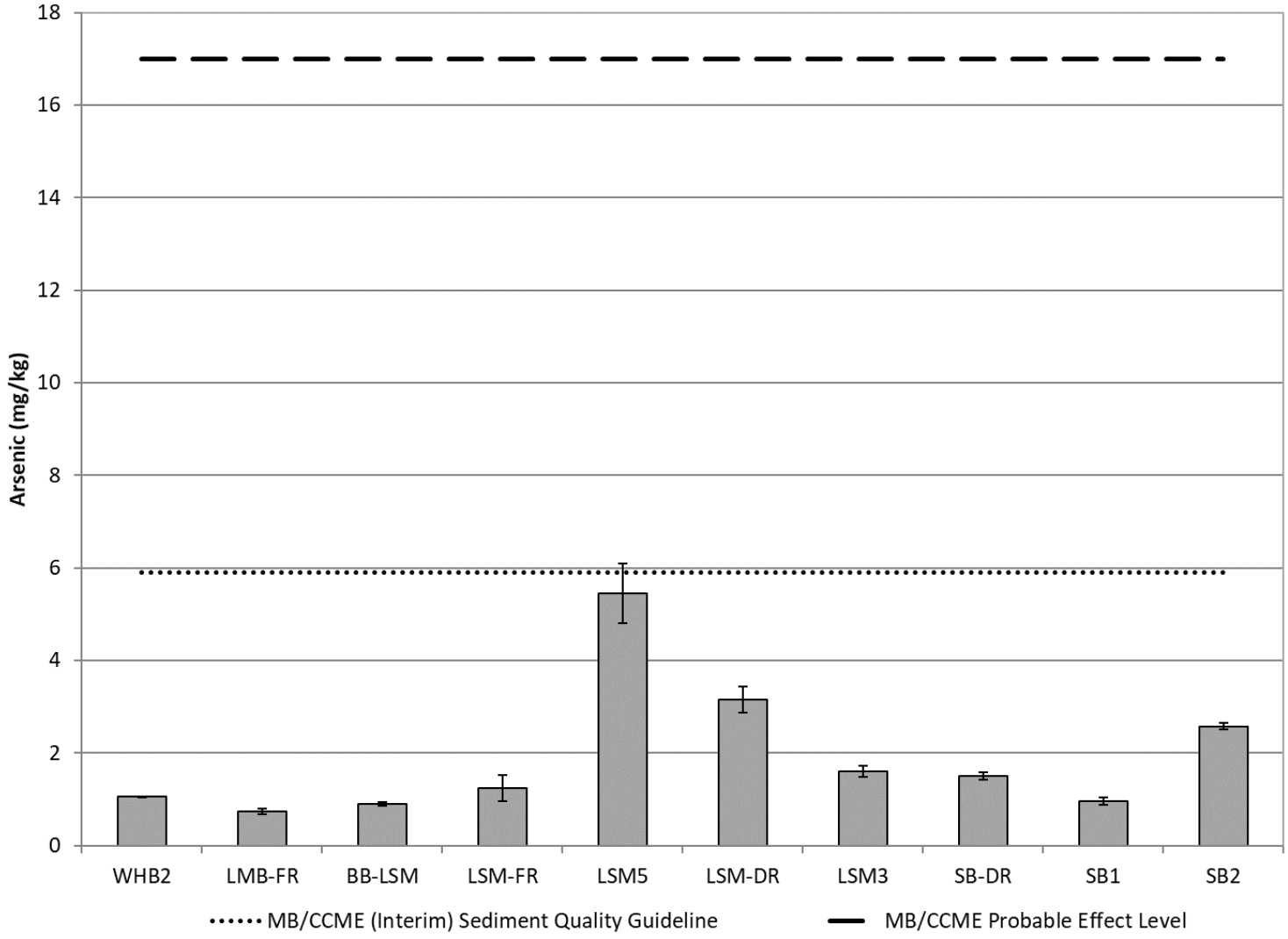


Figure 6. Mean (±SD) concentration of arsenic in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

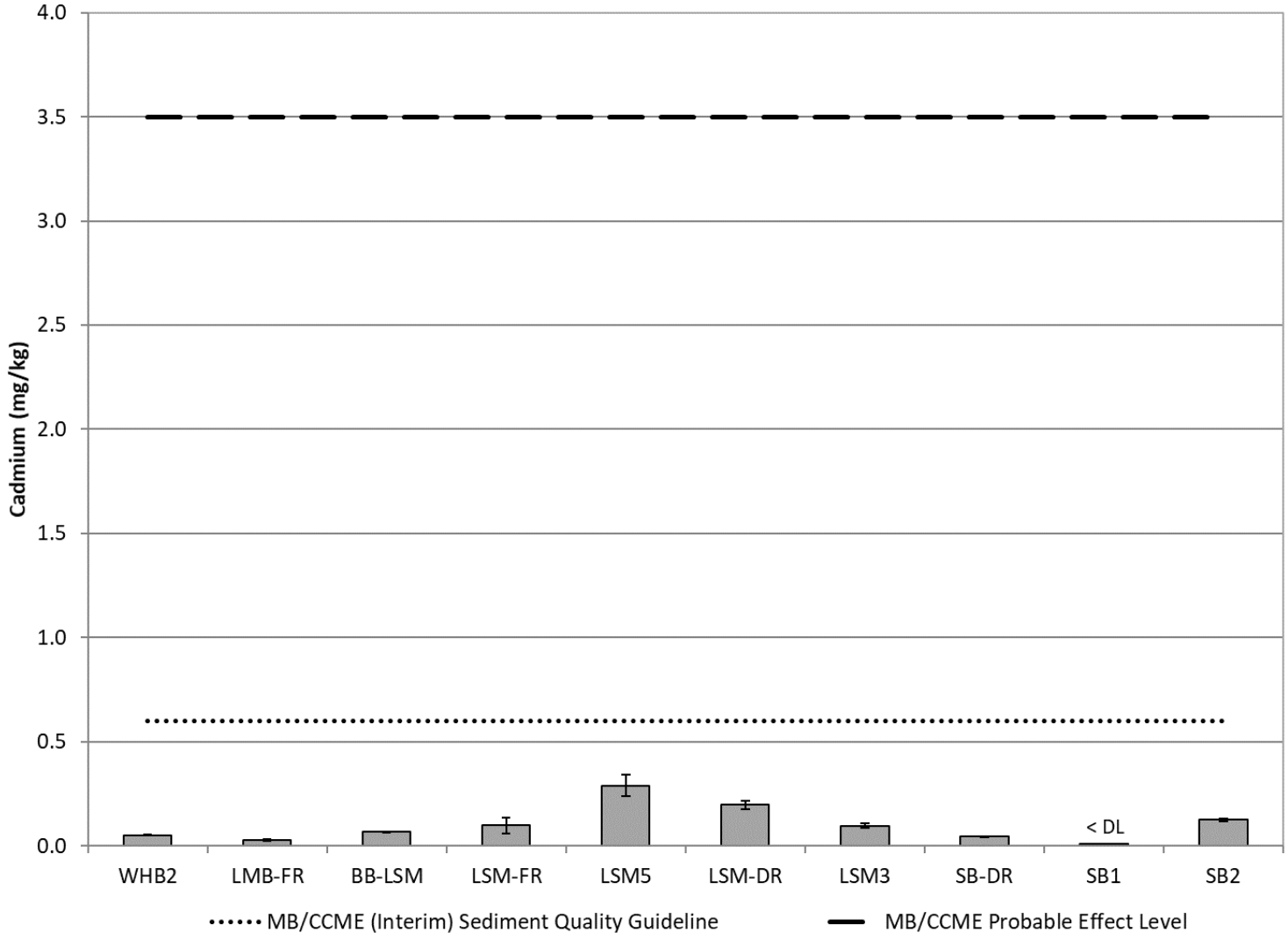


Figure 7. Mean (±SD) concentration of cadmium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

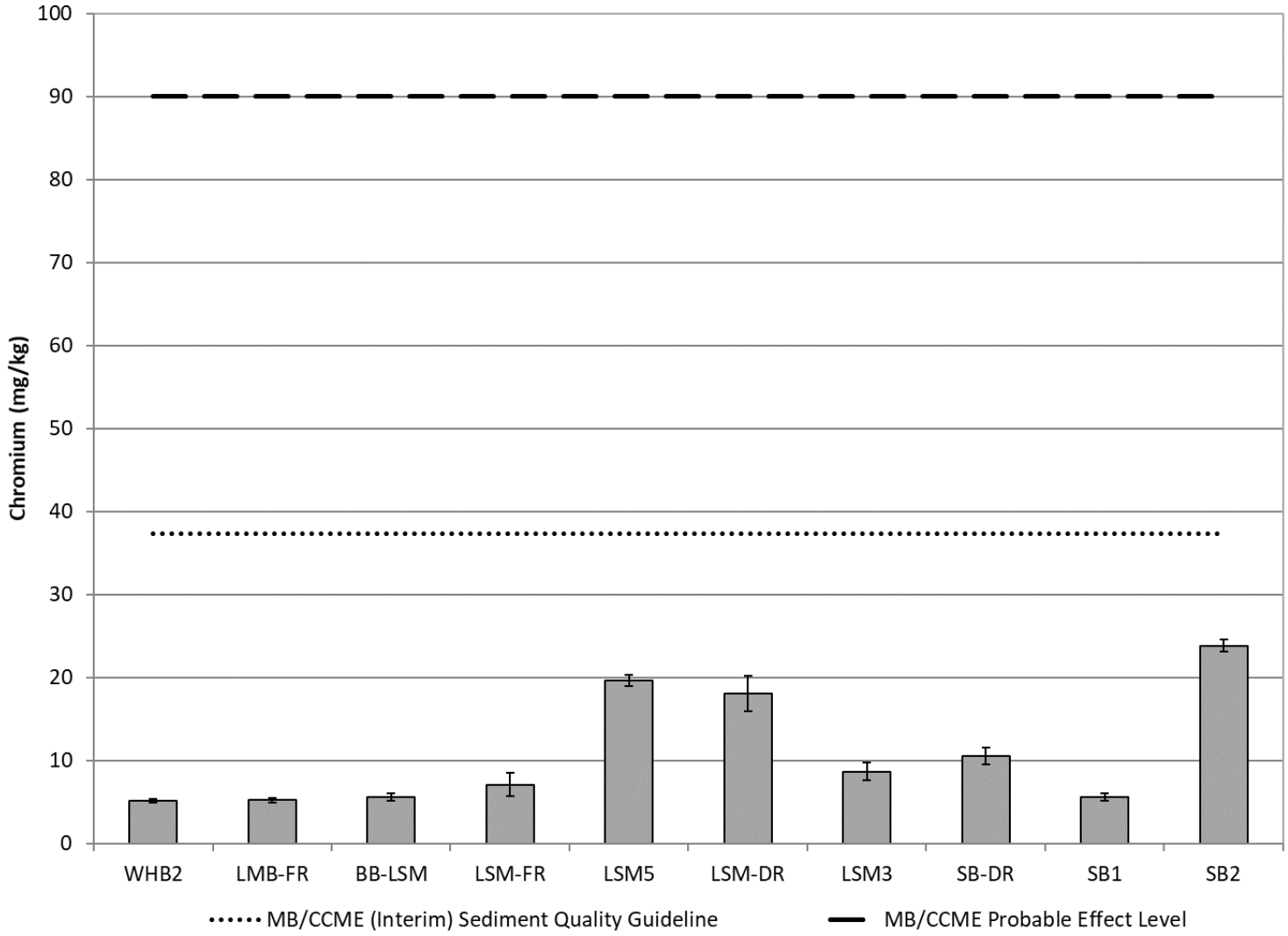


Figure 8. Mean (±SD) concentration of chromium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

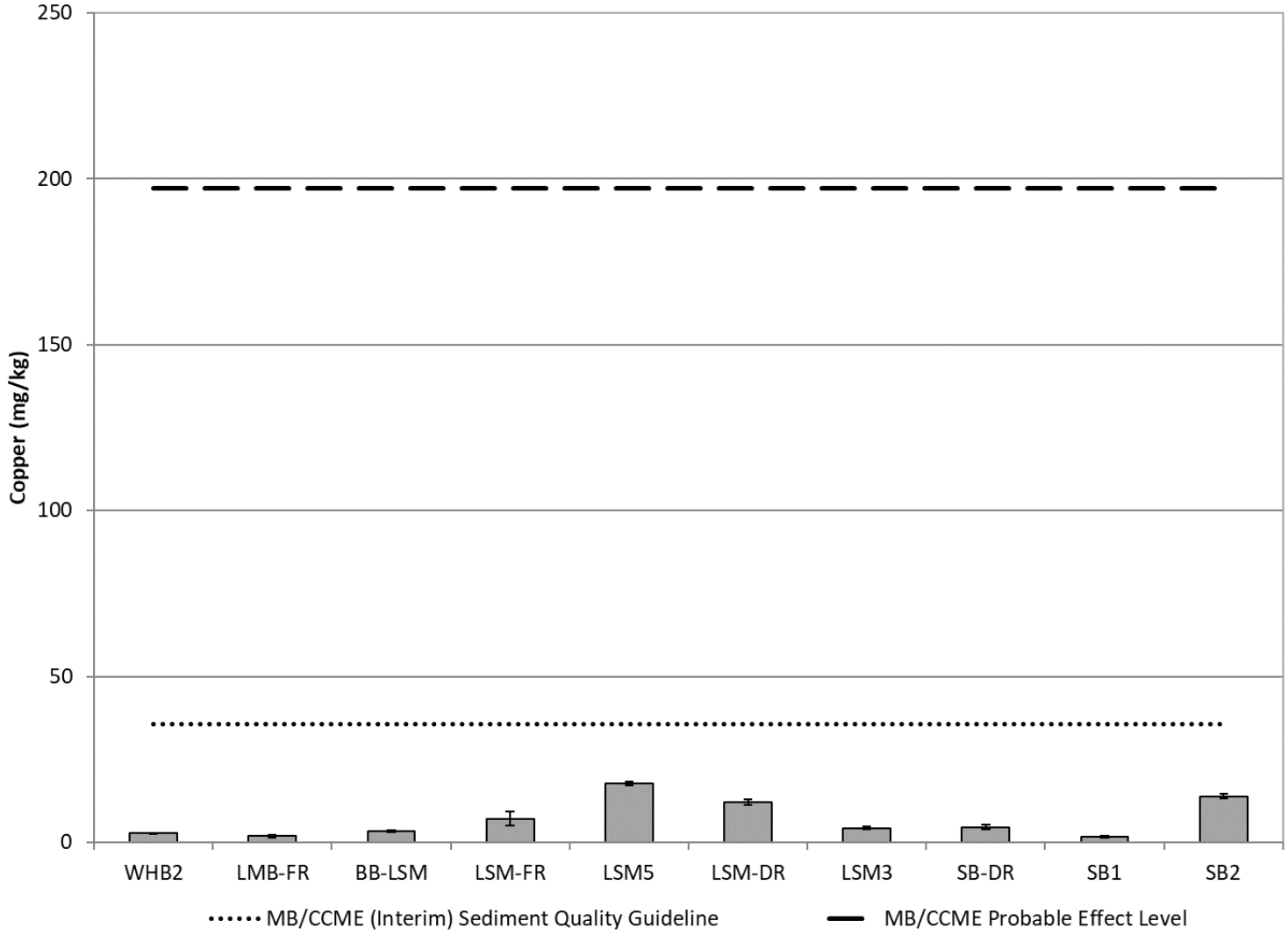


Figure 9. Mean (±SD) concentration of copper in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

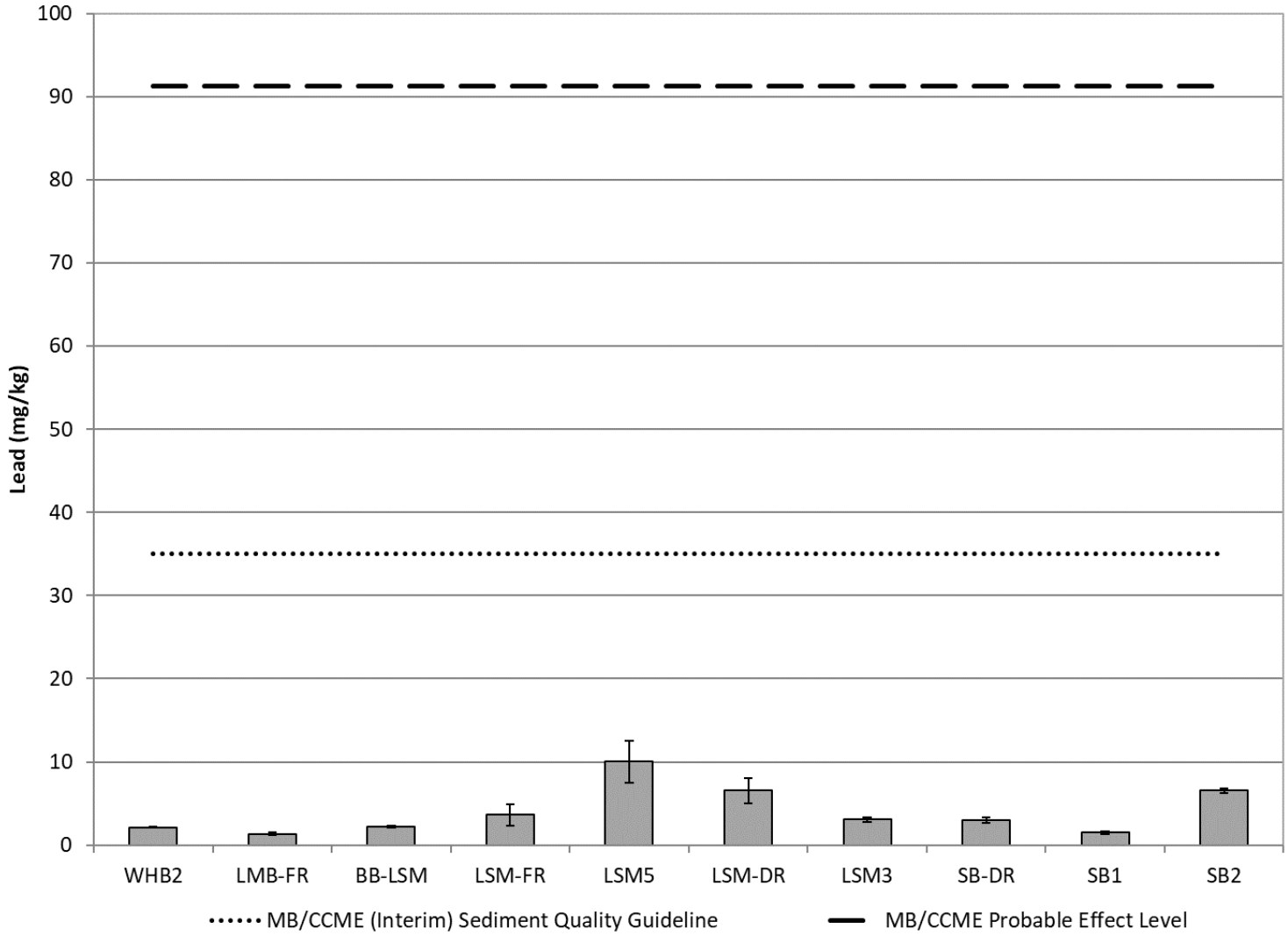


Figure 10. Mean (±SD) concentration of lead in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

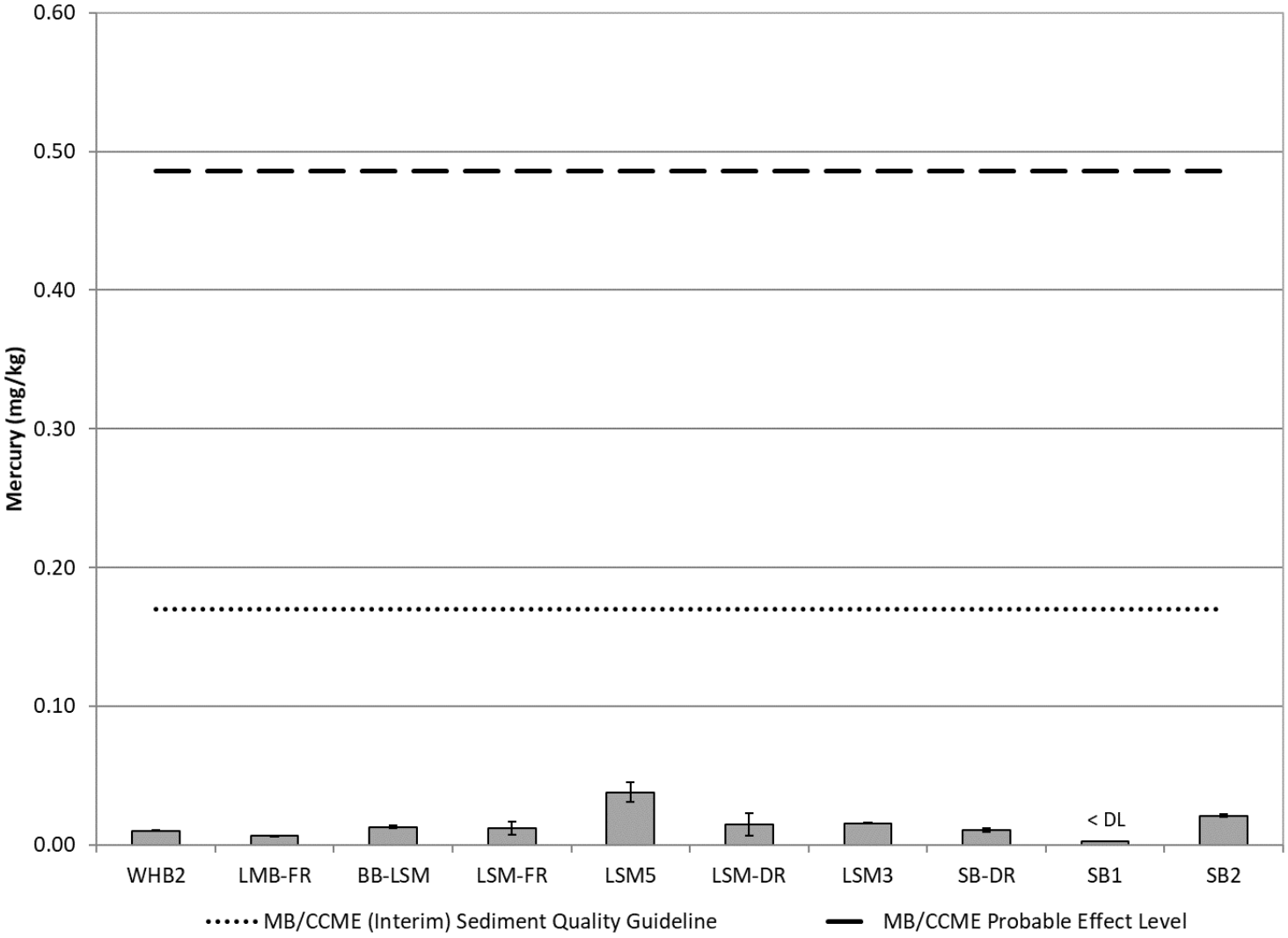


Figure 11. Mean (±SD) concentration of mercury in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

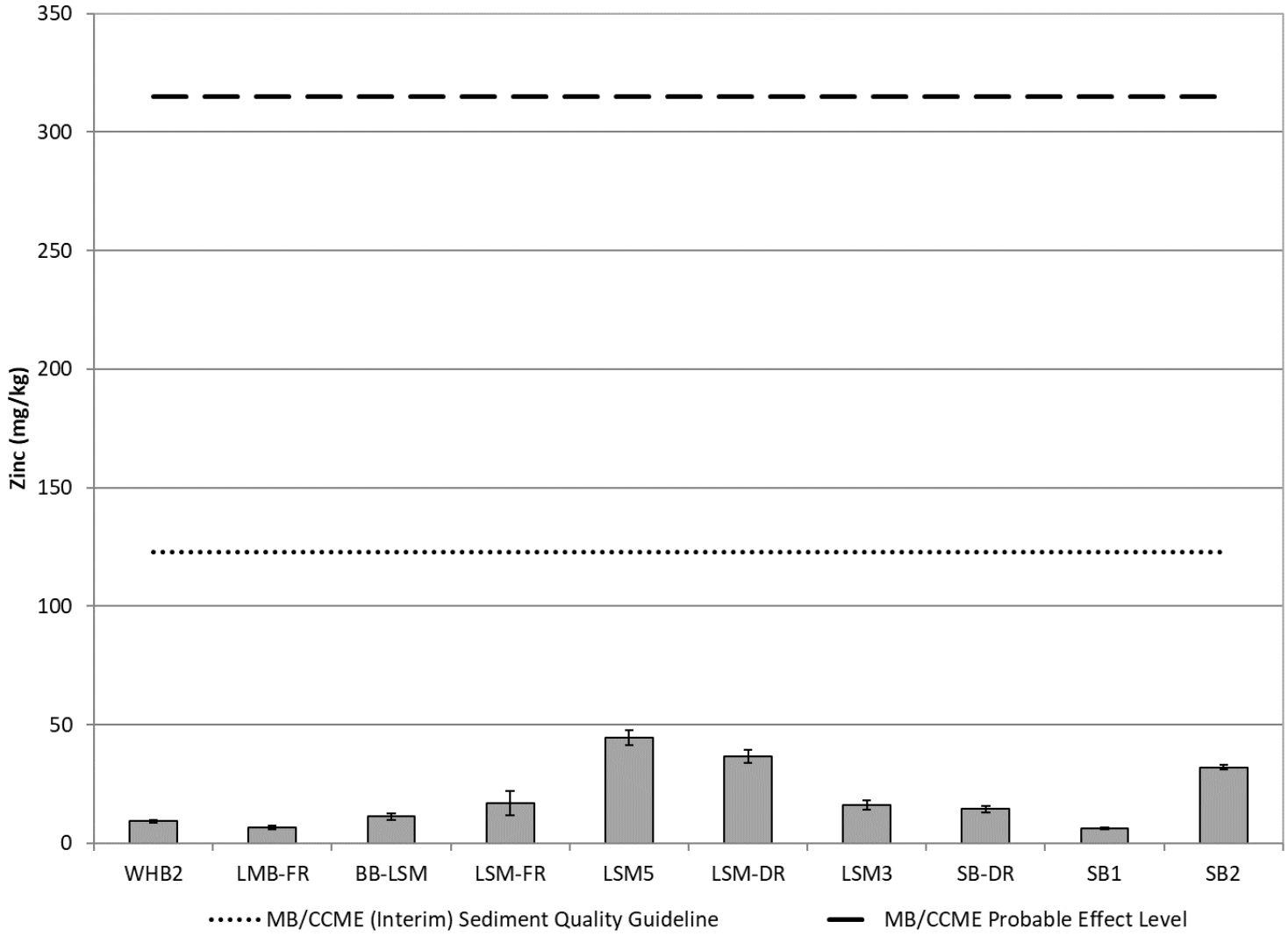


Figure 12. Mean (±SD) concentration of zinc in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

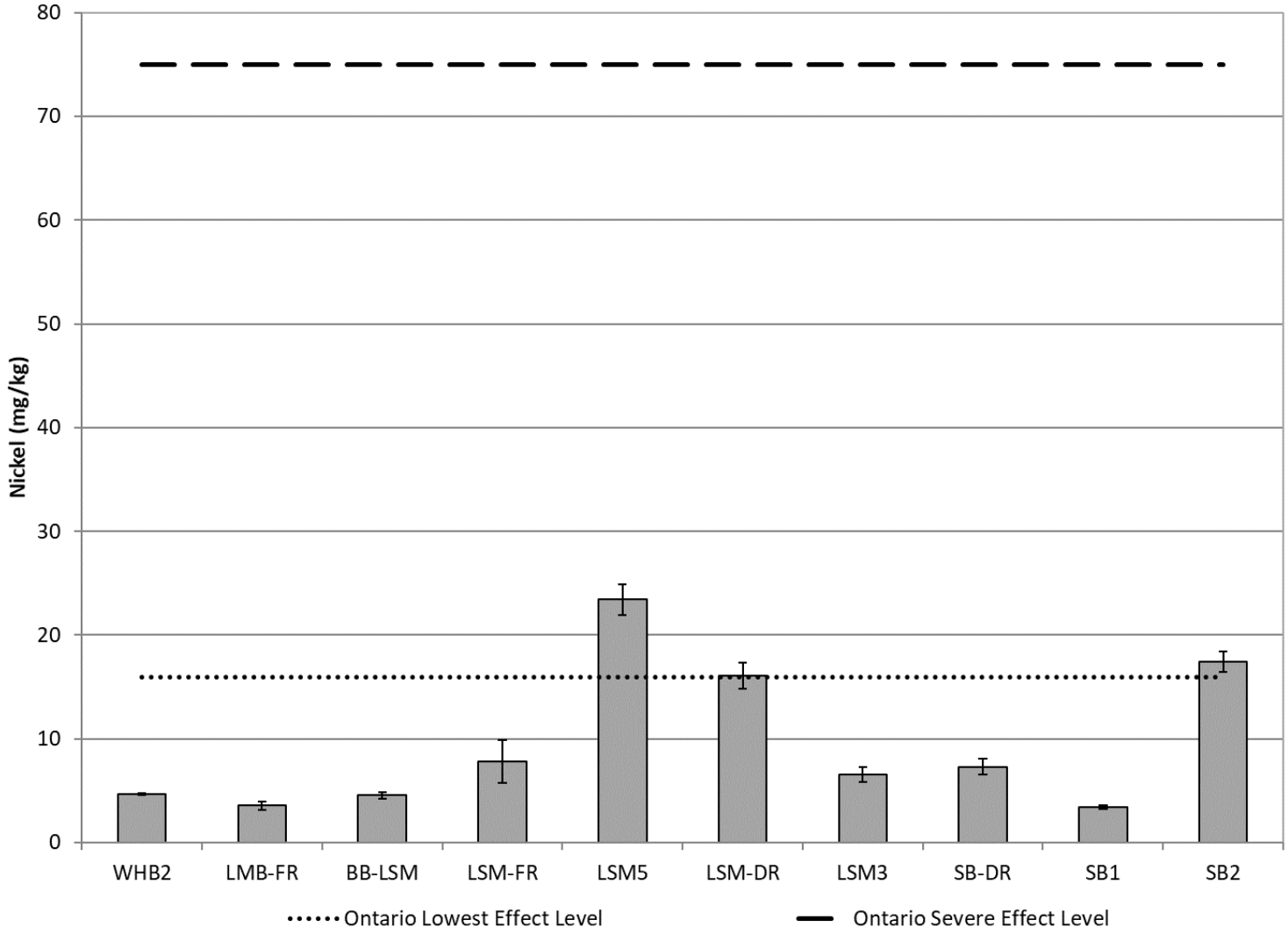


Figure 13. Mean (±SD) concentration of nickel in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

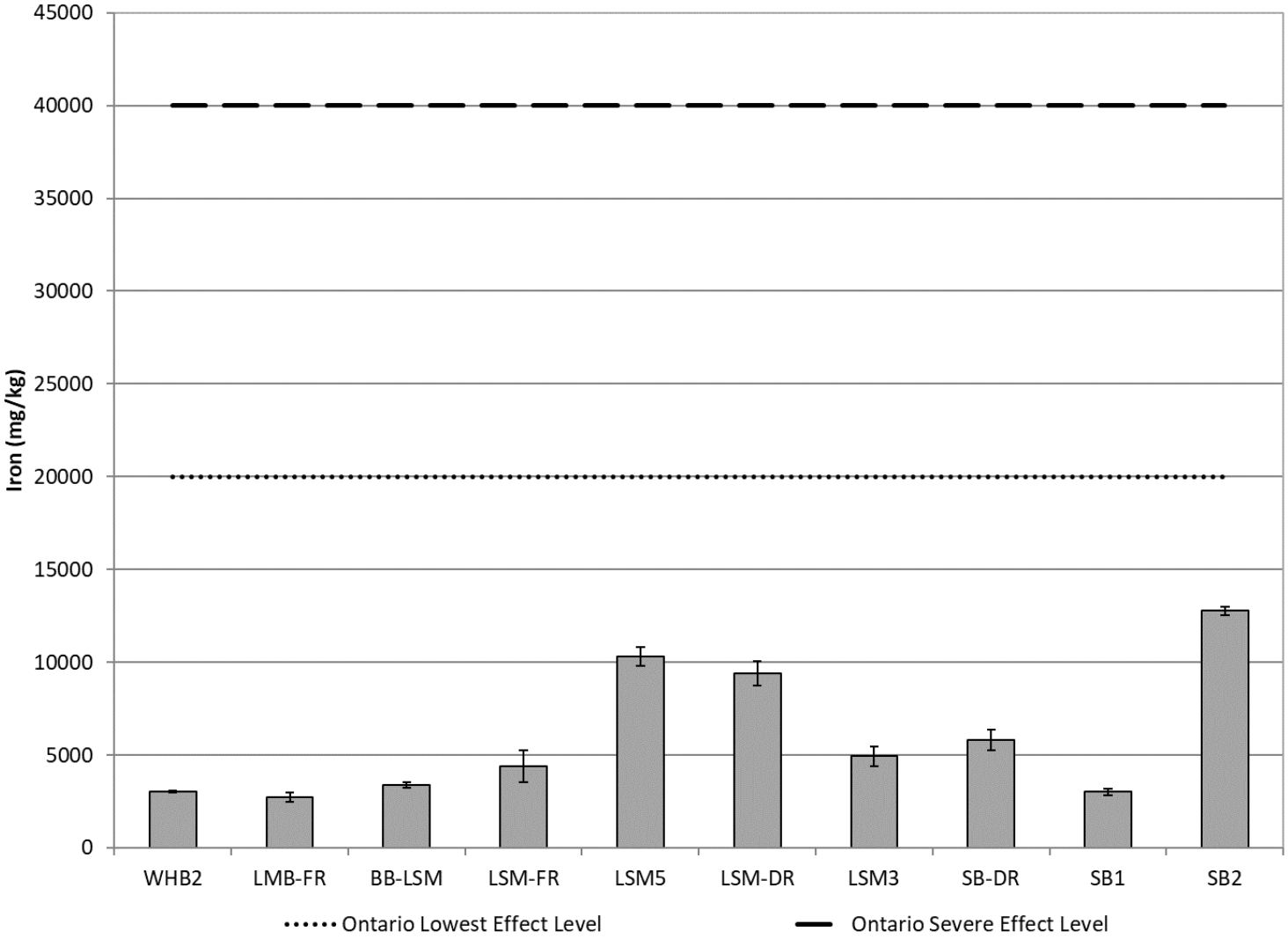


Figure 14. Mean (±SD) concentration of iron in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

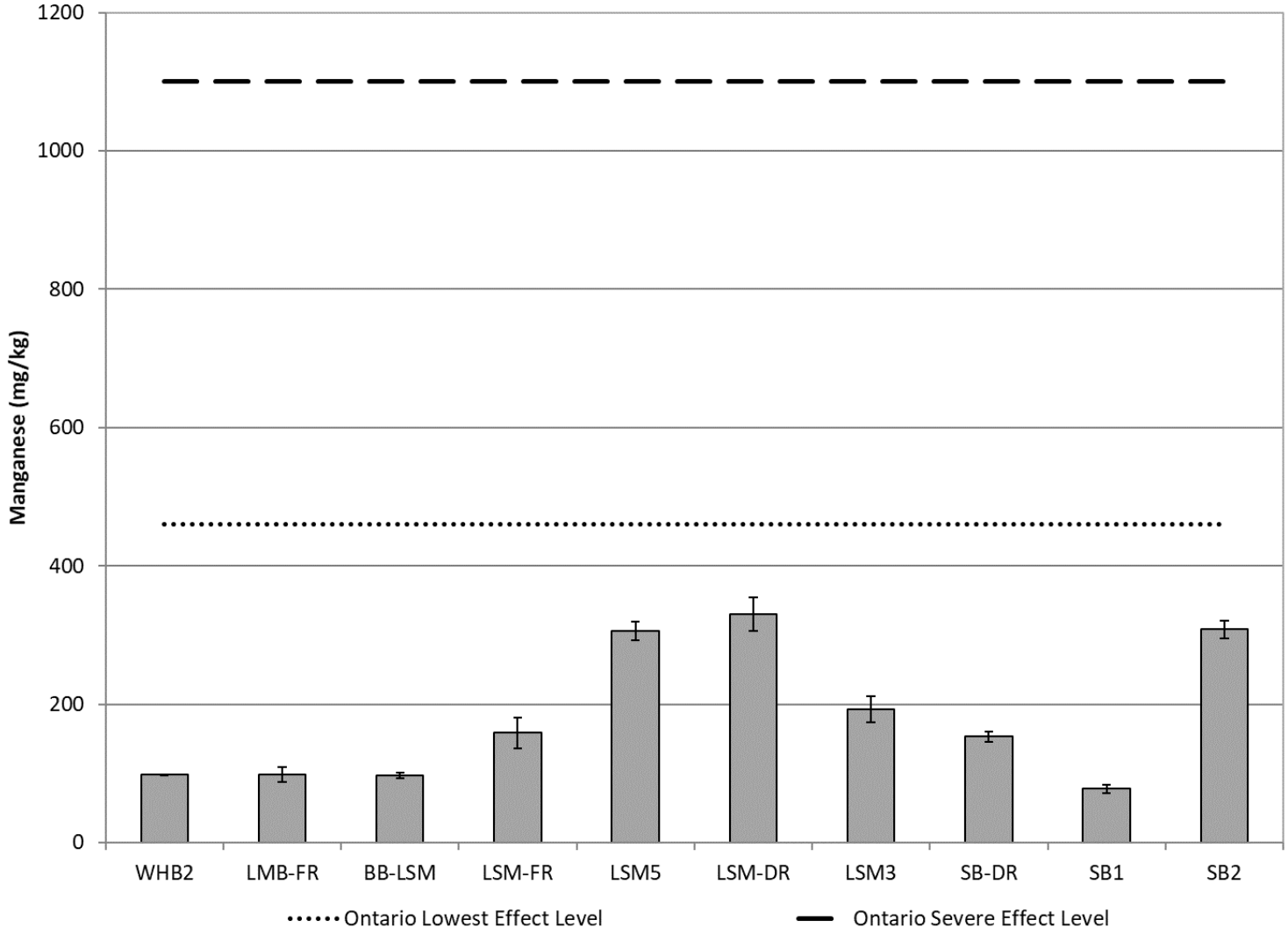


Figure 15. Mean (±SD) concentration of manganese in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to compared to the Ontario sediment quality guidelines.

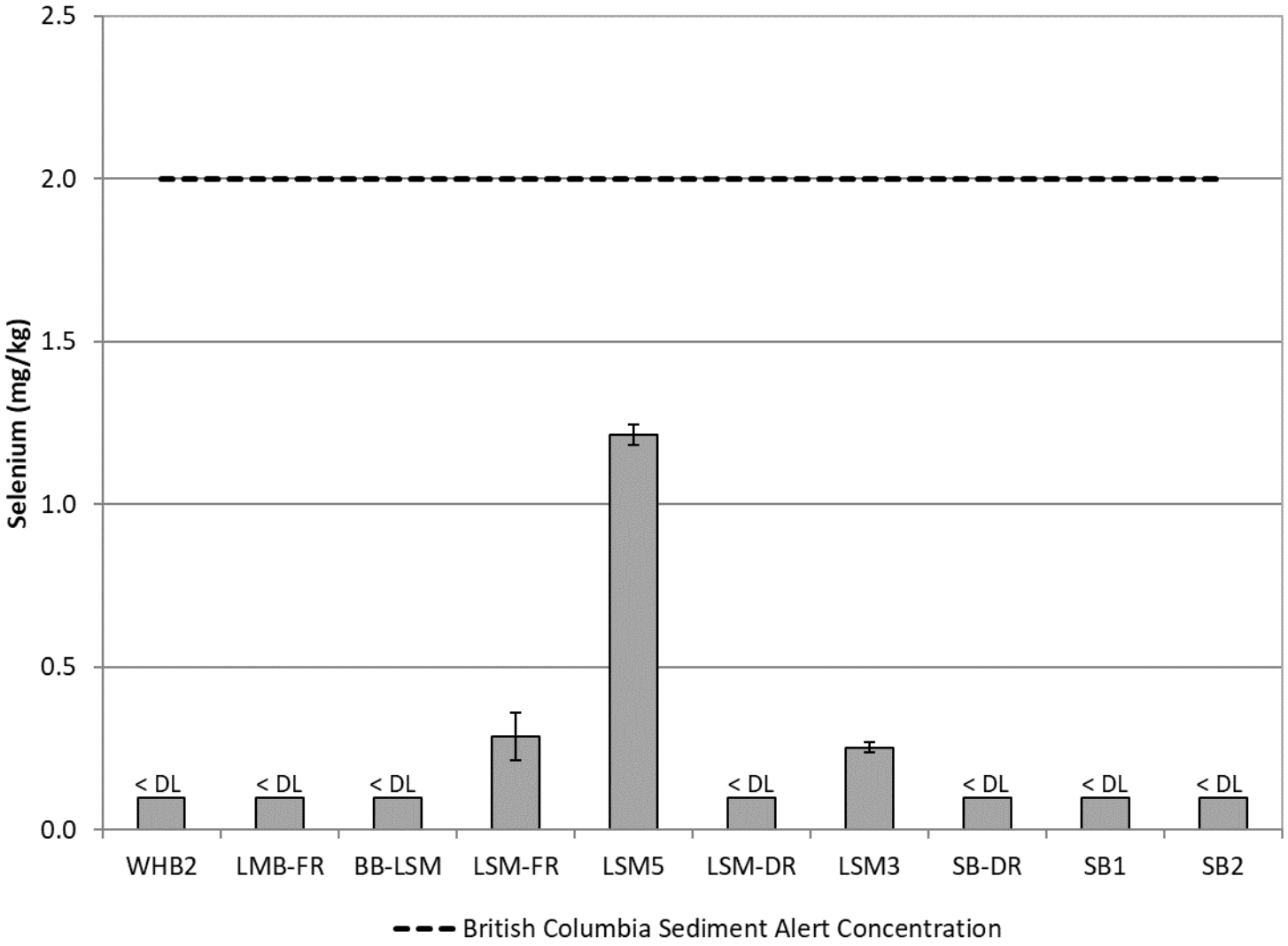


Figure 16. Mean (±SD) concentration of selenium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the British Columbia sediment alert concentration.

APPENDIX 1. SEDIMENT SAMPLE FIELD DATA

Appendix 1. Supplemental field data for sediment samples collected.

Waterbody	Site ID	Sampling Date	Sampling Time	Sample ID	Sample UTM			Gear Type	Number of Grabs	Penetration Depth (cm)
					Zone	Easting	Northing			
Lake Manitoba	WHB2	8-Dec-20	9:20	WHB2-A	14U	529301	5681101	Ponar	3	4
				WHB2-B	14U	529307	5681098	Ponar	3	2-5
				WHB2-C	14U	529302	5681095	Ponar	3	2-4
	LMB-FR	9-Dec-20	8:50	LMB-FR-A	14U	516808	5713014	Ponar	6	2-4
				LMB-FR-B	14U	516808	5713007	Ponar	4	2-3
				LMB-FR-C	14U	516813	5713010	Ponar	4	2-5
Lake St. Martin	BB-LSM	13-Oct-20	12:20	BB-LSM-A	14U	534252	5704278	Ekman	3	~8
				BB-LSM-B	14U	534309	5704302	Ekman	3	10
				BB-LSM-C	14U	534344	5704292	Ekman	3	~8
	LSM-FR	13-Oct-20	15:50	LSM-FR-A	14U	528393	5716449	Ekman	3	15
				LSM-FR-B	14U	528384	5716416	Ekman	3	15
				LSM-FR-C	14U	528370	5716395	Ekman	3	6
	LSM5	9-Dec-20	13:25	LSM5-A	14U	536042	5724701	Ponar	3	5-8
				LSM5-B	14U	536037	5724707	Ponar	3	6-8
				LSM5-C	14U	536038	5724702	Ponar	3	6-8
	LSM-DR	20-Oct-21	11:30	LSM-DR-A	14U	547471	5740360	Ponar	3	8
				LSM-DR-B	14U	547472	5740365	Ponar	3	8
				LSM-DR-C	14U	547475	5740364	Ponar	3	8
	LSM3	11-Dec-20	11:50	LSM3-A	14U	555898	5737193	Ponar	3	4-6
				LSM3-B	14U	555895	5737189	Ponar	3	5
				LSM3-C	14U	555894	5737191	Ponar	3	5-6
Lake Winnipeg	SB-DR	10-Dec-20	15:05	SB-DR-A	14U	566734	5757357	Ponar	3	5-6
				SB-DR-B	14U	566736	5757358	Ponar	3	5-7
				SB-DR-C	14U	566732	5757356	Ponar	3	5-7
	SB1	10-Dec-20	12:50	SB1-A	14U	573475	5751448	Ponar	3	5
				SB1-B	14U	573473	5751446	Ponar	3	4-5
				SB1-C	14U	573477	5751448	Ponar	3	4-5
	SB2	10-Dec-20	9:55	SB2-A	14U	576810	5753558	Ponar	3	5-7
				SB2-B	14U	576815	5753555	Ponar	3	5-6
				SB2-C	14U	576812	5753558	Ponar	3	5-7

Appendix 1. Continued.

Waterbody	Site ID	Sample ID	Field Observations				
			Texture	Consistency	Colour	Odour	Comments
Lake Manitoba	WHB2	WHB2-A	chunky	soft	grey with brown silt	slight sulfur	60% SA/10% CL/5% SI/25% GR
		WHB2-B	chunky	soft/moderate	grey	strong sulfur	20% SA/20% CL/10% SI/50% GR
		WHB2-C	chunky	soft	grey	strong sulfur	40% SA/15% CL/5% SI/40% GR
	LMB-FR	LMB-FR-A	rocky	soft	grey	slight sulfur	20% SA/45% GR/30% CL/5% SI
		LMB-FR-B	rocky	hard	grey	slight sulfur	25% SA/50% GR/5% CO/5% SI
		LMB-FR-C	rocky	moderate	grey	none	55% GR/25% SA/30% CL/5% CO/5% SI
Lake St. Martin	BB-LSM	BB-LSM-A	clay/sand	uniform	grey/brown at surface	slight	small bivalve shells in sample
		BB-LSM-B	clay/sand	uniform	grey/brown at surface	smelly	small bivalve shells in sample
		BB-LSM-C	clay/sand	uniform	grey/brown at surface	smelly	small bivalve shells in sample
	LSM-FR	LSM-FR-A	clay	soft/runny	grey/black	stinky	plants
		LSM-FR-B	clay/sand	soft/runny	grey/black	stinky	some plants; more sand than clay
		LSM-FR-C	sand/silt	soft/runny	grey	n.r.	some snail shells; *Myriophylum*; ground is harder here.
	LSM5	LSM5-A	smooth	soft	grey	slight sulfur	30% CL/70% SI; dead pea clams and snail shells
		LSM5-B	smooth	soft	grey/brown	strong sulfur	30% CL/70% SI; chironomids
		LSM5-C	smooth	soft	grey	strong sulfur	30% CL/70% SI
	LSM-DR	LSM-DR-A	grainy	mucky, soft, runny	grey	slight sulfur	crushed shells, no vegetation
		LSM-DR-B	grainy	mucky, soft, runny	grey	slight sulfur	crushed shells incorporated into sediments, some vegetation and roots
		LSM-DR-C	grainy	mucky, soft, runny	grey	slight sulfur	some vegetation
	LSM3	LSM3-A	smooth	soft	grey	strong sulfur	40% SI/60% CL
		LSM3-B	smooth	soft	grey	strong sulfur	40% SI/60% CL
		LSM3-C	smooth	soft	grey	strong sulfur	50% CL/45% SI/5% SA
Lake Winnipeg	SB-DR	SB-DR-A	grainy	moderate	grey, brown silt on top	n.r.	30% SA/20% SI/50% CL
		SB-DR-B	grainy	moderate	grey, brown silt on top	n.r.	20% SA/40% SI/40% CL
		SB-DR-C	grainy	soft	grey/brown	n.r.	40% SI/50% CL/10% SA
	SB1	SB1-A	moderate	uniform	grey	none	live/dead zebra mussels; 90% SA/10% SI
		SB1-B	moderate	n.r.	grey	n.r.	few live zebra mussels; 90% SA/10% SI
		SB1-C	moderate	sandy	grey/brown	n.r.	few small zebra mussels; 90% SA/10% SI
	SB2	SB2-A	smooth	moderate	grey/brown	n.r.	40% SI/60% CL; ~10 zebra mussels
		SB2-B	smooth	soft/moderate	grey/brown	n.r.	30% SI/70% CL
		SB2-C	smooth	soft/moderate	grey/brown	n.r.	30% SI/70% CL

n.r. = not recorded; CL = clay; SI = silt; SA = sand; GR = gravel; and CO = cobble

APPENDIX 2. RAW LABORATORY RESULTS

Appendix 2. Raw laboratory results for sediment samples collected.

						Particle Size				
Waterbody	Site ID	Sampling Date	Sampling Time	ALS Report ID	Sample ID	Moisture (%)	% Sand (2.0mm - 0.05mm) (%)	% Silt (0.05mm – 2µm) (%)	% Clay (<2µm) (%)	Texture
Analytical Detection Limit						*0.10*	*1.0*	*1.0*	*1.0*	*n/a*
Lake Manitoba	WHB2	8-Dec-20	9:20	L2541414-1	WHB2-A	38.1	87.1	11.9	<1.0	Sand
				L2541414-2	WHB2-B	21.6	93.4	6.0	<1.0	Sand
				L2541414-3	WHB2-C	36.4	92.8	6.4	<1.0	Sand
	LMB-FR	9-Dec-20	8:50	L2541414-19	LMB-FR-A	31.3	95.3	4.7	<1.0	Sand
				L2541414-20	LMB-FR-B	37.0	97.5	2.3	<1.0	Sand
				L2541414-21	LMB-FR-C	34.9	93.9	5.8	<1.0	Sand
Lake St. Martin	BB-LSM	13-Oct-20	12:20	L2520956-1	BB-LSM-A	43.4	91.5	8.4	<1.0	Sand
				L2520956-2	BB-LSM-B	48.8	85.2	14.6	<1.0	Sand/Loamy sand
				L2520956-3	BB-LSM-C	47.0	89.5	10.4	<1.0	Sand
	LSM-FR	13-Oct-20	15:50	L2520956-4	LSM-FR-A	80.7	41.8	55.8	2.4	Silt loam
				L2520956-5	LSM-FR-B	76.4	62.7	36.7	<1.0	Sandy loam
				L2520956-6	LSM-FR-C	56.2	77.5	22.1	<1.0	Loamy sand
	LSM5	9-Dec-20	13:25	L2541414-4	LSM5-A	87.5	5.0	75.2	19.8	Silt loam
				L2541414-5	LSM5-B	88.5	5.5	77.1	17.4	Silt loam
				L2541414-6	LSM5-C	87.8	<1.0	85.2	14.2	Silt loam
	LSM-DR	20-Oct-21	11:30	L2653781-1	LSM-DR-A	75.1	10.6	71.7	17.8	Silt loam
				L2653781-2	LSM-DR-B	77.6	6.9	66.1	27.0	Silt loam
				L2653781-3	LSM-DR-C	77.5	7.5	69.8	22.6	Silt loam
	LSM3	11-Dec-20	11:50	L2541414-7	LSM3-A	59.8	27.2	69.6	3.2	Silt loam
				L2541414-8	LSM3-B	63.9	37.3	59.3	3.3	Silt loam
				L2541414-9	LSM3-C	63.5	36.5	61.1	2.4	Silt loam
Lake Winnipeg	SB-DR	10-Dec-20	15:05	L2541414-10	SB-DR-A	35.0	84.6	12.2	3.2	Loamy sand
				L2541414-11	SB-DR-B	37.1	77.8	18.6	3.6	Loamy sand
				L2541414-12	SB-DR-C	43.6	74.5	21.6	3.9	Loamy sand
	SB1	10-Dec-20	12:50	L2541414-13	SB1-A	24.7	96.5	1.4	2.1	Sand
				L2541414-14	SB1-B	26.7	96.7	1.7	1.6	Sand
				L2541414-15	SB1-C	24.1	96.7	1.8	1.6	Sand
	SB2	10-Dec-20	9:55	L2541414-16	SB2-A	51.7	10.2	71.2	18.6	Silt loam
				L2541414-17	SB2-B	52.3	17.9	72.4	9.7	Silt loam
				L2541414-18	SB2-C	50.5	8.5	72.8	18.6	Silt loam

Appendix 2. Continued.

			Nitrogen				Carbon			
Waterbody	Site ID	Sample ID	Nitrate/ Nitrite (mg N/kg)	Nitrate (mg N/kg)	Nitrite (mg N/kg)	Total Kjeldahl Nitrogen (%)	Inorganic Carbon (%)	Inorganic Carbon (as $CaCO_3$ Equivalent) (%)	Total Organic Carbon (%)	Total Carbon (%)
Analytical Detection Limit			*1.0*	*1.1*	*0.40*	*0.020/0.040/0.10*	*0.050*	*0.40*	*various*	*0.05*
Lake Manitoba	WHB2	WHB2-A	2.1	<1.1	1.39	0.075	3.28	27.3	2.6	5.89
		WHB2-B	1.8	<1.1	1.04	0.065	5.57	46.4	<1.3	6.29
		WHB2-C	1.9	<1.1	1.13	0.076	3.28	27.3	3.2	6.43
	LMB-FR	LMB-FR-A	2.0	<1.1	1.57	0.045	6.70	55.8	<1.2	6.20
		LMB-FR-B	2.0	<1.1	1.63	0.052	5.53	46.1	<1.2	5.86
		LMB-FR-C	2.0	<1.1	1.58	0.052	5.26	43.8	<1.3	6.25
Lake St. Martin	BB-LSM	BB-LSM-A	1.6	<1.1	1.10	0.135	1.45	12.1	2.67	4.12
		BB-LSM-B	1.3	<1.1	0.89	0.161	1.69	14.1	3.18	4.87
		BB-LSM-C	1.2	<1.1	0.73	0.151	1.69	14.0	3.03	4.72
	LSM-FR	LSM-FR-A	1.8	<1.1	1.00	0.59	3.34	27.8	8.3	11.6
		LSM-FR-B	1.2	<1.1	0.78	0.40	3.26	27.1	6.3	9.54
		LSM-FR-C	1.7	<1.1	1.32	0.22	3.10	25.8	4.8	7.89
	LSM5	LSM5-A	3.7	1.2	2.48	0.72	6.05	50.4	8.9	14.9
		LSM5-B	3.7	<1.1	2.66	0.67	5.38	44.8	9.4	14.8
		LSM5-C	4.4	1.1	3.31	0.88	5.56	46.3	9.3	14.9
	LSM-DR	LSM-DR-A	1.4	<1.1	0.97	0.50	6.11	50.9	7.8	13.9
		LSM-DR-B	<1.0	<1.0	0.65	0.70	5.89	49.0	8.5	14.4
		LSM-DR-C	1.6	<1.1	1.19	0.53	5.86	48.8	8.2	14.1
	LSM3	LSM3-A	3.4	<1.1	2.44	0.217	5.55	46.2	4.2	9.7
		LSM3-B	3.7	<1.1	2.81	0.243	4.94	41.1	4.8	9.7
		LSM3-C	3.8	<1.1	2.99	0.218	4.39	36.5	5.6	10.0
Lake Winnipeg	SB-DR	SB-DR-A	3.0	1.6	1.32	0.051	3.52	29.3	<0.83	4.17
		SB-DR-B	4.1	2.3	1.77	0.063	4.45	37.1	<0.87	4.35
		SB-DR-C	6.4	4.6	1.81	0.072	2.85	23.8	1.81	4.66
	SB1	SB1-A	1.7	<1.1	1.08	0.030	2.23	18.6	<0.36	1.79
		SB1-B	1.5	<1.1	0.92	0.030	1.32	11.0	0.45	1.77
		SB1-C	1.4	<1.1	0.90	0.029	1.63	13.6	<0.37	1.87
	SB2	SB2-A	4.0	2.0	1.99	0.159	4.41	36.7	3.1	7.50
		SB2-B	3.4	1.7	1.73	0.147	3.81	31.8	3.5	7.34
		SB2-C	3.1	<1.1	2.27	0.114	3.80	31.7	3.5	7.30

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Aluminum (Al) (mg/kg)	Antimony (Sb) (mg/kg)	Arsenic (As) (mg/kg)	Barium (Ba) (mg/kg)	Beryllium (Be) (mg/kg)	Bismuth (Bi) (mg/kg)	Boron (B) (mg/kg)	Cadmium (Cd) (mg/kg)	Calcium (Ca) (mg/kg)	Chromium (Cr) (mg/kg)
Analytical Detection Limit			*50*	*0.10*	*0.10*	*0.50*	*0.10*	*0.20*	*5.0*	*0.020*	*50*	*0.50*
Lake Manitoba	WHB2	WHB2-A	2220	<0.10	1.06	29.8	<0.10	<0.20	13.5	0.054	62800	5.07
		WHB2-B	2200	<0.10	1.05	28.3	<0.10	<0.20	13.1	0.053	64800	5.10
		WHB2-C	2400	<0.10	1.06	30.5	<0.10	<0.20	14.9	0.048	66500	5.42
	LMB-FR	LMB-FR-A	2170	<0.10	0.74	23.1	<0.10	<0.20	8.0	0.032	70600	5.47
		LMB-FR-B	2080	<0.10	0.67	19.7	<0.10	<0.20	7.9	0.023	67600	4.94
		LMB-FR-C	2250	<0.10	0.80	28.4	<0.10	<0.20	9.6	0.032	82800	5.39
Lake St. Martin	BB-LSM	BB-LSM-A	2380	<0.10	0.86	22.6	<0.10	<0.20	8.8	0.064	65800	5.20
		BB-LSM-B	2530	<0.10	0.93	24.9	<0.10	<0.20	9.6	0.070	69700	6.10
		BB-LSM-C	2450	<0.10	0.93	24.2	<0.10	<0.20	9.3	0.067	69400	5.68
	LSM-FR	LSM-FR-A	2890	<0.10	1.56	76.2	0.15	<0.20	16.2	0.130	122000	8.02
		LSM-FR-B	2080	<0.10	1.15	61.9	0.12	<0.20	13.8	0.105	115000	5.49
		LSM-FR-C	2740	<0.10	1.01	65.2	0.12	<0.20	13.1	0.058	131000	7.79
	LSM5	LSM5-A	7150	0.36	4.73	141	0.27	<0.20	26.0	0.230	208000	19.2
		LSM5-B	7590	0.42	5.65	145	0.30	<0.20	27.1	0.312	200000	19.3
		LSM5-C	8610	0.47	5.98	157	0.30	<0.20	29.9	0.324	206000	20.4
	LSM-DR	LSM-DR-A	8120	0.18	3.26	206	0.32	<0.20	28.1	0.217	266000	19.8
		LSM-DR-B	7700	0.17	3.36	193	0.24	<0.20	26.8	0.199	260000	18.7
		LSM-DR-C	6680	0.14	2.83	179	0.26	<0.20	25.2	0.177	280000	15.7
	LSM3	LSM3-A	3580	<0.10	1.50	56.0	0.12	<0.20	14.7	0.088	140000	7.61
		LSM3-B	4060	<0.10	1.58	62.7	0.13	<0.20	17.3	0.095	158000	8.67
		LSM3-C	4560	<0.10	1.74	71.2	0.15	<0.20	19.0	0.107	167000	9.80
Lake Winnipeg	SB-DR	SB-DR-A	3880	<0.10	1.60	22.3	0.13	<0.20	10.1	0.045	73600	9.52
		SB-DR-B	4270	<0.10	1.44	26.0	0.15	<0.20	9.6	0.045	62800	10.6
		SB-DR-C	4800	<0.10	1.50	29.2	0.16	<0.20	10.8	0.043	71000	11.6
	SB1	SB1-A	2450	<0.10	0.95	12.0	<0.10	<0.20	5.8	<0.020	30700	5.79
		SB1-B	2260	<0.10	0.89	10.3	<0.10	<0.20	5.9	<0.020	30500	5.17
		SB1-C	2630	<0.10	1.05	12.2	<0.10	<0.20	6.3	<0.020	32100	5.91
	SB2	SB2-A	9860	0.13	2.59	67.9	0.37	<0.20	14.0	0.127	85000	23.7
		SB2-B	10600	0.13	2.65	70.3	0.36	<0.20	14.8	0.129	89300	24.7
		SB2-C	9730	0.14	2.50	62.6	0.33	<0.20	14.4	0.117	91000	23.2

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Cobalt (Co) (mg/kg)	Copper (Cu) (mg/kg)	Iron (Fe) (mg/kg)	Lead (Pb) (mg/kg)	Lithium (Li) (mg/kg)	Magnesium (Mg) (mg/kg)	Manganese (Mn) (mg/kg)	Mercury (Hg) (mg/kg)	Molybdenum (Mo) (mg/kg)	Nickel (Ni) (mg/kg)
Analytical Detection Limit			*0.10*	*0.50*	*50*	*0.50*	*2.0*	*20*	*1.0*	*0.0050/0.010*	*0.10*	*0.50*
Lake Manitoba	WHB2	WHB2-A	1.33	2.93	2980	2.24	3.5	20800	97.3	0.0103	0.33	4.61
		WHB2-B	1.37	2.91	3070	2.11	3.8	23100	97.1	0.0105	0.30	4.69
		WHB2-C	1.34	2.86	3060	2.07	3.8	22000	99.3	0.0102	0.34	4.75
	LMB-FR	LMB-FR-A	1.18	2.13	2670	1.31	3.6	27700	94.8	0.0066	0.23	3.68
		LMB-FR-B	1.13	1.46	2530	1.21	3.8	27600	90.5	0.0062	0.22	3.13
		LMB-FR-C	1.34	2.19	3020	1.56	4.3	30000	110	0.0067	0.30	3.95
Lake St. Martin	BB-LSM	BB-LSM-A	1.55	3.01	3240	2.08	4.4	26700	92.2	0.0118	0.16	4.26
		BB-LSM-B	1.68	3.55	3520	2.28	4.7	29100	100	0.0141	0.18	4.85
		BB-LSM-C	1.60	3.31	3430	2.26	4.6	29300	98.0	0.0134	0.18	4.56
	LSM-FR	LSM-FR-A	2.80	9.36	5380	4.86	6.9	28600	184	0.0176	0.53	10.2
		LSM-FR-B	1.85	6.81	3720	3.70	4.8	26000	147	0.0102	0.39	6.79
		LSM-FR-C	1.90	5.19	4130	2.28	5.7	28900	145	0.0084	0.39	6.48
	LSM5	LSM5-A	5.05	17.0	9810	7.23	11.6	20600	293	0.030	2.71	25.1
		LSM5-B	5.35	17.9	10300	10.8	11.4	20400	306	0.040	2.73	22.3
		LSM5-C	5.55	18.3	10800	12.1	12.6	20900	320	0.044	2.93	22.9
	LSM-DR	LSM-DR-A	4.38	12.6	9900	6.52	13.2	25200	340	<0.020	1.16	17.0
		LSM-DR-B	4.40	12.6	9670	8.00	13.4	28200	348	0.024	0.95	16.7
		LSM-DR-C	3.76	11.0	8640	5.07	12.5	24700	303	<0.020	0.84	14.7
	LSM3	LSM3-A	1.74	3.87	4410	2.79	6.2	47500	172	0.0162	0.43	5.86
		LSM3-B	1.94	4.26	4920	3.06	7.3	53800	198	0.0152	0.43	6.55
		LSM3-C	2.13	4.77	5490	3.32	8.1	54000	208	0.0162	0.51	7.34
Lake Winnipeg	SB-DR	SB-DR-A	3.07	3.84	5260	2.62	7.2	39700	146	0.0094	0.10	6.55
		SB-DR-B	3.33	4.93	5800	3.03	7.4	35600	153	0.0113	0.14	7.42
		SB-DR-C	3.52	5.12	6350	3.26	8.5	39400	161	0.0119	0.14	8.02
	SB1	SB1-A	1.53	1.81	3080	1.59	3.9	16900	78.3	<0.0050	<0.10	3.55
		SB1-B	1.36	1.42	2820	1.34	3.6	16400	72.1	<0.0050	<0.10	3.21
		SB1-C	1.55	1.76	3160	1.65	4.1	18000	84.3	<0.0050	<0.10	3.57
	SB2	SB2-A	6.19	14.3	12800	6.74	16.1	50900	302	0.0221	0.23	17.3
		SB2-B	6.43	14.4	13000	6.66	16.1	53600	323	0.0213	0.23	18.5
		SB2-C	5.97	13.0	12500	6.25	14.9	53700	300	0.0200	0.21	16.5

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Phosphorus (P) (mg/kg)	Potassium (K) (mg/kg)	Selenium (Se) (mg/kg)	Silver (Ag) (mg/kg)	Sodium (Na) (mg/kg)	Strontium (Sr) (mg/kg)	Sulfur (S) (mg/kg)	Thallium (Tl) (mg/kg)	Tin (Sn) (mg/kg)	Titanium (Ti) (mg/kg)
Analytical Detection Limit			*50*	*100*	*0.20*	*0.10*	*50*	*0.50*	*1000*	*0.050*	*2.0*	*1.0*
Lake Manitoba	WHB2	WHB2-A	340	490	0.20	<0.10	405	78.2	1200	0.064	<2.0	124
		WHB2-B	387	490	<0.20	<0.10	376	73.1	1300	0.069	<2.0	126
		WHB2-C	323	510	<0.20	<0.10	400	82.0	1300	0.063	<2.0	132
	LMB-FR	LMB-FR-A	239	440	<0.20	<0.10	312	68.1	<1000	0.056	<2.0	135
		LMB-FR-B	279	400	<0.20	<0.10	289	57.6	<1000	0.051	<2.0	151
		LMB-FR-C	263	520	<0.20	<0.10	411	81.7	<1000	0.052	<2.0	124
Lake St. Martin	BB-LSM	BB-LSM-A	336	500	<0.20	<0.10	323	63.7	1300	0.084	<2.0	123
		BB-LSM-B	384	570	0.23	<0.10	356	64.8	1400	0.085	<2.0	132
		BB-LSM-C	352	540	0.21	<0.10	323	67.3	1500	0.079	<2.0	126
	LSM-FR	LSM-FR-A	339	1080	0.37	<0.10	980	199	3000	0.062	<2.0	71.8
		LSM-FR-B	284	750	0.26	<0.10	789	183	2300	0.058	<2.0	65.1
		LSM-FR-C	235	820	0.23	<0.10	551	238	2400	0.075	<2.0	231
	LSM5	LSM5-A	322	2140	1.18	<0.10	1720	462	7000	0.162	<2.0	269
		LSM5-B	436	2270	1.22	<0.10	1700	446	7000	0.161	<2.0	275
		LSM5-C	413	2510	1.24	<0.10	1900	459	7100	0.173	<2.0	328
	LSM-DR	LSM-DR-A	333	2460	0.79	<0.10	1410	793	7100	0.136	<2.0	347
		LSM-DR-B	394	2330	0.77	<0.10	1470	740	6900	0.129	<2.0	319
		LSM-DR-C	333	2120	0.61	<0.10	1460	741	6000	0.134	<2.0	275
	LSM3	LSM3-A	283	910	0.24	<0.10	570	207	2200	0.065	<2.0	173
		LSM3-B	303	1040	0.25	<0.10	683	228	2400	0.075	<2.0	196
		LSM3-C	324	1160	0.27	<0.10	761	256	2800	0.081	<2.0	222
Lake Winnipeg	SB-DR	SB-DR-A	421	820	<0.20	<0.10	247	32.0	<1000	0.074	<2.0	248
		SB-DR-B	424	940	<0.20	<0.10	276	31.1	<1000	0.083	<2.0	265
		SB-DR-C	416	1070	<0.20	<0.10	310	35.2	<1000	0.093	<2.0	294
	SB1	SB1-A	419	410	<0.20	<0.10	115	18.3	<1000	<0.050	<2.0	263
		SB1-B	338	360	<0.20	<0.10	116	17.8	<1000	<0.050	<2.0	261
		SB1-C	405	440	<0.20	<0.10	127	19.6	<1000	<0.050	<2.0	298
	SB2	SB2-A	430	2180	0.22	<0.10	369	44.6	1300	0.151	<2.0	424
		SB2-B	451	2280	0.22	<0.10	406	44.8	1200	0.157	<2.0	467
		SB2-C	446	2140	<0.20	<0.10	377	45.4	1100	0.144	<2.0	452

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals				
			Tungsten (W) (mg/kg)	Uranium (U) (mg/kg)	Vanadium (V) (mg/kg)	Zinc (Zn) (mg/kg)	Zirconium (Zr) (mg/kg)
Analytical Detection Limit			*0.50*	*0.050*	*0.20*	*2.0*	*1.0*
Lake Manitoba	WHB2	WHB2-A	-	0.457	5.81	9.1	1.1
		WHB2-B	-	0.486	5.76	9.8	1.0
		WHB2-C	-	0.431	6.18	8.9	1.1
	LMB-FR	LMB-FR-A	-	0.399	5.60	6.8	1.1
		LMB-FR-B	-	0.378	5.20	6.1	1.1
		LMB-FR-C	-	0.342	5.92	7.7	1.4
Lake St. Martin	BB-LSM	BB-LSM-A	<0.50	0.358	5.69	12.7	1.2
		BB-LSM-B	<0.50	0.400	6.25	11.0	1.2
		BB-LSM-C	<0.50	0.405	6.10	10.1	1.2
	LSM-FR	LSM-FR-A	<0.50	0.786	8.43	22.7	1.6
		LSM-FR-B	<0.50	0.593	6.09	14.9	1.1
		LSM-FR-C	<0.50	0.774	7.69	13.0	1.6
	LSM5	LSM5-A	-	2.58	21.9	41.4	3.7
		LSM5-B	-	2.84	23.6	45.0	3.7
		LSM5-C	-	3.03	26.4	47.5	3.7
	LSM-DR	LSM-DR-A	<0.50	1.32	20.5	36.8	5.9
		LSM-DR-B	<0.50	1.17	19.3	39.2	5.0
		LSM-DR-C	<0.50	1.08	16.7	33.9	4.5
	LSM3	LSM3-A	-	0.601	9.13	14.3	1.8
		LSM3-B	-	0.617	10.1	16.0	1.9
		LSM3-C	-	0.711	11.6	18.2	2.3
Lake Winnipeg	SB-DR	SB-DR-A	-	0.425	10.7	12.9	2.9
		SB-DR-B	-	0.444	11.7	15.2	3.2
		SB-DR-C	-	0.532	13.1	15.5	3.5
	SB1	SB1-A	-	0.353	6.71	6.7	2.6
		SB1-B	-	0.303	6.17	5.7	2.3
		SB1-C	-	0.366	7.16	6.3	2.7
	SB2	SB2-A	-	0.966	26.0	31.8	9.2
		SB2-B	-	0.962	27.3	33.2	8.8
		SB2-C	-	0.920	25.6	31.4	8.5

APPENDIX 3. *IN SITU* WATER QUALITY DATA

Appendix 3. *In situ* water quality data collected during the sediment quality sampling program, fall 2020.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth [1] (m)	Sample Depth [1] (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Lake Manitoba	WHB2	8-Dec-20	9:20	0.00	0.4	1.8	0.3	1.5	13.69	98.1	1253	2.01	7.60
							1.0	2.7	13.41	99.4	1256	2.90	7.62
							1.5	3.3	13.77	104.0	1284	3.20	7.69
Lake Manitoba	LMB-FR	9-Dec-20	8:50	0.00	0.4	2.2	0.3	1.1	13.00	92.2	1214	2.41	8.11
							0.5	1.2	13.80	98.7	1203	2.64	8.10
							1.0	1.6	13.38	96.2	1202	3.04	8.08
							1.5	1.9	13.09	95.1	1196	3.09	8.08
							2.0	2.6	13.03	96.7	1230	3.33	8.06
Lake St. Martin	BB-LSM	13-Oct-20	12:20	-	-	2.6	0.3	7.76	11.13	93.7	1073	6.58	8.38
							1.0	7.76	11.12	93.7	1073	6.48	8.38
Lake St. Martin	LSM-FR	13-Oct-20	15:50	-	-	1.9	0.3	6.98	11.67	96.4	1107	18.50	8.15
							1.0	6.97	11.65	96.3	1107	18.75	8.15
Lake St. Martin	LSM5	9-Dec-20	13:25	0.00	0.35	3.6	0.3	1.1	13.90	98.6	1208	2.30	8.28
							1.0	1.5	13.79	99.0	1201	2.05	8.30
							1.5	1.6	14.14	101.5	1201	2.31	8.31
							2.0	1.8	13.65	98.8	1197	2.13	8.31
							2.5	2.4	12.49	91.0	1189	2.40	8.30
							3.0	3.1	12.38	92.7	1176	2.60	8.29
Lake St. Martin	LSM-DR	20-Oct-21	11:30	-	-	0.8	0.4	6.45	11.40	93.0	1174	9.74	8.59
Lake St. Martin	LSM3	11-Dec-20	11:50	0.03	0.32	0.8	0.3	3.70	11.45	87.4	1418	1.28	8.38
							0.8	4.70	8.04	62.9	1501	2.54	8.19
Lake Winnipeg	SB-DR	10-Dec-20	15:05	0.01	0.4	5.0	0.3	0.30	13.10	90.6	439	24.7	8.14
							1.0	0.50	13.09	91.5	449	22.7	8.11
							2.0	0.60	12.31	86.3	472	15.5	8.08
							3.0	0.60	12.76	89.1	535	16.6	8.06
							4.0	0.10	11.57	80.0	1138	10.3	7.89

Appendix 3. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth [1] (m)	Sample Depth [1] (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Lake Winnipeg	SB1	10-Dec-20	12:50	0.01	0.35	1.3	0.3	0.30	13.64	94.6	492	17.51	8.10
							1.0	1.20	12.69	90.0	500	15.64	8.07
Lake Winnipeg	SB2	10-Dec-20	9:55	0.03	0.33	6.2	0.3	0.30	12.82	89.2	471	20.5	7.96
							1.0	0.50	12.54	87.2	464	17.64	7.95
							2.0	0.50	13.12	91.7	463	19.74	7.94
							3.0	0.50	12.83	89.7	463	18.18	7.94
							4.0	0.60	13.06	91.5	472	18.68	7.92
							5.0	0.80	13.00	91.7	499	19.1	7.91
							6.0	1.80	9.92	73.0	576	14.04	7.85

[1] Represents effective depth during the ice-cover period.



Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring, Fall 2020 to Spring 2021 - Water Quality

REPORT

Prepared for Manitoba Transportation and Infrastructure
By North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4

Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring Fall 2020 to Spring 2021

Water Quality

A Data Report Prepared for

Manitoba Transportation and Infrastructure

By:

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May 2022

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EXECUTIVE SUMMARY

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The AEMP identified the need for the collection of data to supplement existing information that had been presented in the EIS.

Water quality sampling was conducted four times from September 2020 to May 2021 to provide additional pre-construction data for the surface water quality study described in the AEMP. This report presents the results of this sampling and is an update of NSC (2021) which previously reported the results from fall 2020. The surface water quality monitoring study was designed to determine whether water quality conditions change due to channel operations, specifically whether the change in flow patterns affects water quality. As such, the AEMP includes sampling locations throughout the study area. In addition to the locations identified in the AEMP, sampling described in this report was conducted at supplemental locations where historical sampling has occurred or to characterize tributaries in the study area.

In situ water quality measurements and water samples were collected at 20 core sampling sites in the study area from Lake Manitoba to Lake Winnipeg three times during the open-water season, and once during the ice-cover season. Sampling dates were as follows: September 1-10 and October 13-14, 2020; and March 15-18 and May 17-18, 2021. Not all sites were sampled in October (11 sites sampled) and May (19 sites sampled) due to weather conditions. Additional sites were surveyed for the presence of water and *in situ* water quality, including: 10 sites along the alignments of the proposed Lake Manitoba Outlet Channel (LMOC) and Lake St. Martin Outlet Channel (LSMOC) in September 2020; four sites along the proposed LMOC in May 2021; and one site at the downstream end of Reach 1 of the Lake St. Martin Emergency Outlet Channel (LSMEOC) in March 2021.

Quality assurance/quality control (QA/QC) measures were incorporated into the monitoring program including standard sampling methods and QA/QC samples. All results were compared to the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) for the protection of aquatic life (PAL), as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for PAL.

Based on the results of the monitoring that was conducted from September 2020 to May 2021, the water quality of the study area can be described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated. However, during the ice-cover season anoxic conditions were observed in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC.

In general, water quality was similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River; however, during the ice-cover season water quality in the eastern bay of Lake St. Martin near the outlet of the proposed LSMOC had higher alkalinity, hardness, ammonia, carbon, colour, conductivity, TDS, and several metals and major ions compared to other areas of the lake. Additionally, differences in water quality were observed between the sites sampled along the main flow path and Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay, including:

- Birch Creek had higher alkalinity, hardness, total phosphorus (TP), carbon, colour, fluoride, magnesium and dissolved iron, and lower total dissolved solids (TDS), conductivity, chloride, molybdenum, sodium and strontium;
- Big Buffalo Lake had higher carbon, colour and aluminum, and lower conductivity, TDS, chloride, lithium, molybdenum, nickel, potassium, rubidium, sodium, strontium, sulphate and sulphur
- Buffalo Creek had higher carbon, colour, aluminum, chromium, copper, cesium and iron, and lower conductivity, TDS, boron, chloride, lithium, molybdenum, potassium, rubidium, sodium, strontium, sulphate, sulphur and uranium; and
- Sturgeon Bay had higher TP, aluminum, cesium, copper, iron, and nickel, and lower alkalinity, hardness, conductivity, TDS, total nitrogen, carbon, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, sodium, strontium, sulphate, sulphur and uranium compared with sites along the main flow path.

Sampling for additional parameters was conducted at sites in the Fairford and Dauphin rivers, and Birch Creek in September 2020 which showed that *Escherichia coli* concentrations were higher in the Fairford River than in Birch Creek or the Dauphin River; and that blue-green algae (i.e., cyanobacteria) were most abundant in the Dauphin River and least abundant in Birch Creek. Sampling was also conducted at these locations for microcystin, hydrocarbons, and pesticides; all results were below analytical detection limits.

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths at several locations, including: Watchorn Bay; Watchorn Creek at Watchorn Bay; Mercer Creek at Watchorn Bay; Fairford River at Lake St. Martin; Birch Creek at Lake St. Martin; Lake St. Martin; Big Buffalo Lake; the Dauphin River at Sturgeon Bay; and Sturgeon Bay. TP was below the MWQSOG narrative guideline for rivers and streams in the Fairford and Dauphin rivers and in Birch and Buffalo creeks.

During the ice-cover season in March 2021, dissolved oxygen (DO) was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life and CCME PAL guidelines for cold and warm water biota in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC in March 2021.

Aluminum exceeded the MWQSOG and CCME guideline for PAL in approximately half of the samples collected, including samples from Watchorn and Sturgeon bays, Watchorn, Mercer, Birch and Buffalo creeks, the Fairford and Dauphin rivers, and Lake St. Martin. Iron exceeded the MWQSOG and CCME guideline for PAL in samples from Buffalo Creek and Sturgeon Bay. Chloride exceeded the CCME long-

term guideline in all samples collected from along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River. Additionally, fluoride exceeded the CCME PAL, at most sites and times sampled; exceptions were Buffalo Creek and Sturgeon Bay where only some samples exceeded the guideline. Exceedances of these parameters are common in the region.

All other water quality variables measured for which there are MWQSOG and CCME PAL objectives or guidelines were within PAL objectives and guidelines at all core sampling sites.

Of the ten locations in natural waterbodies surveyed along the alignments of the proposed LMOC and LSMOC in September 2020, three were dry and elsewhere total water depths were less than half a metre. Sites along the alignment of the proposed LMOC were well oxygenated, alkaline, and had moderately high specific conductance; whereas, sites along the alignment of the proposed LSMOC were low to moderately oxygenated, circum-neutral, and had lower specific conductance. Turbidity was low at all sites sampled. *In situ* water quality was similar at the four sites along the proposed LMOC that were resampled in May 2021. In March 2021, the site at the downstream end of Reach 1 of the LSMEOC was circum-neutral, with moderately high specific conductance low turbidity and low DO.

At the time of the September survey, DO was below the MWQSOG 7-day objective for cold-water aquatic life, the MWQSOG instantaneous objective for cool-water aquatic life, and the CCME guidelines for warm water biota at the site located on Creek C upstream of the alignment of the proposed LSMOC. Similarly, DO was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life and CCME PAL guidelines for cold and warm water biota at the site sampled near the downstream end of Reach 1 in March 2021. Additionally, pH exceeded the MWQSOG/CCME upper limit for PAL at Water Lake in September 2020. DO and pH were within applicable MWQSOG/CCME PAL objectives/guidelines at all other sites sampled. There are no MWQSOG/CCME PAL guidelines for the other *in situ* parameters measured.

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ACRONYMS

AEMP	Aquatic Effects Monitoring Program
BCMELP	British Columbia Ministry of Environment, Lands, and Parks
BOD	Biological Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
DIN	Dissolved Inorganic Nitrogen
DL	Analytical Detection Limit
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EIS	Environmental Impact Statement
FRWCS	Fairford Water Control Structure
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MTI	Manitoba Transportation and Infrastructure
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
MWS	Manitoba Water Stewardship
NSC	North/South Consultants Inc.
PAL	Protection of Freshwater Aquatic Life
PRSD	Percent Standard Relative Deviation
QA/QC	Quality Assurance/Quality Control
SD	Standard Deviation
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids

1.0 INTRODUCTION

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). The proposed Project is designed to manage flood waters on Lake Manitoba and Lake St. Martin by providing a channel by which flood waters can be conveyed, in addition to the natural outflow via the Fairford and Dauphin rivers (Figure 1). The Project consists of two outlet channels that are intended to work together:

- The 24 km Lake Manitoba Outlet Channel (LMOC) will work in tandem with the existing water control structure on the Fairford River (the Fairford Water Control Structure or FRWCS) to help regulate water levels and mitigate flooding on Lake Manitoba; and
- The 24 km Lake St. Martin Outlet Channel (LSMOC) will restore a more natural water regime to Lake St. Martin and will also provide flood protection by mitigating increased inflows from operation of the FRWCS, as well as additional inflows from the planned outlet from Lake Manitoba.

An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The specific objectives of the AEMP were to:

- Verify the predicted effects presented in the surface water quality and fish and fish habitat sections of the EIS;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation measures if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted measure(s); and
- Confirm compliance with regulatory requirements relevant to surface water quality and fish and fish habitat set out in the Project approvals (e.g., Manitoba Environment Act License; Fisheries Act Authorization).
- The AEMP identified the need for the collection of data to supplement existing information that had been presented in the EIS.

Water quality sampling was conducted four times from September 2020 to May 2021 to provide additional pre-construction data for the surface water quality study described in the AEMP. This report presents the results of this sampling and is an update of NSC (2021) which previously reported the result from 2020. The surface water quality monitoring study was designed to determine whether water quality conditions change due to channel operations, specifically whether the change in flow patterns affects water quality. As such, the AEMP included sampling locations throughout the study area. In addition to the locations identified in the AEMP, sampling described in this report was conducted at supplemental locations where historical sampling has occurred or to characterize tributaries in the study area (Table 1).

2.0 METHODS

2.1 SAMPLING PERIODS

Water quality sampling was conducted four times from September 2020 to May 2021. Three times during the open-water season, and once during ice-cover season. Sampling periods were as follows:

- September 1-10, 2020;
- October 13 and 14, 2020;
- March 15-18, 2021; and
- May 16-19, 2021.

2.2 SAMPLING SITES

The study area for the monitoring program is comprised of Lake Manitoba, the Fairford and Dauphin rivers, Lake St. Martin, creeks and drains along the proposed LMOC alignment, the Buffalo Creek watershed, and Sturgeon Bay in Lake Winnipeg. With few exceptions, water quality sampling was conducted at 20 core sites in the study area; exceptions are noted below. Information on sampling locations is listed in Table 1 and illustrated in Figure 1 . Sampling sites were as follows:

- Two sites in Lake Manitoba in Watchorn Bay,
    - offshore of the proposed LMOC (WHB1), and
    - nearshore at the proposed LMOC (WHB2);
- One site in Watchorn Creek at Watchorn Bay (WHC-WB);
- One site in Mercer Creek at Watchorn Bay (MC-WB);
- Two sites in Birch Creek,
    - at PR 239 (BCD-2018-9), and
    - the outlet at Lake St. Martin (BC-LSM);
- Two sites in the Fairford River,
    - at highway 6 (FR1), and
    - near the outlet at Lake St. Martin (FR2);
- Five sites in Lake St. Martin,
    - Birch Bay (BB-LSM),
    - middle of the south basin (LSM5),
    - at the narrows (LSM4),
    - middle of the north basin (LSM1), and
    - the eastern bay near the proposed LSMOC (LSM3);
- Three sites in the Dauphin River,
    - at Lake St. Martin (DR-A),
    - near the provincial monitoring station at the “Big Bend” (DR-B), and
    - at Sturgeon Bay (DR-E);

- One site in Big Buffalo Lake (BBL);
- One site in Buffalo Creek at the Dauphin River (BC3); and
- Two sites in Lake Winnipeg in Sturgeon Bay,
    - nearshore at the proposed LSMOC (SB1), and
    - offshore of the proposed LSMOC (SB2).

Water quality sampling sites in Watchorn Bay (WHB1 and WHB2) and its associated creeks (WHC-WB and MC-WB), the south bay of Lake St. Martin (LSM5), two sites on the Dauphin River (DR-B and DR-E), and the sites in Sturgeon Bay (SB-1 and SB-2) were not sampled in October, 2020 due to poor weather conditions, including strong winds and the early and rapid formation of ice, which made accessing the sites unsafe. Additionally, the south bay of Lake St. Martin (LSM5) was not sampled in May 2021 due to strong winds which made accessing the site unsafe.

Besides the core sampling sites described above, additional locations along the alignments of the proposed LMOC and LSMOC were surveyed by helicopter on September 1, 2020 to ascertain the presence of water. If possible, *in situ* water quality parameters were measured. Four of these locations were revisited on May 16, 2021 and *in situ* water quality parameters were measured. Additionally, a site in Reach 1 of the LSMEOC was sampled for *in situ* water quality in March 2021. Location information for these sites is presented in Table 2 and Figure 1.

2.3 WATER QUALITY PARAMETERS

In situ measurements of physical and chemical parameters were collected at each sampling site, including: total depth; dissolved oxygen (DO); water temperature; specific conductance; pH; and turbidity. Secchi depth was also measured at sites with low water velocity.

At core sampling sites, water samples were collected for laboratory analysis of routine parameters (e.g., pH, conductivity), nutrients (e.g., nitrogen, phosphorus), chlorophyll *a*, water clarity (e.g., total suspended solids, turbidity), and metals and major ions (e.g., aluminum, iron, calcium). A detailed list of parameters analysed at core sampling sites is provided in Table 3.

In September 2020, selected sites were also sampled for additional parameters including: *Escherichia coli*; blue-green algae (i.e., cyanobacteria); microcystin; hydrocarbons; and pesticides. These additional parameters were analysed from samples collected at BC-LSM, FR1 and DR-A. Detailed lists of hydrocarbons and pesticides measured by the laboratory are presented in Tables 4 and 5, respectively.

In addition, samples for the laboratory analysis of biological oxygen demand (BOD) were collected from six sites during the September sampling period, including: WHC-WB; MC-WB; BCD-2018-9; BC-LSM; BBL; and BC3. An attempt was made to collect samples for BOD from these same sites in March 2021; however, samples for laboratory analysis were not collected as these sites were either frozen to the bottom, or there was insufficient water below the ice to collect a sample without disturbing the sediments.

2.4 FIELD METHODS

Sampling sites were accessed by truck, boat, or helicopter during the open-water season; and by snowmobile or truck during the ice-cover season. Sampling date and time were noted for each site. Sample locations were recorded using a handheld Garmin GPS receiver. Total water depth was recorded using a hand-held depth sounder where possible; at sites sampled from shore, total water depth was estimated. In winter, snow depth and ice-thickness were also recorded.

In situ measurements of water quality parameters including pH, specific conductance, DO, turbidity, and water temperature were collected using a YSI EXO^{TM}2 sonde. At river sites and those accessed from shore, *in situ* parameters were measured at approximately 0.3 m below the water's surface and 0.3 m below the ice in winter. At lake sites, *in situ* profiles were taken such that measurements were recorded near the surface (i.e., at 0.3 m) and at increments of either 0.5 m (if total water depth was less than 5 m) or 1.0 m. Secchi depth was measured at low velocity sites and was defined as the average of two depth readings: (1) the depth at which a circular black and white disk can no longer be seen when lowered into the water column; and (2) the depth at which the disk becomes visible again, when raised. Secchi depth was not recorded in winter. Weather conditions (i.e., wind and waves) prohibited the collection of profiles and Secchi depths at some lake sites in September 2020.

Grab samples were collected from approximately 0.3 m below the water's surface into clean sample bottles supplied by ALS Laboratories. Samples from under the ice were collected from 0.3 m below the ice using a Kemmerer water sampler. Where necessary, samples were preserved according to instructions provided by the analytical laboratory. After collection, samples were placed in a cooler and kept cool using ice packs until submission (within 48 hours) to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory) for analysis.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program. Standard QA/QC measures were followed during sample collection (e.g., use of latex gloves, standard labelling practices, meter calibration, etc.). Additionally, QA/QC samples were collected for the list of parameters in Table 3 including field blanks, trip blanks, and replicate samples. With one exception, two field blanks, two trip blanks and two sets of triplicate samples were submitted to the analytical laboratory during each sampling period. Due to the shortened sampling period in October, only one set of QA/QC samples (blanks and triplicates) was submitted.

2.5.1 Field Blanks

Field blanks are intended to provide information on sample contamination from atmospheric exposure and sample handling techniques, as well as potential laboratory contamination and/or error (British Columbia Ministry of Environment, Lands, and Parks [BCMELP] 1998). Field blanks were prepared by filling sample bottles with deionized water (both provided by the analytical laboratory) in the field and submitting the blanks along with the environmental samples.

2.5.2 Trip Blanks

Trip blanks are used for evaluating the potential for sample contamination that may occur from the container or preservatives through transport and storage of the sample, as well as laboratory precision (BCMELP 1998). Trip blanks were prepared in the laboratory by filling sample bottles with deionized water. Trip blanks were transported to the field sampling sites, but remained sealed, and were then submitted to the analytical laboratory in conjunction with environmental samples for analysis.

2.5.3 Replicate Samples

Triplicate samples were collected at two sites during the September, May, and March sampling periods, and one site during the October sampling period. Replicate samples provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses.

2.6 QA/QC ASSESSMENT

All water quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as “suspect” and the laboratory was asked to verify the result.

QA/QC samples were assessed according to standard criteria to evaluate precision and identify potential sample contamination issues (BCMELP 1998). Percent relative standard deviation (PRSD) was calculated for triplicate samples as follows:

PRSD (%) = standard deviation (SD) of the triplicate values / mean of the triplicate values x 100

Precision of replicate samples was evaluated using the “rule of thumb” criteria for precision of 18% for triplicate samples (BCMELP 1998). Where one or more of the replicate values were less than five times the analytical detection limit (DL), an analysis of precision was not undertaken, in accordance with guidance provided in BCMELP (1998).

Field and trip blank results were also evaluated for evidence of sample contamination. Values for any parameter that exceeded five times the DL were considered to be indicative of sample contamination and/or laboratory error.

2.7 DATA ANALYSIS

All data analyses treated censured values (i.e., values reported as below the DL) as equal to one half the DL. In cases where triplicate samples were collected, sample means are presented. Dissolved inorganic nitrogen (DIN) was calculated as the sum of ammonia-N and nitrate/nitrite-N. Nitrogen to phosphorus molar ratios were also calculated.

2.8 COMPARISON TO WATER QUALITY OBJECTIVES AND GUIDELINES

Results were compared to the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG; MWS 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999; updated to 2021). In general, the MWQSOG for PAL are similar to the CCME guidelines for PAL for parameters measured; however, there are CCME guidelines for some parameters which lack a provincial guideline/objective and others for which the CCME and provincial guidelines are different. Typically, the CCME guideline is more stringent than the provincial guideline. A summary of relevant water quality objectives and guidelines is presented in Appendix 1.

3.0 RESULTS

3.1 QA/QC RESULTS

QA/QC results are presented in Appendix 2.

3.1.1 Field and Trip Blanks

Field and trip blank results generally indicated high precision and no sample contamination. Although some parameters were occasionally detected in blank samples, all parameters were below the threshold of five times the DL.

3.1.2 Replicate Samples

PRSD values were not derived for several parameters due to low concentrations (i.e., concentrations less than five times the DL). In general, the results indicate good agreement between samples and acceptable levels of precision. The PRSD exceeded threshold values (18%) for six parameters, including: carbonate alkalinity; chlorophyll *a*; phaeophytin *a*; total and dissolved aluminum; and total titanium.

Additionally, PRSD exceeded the threshold value for TSS, turbidity, chlorophyll *a*, and phaeophytin *a* for the replicate samples collected at the outlet of the Fairford River (FR2) on May 18, 2021. This was due to the results for one replicate (Rep1B) which were anomalously high. Sampling was conducted from the shore at this site, and it is expected that the sediments may have been disturbed during the collection of this replicate. Out of an abundance of caution, all results for this replicate were considered suspect and were removed from the mean reported (i.e., n = 2 for FR2 on May 18, 2021).

3.2 ROUTINE VARIABLES AND LIMNOLOGY

This section discusses the results for routine and *in situ* water quality parameters measured at the core water quality sampling sites; results of the *in situ* surveys, are presented separately (see Section 3.5 *In Situ* Survey Results). Results for *in situ* and routine water quality parameters measured at core sampling sites are presented in Tables 6 and 7, respectively; the following is a summary of these results.

Based on the results of the sampling that was conducted from fall 2020 to spring 2021, the water quality of the study area can be generally described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated during the open-water season. In March 2021, anoxic conditions were observed in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC (LSM3); the remaining sites sampled in March 2021 were well-oxygenated. BOD was low at all six sites where samples were collected in September 2020, including: Watchorn (WHC-WB), Mercer (MC-WB), Birch (BCD-2018-9 and BC-LSM) and Buffalo (BC3) creeks; and Big Buffalo Lake (BBL).

In situ variables including, temperature, DO, turbidity, pH, and specific conductance were consistent across depth during the open-water season. In March 2021, temperature increased somewhat with

depth in Sturgeon Bay (SB1 and SB2), and at the two sites in Lake St. Martin (BB-LSM and LSM5) where depths were sufficient for profiles to be collected; however, thermal stratification (i.e., >1 °C change within 1 m) was only observed in the middle of the south basin of Lake St. Martin (LSM5). DO, turbidity, pH and specific conductance were similar across depth in Lake St. Martin (BB-LSM and LSM5) and at the nearshore site in Sturgeon Bay (SB1) in March 2021. Conversely, pH and DO were slightly lower and specific conductance was slightly higher near the sediments at the offshore site in Sturgeon Bay (SB2) in March 2021. *In situ* profiles could not be collected at Watchorn and Sturgeon bays in September 2020 due to wavy conditions at the time of sampling.

Total phosphorus (TP) concentrations in the study area were composed of a mix of dissolved and particulate forms. During the open-water season phosphorus was predominately in particulate form; whereas during the ice-cover season, dissolved forms of phosphorus were more prevalent at most sites. Most total nitrogen (TN) was present in organic form at all sites, with ammonia nitrogen generally comprising a greater amount of DIN than nitrate/nitrite nitrogen. Based on TN:TP molar ratios, all waterbodies sampled were phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002).

Routine water quality was generally similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River, including WHB1, WHB2, WHC-WB, MC-WB, FR1, FR2, BB-LSM, LSM5, LSM4, LSM1, LSM3, DR-A, DR-B and DR-E. An exception to this trend occurred during the ice-cover season, when water quality in the eastern bay of Lake St. Martin near the outlet of the proposed LSMOC (i.e., LSM3) differed from the other sites sampled in the lake (BB-LSM, LSM5, LSM4 and LSM1). In March 2021, the eastern bay of Lake St. Martin (LSM3) had higher alkalinity (total and bicarbonate), hardness, ammonia, carbon (inorganic and organic forms), colour, conductivity and total dissolved solids (TDS) compared to other areas of the lake sampled.

Additionally, differences in water quality were observed between the sites sampled along the main flow path and Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay. The following spatial differences in routine water quality were observed:

- Birch Creek (BCD-2018-9 and BC-LSM) had higher alkalinity, hardness, TP, carbon and colour, and lower conductivity and TDS than sites along the main flow;
- Big Buffalo Lake (BBL) and Buffalo Creek (BC3) had higher carbon and colour, and lower conductivity and TDS than the sites sampled along the main flow; and
- Sturgeon Bay (SB1 and SB2) had lower alkalinity, hardness, conductivity, TDS, TN and carbon, and higher TP than upstream sites along the main flow path.

3.2.1 Comparison to Water Quality Guidelines and Objectives

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths (i.e., 0.025 mg/L) in several samples collected, including samples from the following locations:

- Watchorn Bay (WHB1 and WHB2);
- Watchorn Creek at Watchorn Bay (WHC-WB);

- Mercer Creek at Watchorn Bay (MC-WB);
- Fairford River at Lake St. Martin (FR2);
- Birch Creek at Lake St. Martin (BC-LSM);
- Lake St. Martin, at Birch Bay (BB-LSM), at the Narrows (LSM4), the north Basin (LSM1) and eastern bay (LSM3);
- Big Buffalo Lake (BBL);
- the Dauphin River at Sturgeon Bay (DR-E); and
- Sturgeon Bay (SB1 and SB2).

TP was below the MWQSOG narrative guideline for rivers and streams (0.05 mg/L) in all samples collected from sites where the guideline applies, including FR1, BCD-2018-9, DR-A, DR-B and BC3.

DO was below the CCME PAL for early life stages of cold-water biota (9.5 mg/L) at several sites sampled in September, at one site sampled in October, and 5 sites in May. It is unlikely that early life stages of cold-water species were present at the time the measurements were taken, as water temperatures were above 5°C in these cases. DO was within MWQSOG objectives and CCME guidelines for PAL at all other sites and times sampled during the open-water season.

DO was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life (8.0 mg/L and 3.0 mg/L, respectively), and CCME PAL guidelines for cold and warm water biota (5.5-9.5 mg/L; Appendix 1) in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC (LSM3) in March 2021. DO was within MWQSOG objectives and CCME guidelines for PAL at all other sites in March 2021.

All other routine water quality parameters for which there are MWQSOG and CCME PAL objectives/guidelines, including, pH (6.5-9.0 pH units), ammonia (sample specific based on pH and temperature), nitrate (2.93 mg N/L and 3.0 mg/L for MWQSOG and CCME, respectively), and nitrite (0.60 mg N/L) were within PAL objectives and guidelines.

3.3 METALS AND MAJOR IONS

Metal and major ion concentrations measured in the study area are presented in Table 8.

Beryllium, bismuth, silver, tellurium, and tungsten were not detected at any site. Additionally, some metals were not detected in dissolved form at any site, including: cesium; lead; thallium; thorium; and tin.

Total aluminum, arsenic, barium, boron, calcium, dissolved chloride, lithium, magnesium, total manganese, molybdenum, potassium, rubidium, silicon, sodium, strontium, dissolved sulphate, sulphur, uranium, and total vanadium were consistently detected. The remaining metals and major ions were detected in some samples.

Like routine parameters, with the exception the eastern bay of Lake St. Martin (LSM3) in winter, metals and major ions were similar at sites sampled along the main flow path from Lake Manitoba through the

Fairford River to Lake St. Martin and into the Dauphin River (WHB1, WHB2, WHC WB, MC-WB, FR1, FR2, BB-LSM, LSM5, LSM4, LSM1, LSM3, DR-A, DR-B and DR-E). In March 2021, several metals and major ions were higher at LSM3 than at other sites sampled in Lake St. Martin, including: arsenic, barium, boron, calcium, chloride, cobalt, fluoride, lithium, magnesium, manganese, nickel, potassium, rubidium, selenium, silicon, sodium and sulphate.

Again, differences were observed between the sites sampled along the main flow path and Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay. The following spatial differences in metals and major ions were observed:

- Birch Creek (BCD-2018-9 and BC-LSM) had lower chloride, molybdenum, sodium and strontium, and higher fluoride, magnesium and dissolved iron;
- Big Buffalo Lake (BBL) had lower chloride, lithium, molybdenum, nickel, potassium, rubidium, sodium, strontium, sulphate and sulphur, and higher aluminum;
- Buffalo Creek (BC3) had lower boron, chloride, lithium, molybdenum, potassium, rubidium, sodium, strontium, sulphate, sulphur and uranium, and higher aluminum, chromium, copper, cesium and iron; and
- Sturgeon Bay (SB1 and SB2) had lower, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, sodium, strontium, sulphate, sulphur and uranium, and higher aluminum, cesium, copper, iron, and nickel than sites sampled along the flow path from Lake Manitoba through the Dauphin River.

3.3.1 Comparison to Water Quality Guidelines and Objectives

Metals and major ions for which there are MWQSOG or CCME guidelines for PAL were, with few exceptions, within objectives and guidelines at sites sampled from September 2020 to May 2021; PAL exceedances occurred for aluminum, iron, chloride, and fluoride, as described below. Exceedance of PAL guidelines for aluminum and iron are common in waterbodies throughout Manitoba (CAMP 2017) and exceedance of the CCME PAL guidelines for chloride and fluoride was regularly observed in the study area during the monitoring studies conducted for the Lake St. Martin Emergency Outlet Channel project (NSC and KGS Group 2016).

Aluminum exceeded the MWQSOG and CCME guideline for PAL (0.1 mg/L) in 27 of 62 samples collected, including samples from the following locations:

- Watchorn Bay (WHB1 and WHB2);
- Watchorn Creek (WHC-WB);
- Mercer Creek (MC-WB);
- Birch Creek at PR239 (BCD-2018-9);
- Fairford River (FR1 and FR2);
- Lake St. Martin (BB-LSM, LSM1 and LSM3);
- Buffalo Creek (BC3);
- Dauphin River (DR-A, DR-B and DR-E); and

- Sturgeon Bay (SB1 and SB2).

Iron exceeded the MWQSOG and CCME guideline for PAL (0.3 mg/L) in the samples collected from Buffalo Creek (BC3) and Sturgeon Bay (SB1 and SB2) in September 2020 and May 2021; these sites were not sampled in October. Iron was below PAL guidelines at all other sites and times sampled.

Chloride exceeded the CCME long-term guideline (120 mg/L) in all samples collected from Watchorn Bay (WHB1 and WHB2), Watchorn and Mercer creeks (WHC-WB and MC-WB), Lake St. Martin (BB-LSM, LSM5, LSM4, LSM1 and LSM3), and the Fairford (FR1 and FR2) and Dauphin (DR-A, DR-B and DR-E) rivers. Chloride was consistently below the CCME long-term guideline in Birch Creek, Big Buffalo Lake, and Sturgeon Bay. All concentrations were below the CCME short-term guideline (640 mg/L). There are no MWOSOG for PAL for chloride.

Fluoride exceeded the CCME PAL (0.120 mg/L) in most samples collected. The exceptions were samples collected from Buffalo Creek (BC3) and Sturgeon Bay (SB1 and SB2) in September 2020, and samples collected from Sturgeon Bay (SB1 and SB2) in May 2021.

3.4 ADDITIONAL PARAMETERS

This section presents the results for the additional parameters that were analyzed in samples collected from Birch Creek at Lake St. Martin (BC-LSM), the Fairford River at PTH 6 (FR1), and the Dauphin River at Lake St. Martin (DR-A) in September 2020, including: *E. coli*; blue-green algae; microcystin; hydrocarbons; and pesticides. Detailed results are available in Appendix 3, the following is a summary of these results:

- *E. coli* was detected at all three sites sampled and concentrations were higher in the Fairford River (308 MPN/100 mL) than in Birch Creek (9 MPN/100 mL) and the Dauphin River (2 MPN/100 mL);
- blue-green algae were most abundant in the Dauphin River and least abundant in Birch Creek (Figure 2);
- microcystin was not detected (DL = 0.20 µg/L) at any of the three sites;
- hydrocarbons and were not detected at any of the three sites; and
- pesticides were not detected at any of the three sites.
- For a list of hydrocarbons and pesticides measured including DLs, see Tables 4 and 5, respectively.

3.4.1 Comparison to Water Quality Guidelines and Objectives

As all results for hydrocarbons and pesticides were below detection and the DLs were lower than MWQSOG and CCME PAL guidelines, all measurements were also within the PAL guidelines.

There are no MWQSOG or CCME guidelines for PAL for *E. coli*, blue-green algae, or microcystin.

3.5 *IN SITU* SURVEY RESULTS

This section presents the results of the *in situ* measurements taken at numerous locations to support fish habitat assessments. Results from these surveys are presented in Table 9.

Of the ten locations surveyed in September 2020, three sites along the alignment of the proposed LMOC were dry, including: Goodison Lake, Clarks Drain; and Woodale Drain. Water was present at the outlet of the drain at Goodison Lake; however, *in situ* parameters were not measured. All other sites surveyed in September 2020 were quite shallow with total water depths less than 0.5 m. Water was present at Reed, Clear, Water and Goodison lakes in May 2021; however, total depth was not recorded.

Sites along the alignment of the proposed LMOC where water was present in September 2020 (i.e., Reed, Clear and Water lakes) were well oxygenated, alkaline, and had low turbidity. *In situ* water quality was similar at these sites in May 2021, however, DO was somewhat lower at Clear Lake (7.42 mg/L; 77.1%) compared to conditions measured in September (9.82 mg/L; 94.1 %) and at other sites sampled in May (8.90-11.12 mg/L; 94.6-119.1 %). Specific conductance was moderately high and ranged from 470-802 µS/cm at sites along the LMOC.

In March 2021, the site sampled near the downstream end of Reach 1 was circum-neutral and had moderately high specific conductance (1021 µS/cm at 0.3 m), low turbidity and low oxygen (1.81 mg/L; 13.7 % at 0.3m). No other additional sites were surveyed for *in situ* water quality in March 2021.

Sites sampled along the alignment of the proposed LSMOC in September 2020 were low to moderately oxygenated, circum-neutral, and had low turbidity. Specific conductance at these sites was lower (8-367 µS/cm) than at the sites sampled along the alignment of the proposed LMOC. Sites along the LSMOC were not sampled in May 2021.

3.5.1 Comparison to Water Quality Guidelines and Objectives

DO was below the CCME PAL for early life stages of cold-water biota (9.5 mg/L) at Clear and Goodison lakes in May, 2021; however, It is unlikely that early life stages of cold-water species were present at this time. DO was within MWQSOG objectives and CCME guidelines for PAL at Reed and Water lakes in May, 2021, and at all sites sampled along the alignment of the proposed LMOC in September, 2020.

DO was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life (8.0 mg/L and 3.0 mg/L, respectively), and CCME PAL guidelines for cold and warm water biota (5.5-9.5 mg/L; Appendix 1) at the site sampled near the downstream end of Reach 1 in March 2021.

DO was below the MWQSOG 7-day objective for cold-water aquatic life (5.0 mg/L), the MWQSOG instantaneous objective for cool-water aquatic life (5.0 mg/L), and the CCME guidelines for warm water biota (6.0 mg/L and 5.5 mg/L for early life and all other stages, respectively) at the site located on Creek C upstream of the alignment of the proposed LSMOC (4.15 mg/L) in September 2020. Additionally, DO was below the CCME PAL for early life stages of cold-water biota (9.5 mg/L) at all sites sampled along the alignment of the proposed LSMOC in September 2020; however, it is unlikely that early life stages of

cold-water species were present at the time the measurements were taken (i.e., water temperatures were above 5°C in all instances where DO was less than 9.5 mg/L).

In situ pH exceeded the MWQSOG/CCME upper limit for PAL (9.0 pH units) at Water Lake in September 2020 (9.68 pH units); pH was within MWQSOG/CCME PAL guidelines (6.5-9.0 pH units) at all other sites and times.

There are no MWQSOG/CCME PAL guidelines for the other *in situ* parameters measured.

4.0 SUMMARY

Based on the results of the monitoring that was conducted from September 2020 to May 2021, the water quality of the study area can be described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and well-oxygenated. However, during the ice-cover season anoxic conditions were observed in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC.

In general, water quality was similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River; however, during the ice-cover season water quality in the eastern bay of Lake St. Martin near the outlet of the proposed LSMOC had higher alkalinity, hardness, ammonia, carbon, colour, conductivity, TDS, and higher concentrations of several metals and major ions compared to other areas of the lake. Additionally, differences in water quality were observed between the sites sampled along the main flow path and Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay, including:

- Birch Creek had higher alkalinity, hardness, TP, carbon, colour, fluoride, magnesium and dissolved iron, and lower TDS, conductivity, chloride, molybdenum, sodium and strontium;
- Big Buffalo Lake had higher carbon, colour and aluminum, and lower conductivity, TDS, chloride, lithium, molybdenum, nickel, potassium, rubidium, sodium, strontium, sulphate and sulphur;
- Buffalo Creek had higher carbon, colour, aluminum, chromium, copper, cesium and iron, and lower conductivity, TDS, boron, chloride, lithium, molybdenum, potassium, rubidium, sodium, strontium, sulphate, sulphur and uranium; and
- Sturgeon Bay had higher TP, aluminum, cesium, copper, iron, and nickel, and lower alkalinity, hardness, conductivity, TDS, TN, carbon, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, sodium, strontium, sulphate, sulphur and uranium compared with sites along the main flow path.

The results of the additional sampling that was conducted in the Fairford and Dauphin rivers, and Birch Creek in September showed that *E. coli* concentrations were higher in the Fairford River than in Birch Creek or the Dauphin River; and that blue-green algae were most abundant in the Dauphin River and least abundant in Birch Creek. Microcystin, hydrocarbons, and pesticides were not detected.

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths at several locations, including: Watchorn Bay; Watchorn Creek at Watchorn Bay; Mercer Creek at Watchorn Bay; Fairford River at Lake St. Martin; Birch Creek at Lake St. Martin; Lake St. Martin; Big Buffalo Lake; the Dauphin River at Sturgeon Bay; and Sturgeon Bay. TP was below the MWQSOG narrative guideline for rivers and streams in the Fairford and Dauphin rivers and in Birch and Buffalo creeks.

During the ice-cover season in March 2021, DO was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life and CCME PAL guidelines for cold and warm water biota in Big Buffalo Lake and the eastern bay of Lake St. Martin near the proposed LSMOC in March 2021.

Aluminum exceeded the MWQSOG and CCME guideline for PAL in approximately half of the samples collected, including samples from Watchorn and Sturgeon bays, Watchorn, Mercer, Birch and Buffalo creeks, the Fairford and Dauphin rivers, and Lake St. Martin. Iron exceeded the MWQSOG and CCME guideline for PAL in samples from Buffalo Creek and Sturgeon Bay. Chloride exceeded the CCME long-term guideline in all samples collected from along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River. Additionally, fluoride exceeded the CCME PAL, at most sites and times sampled; exceptions were Buffalo Creek and Sturgeon Bay where only some samples exceeded the guideline. Exceedances of these parameters are common in the region.

All other water quality variables measured for which there are MWQSOG and CCME PAL objectives or guidelines were within PAL objectives and guidelines at all core sampling sites.

The *in situ* survey that was conducted in September, 2020 found that, of the ten locations surveyed, three were dry (Goodison Lake, and Clarks and Woodale drains) and elsewhere total water depths were less than half a metre. Sites along the alignment of the proposed LMOC (where water was found) were well oxygenated, alkaline, and had moderately high specific conductance; whereas, sites along the alignment of the proposed LSMOC were low to moderately oxygenated, circum-neutral, and had lower specific conductance. Turbidity was low at all sites sampled. Four sites along the proposed LMOC (i.e., Reed Lake, Clear Lake, Water Lake, and Goodison Lake) were resampled in May 2021 and *in situ* water quality at these sites was similar to conditions recorded in September. Sites along the LSMOC were not sampled in May, 2021. In March 2021, a site near the downstream end of Reach 1 was sampled for *in situ* water quality and it was found to be circum-neutral, with moderately high specific conductance low turbidity and low DO. No other additional sites were surveyed for *in situ* water quality in March 2021.

At the time of the September survey, DO was below the MWQSOG 7-day objective for cold-water aquatic life, the MWQSOG instantaneous objective for cool-water aquatic life, and the CCME guidelines for warm water biota at the site located on Creek C upstream of the alignment of the proposed LSMOC. Similarly, DO was below the MWQSOGs instantaneous minimums for cold-water and cool-water aquatic life and CCME PAL guidelines for cold and warm water biota at the site sampled near the downstream end of Reach 1 in March 2021. Additionally, pH exceeded the MWQSOG/CCME upper limit for PAL at Water Lake in September 2020. DO and pH were within applicable MWQSOG/CCME PAL objectives/guidelines at all other sites sampled. There are no MWQSOG/CCME PAL guidelines for the other *in situ* parameters measured.

5.0 REFERENCES

Armstrong, N. 2012. Manitoba Conservation and Water Stewardship, Water Stewardship Division, Water Science and Management Branch. Suite 160, 123 Main Street, Winnipeg MB, R3C 1A5.

British Columbia Ministry of Environment, Lands, and Parks (BCMELP). 1998. Guidelines for interpreting water quality data. Version 1, May 1998. Prepared for the Land Use Task Force Resource Inventory Committee.

Canadian Council of Ministers of the Environment (CCME). 1999 (Updated to 2021). Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Coordinated Aquatic Monitoring Program (CAMP). 2017. Six year summary report (2008-2013). Report prepared for Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB.

Kalff, J. 2002. Limnology: inland water ecosystems. Prentice Hall, New Jersey. 572 pp.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. July 4, 2011. 68 pp.

North/South Consultants Inc (NSC). 2021. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Water Quality. A data report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. v + 75 pp.

NSC and KSG Group. 2016. Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation – 2011-2015. Volume 3 – Water Quality. A draft report prepared for Manitoba Infrastructure and Transportation. 546 pp.

Table 1. Core water quality sampling sites, 2020-2021.

Waterbody	Location Description	Site ID	Sampling Date	UTM coordinates			AEMP Site [1]
				Zone	Easting	Northing	
Lake Manitoba	offshore at proposed LMOC	WHB1	1-Sep-20	14U	529544	5681689	-
	nearshore at proposed LMOC	WHB2	1-Sep-20	14U	529859	5681409	Yes
Watchorn Creek	at Watchorn Bay	WHC-WB	1-Sep-20	14U	530536	5681120	-
Mercer Creek	at Watchorn Bay	MC-WB	1-Sep-20	14U	528731	5682150	-
Birch Creek	at PR 239	BCD-2018-9	9-Sep-20	14U	531737	5697480	-
	at Lake St. Martin	BC-LSM	1-Sep-20	14U	533227	5702296	Yes
Fairford River	at Highway 6 bridge	FR1	1-Sep-20	14U	518844	5715212	Yes
	at Lake St. Martin	FR2	10-Sep-20	14U	527235	5717448	-
Lake St. Martin	Birch Bay	BB-LSM	10-Sep-20	14U	534236	5704268	Yes
	middle of south basin	LSM5	2-Sep-20	14U	536274	5724382	Yes
	at the narrows	LSM4	2-Sep-20	14U	541937	5733207	Yes
	middle of north basin	LSM1	2-Sep-20	14U	549677	5736337	-
	eastern bay near proposed LSMOC	LSM3	2-Sep-20	14U	555893	5737189	Yes
Dauphin River	at Lake St. Martin	DR-A	2-Sep-20	14U	547145	5742411	Yes
	at Big Bend	DR-B	3-Sep-20	14U	545990	5757471	-
	at Sturgeon Bay	DR-E	3-Sep-20	14U	564901	5757120	Yes
Big Buffalo Lake	Big Buffalo Lake	BBL	1-Sep-20	14U	557985	5745469	-
Buffalo Creek	at the Dauphin River	BC3	1-Sep-20	14U	562248	5754739	-
Lake Winnipeg	nearshore at LSMOC outlet	SB1	3-Sep-20	14U	574355	5751490	Yes
	offshore at LSMOC outlet	SB2	3-Sep-20	14U	576810	5753556	Yes
Birch Creek	at PR 239	BCD-2018-9	13-Oct-20	14U	531731	5697492	-
	at Lake St. Martin	BC-LSM	13-Oct-20	14U	533229	5702304	-
Fairford River	at Highway 6 bridge	FR1	13-Oct-20	14U	518732	5715287	Yes
	at Lake St. Martin	FR2	13-Oct-20	14U	527262	5717433	-
Lake St. Martin	Birch Bay on LSM	BB-LSM	13-Oct-20	14U	534252	5704286	Yes
	at the narrows	LSM4	14-Oct-20	14U	541802	5733290	Yes
	middle of north basin	LSM1	14-Oct-20	14U	549827	5736359	-
	eastern bay near proposed LSMOC	LSM3	14-Oct-20	14U	555975	5737080	Yes
Dauphin River	at Lake St. Martin	DR-A	14-Oct-20	14U	547384	5741997	Yes
Lake Manitoba	offshore at proposed LMOC	WHB1	15-Mar-21	14U	529067	5680745	-
	nearshore at proposed LMOC	WHB2	15-Mar-21	14U	529863	5681400	Yes
Watchorn Creek	at Watchorn Bay	WHC-WB	15-Mar-21	14U	530463	5681194	-
Mercer Creek	at Watchorn Bay	MC-WB	15-Mar-21	14U	528703	5682158	-
Birch Creek drain	at PR 239	BCD-2018-9	16-Mar-21	14U	531728	5697575	-
Birch Creek	at Lake St. Martin	BC-LSM	16-Mar-21	14U	533227	5702296	Yes
Fairford River	at Highway 6 bridge	FR1	16-Mar-21	14U	518732	5715287	Yes
	at Lake St. Martin	FR2	16-Mar-21	14U	527033	5717634	-
Lake St. Martin	Birch Bay	BB-LSM	16-Mar-21	14U	534244	5704276	Yes
	middle of south basin	LSM5	17-Mar-21	14U	536284	5724387	Yes
	at the narrows	LSM4	17-Mar-21	14U	541455	5733199	Yes
	middle of north basin	LSM1	17-Mar-21	14U	549692	5736341	-

Table 1. Continued.

Waterbody	Location Description	Site ID	Sampling Date	UTM coordinates			AEMP Site [1]
				Zone	Easting	Northing	
	eastern bay near proposed LSMOC	LSM3	17-Mar-21	14U	555893	5737189	Yes
Dauphin River	at Lake St. Martin	DR-A	17-Mar-21	14U	547232	5742330	Yes
	at Big Bend	DR-B	18-Mar-21	14U	546039	5757470	-
	at Sturgeon Bay	DR-E	18-Mar-21	14U	564930	5757084	Yes
Big Buffalo Lake	Big Buffalo Lake	BBL	17-Mar-21	14U	558203	5745551	-
Buffalo Creek	at the Dauphin River	BC3	18-Mar-21	14U	562326	5754803	-
Lake Winnipeg	nearshore at LSMOC outlet	SB1	18-Mar-21	14U	574362	5751487	Yes
	offshore at LSMOC outlet	SB2	18-Mar-21	14U	576805	5753572	Yes
Lake Manitoba	offshore at proposed LMOC	WHB1	17-May-21	14U	529060	5680732	-
	nearshore at proposed LMOC	WHB2	17-May-21	14U	529864	5681405	Yes
Watchorn Creek	at Watchorn Bay	WHC-WB	17-May-21	14U	530540	5681117	-
Mercer Creek	at Watchorn Bay	MC-WB	17-May-21	14U	528731	5682161	-
Birch Creek drain	at PR 239	BCD-2018-9	17-May-21	14U	531726	5697512	-
Birch Creek	at Lake St. Martin	BC-LSM	17-May-21	14U	533218	5702301	Yes
Fairford River	at Highway 6 bridge	FR1	18-May-21	14U	518793	5715305	Yes
	at Lake St. Martin	FR2	18-May-21	14U	527203	5717388	-
Lake St. Martin	Birch Bay	BB-LSM	17-May-21	14U	531422	5704309	Yes
	middle of south basin	LSM5 [2]	-	-	-	-	Yes
	at the narrows	LSM4	19-May-21	14U	541968	5733683	Yes
	middle of north basin	LSM1	19-May-21	14U	549671	5736374	-
	eastern bay near proposed LSMOC	LSM3	19-May-21	14U	555858	5737204	Yes
Dauphin River	at Lake St. Martin	DR-A	19-May-21	14U	547128	5742474	Yes
	at Big Bend	DR-B	18-May-21	14U	545996	5757477	-
	at Sturgeon Bay	DR-E	19-May-21	14U	564027	5756402	Yes
Big Buffalo Lake	Big Buffalo Lake	BBL	16-May-21	14U	558203	5745551	-
Buffalo Creek	at the Dauphin River	BC3	16-May-21	14U	562211	5754609	-
Lake Winnipeg	nearshore at LSMOC outlet	SB1	27-May-21	14U	574541	5751375	Yes
	offshore at LSMOC outlet	SB2	27-May-21	14U	576819	5753561	Yes

1 - Sampling sites that were identified for surface water quality monitoring in the AEMP.

2 - Site not sampled in May 2021 due to strong winds which made accessing the site unsafe.

Table 2. Locations surveyed for the presence of water and *in situ* parameters.

Waterbody	Sampling Date	UTM coordinates		
		Zone	Easting	Northing
Reed Lake	01-Sep-20	14U	532101	5688016
Clear Lake	01-Sep-20	14U	531143	5690661
Water Lake	01-Sep-20	14U	531272	5692230
Goodison Lake	01-Sep-20	14U	531826	5695562
Clarks Drain	01-Sep-20	14U	532986	5699419
Woodale Drain	01-Sep-20	14U	532791	5699899
Creek C at LSMOC alignment	01-Sep-20	14U	566275	5749279
Creek C upstream of LSMOC alignment	01-Sep-20	14U	566666	5748941
Unnamed Creek at Buffalo Creek	01-Sep-20	14U	559977	5745858
Unnamed Creek at LSMOC alignment	01-Sep-20	14U	561564	5743054
Reach 1	17-Mar-21	14U	556803	5743909
Reed Lake	16-May-21	14U	532101	5688016
Clear Lake	16-May-21	14U	531143	5690661
Water Lake	16-May-21	14U	531272	5692230
Goodison Lake	16-May-21	14U	531826	5695562

Table 3. Laboratory parameters measured at core water quality sampling sites.

Routine Parameters	Metals (total and dissolved) and Major Ions	
Routine Chemistry	Aluminum	Nickel
Total alkalinity, as $CaCO_3$	Antimony	Phosphorus
Bicarbonate alkalinity as HCO_3	Arsenic	Potassium
Carbonate alkalinity, as CO_3	Barium	Rubidium
Hydroxide alkalinity, as OH	Beryllium	Selenium
pH	Bismuth	Silicon
Conductivity	Boron	Silver
Total Dissolved Solids	Cadmium	Sodium
Hardness, as $CaCO_3$	Calcium	Strontium
Nutrients	Cesium	Sulfate, dissolved
Total Ammonia (as N)	Chloride, dissolved	Sulfur
Nitrate (as N)	Chromium	Tellurium
Nitrite (as N)	Cobalt	Thallium
Nitrate and Nitrite (as N)	Copper	Thorium
Total Kjeldahl Nitrogen	Fluoride, dissolved [1]	Tin
Total Nitrogen	Iron	Titanium
Dissolved Phosphorus	Lead	Tungsten
Total Particulate Phosphorus	Lithium	Uranium
Total Phosphorus	Magnesium	Vanadium
Total Inorganic Carbon	Manganese	Zinc
Total Organic Carbon	Mercury	Zirconium
Dissolved Organic Carbon	Molybdenum	
Total Carbon		
Water Clarity		
Total Suspended Solids		
Turbidity		
True Colour		
Algal Pigments		
Chlorophyll *a*		
Phaeophytin *a*		

1 - Fluoride was not originally included in the analysis package for samples collected in September and October 2020 and therefore fluoride was not previously reported (NSC 2021). Where analytical data were available, laboratory reports were later updated to include fluoride.

Table 4. Hydrocarbon parameters measured at selected water quality sampling sites in September 2020.

Parameter	Unit	DL
Benzene	mg/L	0.00050
Ethyl benzene	mg/L	0.00050
Toluene	mg/L	0.0010
o-Xylene	mg/L	0.00050
m+p-Xylenes	mg/L	0.00040
Xylenes (Total)	mg/L	0.00064
F1 (C6-C10)	mg/L	0.10
F1-BTEX	mg/L	0.10
F2-Naphth	mg/L	0.10
F2 (C10-C16)	mg/L	0.10
F3-PAH	mg/L	0.25
F3 (C16-C34)	mg/L	0.25
F4 (C34-C50)	mg/L	0.25
Total Hydrocarbons (C6-C50)	mg/L	0.38
Acenaphthene	mg/L	0.000020
Acenaphthylene	mg/L	0.000020
Acridine	mg/L	0.000020
Anthracene	mg/L	0.000010
Benzo(a)anthracene	mg/L	0.000010
Benzo(a)pyrene	mg/L	0.0000050
Benzo(b&j)fluoranthene	mg/L	0.000010
Benzo(g,h,i)perylene	mg/L	0.000020
Benzo(k)fluoranthene	mg/L	0.000010
Chrysene	mg/L	0.000020
Dibenzo(a,h)anthracene	mg/L	0.0000050
Fluoranthene	mg/L	0.000020
Fluorene	mg/L	0.000020
Indeno(1,2,3-cd)pyrene	mg/L	0.000010
1-Methyl Naphthalene	mg/L	0.000020
2-Methyl Naphthalene	mg/L	0.000020
Naphthalene	mg/L	0.000050
Phenanthrene	mg/L	0.000050
Pyrene	mg/L	0.000010
Quinoline	mg/L	0.000020
B(a)P Total Potency Equivalent	mg/L	0.000030

Table 5. Pesticides measured at selected water quality sampling sites in September 2020.

Parameter	Unit	DL	Parameter	Unit	DL
Aldrin	µg/L	0.0080	Bromoxynil	mg/L	0.00010
alpha-BHC	µg/L	0.0080	Clopyralid	mg/L	0.00010
beta-BHC	µg/L	0.0080	2,4-D	mg/L	0.00010
gamma-hexachlorocyclohexane	µg/L	0.0080	Dicamba	mg/L	0.00010
delta-BHC	µg/L	0.0080	2,4-DB	mg/L	0.00010
a-chlordane	µg/L	0.0080	2,4-DP	mg/L	0.00010
g-chlordane	µg/L	0.0080	Dinoseb	mg/L	0.00010
o,p-DDD	µg/L	0.0040	MCPA	mg/L	0.00010
pp-DDD	µg/L	0.0040	MCPB	mg/L	0.00010
o,p-DDE	µg/L	0.0040	Mecoprop	mg/L	0.00010
pp-DDE	µg/L	0.0040	Picloram	mg/L	0.00010
op-DDT	µg/L	0.0040	2,4,5-T	mg/L	0.00010
pp-DDT	µg/L	0.0040	2,4,5-TP	mg/L	0.00010
Dieldrin	µg/L	0.0080	Triclopyr	mg/L	0.00010
Endosulfan I	µg/L	0.0070	Atrazine	µg/L	0.10
Endosulfan II	µg/L	0.0070	Atrazine+N-Dealkylated Metabolites	µg/L	0.20
Endosulfan Sulfate	µg/L	0.0070	Ethalfluralin	mg/L	0.00010
Endrin	µg/L	0.010	Atrazine Desethyl	µg/L	0.10
Endrin Aldehyde	µg/L	0.010	Fluazifop-p-butyl	mg/L	0.00010
Heptachlor	µg/L	0.0080	Glyphosate	µg/L	0.20
Heptachlor Epoxide	µg/L	0.0080	Diclofop-methyl	mg/L	0.00010
Hexachlorobenzene	µg/L	0.0080	Triallate	mg/L	0.00010
Hexachlorobutadiene	µg/L	0.0080	Trifluralin	mg/L	0.00010
Hexachloroethane	µg/L	0.0080			
Methoxychlor	µg/L	0.0080			
Mirex	µg/L	0.0080			
trans-Nonachlor	µg/L	0.010			
Oxychlordane	µg/L	0.0080			
Pentachloronitrobenzene	µg/L	0.010			
AMPA	µg/L	0.50			

Table 6. Results for *in situ* parameters measured at core sampling sites.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth[1] (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth[2] (m)
Lake Manitoba	WHB1	1-Sep-20	13:15	-	-	2.1	0.3	15.31	9.37	93.8	1086	13.09	8.62	0.75
							0.7	15.26	9.37	93.8	1086	13.78	8.60	
							1.2	15.26	9.36	93.7	1086	13.64	8.59	
	WHB2	1-Sep-20	15:23	-	-	1.9	0.5	14.13	9.91	96.7	1085	16.47	8.70	0.55
							1.0	14.13	9.90	96.7	1085	16.66	8.69	
Watchorn Creek	WHC-WB	1-Sep-20	16:26	-	-	1.1	0.5	14.24	10.84	106.1	1018	7.22	8.75	>1.1
							0.9	14.24	10.85	106.2	1017	7.44	8.73	
Mercer Creek	MC-WB	1-Sep-20	14:19	-	-	0.7	0.3	13.79	8.92	86.5	1102	13.49	8.20	-
Birch Creek drain	BCD-2018-9	9-Sep-20	19:05	-	-	0.4	0.4	11.68	10.63	100.2	764	21.94	8.08	>0.4
Birch Creek	BC-LSM	1-Sep-20	18:13	-	-	0.4	0.2	14.42	10.76	107.2	680	1.45	8.74	>0.4
Fairford River	FR1	1-Sep-20	19:20	-	-	-	0.2	14.57	11.12	109.6	1079	10.08	8.65	-
	FR2	10-Sep-20	9:45	-	-	1.2	0.3	11.40	10.70	98.2	1089	13.41	8.53	0.55
							0.5	11.39	10.70	98.3	1089	13.40	8.54	
							1.0	11.40	10.70	98.3	1089	13.63	8.54	
Lake St. Martin	BB-LSM	10-Sep-20	11:45	-	-	2.6	0.3	11.90	10.78	100.1	1047	9.43	8.52	0.68
							0.5	11.88	10.78	100.1	1047	9.48	8.52	
							1.0	11.78	10.78	99.9	1047	9.50	8.52	
							1.5	11.78	10.75	99.2	1047	9.66	8.52	
							2.0	11.60	10.72	98.8	1048	9.84	8.52	
							2.5	11.46	10.64	97.8	1048	11.72	8.52	
	LSM5	2-Sep-20	17:13	-	-	3.8	1.0	16.21	9.46	96.5	1053	5.50	8.66	0.62
							2.0	16.20	9.45	96.5	1053	5.53	8.66	
							3.0	16.20	9.45	96.5	1053	5.52	8.66	
	LSM4	2-Sep-20	15:10	-	-	1.0	0.5	14.44	10.58	104.0	1052	3.96	8.75	>1.0
	LSM1	2-Sep-20	13:03	-	-	1.0	0.3	14.26	10.14	99.3	1058	8.68	8.68	0.55

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth[1] (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth[2] (m)
	LSM3	2-Sep-20	12:10	-	-	1.5	0.3	13.38	10.16	97.5	862	9.32	8.73	0.45
							1.0	13.29	10.28	98.5	863	9.14	8.74	
Dauphin River	DR-A	2-Sep-20	9:00	-	-	1.1	0.3	13.07	9.99	95.3	1058	6.25	8.80	0.68
							0.7	13.08	10.00	95.4	1058	6.34	8.79	
	DR-B	3-Sep-20	11:44	-	-	-	0.3	13.86	10.37	100.7	1055	8.67	8.75	-
	DR-E	3-Sep-20	10:09	-	-	2.5	1.0	13.75	9.28	89.9	1044	12.39	8.52	0.55
							2.0	13.64	9.37	90.5	1048	11.38	8.58	
Big Buffalo Lake	BBL	1-Sep-20	11:27	-	-	1.5	0.3	13.98	9.19	89.3	464	4.13	8.54	-
Buffalo Creek	BC3	1-Sep-20	12:16	-	-	<0.1	0.3	13.95	9.38	91.1	448	11.04	7.93	-
Lake Winnipeg	SB-1	3-Sep-20	9:09	-	-	3.8	1.0	15.90	9.04	91.4	531	22.48	8.33	-
							2.0	15.90	9.04	91.7	522	22.20	8.33	
	SB-2	3-Sep-20	8:39	-	-	6.5	1.0	15.90	9.22	93.4	384	17.10	8.31	-
Birch Creek drain	BCD-2018-9	13-Oct-20	10:30	-	-	-	0.3	5.90	7.20	57.9	920	0.38	7.62	-
Birch Creek	BC-LSM	13-Oct-20	11:00	-	-	<1 m	0.3	5.06	11.03	86.7	911	1.09	8.18	-
Fairford River	FR1	13-Oct-20	14:00	-	-	-	0.3	6.51	11.99	98.0	1114	32.00	8.32	-
	FR2	13-Oct-20	15:25	-	-	1.4	0.3	6.88	11.67	96.1	1107	19.76	8.1	0.35
Lake St. Martin	BB-LSM	13-Oct-20	12:20	-	-	2.6	0.3	7.76	11.13	93.7	1073	6.58	8.38	0.75
							1.0	7.76	11.12	93.7	1073	6.48	8.38	
	LSM4	14-Oct-20	9:50	-	-	1.0	0.3	5.41	11.41	90.7	1089	5.40	8.14	-
	LSM-1	14-Oct-20	8:40	-	-	1.4	0.3	5.05	11.56	90.9	1092	19.90	8.18	0.45
	LSM3	14-Oct-20	11:25	-	-	-	0.3	4.73	11.91	92.9	1137	17.80	8.12	-
Dauphin River	DR-A	14-Oct-20	12:00	-	-	0.9	0.3	4.84	12.08	94.5	1091	7.20	8.23	0.70
Lake Manitoba	WHB-1	15-Mar-21	13:00	0.05	0.94	1.7	0.3	1.47	13.32	95.4	1467	0.34	8.00	-
							1.0	1.82	14.41	104.1	1524	0.40	8.03	
	WHB2	15-Mar-21	15:00	0.05	0.95	0.2	0.2	0.46	14.27	99.4	1555	0.36	8.13	-
Watchorn Creek	WHC-WB	15-Mar-21	15:00	0.05	0.77	0.1 [3]	-	-	-	-	-	-	-	-

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth[1] (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth[2] (m)
Mercer Creek	MC-WB	15-Mar-21	14:20	0.05	-	-[3]	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9	16-Mar-21	8:15	0.05	0.35	-[3]	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM	16-Mar-21	8:47	0.00	-	-[3]	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	11:45	-	-[4]	-	0.3	1.27	13.26	94.4	1400	1.57	8.24	-
	FR2	16-Mar-21	12:00	-	-[4]	-	0.3	2.18	13.04	95.2	1362	1.22	8.23	
Lake St. Martin	BB-LSM	16-Mar-21	9:30	0.10	0.85	2.2	0.5	1.81	13.37	96.6	1489	3.08	8.07	-
							1.0	1.80	13.88	100.3	1485	3.23	8.09	
							1.5	2.17	14.33	104.6	1494	1.85	8.15	
	LSM5	17-Mar-21	10:00	0.12	0.97	3.3	0.3	0.75	12.69	89.0	1469	0.40	8.05	-
							1.0	1.62	12.54	90.2	1459	0.51	8.04	
							1.5	2.51	12.06	88.8	1450	0.46	8.02	
							2.0	2.88	11.85	88.2	1447	0.44	8.00	
							2.5	3.50	11.30	85.5	1449	0.54	7.98	
	LSM4	17-Mar-21	11:15	-	-[4]	-	0.3	0.60	11.49	80.4	1571	0.69	7.95	-
	LSM1	17-Mar-21	13:24	0.05	1.0	0.2	0.2	0.26	11.41	79.0	1451	0.71	8.07	-
	LSM3	17-Mar-21	14:15	0.05	0.85	0.95	0.3	1.84	1.83	13.6	2309	0.86	7.52	-
Dauphin River	DR-A	17-Mar-21	17:30	0.05	0.55	0.65	0.3	0.04	11.74	80.8	1476	0.50	8.09	-
	DR-B	18-Mar-21	8:15	0.00	0.17	0.56	0.3	-0.04	10.54	72.3	1521	0.89	8.01	-
	DR-E	18-Mar-21	14:00	0.10	0.7	1.1	0.3	0.02	10.32	71.0	1508	1.25	7.96	-
							1.0	0.01	10.31	70.8	1509	0.89	7.96	
Big Buffalo Lake	BBL	17-Mar-21	16:04	0.05	0.75	0.35	0.3	2.26	0.58	4.3	1985	7.64	7.49	-
Buffalo Creek	BC3	18-Mar-21	9:45	-	0.9	-[3]	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	12:00	0.10	1.0	3.3	0.3	0.46	16.53	114.7	520	4.59	8.36	-
							1.0	0.50	15.91	110.6	516	2.68	8.27	
							1.5	0.61	15.35	107.0	515	4.91	8.20	
							2.0	0.76	15.63	109.4	527	4.23	8.20	

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth[1] (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth[2] (m)
							2.5	1.12	16.91	119.4	526	4.05	8.44	
	SB2	18-Mar-21	11:00	0.10	0.98	5.6	0.3	0.27	15.29	105.5	514	4.54	8.22	-
							1.0	0.44	14.87	103.2	510	4.76	8.17	
							2.0	0.59	14.53	101.2	506	4.92	8.13	
							3.0	0.85	15.45	108.3	531	4.18	8.20	
							4.0	1.84	13.25	95.6	543	4.69	7.96	
							5.0	2.75	8.61	63.8	701	6.56	7.72	
Lake Manitoba	WHB1	17-May-21	11:25	-	-	2.4	0.3	14.07	11.21	109.4	1156	1.76	8.54	1.65
							1.0	14.07	11.20	109.2	1156	1.90	8.50	
							1.5	14.07	11.20	109.2	1156	1.89	8.50	
							2.0	14.08	11.26	109.7	1140	2.06	8.37	
Lake Manitoba	WHB2	17-May-21	12:40	-	-	1.2	0.3	15.57	10.46	105.6	1165	3.12	8.58	-
Watchorn Creek	WHC-WB	17-May-21	13:20	-	-	0.8	0.3	16.77	10.74	110.9	1177	3.59	8.51	0.85
Mercer Creek	MC-WB	17-May-21	12:10	-	-	1.0	0.3	17.40	9.76	102.4	1159	12.2	8.51	>1.0
Birch Creek drain	BCD-2018-9	17-May-21	14:55	-	-	0.75	0.3	14.66	7.36	72.6	691	0.16	7.97	>0.75
Birch Creek	BC-LSM	17-May-21	15:25	-	-	0.9	0.3	20.10	11.72	129.4	687	2.09	8.38	>0.9
Fairford River	FR1	18-May-21	10:15	-	-	1.9	0.3	14.89	10.04	99.7	1148	8.63	8.53	1.05
Fairford River	FR2	18-May-21	11:05	-	-	0.5	0.3	16.89	9.96	103.1	1157	8.08	8.56	>0.5
Lake St. Martin	BB-LSM	17-May-21	16:15	-	-	1.8	0.3	14.60	10.92	107.5	861	2.99	8.60	1.45
							1.0	14.61	10.93	107.6	861	4.00	8.60	
							1.5	14.60	10.93	107.6	861	4.32	8.61	
	LSM5[5]	May 2021	-	-	-	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	11:20	-	-	0.6	0.3	17.33	9.37	97.9	1108	3.75	8.36	>0.6
	LSM1	19-May-21	14:00	-	-	0.75	0.3	18.93	9.37	101.2	1150	10.7	8.55	>0.75
	LSM3	19-May-21	15:40	-	-	1.2	0.3	18.60	9.63	103.2	821	5.49	8.60	0.85

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth[1] (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth[2] (m)
Dauphin River	DR-A	19-May-21	13:10	-	-	0.6	0.3	18.28	8.93	95.2	1168	15.9	8.43	0.28
	DR-B	18-May-21	12:45	-	-	0.6	0.3	18.81	9.53	101.4	1214	9.77	8.58	>0.6
	DR-E	19-May-21	9:50	-	-	1.1	0.3	17.72	8.58	90.4	1209	7.93	8.44	0.55
Big Buffalo Lake	BBL	16-May-21	11:00	-	-	-	-	15.5 [6]	- [7]	- [7]	- [7]	- [7]	- [7]	-
Buffalo Creek	BC3	16-May-21	9:43	-	-	1.8	-	18.0 [6]	- [7]	- [7]	- [7]	- [7]	- [7]	0.90
Lake Winnipeg	SB1	27-May-21	13:00	-	-	3.8	0.3	7.87	11.45	96.6	517	9.72	8.25	0.45
							1.0	7.90	11.43	96.5	517	9.60	8.25	
							1.5	7.80	11.43	96.2	516	9.86	8.25	
							2.0	7.78	11.42	96.1	515	9.46	8.25	
							2.5	7.76	11.41	95.9	514	9.72	8.25	
							3.0	7.76	11.41	95.9	514	9.57	8.25	
	SB2	27-May-21	12:35	-	-	6.4	0.3	8.91	11.21	97.1	474	32.9	8.28	0.25
							1.0	8.81	11.21	96.7	475	33.0	8.30	
							2.0	8.76	11.18	96.1	474	33.0	8.30	
							3.0	8.59	11.15	95.7	472	32.3	8.30	
							4.0	8.49	11.14	95.4	470	32.6	8.29	
							5.0	8.47	11.13	95.2	470	30.7	8.29	

1 - Effective depth during ice-cover

2 - Not measured in March 2021

3 - Site was frozen to the bottom or effective depth was too shallow to accurately measure *in situ* water quality.

4 - Open-water

5 - Site not sampled in May 2021 due to strong winds which made accessing the site unsafe.

6 - Measured with a hand-held thermometer.

7 - Sonde batteries died on site, no *in situ* measurements recorded.

Table 7. Laboratory results for routine parameters measured at core sampling sites.

Waterbody	Site ID	Sampling Date	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Analytical DL				*1.0*	*1.2*	*0.60*	*0.34*	*0.010*	*0.0050 /0.010*	*0.0010 /0.0020*	*0.0051 /0.010*
Lake Manitoba	WHB1	1-Sep-20	L2497954-1	170	193	7.20	<0.34	<0.010	<0.010	<0.0020	<0.010
	WHB2	1-Sep-20	L2497954-2	169	191	7.08	<0.34	<0.010	<0.010	<0.0020	<0.010
Watchorn Creek	WHC-WB	1-Sep-20	L2497954-3	184	206	9.24	<0.34	<0.010	<0.010	<0.0020	<0.010
Mercer Creek	MC-WB	1-Sep-20	Mean	190	231	<0.60	<0.34	0.031	<0.010	<0.0020	<0.010
Birch Creek drain	BCD-2018-9	9-Sep-20	L2501445-3	379	440	11.00	<0.34	0.010	<0.0050	<0.0010	<0.0051
Birch Creek	BC-LSM	1-Sep-20	L2497954-5	320	347	21.2	<0.34	0.024	0.0059	<0.0010	0.0059
Fairford River	FR1	1-Sep-20	L2497954-6	170	192	7.32	<0.34	<0.010	<0.010	0.0035	<0.010
	FR2	10-Sep-20	L2501445-2	201	232	6.60	<0.34	<0.010	<0.010	<0.0020	<0.010
Lake St. Martin	BB-LSM	10-Sep-20	L2501445-1	216	250	6.84	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM5	2-Sep-20	L2498786-4	209	237	9.24	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM4	2-Sep-20	L2498786-3	170	188	9.96	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM1	2-Sep-20	Mean	188	211	8.80	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM3	2-Sep-20	L2498786-2	193	213	10.9	<0.34	<0.010	<0.0050	<0.0010	<0.0051
Dauphin River	DR-A	2-Sep-20	L2497954-7	163	181	8.76	<0.34	<0.010	<0.010	<0.0020	<0.010
	DR-B	3-Sep-20	L2498784-1	184	206	8.64	<0.34	<0.010	<0.010	<0.0020	<0.010
	DR-E	3-Sep-20	L2498784-2	194	223	6.96	<0.34	<0.010	<0.010	<0.0020	<0.010
Big Buffalo Lake	BBL	1-Sep-20	L2497371-1	283	311	16.9	<0.34	0.017	<0.0050	<0.0010	<0.0051
Buffalo Creek	BC3	1-Sep-20	L2497371-2	226	270	3.00	<0.34	0.010	<0.0050	<0.0010	<0.0051
Lake Winnipeg	SB1	3-Sep-20	L2498784-3	128	156	<0.60	<0.34	<0.010	0.0206	<0.0010	0.0206
	SB2	3-Sep-20	L2498784-4	113	138	<0.60	<0.34	<0.010	0.0215	<0.0010	0.0215
Birch Creek drain	BCD-2018-9	13-Oct-20	L2516048-1	381	429	17.4	<0.34	0.026	<0.010	<0.0020	<0.010
Birch Creek	BC-LSM	13-Oct-20	L2516048-2	383	427	19.8	<0.34	0.024	<0.010	<0.0020	<0.010
Fairford River	FR1	13-Oct-20	Mean	183	213	4.60	<0.34	<0.010	<0.010	<0.0020	<0.010
	FR2	13-Oct-20	L2516048-5	181	212	4.32	<0.34	<0.010	<0.010	<0.0020	<0.010

Table 7 Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Lake St. Martin	BB-LSM	13-Oct-20	L2516048-3	180	207	5.88	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM4	14-Oct-20	L2516868-3	179	210	4.20	<0.34	0.013	<0.010	<0.0020	<0.010
	LSM1	14-Oct-20	L2516868-1	181	210	5.28	<0.34	0.011	<0.010	<0.0020	<0.010
	LSM3	14-Oct-20	L2516868-2	207	239	6.48	<0.34	0.029	<0.010	<0.0020	<0.010
Dauphin River	DR-A	14-Oct-20	L2516868-4	181	212	4.32	<0.34	0.025	<0.010	<0.0020	<0.010
Lake Manitoba	WHB1	15-Mar-21	L2567238-1	237	290	<0.60	<0.34	0.163	<0.010	<0.0020	<0.010
	WHB2	15-Mar-21	L2567238-2	251	306	<0.60	<0.34	0.135	0.017	<0.0020	0.017
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	L2567806-2	225	274	<0.60	<0.34	0.130	0.012	0.0025	0.015
	FR2	16-Mar-21	L2567806-3	217	264	<0.60	<0.34	0.131	0.011	0.0055	0.017
Lake St. Martin	BB-LSM	16-Mar-21	L2567806-1	245	298	<0.60	<0.34	0.125	0.015	<0.0020	0.015
	LSM5	17-Mar-21	L2568173-5	235	278	4.20	<0.34	0.190	0.014	0.0031	0.017
	LSM4	17-Mar-21	L2568173-1	256	302	4.68	<0.34	0.178	0.012	<0.0020	0.012
	LSM1	17-Mar-21	L2568173-2	235	280	3.60	<0.34	0.139	0.024	0.0030	0.027
	LSM3	17-Mar-21	L2568173-3	433	528	<0.60	<0.34	0.336	0.014	<0.0020	0.014
Dauphin River	DR-A	17-Mar-21	L2568173-4	240	282	5.52	<0.34	0.200	0.014	0.0034	0.017
	DR-B	18-Mar-21	Mean	248	297	2.90	<0.34	0.149	0.029	<0.0020	0.030
	DR-E	18-Mar-21	L2568772-2	246	300	<0.60	<0.34	0.169	0.021	<0.0020	0.021
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	Mean	138	164	2.04	<0.34	0.026	0.0240	<0.0010	0.0243
	SB2	18-Mar-21	L2568772-4	136	165	<0.60	<0.34	0.030	0.0464	0.0013	0.0477

Table 7 Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Lake Manitoba	WHB1	17-May-21	L2588908-1	183	209	6.48	<0.34	0.013	<0.010	<0.0020	<0.010
	WHB2	17-May-21	L2588908-2	187	214	6.48	<0.34	0.016	<0.010	<0.0020	<0.010
Watchorn Creek	WHC-WB	17-May-21	L2588908-3	203	236	5.64	<0.34	0.051	<0.0050	<0.0010	<0.0051
Mercer Creek	MC-WB	17-May-21	L2588908-4	192	222	6.12	<0.34	0.018	<0.0050	<0.0010	<0.0051
Birch Creek drain	BCD-2018-9	17-May-21	L2588908-5	292	350	3.24	<0.34	<0.010	<0.0050	<0.0010	<0.0051
Birch Creek	BC-LSM	17-May-21	L2588908-6	318	357	14.9	<0.34	0.013	<0.0050	<0.0010	<0.0051
Fairford River	FR1	18-May-21	L2590207-1	181	210	5.64	<0.34	0.024	<0.010	<0.0020	<0.010
	FR2	18-May-21	Mean (n=2) [2]	182	208	6.84	<0.34	0.041	<0.010	<0.0020	<0.010
Lake St. Martin	BB-LSM	17-May-21	L2588908-7	145	169	3.72	<0.34	0.012	<0.0050	<0.0010	<0.0051
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	Mean	182	210	5.60	<0.34	0.024	<0.0050	<0.0010	<0.0051
	LSM1	19-May-21	L2590206-2	186	214	6.60	<0.34	0.069	<0.010	<0.0020	<0.010
	LSM3	19-May-21	L2590206-3	176	203	5.64	<0.34	0.018	<0.0050	<0.0010	<0.0051
Dauphin River	DR-A	19-May-21	L2590206-4	189	220	5.16	<0.34	0.066	<0.0050	<0.0010	<0.0051
	DR-B	18-May-21	L2590207-3	191	219	6.96	<0.34	0.038	<0.010	<0.0020	<0.010
	DR-E	19-May-21	L2590206-5	195	226	5.76	<0.34	0.064	<0.010	<0.0020	<0.010
Big Buffalo Lake	BBL	16-May-21	L2588908-8	190	222	4.56	<0.34	0.155	<0.0050	<0.0010	<0.0051
Buffalo Creek	BC3	16-May-21	L2588908-9	186	227	<0.60	<0.34	0.053	<0.0050	<0.0010	<0.0051
Lake Winnipeg	SB1	27-May-21	L2593508-1	126	154	<0.60	<0.34	0.147	<0.0050	<0.0010	<0.0051
	SB2	27-May-21	L2593508-2	124	151	<0.60	<0.34	0.023	<0.0050	<0.0010	<0.0051

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Nitrogen			Phosphorus				Molar N:P Ratios		
			Dissolved Inorganic Nitrogen (mg/L)[4]	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Dissolved Fraction (%)	TN:TP	DIN:DP	DIN:TP
Analytical DL			*0.010*	*0.20*	*0.20*	*0.0010 /0.0030*	*0.0028 /0.0042*	*0.0010 /0.0030*				
Lake Manitoba	WHB1	1-Sep-20	<0.010	1.23	1.23	0.0058	0.0205	0.0263	22	103	2	0
	WHB2	1-Sep-20	<0.010	1.28	1.28	0.0067	0.0223	0.0289	23	98	2	0
Watchorn Creek	WHC-WB	1-Sep-20	<0.010	1.26	1.26	0.0077	0.0213	0.0290	27	96	1	0
Mercer Creek	MC-WB	1-Sep-20	0.036	1.15	1.15	0.0123	0.0262	0.0386	32	66	6	2
Birch Creek drain	BCD-2018-9	9-Sep-20	0.013	1.82	1.82	0.0122	0.0210	0.0332	37	121	2	1
Birch Creek	BC-LSM	1-Sep-20	0.030	2.35	2.36	0.0235	0.0102	0.0337	70	155	3	2
Fairford River	FR1	1-Sep-20	<0.010	1.10	1.10	0.0068	0.0167	0.0235	29	104	2	0
	FR2	10-Sep-20	<0.010	1.31	1.31	0.0054	0.0187	0.0241	22	120	2	0
Lake St. Martin	BB-LSM	10-Sep-20	<0.010	1.81	1.81	0.0061	0.0161	0.0222	27	180	2	0
	LSM5	2-Sep-20	<0.010	1.45	1.45	0.0081	0.0137	0.0218	37	147	1	1
	LSM4	2-Sep-20	<0.010	1.17	1.17	0.0079	0.0186	0.0265	30	98	1	0
	LSM1	2-Sep-20	<0.010	1.29	1.29	0.0086	0.0169	0.0254	34	112	1	0
	LSM3	2-Sep-20	<0.010	1.46	1.46	0.0096	0.0121	0.0217	44	149	1	1
Dauphin River	DR-A	2-Sep-20	<0.010	1.29	1.29	0.0078	0.0175	0.0253	31	113	1	0
	DR-B	3-Sep-20	<0.010	1.20	1.20	0.0091	0.0169	0.0260	35	102	1	0
	DR-E	3-Sep-20	<0.010	1.33	1.33	0.0088	0.0224	0.0311	28	95	1	0
Big Buffalo Lake	BBL	1-Sep-20	0.020	1.79	1.79	0.0106	0.0473	0.0579	18	68	4	1
Buffalo Creek	BC3	1-Sep-20	0.013	0.99	0.99	0.0081	0.0127	0.0208	39	105	3	1
Lake Winnipeg	SB1	3-Sep-20	0.026	0.64	0.66	0.0208	0.0229	0.0437	48	33	3	1
	SB2	3-Sep-20	0.027	0.46	0.48	0.0266	0.0221	0.0487	55	22	2	1
Birch Creek drain	BCD-2018-9	13-Oct-20	0.031	1.67	1.67	0.0074	<0.0042	0.0106	70	348	9	6
Birch Creek	BC-LSM	13-Oct-20	0.029	1.70	1.70	0.0114	0.0091	0.0204	56	184	6	3
Fairford River	FR1	13-Oct-20	<0.010	1.39	1.39	0.0061	0.0291	0.0352	17	87	2	0
	FR2	13-Oct-20	<0.010	1.08	1.08	0.0070	0.0257	0.0326	21	73	2	0

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Nitrogen			Phosphorus				Molar N:P Ratios		
			Dissolved Inorganic Nitrogen (mg/L)[4]	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Dissolved Fraction (%)	TN:TP	DIN:DP	DIN:TP
Lake St. Martin	BB-LSM	13-Oct-20	<0.010	1.15	1.15	0.0064	0.0164	0.0228	28	112	2	0
	LSM4	14-Oct-20	0.018	1.13	1.13	0.0059	0.0158	0.0218	27	115	7	2
	LSM1	14-Oct-20	0.016	1.49	1.49	0.0062	0.0267	0.0329	19	100	6	1
	LSM3	14-Oct-20	0.034	1.42	1.42	0.0056	0.0235	0.0291	19	108	13	3
Dauphin River	DR-A	14-Oct-20	0.030	1.17	1.17	0.0060	0.0166	0.0226	27	114	11	3
Lake Manitoba	WHB1	15-Mar-21	0.168	1.27	1.27	0.0081	0.0093	0.0173	47	162	21	21
	WHB2	15-Mar-21	0.152	1.49	1.50	0.0088	0.0073	0.0161	55	206	21	21
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	0.145	1.31	1.33	0.0072	0.0086	0.0158	46	186	20	20
	FR2	16-Mar-21	0.148	1.27	1.29	0.0082	0.0098	0.0180	46	159	18	18
Lake St. Martin	BB-LSM	16-Mar-21	0.140	1.30	1.32	0.0084	0.0083	0.0167	50	175	19	19
	LSM5	17-Mar-21	0.207	1.44	1.46	0.0071	0.0069	0.0140	51	231	33	33
	LSM4	17-Mar-21	0.190	1.50	1.51	0.0095	0.0060	0.0155	61	216	27	27
	LSM1	17-Mar-21	0.166	1.47	1.50	0.0079	0.0134	0.0213	37	156	17	17
	LSM3	17-Mar-21	0.350	2.36	2.37	0.0110	0.0101	0.0211	52	248	37	37
Dauphin River	DR-A	17-Mar-21	0.217	1.38	1.40	0.0081	<0.0042	0.0121	67	256	40	40
	DR-B	18-Mar-21	0.179	1.35	1.38	0.0111	0.0082	0.0199	56	154	20	20
	DR-E	18-Mar-21	0.190	1.49	1.52	0.0095	0.0066	0.0161	59	209	26	26
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	0.051	0.55	0.58	0.0188	0.0130	0.0318	59	40	4	4
	SB2	18-Mar-21	0.078	0.51	0.56	0.0219	0.0072	0.0292	75	42	6	6

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Nitrogen			Phosphorus				Molar N:P Ratios		
			Dissolved Inorganic Nitrogen (mg/L)[4]	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Dissolved Fraction (%)	TN:TP	DIN:DP	DIN:TP
Lake Manitoba	WHB1	17-May-21	0.018	1.12	1.12	0.0130	0.0084	0.0214	61	116	2	2
	WHB2	17-May-21	0.021	1.15	1.15	0.0148	0.0141	0.0289	51	88	2	2
Watchorn Creek	WHC-WB	17-May-21	0.054	1.55	1.55	0.0163	0.0242	0.0405	40	85	3	3
Mercer Creek	MC-WB	17-May-21	0.021	1.62	1.62	0.0093	0.0310	0.0403	23	89	1	1
Birch Creek drain	BCD-2018-9	17-May-21	<0.010	1.40	1.40	0.0115	0.0087	0.0202	57	153	1	1
Birch Creek	BC-LSM	17-May-21	0.016	1.22	1.22	0.0102	0.0125	0.0227	45	119	2	2
Fairford River	FR1	18-May-21	0.029	1.12	1.12	0.0086	0.0124	0.0210	41	118	3	3
	FR2	18-May-21	0.046	1.25	1.25	0.011	0.0222	0.0336	34	82	3	3
Lake St. Martin	BB-LSM	17-May-21	0.015	0.97	0.97	0.0066	0.0187	0.0252	26	85	1	1
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	0.026	1.28	1.28	0.009	0.0192	0.0284	33	99	2	2
	LSM1	19-May-21	0.074	1.34	1.34	0.0050	0.0215	0.0266	19	111	6	6
	LSM3	19-May-21	0.021	1.24	1.24	0.0080	0.0169	0.0249	32	110	2	2
Dauphin River	DR-A	19-May-21	0.069	1.58	1.58	0.0071	0.0334	0.0404	18	87	4	4
	DR-B	18-May-21	0.043	1.34	1.34	0.0104	0.0168	0.0272	38	109	3	3
	DR-E	19-May-21	0.069	1.69	1.69	0.0085	0.0268	0.0353	24	106	4	4
Big Buffalo Lake	BBL	16-May-21	0.158	1.26	1.26	0.0131	0.0242	0.0373	35	75	9	9
Buffalo Creek	BC3	16-May-21	0.056	0.95	0.95	0.0085	0.0381	0.0465	18	45	3	3
Lake Winnipeg	SB1	27-May-21	0.150	0.74	0.74	0.0070	0.0209	0.0279	25	59	12	12
	SB2	27-May-21	0.026	0.61	0.61	0.0062	0.0401	0.0462	13	29	1	1

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Carbon				Routine Chemistry				
			Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)	Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Biochemical Oxygen Demand (mg/L) [5]
Analytical DL			*0.50*	*0.50*	*0.50*	*1.0*	*0.10*	*1*	*4.0/20*	*0.2*	*2*
Lake Manitoba	WHB1	1-Sep-20	30.2	13.0	12.4	43.2	8.56	1050	624	237	-
	WHB2	1-Sep-20	37.1	13.0	12.4	50.1	8.57	1060	603	236	-
Watchorn Creek	WHC-WB	1-Sep-20	39.3	14.4	13.9	53.7	8.62	1010	583	248	<2.0
Mercer Creek	MC-WB	1-Sep-20	41.2	13.6	13.3	54.8	8.05	1090	632	256	<2.0
Birch Creek drain	BCD-2018-9	9-Sep-20	77.0	32.1	31.6	109	8.41	766	503	458	2.2
Birch Creek	BC-LSM	1-Sep-20	65.4	35.1	34.6	101	8.72	666	460	383	<2.0
Fairford River	FR1	1-Sep-20	37.5	13.1	12.7	50.6	8.56	1060	615	233	-
	FR2	10-Sep-20	36.8	13.0	12.3	49.8	8.43	1090	604	249	-
Lake St. Martin	BB-LSM	10-Sep-20	39.0	13.4	13.1	52.4	8.45	1050	586	238	-
	LSM5	2-Sep-20	36.6	13.4	12.9	50.1	8.54	1040	606	241	-
	LSM4	2-Sep-20	36.2	13.4	12.9	49.6	8.59	1030	582	249	-
	LSM1	2-Sep-20	34.4	13.3	13.1	47.6	8.54	1047	612	237	
	LSM3	2-Sep-20	38.9	18.5	16.8	57.4	8.58	852	534	234	-
Dauphin River	DR-A	2-Sep-20	35.1	13.8	13.6	48.8	8.66	1030	590	226	-
	DR-B	3-Sep-20	34.0	13.8	13.9	47.8	8.55	1040	612	234	-
	DR-E	3-Sep-20	36.5	13.8	13.4	50.3	8.50	1040	578	232	-
Big Buffalo Lake	BBL	1-Sep-20	58.0	27.5	27.6	85.5	8.63	565	382	279	3.4
Buffalo Creek	BC3	1-Sep-20	49.8	24.4	24.4	74.3	8.31	419	285	229	2.0
Lake Winnipeg	SB1	3-Sep-20	25.0	9.14	9.29	34.1	8.29	521	307	167	-
	SB2	3-Sep-20	22.9	7.47	7.43	30.4	8.26	384	230	144	-
Birch Creek drain	BCD-2018-9	13-Oct-20	70.4	30.4	28.6	101	8.49	937	642	519	-
Birch Creek	BC-LSM	13-Oct-20	74.4	30.6	31.0	105	8.54	936	618	508	-
Fairford River	FR1	13-Oct-20	34.4	12.4	11.9	46.8	8.33	1147	623	246	
	FR2	13-Oct-20	32.4	13.2	11.8	45.6	8.31	1140	588	240	-

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Carbon				Routine Chemistry				
			Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)	Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Biochemical Oxygen Demand (mg/L) [5]
Lake St. Martin	BB-LSM	13-Oct-20	35.4	13.1	12.5	48.5	8.38	1110	593	241	-
	LSM4	14-Oct-20	33.5	14.3	13.3	47.8	8.33	1130	633	251	-
	LSM1	14-Oct-20	33.8	14.6	13.4	48.3	8.36	1130	637	250	-
	LSM3	14-Oct-20	39.4	16.7	16.2	56.1	8.39	1010	580	266	-
Dauphin River	DR-A	14-Oct-20	33.0	14.0	13.4	47.0	8.34	1130	632	252	-
Lake Manitoba	WHB1	15-Mar-21	51.9	15.1	15.0	67.0	8.17	1490	852	342	-
	WHB2	15-Mar-21	54.6	16.2	15.9	70.8	8.21	1570	905	364	-
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	48.0	15.0	14.2	63.0	8.27	1410	788	331	-
	FR2	16-Mar-21	46.6	14.9	14.0	61.5	8.22	1390	759	324	-
Lake St. Martin	BB-LSM	16-Mar-21	55.4	15.8	15.5	71.2	8.27	1510	839	375	-
	LSM5	17-Mar-21	54.1	14.9	14.6	69.0	8.33	1480	841	349	-
	LSM4	17-Mar-21	52.5	16.2	15.4	68.7	8.32	1570	885	385	-
	LSM1	17-Mar-21	54.2	15.3	14.3	69.5	8.30	1460	824	348	-
	LSM3	17-Mar-21	103	24.8	23.4	128	8.17	2280	1320	597	-
Dauphin River	DR-A	17-Mar-21	56.2	15.3	15.0	71.4	8.33	1480	849	353	-
	DR-B	18-Mar-21	57.0	16.0	15.9	73.0	8.30	1533	833	347	
	DR-E	18-Mar-21	57.6	15.5	15.7	73.1	8.25	1520	854	347	-
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	31.3	9.31	9.26	40.6	8.27	530	297	173	
	SB2	18-Mar-21	30.8	9.0	9.05	39.9	8.24	520	290	171	-

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Carbon				Routine Chemistry				
			Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)	Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Biochemical Oxygen Demand (mg/L) [5]
Lake Manitoba	WHB1	17-May-21	36.3	12.5	12.7	48.8	8.38	1160	642	266	-
	WHB2	17-May-21	37.7	13.2	13.2	50.9	8.38	1170	637	270	-
Watchorn Creek	WHC-WB	17-May-21	40.7	14.6	13.8	55.3	8.35	1180	641	290	-
Mercer Creek	MC-WB	17-May-21	38.3	14.6	13.1	52.9	8.37	1190	649	274	-
Birch Creek drain	BCD-2018-9	17-May-21	59.0	22.2	22.0	81.2	8.30	685	434	400	-
Birch Creek	BC-LSM	17-May-21	64.3	20.8	20.3	85.1	8.49	680	421	413	-
Fairford River	FR1	18-May-21	35.9	13.4	13.8	49.3	8.39	1150	650	266	-
	FR2	18-May-21	36.5	14.7	13.3	51.2	8.40	1165	651	263	
Lake St. Martin	BB-LSM	17-May-21	29.7	10.5	9.9	40.1	8.32	863	465	205	-
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	36.8	14.5	14.0	51.3	8.37	1120	586	260	
	LSM1	19-May-21	38.0	14.8	14.7	52.8	8.38	1160	618	264	-
	LSM3	19-May-21	34.8	13.1	13.5	47.9	8.38	831	428	223	-
Dauphin River	DR-A	19-May-21	37.3	16.0	15.8	53.3	8.37	1170	628	274	-
	DR-B	18-May-21	39.2	15.4	15.6	54.6	8.42	1220	691	283	-
	DR-E	19-May-21	39.9	15.9	15.0	55.8	8.36	1230	644	288	-
Big Buffalo Lake	BBL	16-May-21	39.0	12.2	11.6	51.2	8.33	436	252	212	-
Buffalo Creek	BC3	16-May-21	38.4	15.7	15.2	54.0	8.28	398	253	207	-
Lake Winnipeg	SB1	27-May-21	26.2	8.27	8.0	34.5	8.20	502	288	168	-
	SB2	27-May-21	25.2	7.32	8.3	32.5	8.24	487	276	159	-

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Water Clarity			Algal Pigments	
			Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Analytical DL			*1.0*	*0.1*	*5.0*	*0.10*	*0.10*
Lake Manitoba	WHB1	1-Sep-20	22.4	17.8	<5.0	9.39	2.08
	WHB2	1-Sep-20	28.1	20.1	<5.0	8.56	1.96
Watchorn Creek	WHC-WB	1-Sep-20	14.0	10.5	14.2	6.55	2.44
Mercer Creek	MC-WB	1-Sep-20	7.9	5.73	17.5	6.98	4.73
Birch Creek drain	BCD-2018-9	9-Sep-20	12.9	3.13	113	7.95	5.68
Birch Creek	BC-LSM	1-Sep-20	3.5	2.17	117	3.30	3.22
Fairford River	FR1	1-Sep-20	18.6	13.8	7.0	7.54	1.95
	FR2	10-Sep-20	19.4	15.0	<5.0	6.41	1.43
Lake St. Martin	BB-LSM	10-Sep-20	13.7	7.76	5.7	9.94	1.88
	LSM5	2-Sep-20	13.0	6.59	<5.0	7.99	2.04
	LSM4	2-Sep-20	9.2	5.00	<5.0	6.91	1.70
	LSM1	2-Sep-20	17.3	11.5	5.8	7.79	2.10
	LSM3	2-Sep-20	15.3	10.8	16.8	7.49	2.16
Dauphin River	DR-A	2-Sep-20	12.3	7.53	9.2	10.5	2.80
	DR-B	3-Sep-20	15.4	10.1	7.8	9.17	2.32
	DR-E	3-Sep-20	18.7	13.8	14	9.92	3.04
Big Buffalo Lake	BBL	1-Sep-20	16.1	6.21	61.0	20.7	5.83
Buffalo Creek	BC3	1-Sep-20	3.5	9.94	60.7	1.14	1.33
Lake Winnipeg	SB1	3-Sep-20	20.8	22.0	13.2	2.58	2.52
	SB2	3-Sep-20	19.6	16.6	13.1	2.63	1.58
Birch Creek drain	BCD-2018-9	13-Oct-20	<1.0	0.83	106	3.13	2.32
Birch Creek	BC-LSM	13-Oct-20	1.5	1.62	109	3.97	2.36
Fairford River	FR1	13-Oct-20	43.0	32.4	6.6	10.9	2.53
	FR2	13-Oct-20	31.9	22.7	7.0	9.68	2.59

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Water Clarity			Algal Pigments	
			Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Lake St. Martin	BB-LSM	13-Oct-20	12.9	7.82	8.0	9.46	2.22
	LSM4	14-Oct-20	11.0	5.49	7.5	7.36	2.40
	LSM1	14-Oct-20	30.8	21.3	7.0	7.43	2.51
	LSM3	14-Oct-20	25.4	19.3	15.2	8.36	2.78
Dauphin River	DR-A	14-Oct-20	11.0	7.24	<5.0	6.29	1.77
Lake Manitoba	WHB1	15-Mar-21	1.1	0.77	<5.0	5.03	4.20
	WHB2	15-Mar-21	1.2	1.01	<5.0	6.80	5.04
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-
Fairford River	FR1	16-Mar-21	2.1	1.65	<5.0	2.38	1.25
	FR2	16-Mar-21	1.9	1.55	<5.0	2.22	1.33
Lake St. Martin	BB-LSM	16-Mar-21	<1.0	0.93	<5.0	3.48	1.39
	LSM5	17-Mar-21	1.2	0.77	<5.0	2.95	1.40
	LSM4	17-Mar-21	4.0	1.51	<5.0	2.76	2.17
	LSM1	17-Mar-21	11.0	3.76	<5.0	4.82	2.37
	LSM3	17-Mar-21	5.2	1.52	14.2	3.35	2.49
Dauphin River	DR-A	17-Mar-21	1.8	1.04	<5.0	1.64	1.59
	DR-B	18-Mar-21	1.9	1.30	<5.0	1.80	1.48
	DR-E	18-Mar-21	2.0	1.42	<5.0	1.94	1.51
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	1.1	4.71	7.6	9.50	2.62
	SB2	18-Mar-21	<1.0	4.26	7.2	3.47	1.27

Table 7 Continued.

Waterbody	Site ID	Sampling Date	Water Clarity			Algal Pigments	
			Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Lake Manitoba	WHB1	17-May-21	4.7	2.63	6.3	5.05	1.68
	WHB2	17-May-21	7.9	5.13	8.6	5.90	1.78
Watchorn Creek	WHC-WB	17-May-21	7.7	3.90	12.5	8.81	3.78
Mercer Creek	MC-WB	17-May-21	30.9	18.4	9.8	8.36	3.15
Birch Creek drain	BCD-2018-9	17-May-21	1.1	0.63	81.4	10.7	3.18
Birch Creek	BC-LSM	17-May-21	2.3	2.02	74.4	2.68	1.92
Fairford River	FR1	18-May-21	21.9	12.3	<5.0	7.25	3.00
	FR2	18-May-21	16.2	9.39	<5.0	8.95	4.14
Lake St. Martin	BB-LSM	17-May-21	5.7	4.40	7.5	5.09	1.50
	LSM5 [3]	May 2021	-	-	-	-	-
	LSM4	19-May-21	7.9	5.16	<5.0	10.2	5.82
	LSM1	19-May-21	16.5	13.0	<5.0	9.83	3.54
	LSM3	19-May-21	11.1	7.95	<5.0	15.4	5.80
Dauphin River	DR-A	19-May-21	29.2	22.4	6.1	23.4	9.31
	DR-B	18-May-21	20.7	15.0	<5.0	12.9	5.77
	DR-E	19-May-21	10.5	7.76	<5.0	14.2	4.84
Big Buffalo Lake	BBL	16-May-21	7.9	4.05	29.6	6.89	3.67
Buffalo Creek	BC3	16-May-21	11.3	17.1	42.4	2.36	2.09
Lake Winnipeg	SB1	27-May-21	10.0	13.6	13.0	2.16	1.33
	SB2	27-May-21	27.5	44.9	13.8	5.36	3.93

1 - No sample collected, site was frozen to the bottom or effective depth was too shallow to collect a sample.

2 - Site not sampled in May 2021 due to strong winds which made accessing the site unsafe.

3 - One of the replicates was considered suspect and was removed from the sample mean; see Section 3.1.2 and Appendix 2 for details.

4 - Calculated as the sum of total ammonia and nitrate/nitrite

5 - Samples for BOD were only collected during the September sampling period and only from selected sites.

Table 8. Laboratory results for metals and major ions measured at core sampling sites. All units are mg/L.

Waterbody	Site ID	Sampling Date	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	1-Sep-20	L2497954-1	0.0027	0.107	0.00017	0.00018	0.00222	0.00236	0.0414	0.0443
	WHB2	1-Sep-20	L2497954-2	0.0041	0.190	0.00016	0.00018	0.00217	0.00230	0.0409	0.0452
Watchorn Creek	WHC-WB	1-Sep-20	L2497954-3	0.0030	0.101	0.00015	0.00017	0.00198	0.00209	0.0387	0.0410
Mercer Creek	MC-WB	1-Sep-20	Mean	0.0040	0.0686	0.00018	0.00017	0.00213	0.00214	0.0452	0.0453
Birch Creek drain	BCD-2018-9	9-Sep-20	L2501445-3	<0.0010	0.108	<0.00010	<0.00010	0.00152	0.00157	0.0361	0.0402
Birch Creek	BC-LSM	1-Sep-20	L2497954-5	0.0639	0.0912	0.00011	0.00011	0.00271	0.00258	0.0330	0.0337
Fairford River	FR1	1-Sep-20	L2497954-6	0.0046	0.0982	0.00019	0.00019	0.00214	0.00222	0.0386	0.0415
	FR2	10-Sep-20	L2501445-2	0.0033	0.123	0.00017	0.00021	0.00228	0.00219	0.0406	0.0424
Lake St. Martin	BB-LSM	10-Sep-20	L2501445-1	0.0072	0.109	0.00022	0.00022	0.00245	0.00239	0.0413	0.0424
	LSM5	2-Sep-20	L2498786-4	0.0025	0.0358	0.00017	0.00018	0.00224	0.00226	0.0400	0.0407
	LSM4	2-Sep-20	L2498786-3	0.0019	0.0160	0.00016	0.00017	0.00224	0.00221	0.0367	0.0378
	LSM1	2-Sep-20	Mean	0.0041	0.0957	0.00016	0.00020	0.00230	0.00226	0.0379	0.0407
	LSM3	2-Sep-20	L2498786-2	0.0073	0.117	0.00014	0.00015	0.00225	0.00226	0.0328	0.0357
Dauphin River	DR-A	2-Sep-20	L2497954-7	0.0047	0.039	0.00017	0.00022	0.00219	0.00224	0.0338	0.0354
	DR-B	3-Sep-20	L2498784-1	0.0048	0.0757	0.00018	0.0002	0.00229	0.00234	0.0365	0.0384
	DR-E	3-Sep-20	L2498784-2	0.0058	0.215	0.00017	0.00018	0.00231	0.00233	0.0343	0.0394
Big Buffalo Lake	BBL	1-Sep-20	L2497371-1	0.0041	0.0706	0.00011	0.00012	0.00189	0.00179	0.0410	0.0408
Buffalo Creek	BC3	1-Sep-20	L2497371-2	0.0320	0.433	<0.00010	<0.00010	0.00155	0.0015	0.0230	0.0260
Lake Winnipeg	SB1	3-Sep-20	L2498784-3	0.0495	0.825	0.00011	0.00013	0.00205	0.00208	0.0361	0.0422
	SB2	3-Sep-20	L2498784-4	0.0432	0.700	0.0001	0.00012	0.00183	0.00186	0.0335	0.0413
Birch Creek drain	BCD-2018-9	13-Oct-20	L2516048-1	0.0028	0.0281	<0.00010	<0.00010	0.00110	0.00101	0.0481	0.0465
Birch Creek	BC-LSM	13-Oct-20	L2516048-2	0.0045	0.0449	<0.00010	<0.00010	0.00126	0.00123	0.0561	0.0517
Fairford River	FR1	13-Oct-20	Mean	0.0128	0.215	0.00019	0.00020	0.00206	0.00217	0.0447	0.0475
	FR2	13-Oct-20	L2516048-5	0.0102	0.163	0.00019	0.00019	0.00210	0.00216	0.0439	0.0448

Table 8. Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	L2516048-3	0.0082	0.0813	0.00021	0.00023	0.00216	0.00218	0.0439	0.0438
	LSM4	14-Oct-20	L2516868-3	0.0024	0.0333	0.00018	0.0002	0.00202	0.00221	0.0380	0.0415
	LSM1	14-Oct-20	L2516868-1	0.0030	0.178	0.00018	0.00019	0.00203	0.00220	0.0385	0.0448
	LSM3	14-Oct-20	L2516868-2	0.0078	0.224	0.00015	0.00018	0.00183	0.00194	0.0355	0.0418
Dauphin River	DR-A	14-Oct-20	L2516868-4	0.0032	0.046	0.00019	0.00019	0.00195	0.00209	0.0368	0.0404
Lake Manitoba	WHB1	15-Mar-21	L2567238-1	0.0014	0.0053	0.00024	0.00023	0.00282	0.00264	0.0562	0.0571
	WHB2	15-Mar-21	L2567238-2	0.0019	0.0086	0.0006	0.00100	0.00314	0.00290	0.0587	0.0593
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	L2567806-2	0.0024	0.0218	0.00020	0.00023	0.00254	0.00233	0.0512	0.0512
	FR2	16-Mar-21	L2567806-3	0.0016	0.0141	0.00020	0.00021	0.00255	0.00234	0.0507	0.0509
Lake St. Martin	BB-LSM	16-Mar-21	L2567806-1	0.0012	0.0091	0.00023	0.00025	0.00285	0.00254	0.0574	0.0570
	LSM5	17-Mar-21	L2568173-5	<0.0010	0.006	0.00023	0.00025	0.00261	0.00246	0.0531	0.0552
	LSM4	17-Mar-21	L2568173-1	0.0012	0.0118	0.00025	0.00027	0.00282	0.00253	0.0584	0.0590
	LSM1	17-Mar-21	L2568173-2	0.0017	0.0563	0.00023	0.00028	0.00266	0.00242	0.0538	0.0564
	LSM3	17-Mar-21	L2568173-3	<0.0010	0.0270	0.00040	0.00066	0.00402	0.00327	0.0848	0.0836
Dauphin River	DR-A	17-Mar-21	L2568173-4	0.0015	0.0086	0.00032	0.00044	0.00269	0.00244	0.0546	0.0563
	DR-B	18-Mar-21	Mean	0.0013	0.0118	0.00024	0.00027	0.00247	0.00243	0.0575	0.0574
	DR-E	18-Mar-21	L2568772-2	0.0023	0.0144	0.00031	0.00061	0.00256	0.00246	0.0566	0.0573
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	Mean	0.0362	0.217	0.00018	0.00042	0.00186	0.00188	0.0423	0.0442
Lake Winnipeg	SB2	18-Mar-21	L2568772-4	0.0329	0.240	0.00019	0.00025	0.00188	0.00186	0.0413	0.0434

Table 8. Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	L2588908-1	0.0012	0.0185	0.00017	0.00019	0.00192	0.00194	0.0440	0.0440
	WHB2	17-May-21	L2588908-2	0.0015	0.0479	0.00018	0.00020	0.00207	0.00202	0.0458	0.0451
Watchorn Creek	WHC-WB	17-May-21	L2588908-3	<0.0010	0.0516	0.00018	<0.00010	0.00206	0.00205	0.0447	0.0446
Mercer Creek	MC-WB	17-May-21	L2588908-4	0.0026	0.150	0.00021	0.00022	0.00209	0.00209	0.0456	0.0483
Birch Creek drain	BCD-2018-9	17-May-21	L2588908-5	<0.0010	0.0246	<0.00010	0.00011	0.00081	0.00082	0.0336	0.0343
Birch Creek	BC-LSM	17-May-21	L2588908-6	0.0022	0.0668	<0.00010	<0.00010	0.00105	0.00105	0.0334	0.0339
Fairford River	FR1	18-May-21	L2590207-1	0.0019	0.121	0.00017	0.00019	0.00196	0.00185	0.0409	0.0422
	FR2	18-May-21	Mean (n=2) [2]	0.0024	0.157	0.00017	0.00020	0.00193	0.0020	0.0413	0.045
Lake St. Martin	BB-LSM	17-May-21	L2588908-7	0.0031	0.0601	0.00013	0.00014	0.00135	0.00138	0.0329	0.0337
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	Mean	0.0032	0.062	0.0002	0.0002	0.00207	0.0020	0.0426	0.045
	LSM1	19-May-21	L2590206-2	0.0049	0.115	0.00021	0.00020	0.00211	0.00210	0.0431	0.0471
	LSM3	19-May-21	L2590206-3	0.0044	0.0976	0.00012	0.00015	0.00149	0.00149	0.0342	0.0365
Dauphin River	DR-A	19-May-21	L2590206-4	0.0065	0.216	0.00020	0.00023	0.00220	0.00217	0.0458	0.0501
	DR-B	18-May-21	L2590207-3	0.0040	0.171	0.00019	0.00022	0.00210	0.00210	0.0444	0.0476
	DR-E	19-May-21	L2590206-5	0.0036	0.109	0.00019	0.00023	0.00234	0.00329	0.0460	0.0485
Big Buffalo Lake	BBL	16-May-21	L2588908-8	0.0013	0.0408	<0.00010	<0.00010	0.00083	0.00085	0.0272	0.0273
Buffalo Creek	BC3	16-May-21	L2588908-9	0.0195	0.590	<0.00010	<0.00010	0.00096	0.00119	0.0230	0.0277
Lake Winnipeg	SB1	27-May-21	L2593508-1	0.0225	0.484	0.00014	0.00012	0.00148	0.00156	0.0331	0.0376
	SB2	27-May-21	L2593508-2	0.0416	1.57	0.00013	0.00012	0.00131	0.00159	0.0327	0.0468

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake Manitoba	WHB1	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.096	0.086	<0.0000050	0.0000089
	WHB2	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.096	0.086	<0.0000050	<0.0000050
Watchorn Creek	WHC-WB	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.093	0.081	<0.0000050	<0.0000050
Mercer Creek	MC-WB	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.092	0.083	<0.0000050	<0.0000050
Birch Creek drain	BCD-2018-9	9-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.132	0.150	<0.0000050	0.0000073
Birch Creek	BC-LSM	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.146	0.129	<0.0000050	<0.0000050
Fairford River	FR1	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.095	0.083	<0.0000050	<0.0000050
	FR2	10-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.109	0.122	<0.0000050	0.0000070
Lake St. Martin	BB-LSM	10-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.110	0.118	<0.0000050	<0.0000050
	LSM5	2-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.098	0.091	<0.0000050	<0.0000050
	LSM4	2-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.094	0.090	<0.0000050	<0.0000050
	LSM1	2-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.092	0.088	<0.0000050	<0.0000050
	LSM3	2-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.072	0.076	<0.0000050	<0.0000050
Dauphin River	DR-A	2-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.091	0.079	<0.0000050	<0.0000050
	DR-B	3-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.087	0.090	<0.0000050	<0.0000050
	DR-E	3-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.092	0.089	<0.0000050	0.0000059
Big Buffalo Lake	BBL	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.094	0.098	0.0000105	0.0000205
Buffalo Creek	BC3	1-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.043	0.043	<0.0000050	<0.0000050
Lake Winnipeg	SB1	3-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.048	0.046	<0.0000050	0.0000053
	SB2	3-Sep-20	<0.00010	<0.00010	<0.000050	<0.000050	0.034	0.034	<0.0000050	0.0000056
Birch Creek drain	BCD-2018-9	13-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.090	0.108	<0.0000050	<0.0000050
Birch Creek	BC-LSM	13-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.114	<0.0000050	<0.0000050
Fairford River	FR1	13-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.111	<0.0000050	0.00000843
	FR2	13-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.115	0.108	<0.0000050	0.0000054

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake St. Martin	BB-LSM	13-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.106	0.104	<0.0000050	<0.0000050
	LSM4	14-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.093	0.104	<0.0000050	<0.0000050
	LSM1	14-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.090	0.101	<0.0000050	0.0000057
	LSM3	14-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.076	0.085	<0.0000050	0.0000073
Dauphin River	DR-A	14-Oct-20	<0.00010	<0.00010	<0.000050	<0.000050	0.089	0.102	<0.0000050	<0.0000050
Lake Manitoba	WHB1	15-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.143	0.135	0.000046	0.000111
	WHB2	15-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.153	0.149	0.000022	0.000039
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.148	0.124	<0.0000050	<0.0000050
	FR2	16-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.137	0.122	<0.0000050	<0.0000050
Lake St. Martin	BB-LSM	16-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.164	0.130	0.0000085	0.0000145
	LSM5	17-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.164	0.133	0.0000109	0.0000168
	LSM4	17-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.170	0.138	<0.0000050	<0.0000050
	LSM1	17-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.155	0.129	<0.0000050	0.0000174
	LSM3	17-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.234	0.176	<0.0000050	0.0000102
Dauphin River	DR-A	17-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.165	0.133	<0.0000050	0.0000068
	DR-B	18-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.149	0.144	<0.0000050	<0.0000050
	DR-E	18-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.135	0.141	0.0000064	0.0000085
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.046	0.047	<0.0000050	0.0000057
Lake Winnipeg	SB2	18-Mar-21	<0.00010	<0.00010	<0.000050	<0.000050	0.046	0.049	0.0000051	0.0000057

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake Manitoba	WHB1	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.114	0.105	<0.0000050	0.0000051
	WHB2	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.116	0.105	<0.0000050	0.0000054
Watchorn Creek	WHC-WB	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.120	0.111	<0.0000050	0.0000082
Mercer Creek	MC-WB	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.117	0.108	<0.0000050	0.0000105
Birch Creek drain	BCD-2018-9	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.095	0.083	<0.0000050	0.0000083
Birch Creek	BC-LSM	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.099	0.080	<0.0000050	0.0000050
Fairford River	FR1	18-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.106	<0.0000050	<0.0000050
	FR2	18-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.110	0.112	<0.0000050	0.0000068
Lake St. Martin	BB-LSM	17-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.083	0.077	<0.0000050	0.0000052
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.099	<0.0000050	<0.0000050
	LSM1	19-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.109	0.104	<0.0000050	<0.0000050
	LSM3	19-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.070	0.067	<0.0000050	0.0000061
Dauphin River	DR-A	19-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.113	0.104	<0.0000050	0.0000073
	DR-B	18-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.118	0.121	<0.0000050	0.0000070
	DR-E	19-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.121	0.108	<0.0000050	0.0000060
Big Buffalo Lake	BBL	16-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.066	0.057	<0.0000050	0.0000052
Buffalo Creek	BC3	16-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.053	0.043	<0.0000050	0.0000054
Lake Winnipeg	SB1	27-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.047	0.045	<0.0000050	0.0000058
	SB2	27-May-21	<0.00010	<0.00010	<0.000050	<0.000050	0.042	0.043	<0.0000050	0.0000089

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical DL			*0.05*	*0.050*	*0.000010*	*0.000010*	*0.10/0.20*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	1-Sep-20	34.2	38.3	<0.000010	0.000014	206	<0.00010	0.00026	<0.00010	0.00011
	WHB2	1-Sep-20	34.6	38.8	<0.000010	0.000033	203	<0.00010	0.00041	<0.00010	0.00015
Watchorn Creek	WHC-WB	1-Sep-20	33.9	35.3	<0.000010	0.000014	185	<0.00010	0.00022	<0.00010	0.00011
Mercer Creek	MC-WB	1-Sep-20	39.0	39.5	<0.000010	<0.000010	200	<0.00010	0.00018	<0.00010	<0.00010
Birch Creek drain	BCD-2018-9	9-Sep-20	62.0	63.7	<0.000010	0.000014	11.8	<0.00010	0.00058	<0.00010	0.00017
Birch Creek	BC-LSM	1-Sep-20	35.0	35.9	<0.000010	<0.000010	15.4	0.00017	0.00025	0.00023	0.00025
Fairford River	FR1	1-Sep-20	33.4	35.1	<0.000010	<0.000010	200	<0.00010	0.00022	<0.00010	0.00010
	FR2	10-Sep-20	37.4	39.0	<0.000010	0.000035	205	<0.00010	0.00030	<0.00010	0.00014
Lake St. Martin	BB-LSM	10-Sep-20	35.2	38.8	<0.000010	0.000017	198	<0.00010	0.00024	<0.00010	0.00014
	LSM5	2-Sep-20	35.5	35.7	<0.000010	<0.000010	198	<0.00010	0.00014	<0.00010	<0.00010
	LSM4	2-Sep-20	34.9	36.1	<0.000010	<0.000010	198	<0.00010	<0.00010	<0.00010	<0.00010
	LSM1	2-Sep-20	33.8	35.7	<0.000010	0.000017	199	<0.00010	0.00023	<0.00010	0.00011
	LSM3	2-Sep-20	34.5	37.8	<0.000010	0.000011	140	<0.00010	0.00018	<0.00010	0.00013
Dauphin River	DR-A	2-Sep-20	32.1	32.1	<0.000010	<0.000010	203	<0.00010	0.00010	<0.00010	<0.00010
	DR-B	3-Sep-20	33.1	35.8	<0.000010	0.000013	198	<0.00010	0.00020	<0.00010	0.00012
	DR-E	3-Sep-20	32.0	34.5	<0.000010	0.000036	197	<0.00010	0.00039	<0.00010	0.00017
Big Buffalo Lake	BBL	1-Sep-20	49.9	51.9	<0.000010	<0.000010	20.4	<0.00010	0.00013	<0.00010	0.00010
Buffalo Creek	BC3	1-Sep-20	43.6	45.7	<0.000010	0.000040	4.9	<0.00010	0.00175	<0.00010	0.00022
Lake Winnipeg	SB1	3-Sep-20	30.3	30.4	<0.000010	0.00009	66.2	<0.00010	0.00132	<0.00010	0.00038
	SB2	3-Sep-20	27.8	29.2	<0.000010	0.000081	31.6	<0.00010	0.00117	<0.00010	0.00035
Birch Creek drain	BCD-2018-9	13-Oct-20	76.7	71.8	<0.000010	<0.000010	20.5	<0.00010	0.00012	<0.00010	<0.00010
Birch Creek	BC-LSM	13-Oct-20	75.7	72.0	<0.000010	<0.000010	23.4	<0.00010	0.00014	<0.00010	<0.00010
Fairford River	FR1	13-Oct-20	42.7	44.9	<0.000010	0.000031	206	<0.00010	0.00049	<0.00010	0.00018
	FR2	13-Oct-20	41.9	42.3	<0.000010	0.000023	206	<0.00010	0.00036	<0.00010	0.00015

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	41.5	39.0	<0.000010	0.000012	199	<0.00010	0.00020	<0.00010	0.00011
	LSM4	14-Oct-20	37.2	39.1	<0.000010	<0.000010	202	<0.00010	<0.00010	<0.00010	<0.00010
	LSM1	14-Oct-20	37.7	42.5	<0.000010	0.000031	204	<0.00010	0.00046	<0.00010	0.00017
	LSM3	14-Oct-20	41.9	45.7	<0.000010	0.000034	163	<0.00010	0.00047	<0.00010	0.00018
Dauphin River	DR-A	14-Oct-20	37.6	39.8	<0.000010	<0.000010	202	<0.00010	0.00014	<0.00010	<0.00010
Lake Manitoba	WHB1	15-Mar-21	53.1	56.9	<0.000010	<0.000010	256	<0.00010	<0.00010	<0.00010	<0.00010
	WHB2	15-Mar-21	56.8	60.8	<0.000010	<0.000010	268	<0.00010	<0.00010	<0.00010	<0.00010
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	50.6	49.6	<0.000010	<0.000010	239	<0.00010	<0.00010	<0.00010	<0.00010
	FR2	16-Mar-21	47.9	49.7	<0.000010	<0.000010	237	<0.00010	<0.00010	<0.00010	<0.00010
Lake St. Martin	BB-LSM	16-Mar-21	59.6	55.2	<0.000010	<0.000010	266	<0.00010	<0.00010	<0.00010	<0.00010
	LSM5	17-Mar-21	54.4	54.7	<0.000010	<0.000010	261	<0.00010	<0.00010	<0.00010	<0.00010
	LSM4	17-Mar-21	61.8	58.8	<0.000010	<0.000010	270	<0.00010	0.00010	<0.00010	<0.00010
	LSM1	17-Mar-21	54.7	54.7	<0.000010	0.000012	251	<0.00010	0.00022	<0.00010	<0.00010
	LSM3	17-Mar-21	96.0	92.5	<0.000010	<0.000010	393	<0.00010	0.00014	0.00010	0.00012
Dauphin River	DR-A	17-Mar-21	56.0	55.9	<0.000010	<0.000010	257	<0.00010	<0.00010	<0.00010	<0.00010
	DR-B	18-Mar-21	55.8	57.0	<0.000010	<0.000010	266	<0.00010	<0.00010	<0.00010	<0.00010
	DR-E	18-Mar-21	54.2	54.9	<0.000010	<0.000010	261	<0.00010	<0.00010	<0.00010	<0.00010
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	33.5	35.7	<0.000010	0.000013	49.6	<0.00010	0.00025	<0.00010	<0.00010
Lake Winnipeg	SB2	18-Mar-21	33.4	34.9	<0.000010	0.000014	50.3	<0.00010	0.00025	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	40.7	40.7	<0.000010	<0.000010	202	<0.00010	<0.00010	<0.00010	<0.00010
	WHB2	17-May-21	41.1	41.1	<0.000010	0.000011	204	<0.00010	0.00013	<0.00010	<0.00010
Watchorn Creek	WHC-WB	17-May-21	44.0	44.9	<0.000010	0.000011	194	<0.00010	0.00015	<0.00010	0.00010
Mercer Creek	MC-WB	17-May-21	41.5	45.4	<0.000010	0.000024	204	<0.00010	0.00036	<0.00010	0.00015
Birch Creek drain	BCD-2018-9	17-May-21	52.9	54.8	<0.000010	<0.000010	10.7	<0.00010	0.00017	<0.00010	<0.00010
Birch Creek	BC-LSM	17-May-21	60.2	58.0	<0.000010	<0.000010	7.82	<0.00010	0.00022	<0.00010	0.00013
Fairford River	FR1	18-May-21	42.6	42.4	<0.000010	0.000015	215	<0.00010	0.00031	<0.00010	0.00011
	FR2	18-May-21	41.4	44.7	<0.000010	0.000024	218	<0.00010	0.00039	<0.00010	0.00015
Lake St. Martin	BB-LSM	17-May-21	31.9	32.6	<0.000010	0.000010	147	<0.00010	0.00013	<0.00010	<0.00010
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	40.9	40.1	<0.000010	<0.000010	197	<0.00010	0.00014	<0.00010	<0.00010
	LSM1	19-May-21	41.2	43.6	<0.000010	0.000017	207	<0.00010	0.00027	<0.00010	0.00012
	LSM3	19-May-21	36.7	37.8	<0.000010	0.000013	126	<0.00010	0.00016	<0.00010	<0.00010
Dauphin River	DR-A	19-May-21	41.3	43.0	<0.000010	0.000031	208	<0.00010	0.00042	<0.00010	0.00017
	DR-B	18-May-21	42.4	46.2	<0.000010	0.000024	222	<0.00010	0.00036	<0.00010	0.00013
	DR-E	19-May-21	44.1	42.0	<0.000010	0.000017	221	<0.00010	0.00152	<0.00010	0.00012
Big Buffalo Lake	BBL	16-May-21	36.5	35.3	<0.000010	<0.000010	12.3	<0.00010	<0.00010	<0.00010	<0.00010
Buffalo Creek	BC3	16-May-21	38.2	37.7	<0.000010	0.000070	8.03	<0.00010	0.00131	<0.00010	0.00031
Lake Winnipeg	SB1	27-May-21	32.7	33.1	<0.000010	0.000056	54.5	<0.00010	0.00084	<0.00010	0.00024
	SB2	27-May-21	30.9	32.4	<0.000010	0.000180	49.4	<0.00010	0.00266	<0.00010	0.00075

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.020*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake Manitoba	WHB1	1-Sep-20	0.00024	0.00050	0.152	<0.010	0.104	<0.000050	0.000205	0.0337	0.0310
	WHB2	1-Sep-20	0.00024	0.00055	0.157	<0.010	0.176	<0.000050	0.000262	0.0345	0.0315
Watchorn Creek	WHC-WB	1-Sep-20	0.00026	<0.00050	0.156	<0.010	0.090	<0.000050	0.000196	0.0348	0.0307
Mercer Creek	MC-WB	1-Sep-20	<0.00020	<0.00050	0.154	<0.010	0.062	<0.000050	0.000093	0.0333	0.0310
Birch Creek drain	BCD-2018-9	9-Sep-20	0.00023	0.00055	0.339	0.021	0.249	<0.000050	0.000152	0.0241	0.0266
Birch Creek	BC-LSM	1-Sep-20	0.00039	0.00054	0.271	0.028	0.055	<0.000050	<0.000050	0.0222	0.0194
Fairford River	FR1	1-Sep-20	0.00028	<0.00050	0.137	<0.010	0.072	<0.000050	0.000175	0.0334	0.0308
	FR2	10-Sep-20	0.00030	0.00054	0.161	<0.010	0.134	<0.000050	0.000268	0.0372	0.0399
Lake St. Martin	BB-LSM	10-Sep-20	0.00030	0.00053	0.164	<0.010	0.106	<0.000050	0.000341	0.0320	0.0362
	LSM5	2-Sep-20	0.00024	<0.00050	0.155	<0.010	0.031	<0.000050	0.000143	0.0348	0.0317
	LSM4	2-Sep-20	0.00023	<0.00050	0.152	<0.010	0.016	<0.000050	0.000107	0.0316	0.0319
	LSM1	2-Sep-20	0.00026	<0.00050	0.158	<0.010	0.082	<0.000050	0.000207	0.0336	0.0322
	LSM3	2-Sep-20	0.00033	0.00064	0.155	<0.010	0.083	<0.000050	0.000239	0.0243	0.0247
Dauphin River	DR-A	2-Sep-20	0.00023	<0.00050	0.154	<0.010	0.033	<0.000050	0.000154	0.0314	0.0284
	DR-B	3-Sep-20	0.00028	0.00137	0.157	<0.010	0.079	<0.000050	0.000202	0.0310	0.0329
	DR-E	3-Sep-20	0.00027	0.00052	0.155	<0.010	0.187	<0.000050	0.000306	0.0316	0.0319
Big Buffalo Lake	BBL	1-Sep-20	0.00034	<0.00050	0.164	<0.010	0.066	<0.000050	0.000093	0.0148	0.0159
Buffalo Creek	BC3	1-Sep-20	0.00064	0.00090	0.117	0.033	0.384	<0.000050	0.000175	0.0088	0.0097
Lake Winnipeg	SB1	3-Sep-20	0.00105	0.00209	0.116	<0.010	0.747	<0.000050	0.000450	0.0177	0.0171
	SB2	3-Sep-20	0.00117	0.00185	0.102	<0.010	0.678	<0.000050	0.000346	0.0135	0.0138
Birch Creek drain	BCD-2018-9	13-Oct-20	<0.00020	<0.00050	0.265	0.024	0.041	<0.000050	0.000076	0.0287	0.0304
Birch Creek	BC-LSM	13-Oct-20	0.00065	0.00077	0.285	0.026	0.048	<0.000050	<0.000050	0.0320	0.0298
Fairford River	FR1	13-Oct-20	0.00032	0.00069	0.133	<0.010	0.238	<0.000050	0.000356	0.0387	0.0370
	FR2	13-Oct-20	0.00027	0.00059	0.161	<0.010	0.182	<0.000050	0.000289	0.0391	0.0363

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.020*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake St. Martin	BB-LSM	13-Oct-20	0.00031	<0.00050	0.161	<0.010	0.069	<0.000050	0.000256	0.0355	0.0330
	LSM4	14-Oct-20	0.00026	<0.00050	-	<0.010	0.032	<0.000050	0.000149	0.0309	0.0323
	LSM1	14-Oct-20	0.00032	0.00066	-	<0.010	0.206	<0.000050	0.000297	0.0316	0.0321
	LSM3	14-Oct-20	0.00044	0.00072	-	<0.010	0.236	<0.000050	0.000338	0.0270	0.0278
Dauphin River	DR-A	14-Oct-20	0.00029	<0.00050	-	<0.010	0.043	<0.000050	0.000145	0.0309	0.0326
Lake Manitoba	WHB1	15-Mar-21	0.00072	0.00098	0.190	<0.010	<0.010	<0.000050	<0.000050	0.0448	0.0458
	WHB2	15-Mar-21	0.00069	0.00090	0.208	<0.010	0.011	<0.000050	0.000053	0.0492	0.0494
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	0.00045	0.00053	0.189	<0.010	0.025	<0.000050	0.000057	0.0408	0.0412
	FR2	16-Mar-21	0.00037	<0.00050	0.186	<0.010	0.015	<0.000050	0.000057	0.0390	0.0405
Lake St. Martin	BB-LSM	16-Mar-21	0.00050	0.00059	0.206	<0.010	0.014	<0.000050	<0.000050	0.0475	0.0436
	LSM5	17-Mar-21	0.00057	0.00054	0.206	<0.010	<0.010	<0.000050	<0.000050	0.0460	0.0481
	LSM4	17-Mar-21	0.00038	<0.00050	0.216	<0.010	0.013	<0.000050	0.000053	0.0509	0.0509
	LSM1	17-Mar-21	0.00063	0.00094	0.202	<0.010	0.069	<0.000050	0.000114	0.0431	0.0445
	LSM3	17-Mar-21	0.00059	0.00089	0.286	0.013	0.068	<0.000050	0.000071	0.0632	0.0695
Dauphin River	DR-A	17-Mar-21	0.00040	0.00052	0.201	<0.010	<0.010	<0.000050	<0.000050	0.0442	0.0461
	DR-B	18-Mar-21	0.00037	0.00054	0.218	<0.010	0.013	<0.000050	<0.000050	0.0468	0.0495
	DR-E	18-Mar-21	0.00048	0.00067	0.218	<0.010	0.017	<0.000050	0.000060	0.0452	0.0487
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	0.00147	0.00183	0.131	<0.010	0.099	<0.000050	0.000084	0.0160	0.0175
Lake Winnipeg	SB2	18-Mar-21	0.00166	0.00189	0.130	<0.010	0.106	<0.000050	0.000080	0.0162	0.0175

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.020*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake Manitoba	WHB1	17-May-21	0.00033	0.00051	0.149	<0.010	0.022	<0.000050	0.000058	0.0355	0.0351
	WHB2	17-May-21	0.00034	0.00053	0.151	<0.010	0.052	<0.000050	0.000079	0.0349	0.0348
Watchorn Creek	WHC-WB	17-May-21	0.00035	0.00060	0.164	<0.010	0.056	<0.000050	0.000097	0.0368	0.0368
Mercer Creek	MC-WB	17-May-21	0.00087	0.00094	0.157	<0.010	0.172	<0.000050	0.000197	0.0353	0.0366
Birch Creek drain	BCD-2018-9	17-May-21	0.00025	0.00089	0.244	0.015	0.046	<0.000050	0.000074	0.0176	0.0201
Birch Creek	BC-LSM	17-May-21	0.00070	0.00093	0.268	0.022	0.083	<0.000050	0.000063	0.0169	0.0177
Fairford River	FR1	18-May-21	0.00040	0.00064	0.156	<0.010	0.133	<0.000050	0.000107	0.0352	0.0374
	FR2	18-May-21	0.00044	0.00077	0.158	<0.010	0.187	<0.000050	0.000184	0.0364	0.038
Lake St. Martin	BB-LSM	17-May-21	0.00032	0.00052	0.127	<0.010	0.058	<0.000050	0.000114	0.0238	0.0253
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-	-
	LSM4	19-May-21	0.00048	<0.00050	0.164	<0.010	0.045	<0.000050	0.000117	0.0338	0.0330
	LSM1	19-May-21	0.00039	0.00063	0.160	<0.010	0.108	<0.000050	0.000175	0.0352	0.0355
	LSM3	19-May-21	0.00039	0.00050	0.138	<0.010	0.073	<0.000050	0.000113	0.0225	0.0222
Dauphin River	DR-A	19-May-21	0.00041	0.00077	0.169	<0.010	0.205	<0.000050	0.000261	0.0379	0.0343
	DR-B	18-May-21	0.00042	0.00073	0.170	<0.010	0.167	<0.000050	0.000169	0.0383	0.0413
	DR-E	19-May-21	0.00053	0.00096	0.169	<0.010	0.118	<0.000050	0.000154	0.0392	0.0365
Big Buffalo Lake	BBL	16-May-21	0.00021	<0.00050	0.125	<0.010	0.039	<0.000050	0.000081	0.0108	0.0116
Buffalo Creek	BC3	16-May-21	0.00080	0.00135	0.121	0.012	0.568	<0.000050	0.000282	0.0094	0.0105
Lake Winnipeg	SB1	27-May-21	0.00105	0.00175	0.108	<0.010	0.450	<0.000050	0.000243	0.0146	0.0168
	SB2	27-May-21	0.00115	0.00301	0.073	<0.010	1.51	<0.000050	0.000728	0.0138	0.0178

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.0050*	*0.0050*	*0.00010*	*0.00010*	*0.0000050/ 0.00000050*	*0.0000020/ 0.0000050/ 0.00000050*	*0.000050*	*0.000050*
Lake Manitoba	WHB1	1-Sep-20	36.7	36.9	<0.00010	0.00839	<0.00000050	0.00000072	0.00212	0.00221
	WHB2	1-Sep-20	36.3	38.0	<0.00010	0.00947	<0.00000050	0.00000074	0.00221	0.00227
Watchorn Creek	WHC-WB	1-Sep-20	39.6	38.8	0.00017	0.00707	<0.00000050	0.00000061	0.00193	0.00199
Mercer Creek	MC-WB	1-Sep-20	38.5	38.9	0.00016	0.00751	<0.00000050	0.00000060	0.00217	0.00219
Birch Creek drain	BCD-2018-9	9-Sep-20	73.7	76.6	0.00046	0.264	0.00000097	0.00000166	0.000291	0.000383
Birch Creek	BC-LSM	1-Sep-20	71.8	70.5	0.00450	0.0262	<0.00000050	0.00000079	0.000530	0.00056
Fairford River	FR1	1-Sep-20	36.3	36.1	<0.00010	0.00735	<0.00000050	0.00000123	0.00204	0.00204
	FR2	10-Sep-20	37.8	39.2	<0.00010	0.0102	<0.00000050	0.00000084	0.00225	0.00229
Lake St. Martin	BB-LSM	10-Sep-20	36.4	36.7	<0.00010	0.0106	<0.00000050	0.00000077	0.00245	0.00239
	LSM5	2-Sep-20	37.1	35.5	<0.00010	0.00614	<0.00000050	0.00000066	0.00226	0.00228
	LSM4	2-Sep-20	39.2	35.0	<0.00010	0.00526	<0.00000050	0.00000057	0.00212	0.00221
	LSM1	2-Sep-20	37.1	35.8	<0.00010	0.00913	<0.00000050	0.00000080	0.00232	0.00232
	LSM3	2-Sep-20	35.9	36.4	0.00013	0.0115	<0.00000050	0.00000112	0.00184	0.00188
Dauphin River	DR-A	2-Sep-20	35.5	34.1	<0.00010	0.00797	<0.00000050	0.00000056	0.00212	0.00228
	DR-B	3-Sep-20	36.7	34.3	<0.00010	0.00939	<0.00000050	0.00000087	0.00228	0.00232
	DR-E	3-Sep-20	37.0	36.0	<0.00010	0.0133	<0.00000050	0.00000095	0.00219	0.00230
Big Buffalo Lake	BBL	1-Sep-20	37.4	38.5	0.00032	0.0154	<0.0000050	<0.0000050	0.000491	0.000512
Buffalo Creek	BC3	1-Sep-20	29.0	28.9	0.00162	0.0231	<0.0000050	<0.0000050	0.000305	0.000308
Lake Winnipeg	SB1	3-Sep-20	22.2	21.2	0.00015	0.0191	<0.00000050	0.00000105	0.00114	0.00115
	SB2	3-Sep-20	18.1	17.4	<0.00010	0.0153	<0.00000050	0.00000102	0.000881	0.000857
Birch Creek drain	BCD-2018-9	13-Oct-20	79.5	87.5	0.00449	0.00943	0.00000051	0.00000073	0.000501	0.000565
Birch Creek	BC-LSM	13-Oct-20	77.6	88.1	0.00198	0.0054	0.00000084	0.00000067	0.000671	0.000656
Fairford River	FR1	13-Oct-20	33.8	40.1	<0.00010	0.01593	<0.00000050	0.00000112	0.00224	0.00238
	FR2	13-Oct-20	32.8	39.1	0.00014	0.0121	<0.00000050	0.00000111	0.00228	0.00232

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	33.4	37.2	0.00016	0.00765	<0.00000050	0.00000061	0.00251	0.00252
	LSM4	14-Oct-20	38.3	38.5	<0.00010	0.00493	<0.00000050	<0.00000050	0.00219	0.00226
	LSM1	14-Oct-20	37.8	38.9	<0.00010	0.0114	<0.00000050	0.00000118	0.00227	0.00225
	LSM3	14-Oct-20	39.2	39.5	0.00010	0.0140	<0.00000050	0.00000110	0.00211	0.00224
Dauphin River	DR-A	14-Oct-20	38.4	38.8	<0.00010	0.00513	<0.00000050	0.00000055	0.00222	0.00233
Lake Manitoba	WHB1	15-Mar-21	50.9	48.8	<0.00010	0.00215	<0.00000050	0.00000053	0.00285	0.00293
	WHB2	15-Mar-21	54.0	51.9	0.00010	0.00178	0.00000076	0.00000147	0.00320	0.00314
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	49.8	46.4	<0.00010	0.00283	<0.00000050	<0.00000050	0.00275	0.00268
	FR2	16-Mar-21	49.6	46.7	0.00012	0.00323	<0.00000050	<0.00000050	0.00265	0.00273
Lake St. Martin	BB-LSM	16-Mar-21	54.8	51.5	<0.00010	0.00381	<0.00000050	0.00000070	0.00305	0.00307
	LSM5	17-Mar-21	51.9	50.8	<0.00010	0.00552	<0.00000050	<0.00000050	0.00292	0.00298
	LSM4	17-Mar-21	56.0	54.1	<0.00010	0.00650	<0.00000050	<0.00000050	0.00306	0.00303
	LSM1	17-Mar-21	51.3	50.4	<0.00010	0.0104	0.00000073	0.00000255	0.00284	0.00279
	LSM3	17-Mar-21	86.7	77.9	0.0355	0.0373	0.00000079	0.00000246	0.00333	0.00345
Dauphin River	DR-A	17-Mar-21	51.7	50.9	<0.00010	0.00544	<0.00000050	<0.00000050	0.00279	0.00293
	DR-B	18-Mar-21	50.5	50.4	<0.00010	0.00554	<0.00000050	<0.00000050	0.00278	0.00280
	DR-E	18-Mar-21	51.3	51.3	0.00010	0.00520	<0.00000050	0.00000077	0.00281	0.00284
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	21.6	21.6	<0.00010	0.00142	<0.00000050	0.00000090	0.00120	0.001233
Lake Winnipeg	SB2	18-Mar-21	21.3	21.2	<0.00010	0.00157	<0.00000050	0.00000095	0.00119	0.00124

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	39.9	39.6	<0.00010	0.00407	<0.00000050	0.00000053	0.00223	0.00224
	WHB2	17-May-21	40.7	40.6	<0.00010	0.00587	<0.00000050	0.00000056	0.00225	0.00227
Watchorn Creek	WHC-WB	17-May-21	43.7	42.5	0.00010	0.0110	<0.00000050	0.00000067	0.00221	0.00214
Mercer Creek	MC-WB	17-May-21	41.4	41.1	0.00014	0.0104	<0.00000050	<0.0000020	0.00226	0.00223
Birch Creek drain	BCD-2018-9	17-May-21	65.0	62.0	0.00032	0.0234	0.00000089	0.00000065	0.000491	0.000517
Birch Creek	BC-LSM	17-May-21	63.8	61.7	0.00066	0.0166	0.00000101	0.00000109	0.000604	0.000626
Fairford River	FR1	18-May-21	38.7	39.2	<0.00010	0.00688	<0.00000050	0.00000068	0.00213	0.00211
	FR2	18-May-21	38.9	40.4	<0.00010	0.0100	<0.00000050	0.00000081	0.00218	0.00221
Lake St. Martin	BB-LSM	17-May-21	30.4	28.8	<0.00010	0.00518	<0.00000050	0.00000055	0.00172	0.00173
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	38.5	38.4	0.00012	0.00711	<0.00000050	<0.00000050	0.00228	0.00225
	LSM1	19-May-21	39.2	40.1	<0.00010	0.0106	<0.00000050	0.00000073	0.00236	0.00221
	LSM3	19-May-21	31.8	31.5	<0.00010	0.00634	<0.00000050	0.00000076	0.00163	0.00164
Dauphin River	DR-A	19-May-21	41.4	39.8	<0.00010	0.0122	<0.00000050	0.00000122	0.00251	0.00256
	DR-B	18-May-21	43.1	43.9	<0.00010	0.00934	<0.00000050	0.00000096	0.00232	0.00239
	DR-E	19-May-21	43.2	41.1	<0.00010	0.0102	<0.00000050	0.00000097	0.00240	0.00233
Big Buffalo Lake	BBL	16-May-21	29.4	29.0	<0.00010	0.00820	<0.00000050	0.00000092	0.000531	0.000523
Buffalo Creek	BC3	16-May-21	27.0	26.1	0.00038	0.0571	0.00000056	0.00000119	0.000417	0.000420
Lake Winnipeg	SB1	27-May-21	21.0	20.9	<0.00010	0.00806	<0.00000050	<0.0000020	0.00110	0.00110
	SB2	27-May-21	19.9	20.8	<0.00010	0.0250	<0.00000050	0.00000146	0.00102	0.000987

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*
Lake Manitoba	WHB1	1-Sep-20	<0.00050	0.00075	9.81	9.95	0.00391	0.00429	0.000094	<0.000050
	WHB2	1-Sep-20	<0.00050	0.00084	9.91	10.1	0.00404	0.00452	0.000059	<0.000050
Watchorn Creek	WHC-WB	1-Sep-20	<0.00050	0.00069	9.41	9.51	0.00381	0.00414	0.000094	0.000058
Mercer Creek	MC-WB	1-Sep-20	<0.00050	0.00065	9.98	10.0	0.00406	0.00402	0.000084	<0.000050
Birch Creek drain	BCD-2018-9	9-Sep-20	<0.00050	0.00078	7.04	6.84	0.00356	0.00360	0.000220	0.000177
Birch Creek	BC-LSM	1-Sep-20	0.00101	0.00107	10.8	10.6	0.00471	0.00480	0.000207	0.000109
Fairford River	FR1	1-Sep-20	<0.00050	0.00068	9.83	9.51	0.00389	0.00390	0.000085	<0.000050
	FR2	10-Sep-20	<0.00050	0.00078	10.5	9.86	0.00407	0.00412	0.000093	0.000085
Lake St. Martin	BB-LSM	10-Sep-20	0.00050	0.00077	9.06	9.02	0.00405	0.00394	0.000074	0.000108
	LSM5	2-Sep-20	<0.00050	0.00063	9.96	9.35	0.00428	0.00412	0.000070	0.000054
	LSM4	2-Sep-20	<0.00050	0.00053	10.8	9.35	0.00415	0.00401	0.000055	0.000095
	LSM1	2-Sep-20	<0.00050	0.00069	9.77	9.62	0.00420	0.00435	0.000076	0.000086
	LSM3	2-Sep-20	0.00050	0.00068	7.01	6.90	0.00392	0.00414	0.000111	0.000097
Dauphin River	DR-A	2-Sep-20	<0.00050	0.00066	9.26	9.28	0.00393	0.00393	0.000064	<0.000050
	DR-B	3-Sep-20	<0.00050	0.00072	9.84	9.37	0.00441	0.00432	0.000089	0.000075
	DR-E	3-Sep-20	<0.00050	0.00081	9.86	9.52	0.00422	0.00444	0.000069	0.000071
Big Buffalo Lake	BBL	1-Sep-20	<0.00050	<0.00050	3.10	3.16	0.00246	0.00260	0.000120	0.000129
Buffalo Creek	BC3	1-Sep-20	0.00060	0.00109	1.40	1.52	0.00170	0.00246	0.000091	0.000110
Lake Winnipeg	SB1	3-Sep-20	0.00070	0.00182	4.84	4.91	0.00220	0.00369	0.000126	0.000111
	SB2	3-Sep-20	0.00078	0.00177	3.95	3.86	0.00157	0.00297	0.000131	0.000121
Birch Creek drain	BCD-2018-9	13-Oct-20	<0.00050	0.00078	13.7	14.6	0.00396	0.00422	0.000136	0.000128
Birch Creek	BC-LSM	13-Oct-20	<0.00050	0.00052	14.9	14.8	0.00416	0.00434	0.000155	0.000089
Fairford River	FR1	13-Oct-20	<0.00050	0.00106	10.1	10.4	0.00406	0.00449	0.000069	0.000099
	FR2	13-Oct-20	<0.00050	0.00090	9.70	10.2	0.00428	0.00440	0.000085	0.000089

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	0.00054	0.00074	9.39	9.59	0.00413	0.00413	0.000072	0.000084
	LSM4	14-Oct-20	<0.00050	0.00059	10.3	10.1	0.00416	0.00412	0.000109	0.000081
	LSM1	14-Oct-20	0.00051	0.00094	10.1	10.1	0.00399	0.00450	0.000100	0.000100
	LSM3	14-Oct-20	0.00051	0.00097	8.29	8.24	0.00378	0.00435	0.000093	0.000102
Dauphin River	DR-A	14-Oct-20	<0.00050	0.00063	10.0	10.2	0.00412	0.00418	0.000103	0.000123
Lake Manitoba	WHB1	15-Mar-21	0.00071	0.00083	14.1	14.6	0.00543	0.00539	0.000095	0.000127
	WHB2	15-Mar-21	0.00073	0.00087	15.3	15.5	0.00593	0.00585	0.000109	0.000072
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	0.00066	0.00081	12.9	12.8	0.00492	0.00490	0.000092	0.000062
	FR2	16-Mar-21	0.00065	0.00077	13.0	12.8	0.00497	0.00496	0.000107	0.000084
Lake St. Martin	BB-LSM	16-Mar-21	0.00077	0.00091	14.9	13.7	0.00542	0.00548	0.000066	0.000090
	LSM5	17-Mar-21	0.00072	0.00080	13.8	13.7	0.00526	0.00551	0.000067	0.000096
	LSM4	17-Mar-21	0.00076	0.00088	15.0	14.3	0.00568	0.00579	0.000097	0.000105
	LSM1	17-Mar-21	0.00070	0.00094	13.5	13.4	0.00488	0.00539	0.000121	0.000086
	LSM3	17-Mar-21	0.00103	0.00114	20.1	19.0	0.00741	0.00729	0.000173	0.000143
Dauphin River	DR-A	17-Mar-21	0.00070	0.00084	14.0	13.8	0.00511	0.00514	0.000087	0.000095
	DR-B	18-Mar-21	0.00069	0.00081	13.4	13.0	0.00524	0.00515	0.000105	0.000109
	DR-E	18-Mar-21	0.00069	0.00082	13.3	12.7	0.00529	0.00511	0.000085	0.000080
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	0.00087	0.00109	4.8	4.71	0.00181	0.00206	0.000149	0.000124
Lake Winnipeg	SB2	18-Mar-21	0.00086	0.00113	4.72	4.60	0.00176	0.00205	0.000127	0.000123

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	0.00053	0.00070	10.6	10.1	0.00400	0.00382	0.000101	0.000097
	WHB2	17-May-21	0.00060	0.00077	11.0	10.5	0.00418	0.00393	0.000095	0.000084
Watchorn Creek	WHC-WB	17-May-21	0.00063	0.00081	11.2	10.8	0.00409	0.00406	0.000069	0.000102
Mercer Creek	MC-WB	17-May-21	0.00067	0.00106	11.0	10.3	0.00422	0.00413	0.000064	0.000084
Birch Creek drain	BCD-2018-9	17-May-21	<0.00050	0.00052	9.42	9.08	0.00313	0.00296	0.000098	0.000075
Birch Creek	BC-LSM	17-May-21	0.00061	0.00081	7.28	6.90	0.00267	0.00262	0.000108	0.000113
Fairford River	FR1	18-May-21	0.00059	0.00088	10.6	9.95	0.00399	0.00410	0.000099	0.000092
	FR2	18-May-21	0.00061	0.00098	10.6	10.4	0.00391	0.00437	0.000084	0.000106
Lake St. Martin	BB-LSM	17-May-21	<0.00050	0.00061	7.72	7.29	0.00287	0.00292	<0.000050	0.000067
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	0.00056	0.00078	10.2	10.4	0.00386	0.00407	0.000071	<0.000050
	LSM1	19-May-21	0.00060	0.00090	10.5	10.6	0.00404	0.00430	0.000082	0.000071
	LSM3	19-May-21	<0.00050	0.00057	7.32	7.22	0.00298	0.00323	0.000069	0.000084
Dauphin River	DR-A	19-May-21	0.00060	0.00105	10.9	10.8	0.00420	0.00469	0.000082	0.000087
	DR-B	18-May-21	0.00061	0.00096	11.3	10.9	0.00433	0.00453	0.000072	0.000120
	DR-E	19-May-21	0.00065	0.00090	11.5	11.2	0.00421	0.00464	0.000091	0.000052
Big Buffalo Lake	BBL	16-May-21	<0.00050	<0.00050	3.27	3.31	0.00158	0.00163	<0.000050	0.000073
Buffalo Creek	BC3	16-May-21	0.00058	0.00132	2.86	3.02	0.00236	0.00334	0.000053	0.000065
Lake Winnipeg	SB1	27-May-21	0.00068	0.00142	4.56	4.64	0.00168	0.00276	0.000106	0.000141
	SB2	27-May-21	0.00062	0.00289	4.23	4.54	0.00159	0.00502	0.000120	0.000098

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.050*	*0.10*	*0.000010*	*0.000010*	*0.050*	*0.050*	*0.00010*	*0.00020*
Lake Manitoba	WHB1	1-Sep-20	4.24	4.74	<0.000010	<0.000010	130	133	0.259	0.276
	WHB2	1-Sep-20	4.20	5.07	<0.000010	<0.000010	136	130	0.266	0.266
Watchorn Creek	WHC-WB	1-Sep-20	3.29	3.68	<0.000010	<0.000010	121	121	0.253	0.245
Mercer Creek	MC-WB	1-Sep-20	3.79	3.95	<0.000010	<0.000010	128	126	0.262	0.261
Birch Creek drain	BCD-2018-9	9-Sep-20	10.3	11.1	<0.000010	<0.000010	13.7	14.4	0.205	0.205
Birch Creek	BC-LSM	1-Sep-20	1.34	1.42	<0.000010	<0.000010	15.2	15.0	0.151	0.153
Fairford River	FR1	1-Sep-20	4.19	4.49	<0.000010	<0.000010	129	128	0.257	0.266
	FR2	10-Sep-20	4.15	4.83	<0.000010	<0.000010	136	144	0.275	0.273
Lake St. Martin	BB-LSM	10-Sep-20	4.32	4.75	<0.000010	<0.000010	127	134	0.253	0.249
	LSM5	2-Sep-20	4.15	4.23	<0.000010	<0.000010	134	125	0.267	0.257
	LSM4	2-Sep-20	3.87	4.06	<0.000010	<0.000010	145	127	0.254	0.254
	LSM1	2-Sep-20	4.19	4.47	<0.000010	<0.000010	131	126	0.255	0.254
	LSM3	2-Sep-20	6.21	6.55	<0.000010	<0.000010	89.3	90.2	0.196	0.203
Dauphin River	DR-A	2-Sep-20	3.92	4.10	<0.000010	<0.000010	130	130	0.235	0.242
	DR-B	3-Sep-20	4.29	4.78	<0.000010	<0.000010	130	124	0.249	0.244
	DR-E	3-Sep-20	4.38	5.50	<0.000010	<0.000010	132	126	0.235	0.242
Big Buffalo Lake	BBL	1-Sep-20	12.1	14.8	<0.000010	<0.000010	27.4	27.7	0.209	0.204
Buffalo Creek	BC3	1-Sep-20	9.39	10.6	<0.000010	<0.000010	10.1	10.2	0.114	0.108
Lake Winnipeg	SB1	3-Sep-20	3.40	4.95	<0.000010	<0.000010	44.5	44.3	0.155	0.156
	SB2	3-Sep-20	2.78	4.29	<0.000010	<0.000010	28.5	26.6	0.135	0.134
Birch Creek drain	BCD-2018-9	13-Oct-20	11.0	11.8	<0.000010	<0.000010	17.1	18.4	0.207	0.233
Birch Creek	BC-LSM	13-Oct-20	11.4	9.98	<0.000010	<0.000010	17.2	18.8	0.221	0.234
Fairford River	FR1	13-Oct-20	4.53	4.93	<0.000010	<0.000010	130	146	0.259	0.293
	FR2	13-Oct-20	4.38	4.70	<0.000010	<0.000010	128	142	0.259	0.282

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	4.48	4.35	<0.000010	<0.000010	129	139	0.248	0.254
	LSM4	14-Oct-20	3.83	4.08	<0.000010	<0.000010	143	144	0.263	0.254
	LSM1	14-Oct-20	3.79	4.34	<0.000010	<0.000010	141	144	0.264	0.262
	LSM3	14-Oct-20	4.61	5.23	<0.000010	<0.000010	117	117	0.227	0.229
Dauphin River	DR-A	14-Oct-20	3.70	4.01	<0.000010	<0.000010	142	142	0.262	0.260
Lake Manitoba	WHB1	15-Mar-21	5.88	6.29	<0.000010	<0.000010	187	196	0.371	0.386
	WHB2	15-Mar-21	6.03	6.50	<0.000010	<0.000010	200	205	0.409	0.405
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	5.39	5.26	<0.000010	<0.000010	182	177	0.357	0.351
	FR2	16-Mar-21	5.71	5.46	<0.000010	<0.000010	175	175	0.357	0.346
Lake St. Martin	BB-LSM	16-Mar-21	6.44	6.10	<0.000010	<0.000010	201	192	0.405	0.379
	LSM5	17-Mar-21	6.13	6.22	<0.000010	<0.000010	190	191	0.385	0.382
	LSM4	17-Mar-21	5.90	5.75	<0.000010	<0.000010	204	200	0.412	0.407
	LSM1	17-Mar-21	5.38	5.21	<0.000010	<0.000010	188	188	0.377	0.374
	LSM3	17-Mar-21	9.04	8.75	<0.000010	<0.000010	283	266	0.582	0.540
Dauphin River	DR-A	17-Mar-21	5.64	5.29	<0.000010	<0.000010	193	192	0.394	0.396
	DR-B	18-Mar-21	4.98	5.16	<0.000010	<0.000010	179	186	0.384	0.388
	DR-E	18-Mar-21	4.95	5.22	<0.000010	<0.000010	183	183	0.379	0.381
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	2.47	2.83	<0.000010	<0.000010	39.7	41.0	0.173	0.174
Lake Winnipeg	SB2	18-Mar-21	2.46	2.96	<0.000010	<0.000010	39.1	40.6	0.170	0.174

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	2.86	2.81	<0.000010	<0.000010	142	144	0.286	0.285
	WHB2	17-May-21	2.71	2.68	<0.000010	<0.000010	147	145	0.293	0.293
Watchorn Creek	WHC-WB	17-May-21	2.05	2.12	<0.000010	<0.000010	141	140	0.292	0.293
Mercer Creek	MC-WB	17-May-21	2.57	2.79	<0.000010	<0.000010	144	147	0.295	0.302
Birch Creek drain	BCD-2018-9	17-May-21	1.97	2.06	<0.000010	<0.000010	11.9	11.7	0.172	0.173
Birch Creek	BC-LSM	17-May-21	2.40	2.54	<0.000010	<0.000010	10.2	10.2	0.160	0.165
Fairford River	FR1	18-May-21	2.84	3.18	<0.000010	<0.000010	151	150	0.285	0.288
	FR2	18-May-21	2.47	2.85	<0.000010	<0.000010	149	153	0.285	0.296
Lake St. Martin	BB-LSM	17-May-21	1.65	1.76	<0.000010	<0.000010	104	102	0.213	0.214
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	1.35	1.53	<0.000010	<0.000010	142	141	0.280	0.290
	LSM1	19-May-21	1.18	1.40	<0.000010	<0.000010	143	151	0.292	0.301
	LSM3	19-May-21	0.45	0.70	<0.000010	<0.000010	91.3	91.6	0.200	0.210
Dauphin River	DR-A	19-May-21	0.31	0.75	<0.000010	<0.000010	155	146	0.281	0.299
	DR-B	18-May-21	0.45	0.82	<0.000010	<0.000010	158	159	0.296	0.303
	DR-E	19-May-21	0.35	0.55	<0.000010	<0.000010	157	154	0.298	0.309
Big Buffalo Lake	BBL	16-May-21	1.88	1.89	<0.000010	<0.000010	18.9	19.0	0.130	0.128
Buffalo Creek	BC3	16-May-21	2.19	3.27	<0.000010	<0.000010	14.9	14.7	0.0977	0.102
Lake Winnipeg	SB1	27-May-21	1.97	2.80	<0.000010	<0.000010	44.3	44.8	0.157	0.165
	SB2	27-May-21	1.57	4.60	<0.000010	<0.000010	41.0	41.0	0.140	0.146

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Sulphate (SO4)	Sulphur (S)		Tellurium (Te)		Thallium (Tl)	
			Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.30/0.60*	*0.50*	*0.50*	*0.00020*	*0.00020*	*0.000010*	*0.000010*
Lake Manitoba	WHB1	1-Sep-20	97.6	30.9	32.2	<0.00020	<0.00020	<0.000010	<0.000010
	WHB2	1-Sep-20	97.9	32.1	31.6	<0.00020	<0.00020	<0.000010	<0.000010
Watchorn Creek	WHC-WB	1-Sep-20	90.7	29.1	30.8	<0.00020	<0.00020	<0.000010	<0.000010
Mercer Creek	MC-WB	1-Sep-20	97.9	30.6	31.6	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek drain	BCD-2018-9	9-Sep-20	85.6	28.6	30.0	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek	BC-LSM	1-Sep-20	65.5	22.4	22.5	<0.00020	<0.00020	<0.000010	<0.000010
Fairford River	FR1	1-Sep-20	92.6	29.7	30.4	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	10-Sep-20	93.5	29.9	32.5	<0.00020	<0.00020	<0.000010	<0.000010
Lake St. Martin	BB-LSM	10-Sep-20	82.4	28.5	29.1	<0.00020	<0.00020	<0.000010	<0.000010
	LSM5	2-Sep-20	81.7	27.2	29.6	<0.00020	<0.00020	<0.000010	<0.000010
	LSM4	2-Sep-20	82.8	27.4	29.9	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	2-Sep-20	83.3	28.1	30.3	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	2-Sep-20	56.7	19.2	20.6	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	2-Sep-20	85.9	27.4	27.5	<0.00020	<0.00020	<0.000010	<0.000010
	DR-B	3-Sep-20	82.8	27.3	28.9	<0.00020	<0.00020	<0.000010	<0.000010
	DR-E	3-Sep-20	82.5	28.8	29.7	<0.00020	<0.00020	<0.000010	<0.000010
Big Buffalo Lake	BBL	1-Sep-20	24.6	8.82	9.33	<0.00020	<0.00020	<0.000010	<0.000010
Buffalo Creek	BC3	1-Sep-20	12.8	4.75	5.01	<0.00020	<0.00020	<0.000010	<0.000010
Lake Winnipeg	SB1	3-Sep-20	50.3	16.2	17.3	<0.00020	<0.00020	<0.000010	0.000013
	SB2	3-Sep-20	44.8	14.9	15.5	<0.00020	<0.00020	<0.000010	0.000010
Birch Creek drain	BCD-2018-9	13-Oct-20	149	47.4	54.6	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek	BC-LSM	13-Oct-20	136	52.9	45.9	<0.00020	<0.00020	<0.000010	<0.000010
Fairford River	FR1	13-Oct-20	92.4	33.6	34.0	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	13-Oct-20	92.1	32.5	33.5	<0.00020	<0.00020	<0.000010	<0.000010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Sulphate (SO4)	Sulphur (S)		Tellurium (Te)		Thallium (Tl)	
			Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	84.9	31.3	28.9	<0.00020	<0.00020	<0.000010	<0.000010
	LSM4	14-Oct-20	87.2	29.1	32.1	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	14-Oct-20	88.0	29.1	31.7	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	14-Oct-20	71.0	23.5	25.6	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	14-Oct-20	86.4	28.7	32.1	<0.00020	<0.00020	<0.000010	<0.000010
Lake Manitoba	WHB1	15-Mar-21	114	45.4	49.5	<0.00020	<0.00020	<0.000010	<0.000010
	WHB2	15-Mar-21	120	46.3	52.7	<0.00020	<0.00020	<0.000010	<0.000010
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	104	41.7	42.7	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	16-Mar-21	104	40.9	42.0	<0.00020	<0.00020	<0.000010	<0.000010
Lake St. Martin	BB-LSM	16-Mar-21	116	45.7	47.0	<0.00020	<0.00020	<0.000010	<0.000010
	LSM5	17-Mar-21	112	45.5	47.7	<0.00020	<0.00020	<0.000010	<0.000010
	LSM4	17-Mar-21	120	47.5	48.4	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	17-Mar-21	108	44.6	45.8	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	17-Mar-21	171	61.6	64.9	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	17-Mar-21	111	45.7	46.3	<0.00020	<0.00020	<0.000010	<0.000010
	DR-B	18-Mar-21	117	42.2	45.1	<0.00020	<0.00020	<0.000010	<0.000010
	DR-E	18-Mar-21	119	42.8	45.8	<0.00020	<0.00020	<0.000010	<0.000010
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	54.7	19.4	20.5	<0.00020	<0.00020	<0.000010	<0.000010
Lake Winnipeg	SB2	18-Mar-21	53.7	19.8	19.6	<0.00020	<0.00020	<0.000010	<0.000010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Sulphate (SO4)	Sulphur (S)		Tellurium (Te)		Thallium (Tl)	
			Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	92.5	33.1	34.0	<0.00020	<0.00020	<0.000010	<0.000010
	WHB2	17-May-21	92.6	33.3	34.2	<0.00020	<0.00020	<0.000010	<0.000010
Watchorn Creek	WHC-WB	17-May-21	93.7	34.1	36.4	<0.00020	<0.00020	<0.000010	<0.000010
Mercer Creek	MC-WB	17-May-21	93.1	33.8	35.4	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek drain	BCD-2018-9	17-May-21	87.3	31.5	34.4	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek	BC-LSM	17-May-21	71.9	25.8	27.6	<0.00020	<0.00020	<0.000010	<0.000010
Fairford River	FR1	18-May-21	89.9	32.2	33.2	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	18-May-21	92.5	33.7	34.1	<0.00020	<0.00020	<0.000010	<0.000010
Lake St. Martin	BB-LSM	17-May-21	65.7	23.9	25.1	<0.00020	<0.00020	<0.000010	<0.000010
	LSM5 [3]	May 2021	-	-	-	-	-	-	-
	LSM4	19-May-21	85.9	32.4	32.6	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	19-May-21	89.7	32.6	34.0	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	19-May-21	56.5	21.0	22.4	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	19-May-21	91.0	34.6	34.6	<0.00020	<0.00020	<0.000010	<0.000010
	DR-B	18-May-21	96.6	36.6	36.7	<0.00020	<0.00020	<0.000010	<0.000010
	DR-E	19-May-21	96.2	35.5	36.2	<0.00020	<0.00020	<0.000010	<0.000010
Big Buffalo Lake	BBL	16-May-21	31.3	11.7	12.1	<0.00020	<0.00020	<0.000010	<0.000010
Buffalo Creek	BC3	16-May-21	23.7	8.71	9.62	<0.00020	<0.00020	<0.000010	<0.000010
Lake Winnipeg	SB1	27-May-21	49.5	18.1	18.6	<0.00020	<0.00020	<0.000010	<0.000010
	SB2	27-May-21	44.5	16.3	16.3	<0.00020	<0.00020	<0.000010	0.000026

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Thorium (Th)		Tin (Sn)		Titanium (Ti)		Tungsten (W)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00030*	*0.00030*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00455	<0.00010	<0.00010
	WHB2	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00835	<0.00010	<0.00010
Watchorn Creek	WHC-WB	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00444	<0.00010	<0.00010
Mercer Creek	MC-WB	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00291	<0.00010	<0.00010
Birch Creek drain	BCD-2018-9	9-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00542	<0.00010	<0.00010
Birch Creek	BC-LSM	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	0.00039	0.00154	<0.00010	<0.00010
Fairford River	FR1	1-Sep-20	<0.00010	<0.00010	<0.00010	0.00012	<0.00030	0.00357	<0.00010	<0.00010
	FR2	10-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00530	<0.00010	<0.00010
Lake St. Martin	BB-LSM	10-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00463	<0.00010	<0.00010
	LSM5	2-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00137	<0.00010	<0.00010
	LSM4	2-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00048	<0.00010	<0.00010
	LSM1	2-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00399	<0.00010	<0.00010
	LSM3	2-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00393	<0.00010	<0.00010
Dauphin River	DR-A	2-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00168	<0.00010	<0.00010
	DR-B	3-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00398	<0.00010	<0.00010
	DR-E	3-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00939	<0.00010	<0.00010
Big Buffalo Lake	BBL	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00252	<0.00010	<0.00010
Buffalo Creek	BC3	1-Sep-20	<0.00010	<0.00010	<0.00010	<0.00010	0.00172	0.0163	<0.00010	<0.00010
Lake Winnipeg	SB1	3-Sep-20	<0.00010	0.00013	<0.00010	<0.00010	0.00087	0.0330	<0.00010	<0.00010
	SB2	3-Sep-20	<0.00010	0.00011	<0.00010	<0.00010	0.00072	0.0288	<0.00010	<0.00010
Birch Creek drain	BCD-2018-9	13-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00065	<0.00010	<0.00010
Birch Creek	BC-LSM	13-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	0.00031	0.00166	<0.00010	<0.00010
Fairford River	FR1	13-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00955	<0.00010	<0.00010
	FR2	13-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00730	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Thorium (Th)		Tin (Sn)		Titanium (Ti)		Tungsten (W)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00321	<0.00010	<0.00010
	LSM4	14-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00133	<0.00010	<0.00010
	LSM1	14-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00818	<0.00010	<0.00010
	LSM3	14-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00919	<0.00010	<0.00010
Dauphin River	DR-A	14-Oct-20	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00174	<0.00010	<0.00010
Lake Manitoba	WHB1	15-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
	WHB2	15-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00090	<0.00010	<0.00010
	FR2	16-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00057	<0.00010	<0.00010
Lake St. Martin	BB-LSM	16-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00032	<0.00010	<0.00010
	LSM5	17-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
	LSM4	17-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00038	<0.00010	<0.00010
	LSM1	17-Mar-21	<0.00010	<0.00010	<0.00010	0.00015	<0.00030	0.00247	<0.00010	<0.00010
	LSM3	17-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00105	<0.00010	<0.00010
Dauphin River	DR-A	17-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
	DR-B	18-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00039	<0.00010	<0.00010
	DR-E	18-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00050	<0.00010	<0.00010
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00066	0.00472	<0.00010	<0.00010
Lake Winnipeg	SB2	18-Mar-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00067	0.00509	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Thorium (Th)		Tin (Sn)		Titanium (Ti)		Tungsten (W)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00076	<0.00010	<0.00010
	WHB2	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00194	<0.00010	<0.00010
Watchorn Creek	WHC-WB	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00229	<0.00010	<0.00010
Mercer Creek	MC-WB	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00670	<0.00010	<0.00010
Birch Creek drain	BCD-2018-9	17-May-21	<0.00010	<0.00010	<0.00010	0.00015	<0.00030	0.00118	<0.00010	<0.00010
Birch Creek	BC-LSM	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00320	<0.00010	<0.00010
Fairford River	FR1	18-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00569	<0.00010	<0.00010
	FR2	18-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00701	<0.00010	<0.00010
Lake St. Martin	BB-LSM	17-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00229	<0.00010	<0.00010
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00204	<0.00010	<0.00010
	LSM1	19-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00428	<0.00010	<0.00010
	LSM3	19-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00308	<0.00010	<0.00010
Dauphin River	DR-A	19-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00838	<0.00010	<0.00010
	DR-B	18-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00697	<0.00010	<0.00010
	DR-E	19-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00431	<0.00010	<0.00010
Big Buffalo Lake	BBL	16-May-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00126	<0.00010	<0.00010
Buffalo Creek	BC3	16-May-21	<0.00010	0.00022	<0.00010	<0.00010	0.00095	0.0239	<0.00010	<0.00010
Lake Winnipeg	SB1	27-May-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00035	0.0198	<0.00010	<0.00010
	SB2	27-May-21	<0.00010	0.00039	<0.00010	<0.00010	0.00060	0.0687	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Uranium (U)		Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.000010*	*0.000010*	*0.00050*	*0.00050*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Lake Manitoba	WHB1	1-Sep-20	0.00170	0.00159	0.00142	0.00213	<0.0010	<0.0030	<0.00020	<0.00020
	WHB2	1-Sep-20	0.00172	0.00166	0.00148	0.00226	<0.0010	<0.0030	<0.00020	0.00060
Watchorn Creek	WHC-WB	1-Sep-20	0.00160	0.00154	0.00129	0.00194	<0.0010	<0.0030	<0.00020	<0.00020
Mercer Creek	MC-WB	1-Sep-20	0.00168	0.00161	0.00126	0.00179	<0.0010	<0.0030	<0.00020	<0.00020
Birch Creek drain	BCD-2018-9	9-Sep-20	0.000532	0.00063	<0.00050	0.00076	<0.0010	<0.0030	<0.00020	<0.00020
Birch Creek	BC-LSM	1-Sep-20	0.000693	0.000691	0.00060	0.00109	<0.0010	<0.0030	0.00032	0.00028
Fairford River	FR1	1-Sep-20	0.00163	0.00157	0.00136	0.00191	<0.0010	<0.0030	<0.00020	<0.00020
	FR2	10-Sep-20	0.00147	0.00170	0.00140	0.00180	<0.0010	<0.0030	<0.00020	0.00053
Lake St. Martin	BB-LSM	10-Sep-20	0.00184	0.00180	0.00173	0.00214	<0.0010	<0.0030	<0.00020	<0.00020
	LSM5	2-Sep-20	0.00154	0.00161	0.00153	0.00202	<0.0010	<0.0030	<0.00020	<0.00020
	LSM4	2-Sep-20	0.00161	0.00165	0.00160	0.00198	<0.0010	<0.0030	<0.00020	<0.00020
	LSM1	2-Sep-20	0.00165	0.00171	0.00160	0.00217	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	2-Sep-20	0.00131	0.00138	0.00173	0.00227	<0.0010	<0.0030	<0.00020	<0.00020
Dauphin River	DR-A	2-Sep-20	0.00170	0.00161	0.00158	0.00199	<0.0010	<0.0030	<0.00020	<0.00020
	DR-B	3-Sep-20	0.00167	0.00172	0.00156	0.00219	<0.0010	<0.0030	<0.00020	<0.00020
	DR-E	3-Sep-20	0.00165	0.00173	0.00167	0.00235	<0.0010	<0.0030	<0.00020	0.00052
Big Buffalo Lake	BBL	1-Sep-20	0.000671	0.000656	0.00078	0.00126	0.0011	<0.0030	<0.00020	<0.00020
Buffalo Creek	BC3	1-Sep-20	0.000320	0.000317	0.00077	0.00170	<0.0010	<0.0030	0.00022	0.00122
Lake Winnipeg	SB1	3-Sep-20	0.000942	0.000988	0.00165	0.00342	<0.0010	0.0030	<0.00020	0.00042
	SB2	3-Sep-20	0.000826	0.000893	0.00152	0.00298	<0.0010	<0.0030	<0.00020	0.00040
Birch Creek drain	BCD-2018-9	13-Oct-20	0.00174	0.00177	<0.00050	0.00072	0.0011	<0.0030	<0.00020	<0.00020
Birch Creek	BC-LSM	13-Oct-20	0.00225	0.00211	0.00088	0.00130	<0.0010	<0.0030	<0.00020	<0.00020
Fairford River	FR1	13-Oct-20	0.00186	0.00178	0.00125	0.00220	<0.0010	<0.0030	<0.00020	<0.00020
	FR2	13-Oct-20	0.00191	0.00173	0.00129	0.00200	<0.0010	<0.0030	<0.00020	<0.00020

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Uranium (U)		Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake St. Martin	BB-LSM	13-Oct-20	0.00201	0.00190	0.00159	0.00214	<0.0010	<0.0030	<0.00020	<0.00020
	LSM4	14-Oct-20	0.00159	0.00178	0.00143	0.00171	<0.0010	<0.0030	<0.00020	<0.00020
	LSM1	14-Oct-20	0.00165	0.00180	0.00139	0.00207	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	14-Oct-20	0.00156	0.00170	0.00131	0.00194	<0.0010	<0.0030	<0.00020	<0.00020
Dauphin River	DR-A	14-Oct-20	0.00165	0.00181	0.00141	0.00174	<0.0010	<0.0030	<0.00020	<0.00020
Lake Manitoba	WHB1	15-Mar-21	0.00215	0.00217	0.00138	0.00166	<0.0010	<0.0030	<0.00020	<0.00020
	WHB2	15-Mar-21	0.00235	0.00222	0.00159	0.00178	0.0015	0.0046	<0.00020	<0.00020
Watchorn Creek	WHC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Mercer Creek	MC-WB [1]	15-Mar-21	-	-	-	-	-	-	-	-
Birch Creek drain	BCD-2018-9 [1]	16-Mar-21	-	-	-	-	-	-	-	-
Birch Creek	BC-LSM [1]	16-Mar-21	-	-	-	-	-	-	-	-
Fairford River	FR1	16-Mar-21	0.00202	0.00211	0.00122	0.00139	0.0021	<0.0030	<0.00020	<0.00020
	FR2	16-Mar-21	0.00194	0.00203	0.00126	0.00141	<0.0010	<0.0030	<0.00020	<0.00020
Lake St. Martin	BB-LSM	16-Mar-21	0.00218	0.00229	0.00142	0.00152	<0.0010	<0.0030	<0.00020	<0.00020
	LSM5	17-Mar-21	0.00215	0.00227	0.00131	0.00145	<0.0010	<0.0030	<0.00020	<0.00020
	LSM4	17-Mar-21	0.00239	0.00239	0.00134	0.00146	<0.0010	0.0082	<0.00020	<0.00020
	LSM1	17-Mar-21	0.00211	0.00213	0.00122	0.00152	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	17-Mar-21	0.00308	0.00305	0.00119	0.00144	0.0013	0.0030	<0.00020	<0.00020
Dauphin River	DR-A	17-Mar-21	0.00205	0.00223	0.00122	0.00135	<0.0010	<0.0030	<0.00020	<0.00020
	DR-B	18-Mar-21	0.00220	0.00239	0.00117	0.00132	<0.0010	<0.0030	<0.00020	<0.00020
	DR-E	18-Mar-21	0.00214	0.00223	0.00117	0.00134	0.0011	<0.0030	<0.00020	<0.00020
Big Buffalo Lake	BBL [1]	17-Mar-21	-	-	-	-	-	-	-	-
Buffalo Creek	BC3 [1]	18-Mar-21	-	-	-	-	-	-	-	-
Lake Winnipeg	SB1	18-Mar-21	0.00114	0.00121	0.00143	0.00173	<0.0010	<0.0030	<0.00020	<0.00020
Lake Winnipeg	SB2	18-Mar-21	0.00113	0.00116	0.00138	0.00174	<0.0010	<0.0030	<0.00020	<0.00020

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Uranium (U)		Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	17-May-21	0.00170	0.00186	0.00097	0.00124	<0.0010	<0.0030	<0.00020	<0.00020
	WHB2	17-May-21	0.00176	0.00190	0.00102	0.00141	<0.0010	<0.0030	<0.00020	<0.00020
Watchorn Creek	WHC-WB	17-May-21	0.00190	0.00201	0.00107	0.00147	<0.0010	<0.0030	<0.00020	<0.00020
Mercer Creek	MC-WB	17-May-21	0.00178	0.00193	0.00108	0.00168	0.0014	<0.0030	<0.00020	<0.00020
Birch Creek drain	BCD-2018-9	17-May-21	0.00145	0.00158	<0.00050	0.00061	<0.0010	0.0064	<0.00020	<0.00020
Birch Creek	BC-LSM	17-May-21	0.00191	0.00207	0.00069	0.00106	<0.0010	<0.0030	<0.00020	0.00024
Fairford River	FR1	18-May-21	0.00167	0.00166	0.00091	0.00133	<0.0010	<0.0030	<0.00020	<0.00020
	FR2	18-May-21	0.00167	0.00170	0.00097	0.00157	<0.0010	<0.0030	<0.00020	<0.00020
Lake St. Martin	BB-LSM	17-May-21	0.00135	0.00143	0.00076	0.00115	<0.0010	0.0033	<0.00020	<0.00020
	LSM5 [3]	May 2021	-	-	-	-	-	-	-	-
	LSM4	19-May-21	0.00168	0.00166	0.00112	0.00145	<0.0010	<0.0030	<0.00020	<0.00020
	LSM1	19-May-21	0.00173	0.00176	0.00104	0.00150	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	19-May-21	0.00128	0.00123	0.00059	0.00095	<0.0010	<0.0030	<0.00020	<0.00020
Dauphin River	DR-A	19-May-21	0.00188	0.00189	0.00104	0.00168	<0.0010	<0.0030	<0.00020	<0.00020
	DR-B	18-May-21	0.00189	0.00195	0.00104	0.00163	<0.0010	<0.0030	<0.00020	<0.00020
	DR-E	19-May-21	0.00187	0.00176	0.00099	0.00145	<0.0010	0.0040	<0.00020	<0.00020
Big Buffalo Lake	BBL	16-May-21	0.000562	0.00061	<0.00050	0.00072	<0.0010	<0.0030	<0.00020	<0.00020
Buffalo Creek	BC3	16-May-21	0.000538	0.00059	0.00067	0.00191	<0.0010	<0.0030	<0.00020	0.00045
Lake Winnipeg	SB1	27-May-21	0.00105	0.00103	0.00099	0.00209	<0.0010	0.0041	<0.00020	0.00038
	SB2	27-May-21	0.000949	0.00101	0.00094	0.00414	<0.0010	0.0066	<0.00020	0.00117

1 - No sample collected, site was frozen to the bottom or effective depth was too shallow to collect a sample.

2 - Site not sampled in May 2021 due to strong winds which made accessing the site unsafe.

3 - One of the replicates was considered suspect and was removed from the sample mean; see Section 3.1.2 and Appendix 2 for details.

Table 9. *In situ* survey results.

Location Description	Sampling Date	Sampling Time	Total Water Depth [1] (m)	Sample Depth [1] (m)	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	Comments
Reed Lake	1-Sep-20	13:36	<0.05	0.3	14.03	8.56	10.10	98.2	641	0.88	heavy vegetation
Clear Lake	1-Sep-20	10:10	<0.05	0.3	13.40	8.88	9.82	94.1	802	1.75	heavy vegetation
Water Lake	1-Sep-20	10:13	<0.05	0.3	14.01	9.68	10.40	101.4	470	1.74	heavy vegetation
Goodison Lake	1-Sep-20	10:18	0.0	-	-	-	-	-	-	-	No water
Clarks Drain	1-Sep-20	10:21	0.0	-	-	-	-	-	-	-	No water
Woodale Drain	1-Sep-20	10:22	0.0	-	-	-	-	-	-	-	No water
Creek C											
at LSMOC alignment	1-Sep-20	12:58	<0.1	0.3	13.06	7.33	6.96	66.2	319	1.19	-
upstream of LSMOC alignment	1-Sep-20	12:59	<0.1	0.3	13.17	7.04	4.15	39.5	281	1.52	-
Unnamed Creek											
at Buffalo Creek	1-Sep-20	13:09	<0.1	0.3	13.49	7.24	7.47	71.7	8.2 [2]	2.96	-
at LSMOC alignment	1-Sep-20	13:11	<0.1	0.3	13.36	7.19	6.88	65.8	367	0.15	-
Reach 1	17-Mar-21	16:30	1.0	0.3	2.56	7.49	1.81	13.7	1021	0.50	Snow 5 cm; Ice 0.85 m
				1.0	3.89	7.51	2.17	16.3	1053	0.85	
Reed Lake	16-May-21	14:06	-	surface	18.59	8.24	11.12	119.1	696	1.13	-
Clear Lake	16-May-21	14:15	-	surface	17.13	7.40	7.42	77.1	588	0.65	-
Water Lake	16-May-21	14:18	-	surface	17.70	7.67	9.83	103.5	762	25.2	-
Goodison Lake	16-May-21	14:21	-	surface	-	6.99	8.90	94.6	-	8.0	-

1 - Effective depth during ice-cover

2 - Result suspect

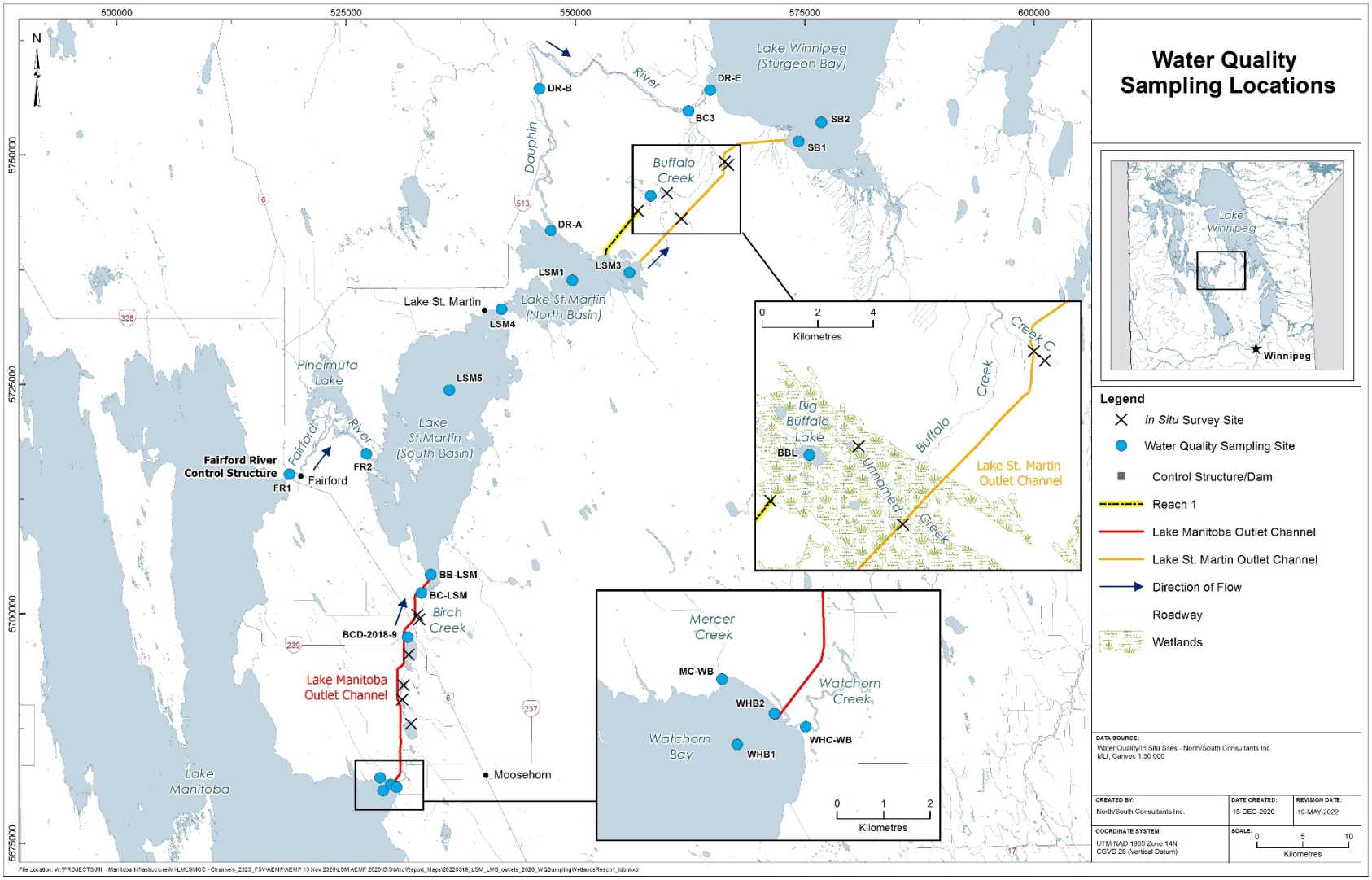


Figure 1. Water quality sampling locations.

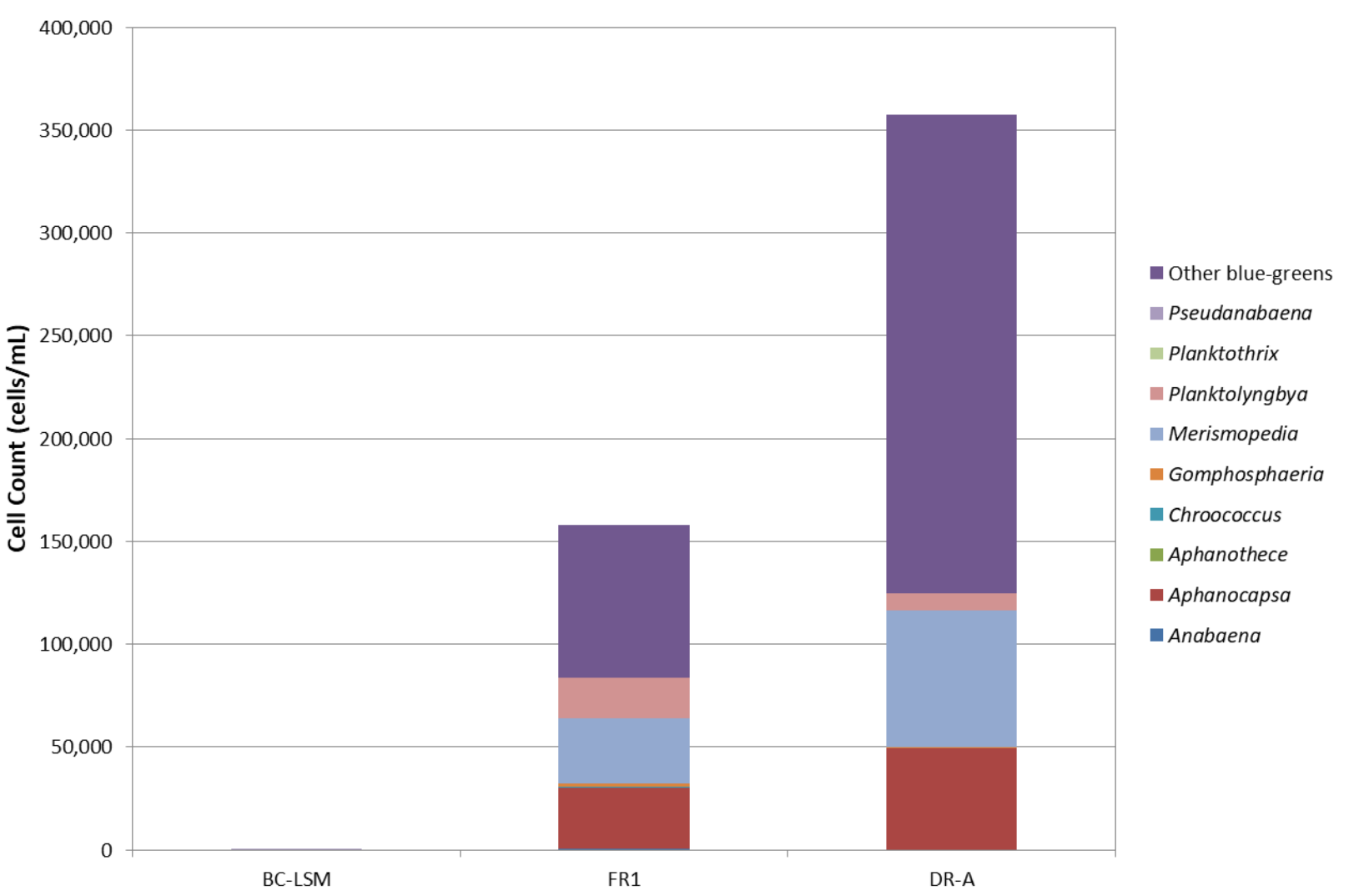


Figure 2. Abundance of blue-green algae at selected sampling sites in September 2020.

APPENDIX 1. WATER QUALITY OBJECTIVES AND GUIDELINES

WATER QUALITY OBJECTIVES AND GUIDELINES

The following is a summary of applicable water quality objectives and guidelines for evaluation of water chemistry data collected in the study area, including: the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for the protection of aquatic life (PAL; MWS 2011); and the Canadian Council of Ministers for the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999, updated to 2021).

AMMONIA

Both MWQ objectives and CCME guidelines for PAL exist for ammonia; these criteria are dependent upon water temperature and pH. A representative range of Manitoba water quality objectives and CCME guidelines for ammonia appropriate for the range of pH and temperature measured in the study area (i.e., site-specific objectives) in 2020 are presented in Tables A1-1 and A1-2, respectively.

Table A1-1. Range of applicable Manitoba Water Quality Objectives for ammonia, for the protection of cool-water and cold-water aquatic life and wildlife.

Water Use	pH	Temperature (°C)	Manitoba Water Quality Objective (mg N/L) [1]		
			30-day	4-day	1-hour
Cool water aquatic life, early life stages present					
	7.49	-0.40	4.40	11.0	20.2
		20.10	3.07	7.68	20.2
	8.80	-0.40	0.66	1.65	1.84
		20.10	0.46	1.15	1.84
Cool water aquatic life, early life stages absent					
	7.49	-0.40	7.15	17.9	20.2
		20.10	3.07	7.68	20.2
	8.80	-0.40	1.07	1.84	1.84
		20.10	0.46	1.15	1.84
Cold water aquatic life, early life stages present					
	7.49	-0.40	4.40	11.0	13.5
		20.10	3.07	7.68	13.5
	8.80	-0.40	0.66	1.23	1.23
		20.10	0.46	1.15	1.23
Cold water aquatic life, early life stages absent					
	7.49	-0.40	7.15	13.5	13.5
		20.10	3.07	7.68	13.5
	8.80	-0.40	1.07	1.23	1.23
		20.10	0.46	1.15	1.23

1 - Values calculated from algorithms provided in MWS (2011) and the range of pH and water temperature measured during the study. The most stringent objective is indicated in red.

Table A1-2. CCME water quality guidelines for total ammonia for the protection of freshwater aquatic life.

Temperature (°C)	CCME water quality guideline (mg N/L) [1]				
	pH				
	7.0	7.5	8.0	8.5	9.0
0	19.0	6.02	1.92	0.616	0.206
5	12.6	3.98	1.27	0.413	0.141
10	8.47	2.68	0.855	0.282	0.100
15	5.74	1.83	0.588	0.197	0.073
20	3.96	1.27	0.410	0.141	0.055
25	2.77	0.888	0.291	0.103	0.044

1 - Guidelines presented are for the range of pH and water temperature measured in the study area in 2020. The most stringent guideline is indicated in red.

DISSOLVED OXYGEN

Manitoba objectives for dissolved oxygen (DO) are dependent upon water temperature, the presence of early life stages, and the presence of sensitive fish species (e.g., cool-water fish such as Northern Pike and Walleye or cold-water fish species such as Lake Whitefish, MWS 2011). Objectives, which are specific for early life stages and mature life stages and vary according to the averaging duration, are presented in Table A1-3. Similarly, the CCME lowest acceptable level of DO varies by warm/cold water biota and life stage, as shown in Table A1-4.

Table A1-3. Manitoba Water Quality Objectives for dissolved oxygen.

Applicable Conditions	Dissolved Oxygen Objective (mg/L)			
	Averaging Duration			
	Instantaneous Minimum	7 Day Minimum	7 Days	30 Days
Cold-Water Aquatic Life and Wildlife				
Water Temperature ≤ 5°C and Early Life Stages Present	8.0	-	9.5	-
Water Temperature > 5°C and Mature Life Stages Present	4.0	5.0	-	6.5
Cool-Water Aquatic Life and Wildlife				
Water Temperature ≤ 5°C and Mature Life Stages Present	3.0	4.0	-	5.5
Water Temperature > 5°C and Early Life Stages Present	5.0	-	6.0	-

Table A1-4. CCME lowest acceptable concentration of dissolved oxygen for the protection of freshwater aquatic life.

	Dissolved Oxygen Value (mg/L)	
	Early life stages	Other life stages
Warm water biota	6.0	5.5
Cold water biota	9.5	6.5

TOTAL SUSPENDED SOLIDS AND TURBIDITY

MWQSOG and CCME guidelines for PAL for total suspended solids (TSS) are similar and allow the following: a maximum increase of 25 mg/L from background for short term exposure (up to 24 hrs.); an average increase of 5 mg/L from background for long term exposure (i.e., 1 to 30 days); a maximum increase of 25 mg/L from background when background TSS is between 25 mg/L and 250 mg/L; and a maximum change of 10% from background when TSS greater than 250 mg/L.

There are different criteria for turbidity for the MWQSOG and CCME guidelines for PAL. The Manitoba objective for turbidity for PAL is for "equivalent induced levels of change as calculated from site-specific or regional-specific correlation between total suspended solids and turbidity" (MWS 2011). The CCME guideline is more definitive and allows for the following (CCME 1999, updated to 2021) a maximum increase of 8 NTU from background for short term exposure (up to 24 hrs.); an average increase of 2 NTU from background for long term exposure (i.e., 1 to 30 days); a maximum increase of 8 NTU from background when background TSS is between 8 NTU and 80 NTU; and a maximum change of 10% from background when background is greater than 80 NTU.

There is also a MWQSOG maximum acceptable concentration of 1.0 NTU for drinking water. However, this guideline, as with all drinking water guidelines/objectives, is to be applied to finished drinking water; and, since the majority of natural surface waters will exceed this guideline, it has not been included in this assessment.

PHOSPHORUS

MWQSOG include narrative guidelines for total phosphorus (TP) which state: "[TP] should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, [TP] should not exceed 0.05 mg/L" (MWS 2011).

CCME guidelines for the protection of freshwater aquatic life provide a guidance framework for the development of site-specific guidelines; this is a detailed process that requires sufficient baseline data for guideline development and is beyond the scoop of this report.

OTHER ROUTINE PARAMETERS

Table A1-5 presents water quality criteria for other routine parameters not discussed above.

METALS AND MAJOR IONS

Table A1-6 presents water quality criteria for select metals and major ions.

HYDROCARBONS

Table A1-7 presents water quality criteria for select hydrocarbons.

PESTICIDES

Table A1-8 presents water quality criteria for select pesticides.

Table A1-5. Manitoba and CCME guidelines for the protection of aquatic life for other routine parameters measured.

Parameter	Guidelines/Objectives for PAL		
	MWQSOG [1]	CCME [2]	
		Short Term	Long Term
Nitrate	2.93 mg N/L[3]	124 mg N/L	3.0 mg N/L
Nitrite	0.060 mg N/L	-	0.060 mg N/L
pH	6.5 to 9.0	-	6.5 to 9.0

1 - Manitoba Water Quality Standards, Objectives, and Guidelines (MWS 2011).

2 - CCME guidelines for the protection of freshwater aquatic life (CCME 1999, updated to 2021).

3 - The Manitoba PAL guideline for nitrate indicated in MWS (2011) was incorrectly identified as 13 mg N/L. The PAL guideline should read 2.93 mg N/L (N. Armstrong, Pers. Comm.).

Table A1-6. Manitoba and CCME guidelines for the protection of aquatic life for metals and major ions.

Parameter	Manitoba Objectives and Guidelines (mg/L)					CCME Guidelines (mg/L)		
	Tier II Objectives		Tier III Guidelines					
	Acute[1]	Chronic[2]	MWQG	Short-term	Long-term	CWQG	Short-term	Long-term
Aluminum	-	-	0.1 [3]	-	-	0.1 [3]	-	-
Arsenic, dissolved	0.34	0.15	-	-	-	-	-	-
Arsenic, total	-	-	-	-	-	0.005	-	-
Boron	-	-	-	29	1.5	-	29	1.5
Cadmium, dissolved	0.00287 to 0.0114 [4]	0.000317 to 0.000848 [4]	-	-	-	-	0.00304 to 0.00770 [4]	0.000215 to 0.000370 [4]
Chloride	-	-	-	-	-	-	640	120
Chromium (III), dissolved	0.768 to 2.46 [4]	0.0999 to 0.320 [4]	-	-	-	0.0089 [5]	-	-
Copper, dissolved	0.0189 to 0.0724 [4]	0.0122 to 0.0412 [4]	-	-	-	0.00323 to 0.004 [4*]	-	-
Fluoride	-	-	-	-	-	0.12[5]		
Iron	-	-	≤0.3	-	-	0.3	-	-
Lead, dissolved	0.0958 to 0.421 [4]	0.00373 to 0.0164 [4]	-	-	-	0.00506 to 0.007 [4*]	-	-
Manganese, dissolved	-	-	-	-	-	-	9.2 to 14.8 [6]	0.120 to 0.650 [6]
Mercury	-	-	0.000026	-	-	0.000026 [5]	-	-
Molybdenum	-	-	0.073	-	-	0.073 [5]	-	-
Nickel, dissolved	0.637 to 2.12 [4]	0.0708 to 0.236 [4]	-	-	-	0.126 to 0.150 [4*]	-	-
Selenium, total	-	-	0.001	-	-	0.001	-	-
Silver, total	-	-	0.0001	-	-	-	-	0.00025
Thallium	-	-	0.0008	-	-	0.0008	-	-
Uranium	-	-	-	0.033	0.015	-	0.033	0.015
Zinc, dissolved	0.160 to 0.533 [4]	0.161 to 0.537 [4]	-	-	-	-	0.172 to 0.334 [7]	0.0193 to 0.230 [8]

1 - 1-hour averaging objective.

2 - 4-day averaging objective.

3 - Value represents the guideline where pH > 6.5.

4 - Calculated based on the range of hardness (144-597 mg/L) observed in all samples collected.

5 - Interim guideline

6 - Calculated based on the range of hardness (144-597 mg/L) and pH (7.49-8.80) observed in all samples collected.

7 - Calculated based on the range of hardness (144-597 mg/L) and dissolved organic carbon (DOC; 7.43-34.6 mg/L) observed in all samples collected.

8 - Calculated based on the range of hardness (144-597 mg/L), DOC (7.43-34.6 mg/L) and pH (7.49-8.80) observed in all samples collected.

Table A1-7. Manitoba and CCME guidelines for the protection of aquatic life for hydrocarbons.

Parameter	Units	PAL Guideline [1]
Benzene	mg/L	0.370
Ethyl benzene	mg/L	0.090
Toluene	mg/L	0.002
Acenaphthene	mg/L	0.0058
Acridine	mg/L	0.0044
Anthracene	mg/L	0.000012
Benzo(a)anthracene	mg/L	0.000018
Benzo(a)pyrene	mg/L	0.000015
Fluoranthene	mg/L	0.00004
Fluorene	mg/L	0.003
Naphthalene	mg/L	0.0011
Phenanthrene	mg/L	0.0004
Pyrene	mg/L	0.000025
Quinoline	mg/L	0.0034

1 - MWQSOG and CCME guidelines are the same for these parameters.

Table A1-8. Manitoba and CCME guidelines for the protection of aquatic life for pesticides.

Parameter	Unit	MWQSOG			CCME Guidelines		
		MWQG	Short-term	Long-term	CWQG	Short-term	Long-term
Aldrin	µg/L	-	-	-	-	-	0.004
alpha-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
beta-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
gamma-hexachlorocyclohexane	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
delta-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
a-chlordane	µg/L	-	-	-	-	-	0.006 [2]
g-chlordane	µg/L	-	-	-	-	-	0.006 [2]
Endosulfan	µg/L	-	0.06	0.003	-	0.06	0.003
Hexachlorobutadiene	µg/L	1.3	-	-	1.3	-	-
Bromoxynil	mg/L	0.005	-	-	-	-	0.005
2,4-D	mg/L	-	-	-	-	-	0.004
Dicamba	mg/L	0.01	-	-	-	-	0.01
Dinoseb	mg/L	0.00005	-	-	-	-	0.00005
MCPA	mg/L	0.0026	-	-	-	-	0.0026
Picloram	mg/L	0.029	-	-	-	-	0.029
Atrazine	µg/L	1.8 [3]	-	-	-	-	1.8
Atrazine+N-Dealkylated Metabolites	µg/L	1.8 [3]	-	-	-	-	-
Glyphosate	µg/L	65	-	-	-	27000	800
Diclofop-methyl	mg/L	0.0061	-	-	-	-	0.0061
Triallate	mg/L	0.00024	-	-	-	-	0.00024
Trifluralin	mg/L	0.00020	-	-	-	-	0.0002

APPENDIX 2. QUALITY ASSURANCE / QUALITY CONTROL RESULTS

Table A2-1. QA/QC results for routine parameters. Percent relative standard deviation (PRSD) values greater than 18 are indicated in red bold. Results for all blanks are less than five times the analytical detection limit. Values in blue italics are considered suspect.

				Alkalinity				Nitrogen			
Waterbody	Sampling Date	Site ID	ALS ID	Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Analytical DL				*1.0*	*1.2*	*0.60*	*0.34*	*0.010*	*0.0050 /0.010*	*0.0010 /0.0020*	*0.0051 /0.010*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	L2497954-4	188	230	<0.60	<0.34	0.030	<0.010	<0.0020	<0.010
		REP 2A	L2497954-8	189	230	<0.60	<0.34	0.031	<0.010	<0.0020	<0.010
		REP 2B	L2497954-9	192	234	<0.60	<0.34	0.031	<0.010	<0.0020	<0.010
		Mean		190	231	<0.60	<0.34	0.031	<0.010	<0.0020	<0.010
		SD		2.1	2.3	-	-	0.0006	-	-	-
		PRSD		1	1	-	-	-	-	-	-
Lake St. Martin	2-Sep-20	LSM1	L2498786-1	168	186	9.24	<0.34	<0.010	<0.010	<0.0020	<0.010
		REP-1A	L2498786-6	205	233	8.40	<0.34	<0.010	<0.010	<0.0020	<0.010
		REP-1B	L2498786-7	191	215	8.76	<0.34	<0.010	<0.010	<0.0020	<0.010
		Mean		188	211	8.80	<0.34	<0.010	<0.010	<0.0020	<0.010
		SD		18.7	23.7	0.421	-	-	-	-	-
		PRSD		10	11	5	-	-	-	-	-
Fairford River	13-Oct-20	FR1	L2516048-4	183	216	3.48	<0.34	<0.010	<0.010	<0.0020	<0.010
		REP-2A	L2516048-6	183	211	5.76	<0.34	<0.010	<0.010	<0.0020	<0.010
		REP-2B	L2516048-7	182	213	4.56	<0.34	0.010	<0.010	<0.0020	<0.010
		Mean		183	213	4.60	<0.34	<0.010	<0.010	<0.0020	<0.010
		SD		0.6	2.5	1.14	-	-	-	-	-
		PRSD		0	1	**25**	-	-	-	-	-

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Lake Winnipeg	18-Mar-21	SB1	L2568772-3	138	165	1.68	<0.34	0.027	0.0236	0.0010	0.0246
		REP-1A	L2568772-5	138	164	2.16	<0.34	0.026	0.0275	<0.0010	0.0275
		REP-1B	L2568772-6	138	164	2.28	<0.34	0.026	0.0208	<0.0010	0.0208
		Mean		138	164	2.04	<0.34	0.0263	0.0240	<0.0010	0.0243
		SD		0.0	0.6	0.32	-	0.00058	0.00337	-	0.00336
		PRSD		0	0	16	-	-	-	-	14
Dauphin River	18-Mar-21	DR-B	L2568772-1	248	302	<0.60	<0.34	0.151	0.044	0.0026	0.046
		REP-2A	L2568772-7	248	295	3.60	<0.34	0.155	0.023	<0.0020	0.023
		REP-2B	L2568772-8	249	294	4.80	<0.34	0.141	0.021	<0.0020	0.021
		Mean		248	297	2.90	<0.34	0.149	0.029	<0.0020	0.030
		SD		0.6	4.36	2.33	-	0.0072	0.013	-	0.0139
		PRSD		0	1	-	-	5	-	-	-
Lake St. Martin	19-May-21	REP-2A	L2590206-6	180	207	6.12	<0.34	0.022	<0.0050	<0.0010	<0.0051
		REP-2B	L2590206-7	183	212	5.16	<0.34	0.032	<0.0050	<0.0010	<0.0051
		LSM4	L2590206-1	182	210	5.52	<0.34	0.017	<0.0050	<0.0010	<0.0051
		Mean		182	210	5.60	<0.34	0.024	<0.0050	<0.0010	<0.0051
		SD		1.5	2.5	0.485	-	0.0076	-	-	-
		PRSD		1	1	9	-	-	-	-	-
Fairford River	18-May-21	REP-1A	L2590207-4	181	207	6.96	<0.34	0.041	<0.010	<0.0020	<0.010
		REP-1B	L2590207-5	183	210	6.12	<0.34	0.038	<0.010	<0.0020	<0.010
		FR2	L2590207-2	182	208	6.72	<0.34	0.041	<0.010	<0.0020	<0.010
		Mean		182	208	6.60	<0.34	0.040	<0.010	<0.0020	<0.010
		SD		1.0	1.5	0.433	-	0.0017	-	-	-
		PRSD		1	1	7	-	-	-	-	-

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Blanks											
Field Blanks	2-Sep-20	WB-1A	L2498786-5	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	3-Sep-20	WB-2A	L2498784-6	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	13-Oct-20	WB-2A	L2516048-8	1.6	2.0	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	15-Mar-21	WB-1A	L2567238-3	<1.0	<1.2	<0.60	<0.34	0.021	<0.0050	<0.0010	<0.0051
	18-Mar-21	WB-2A	L2568772-9	<1.0	<1.2	<0.60	<0.34	0.012	<0.0050	<0.0010	<0.0051
	18-May-21	WB-1A	L2590207-6	1.2	1.5	<0.60	<0.34	0.05	<0.0050	<0.0010	<0.0051
	19-May-21	WB-2A	L2590206-8	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
Trip Blanks	2-Sep-20	WB-1B	L2498784-8	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	3-Sep-20	WB-2B	L2498784-7	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	13-Oct-20	WB-2B	L2516048-9	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	15-Mar-21	WB-1B	L2567238-4	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	18-Mar-21	WB-2B	L2568772-10	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	18-May-21	WB-1B	L2590207-7	1.0	1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	19-May-21	WB-2B	L2590206-9	1.1	1.3	<0.60	<0.34	0.021	<0.0050	<0.0010	<0.0051

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Phosphorus: Dissolved Phosphorus (mg/L)	Phosphorus: Total Particulate Phosphorus (mg/L)	Phosphorus: Total Phosphorus (mg/L)	Carbon: Total Inorganic Carbon (mg/L)	Carbon: Total Organic Carbon (mg/L)	Carbon: Dissolved Organic Carbon (mg/L)	Carbon: Total Carbon (mg/L)
Analytical DL			*0.20*	*0.20*	*0.0010 /0.0030*	*0.0028 /0.0042*	*0.0010 /0.0030*	*0.50*	*0.50*	*0.50*	*1.0*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	1.18	1.18	0.0117	0.0264	0.0382	40.5	13.3	13.1	53.8
		REP 2A	1.13	1.13	0.0126	0.0267	0.0393	41.2	13.6	13.4	54.8
		REP 2B	1.13	1.13	0.0127	0.0254	0.0382	42.0	13.9	13.4	55.9
		Mean	1.15	1.15	0.0123	0.0262	0.0386	41.2	13.6	13.3	54.8
		SD	0.029	0.029	0.00055	0.00068	0.00064	0.75	0.30	0.17	1.05
		PRSD	3	3	4	3	2	2	2	1	2
Lake St. Martin	2-Sep-20	LSM1	1.30	1.30	0.0086	0.0162	0.0247	34.1	13.4	13.1	47.5
		REP-1A	1.29	1.29	0.0073	0.0181	0.0254	34.1	13.5	12.8	47.6
		REP-1B	1.27	1.27	0.0098	0.0163	0.0260	34.9	12.9	13.4	47.8
		Mean	1.29	1.29	0.0086	0.0169	0.0254	34.4	13.3	13.1	47.6
		SD	0.015	0.015	0.00125	0.00107	0.00065	0.46	0.32	0.30	0.15
		PRSD	1	1	15	-	3	1	2	2	0
Fairford River	13-Oct-20	FR1	1.41	1.41	0.0061	0.0314	0.0375	34.2	12.8	11.9	47.0
		REP-2A	1.17	1.17	0.0059	0.0274	0.0333	34.7	12.3	12.2	47.0
		REP-2B	1.59	1.59	0.0064	0.0284	0.0348	34.3	12.2	11.5	46.4
		Mean	1.39	1.39	0.0061	0.0291	0.0352	34.4	12.4	11.9	46.8
		SD	0.211	0.211	0.00025	0.00208	0.00213	0.26	0.32	0.35	0.35
		PRSD	15	15	4	7	6	1	3	3	1

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID			Phosphorus			Carbon			
			Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)
Lake Winnipeg	18-Mar-21	SB1	0.58	0.60	0.0183	0.0122	0.0305	31.6	9.4	9.30	41.1
		REP-1A	0.50	0.53	0.0180	0.0144	0.0324	30.6	9.34	9.22	39.9
		REP-1B	0.58	0.60	0.0202	0.0125	0.0326	31.6	9.15	9.27	40.8
		Mean	0.55	0.58	0.0188	0.0130	0.0318	31.3	9.31	9.26	40.6
		SD	0.046	0.040	0.00119	0.00119	0.00116	0.58	0.15	0.040	0.62
		PRSD	-	7	6	-	4	2	2	0	2
Dauphin River	18-Mar-21	DR-B	1.37	1.42	0.0105	0.0077	0.0182	59.0	15.9	15.8	74.9
		REP-2A	1.31	1.33	0.0105	0.0075	0.0180	54.2	16.2	15.8	70.5
		REP-2B	1.38	1.40	0.0123	0.0093	0.0215	57.7	15.8	16.0	73.5
		Mean	1.35	1.38	0.0111	0.0082	0.0199	57.0	16.0	15.9	73.0
		SD	0.038	0.047	0.00104	0.00099	0.00233	2.5	0.21	0.12	2.25
		PRSD	3	3	-	-	12	4	1	1	3
Lake St. Martin	19-May-21	REP-2A	1.23	1.23	0.008	0.0230	0.0305	37.0	14.4	14.0	51.3
		REP-2B	1.31	1.31	0.012	0.0160	0.0284	36.9	15.0	13.8	51.8
		LSM4	1.29	1.29	0.008	0.0185	0.0263	36.6	14.2	14.3	50.8
		Mean	1.28	1.28	0.009	0.0192	0.0284	36.8	14.5	14.0	51.3
		SD	0.042	0.042	0.0027	0.00355	0.00210	0.21	0.42	0.25	0.50
		PRSD	3	3	-	-	7	1	3	2	1
Fairford River	18-May-21	REP-1A	1.26	1.26	0.011	0.0253	0.0358	36.4	14.1	13.5	50.5
		REP-1B	1.29	1.29	0.006	0.0286	0.0350	36.5	14.0	13.6	50.4
		FR2	1.24	1.24	0.012	0.0190	0.0314	36.5	15.3	13.1	51.8
		Mean	1.26	1.26	0.010	0.0243	0.0341	36.5	14.5	13.4	50.9
		SD	0.025	0.025	0.00302	0.00488	0.00234	0.06	0.72	0.26	0.78
		PRSD	2	2	-	-	7	0	5	2	2

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID			Phosphorus			Carbon			
			Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)
Blanks											
Field Blanks	2-Sep-20	WB-1A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	1.31	<0.50	<0.50	1.3
	3-Sep-20	WB-2A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	0.64	<0.50	<0.50	<1.0
	13-Oct-20	WB-2A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	0.66	<0.50	<0.50	<1.0
	15-Mar-21	WB-1A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	18-Mar-21	WB-2A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	18-May-21	WB-1A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	19-May-21	WB-2A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
Trip Blanks	2-Sep-20	WB-1B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	3-Sep-20	WB-2B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	13-Oct-20	WB-2B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	15-Mar-21	WB-1B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	18-Mar-21	WB-2B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	18-May-21	WB-1B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	19-May-21	WB-2B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	Routine Chemistry				Water Clarity			Algal Pigments	
			Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Analytical DL			*0.10*	*1*	*4.0/20*	*0.2*	*1.0*	*0.1*	*5.0*	*0.10*	*0.10*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	8.06	1090	628	255	8.5	6.57	15.9	6.77	4.54
		REP 2A	8.07	1090	636	250	8.8	6.06	17.8	7.40	4.84
		REP 2B	8.03	1090	632	263	6.4	4.57	18.7	6.78	4.82
		Mean	8.05	1090	632	256	7.9	5.73	17.5	6.98	4.73
		SD	0.021	0.0	4.0	6.6	1.31	1.04	1.43	0.361	0.168
		PRSD	0	0	1	3	17	18	-	5	4
Lake St. Martin	2-Sep-20	LSM1	8.53	1050	618	234	17.8	11.7	5.0	8.00	2.09
		REP-1A	8.55	1040	597	237	16.6	11.5	6.5	7.39	1.82
		REP-1B	8.54	1050	620	241	17.5	11.4	5.8	7.97	2.38
		Mean	8.54	1047	612	237	17.3	11.5	5.8	7.79	2.10
		SD	0.010	5.8	12.7	3.5	0.62	0.15	0.75	0.344	0.280
		PRSD	0	1	2	1	4	1	-	4	13
Fairford River	13-Oct-20	FR1	8.30	1150	626	252	42.0	30.9	5.7	10.9	2.48
		REP-2A	8.35	1150	620	243	44.3	33.8	7.1	11.2	2.63
		REP-2B	8.34	1140	622	242	42.6	32.4	6.9	10.5	2.47
		Mean	8.33	1147	623	246	43.0	32.4	6.6	10.9	2.53
		SD	0.026	5.8	3.1	5.5	1.19	1.45	0.76	0.35	0.090
		PRSD	0	1	0	2	3	4	-	3	4

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	Routine Chemistry				Water Clarity			Algal Pigments	
			Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Lake Winnipeg	18-Mar-21	SB1	8.23	531	309	173	<1.0	4.72	7.3	9.25	2.48
		REP-1A	8.29	527	290	171	1.3	4.81	7.4	9.73	2.72
		REP-1B	8.30	532	291	174	1.4	4.61	8.1	9.53	2.67
		Mean	8.27	530	297	173	1.1	4.71	7.6	9.50	2.62
		SD	0.038	2.6	10.7	1.5	0.49	0.100	0.44	0.241	0.127
		PRSD	0	0	4	1	-	2	6	3	5
Dauphin River	18-Mar-21	DR-B	8.27	1540	851	351	1.6	1.33	<5.0	1.70	1.42
		REP-2A	8.30	1530	841	345	1.9	1.27	<5.0	1.77	1.51
		REP-2B	8.33	1530	808	346	2.2	1.29	<5.0	1.93	1.50
		Mean	8.30	1533	833	347	1.9	1.30	<5.0	1.80	1.48
		SD	0.030	5.8	22.5	3.2	0.3	0.03	-	0.118	0.049
		PRSD	0	0	3	1	16	2	-	7	3
Lake St. Martin	19-May-21	REP-2A	8.38	1120	587	260	8.4	4.95	<5.0	12.0	7.17
		REP-2B	8.38	1120	613	258	7.3	5.46	5.2	12.5	6.86
		LSM4	8.36	1120	559	263	7.9	5.08	6.2	5.96	3.44
		Mean	8.37	1120	586	260	7.9	5.16	<5.0	10.2	5.82
		SD	0.012	0.0	27.0	2.5	0.55	0.265	1.9	3.64	2.07
		PRSD	0	0	5	1	7	5	-	**36**	**36**
Fairford River	18-May-21	REP-1A	8.40	1170	662	263	15.5	10.7	<5.0	9.08	4.11
		REP-1B	8.38	1180	640	262	***83.6***	***36.2***	<5.0	***13.4***	***6.78***
		FR2	8.40	1160	640	263	16.8	8.08	<5.0	8.81	4.17
		Mean	8.39	1170	647	263	38.6	18.3	<5.0	10.4	5.02
		SD	0.012	10.0	12.7	0.6	38.9	15.5	-	2.58	1.52
		PRSD	0	1	2	0	**101**	**85**	-	**25**	**30**

Table A2-1. Continued.

Waterbody	Sampling Date	Site ID	Routine Chemistry				Water Clarity			Algal Pigments	
			Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Blanks											
Field Blanks	2-Sep-20	WB-1A	5.38	1.2	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	3-Sep-20	WB-2A	5.53	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	13-Oct-20	WB-2A	6.06	3.3	<4.0	<0.20	<1.0	0.22	<5.0	<0.10	<0.10
	15-Mar-21	WB-1A	5.71	<1.0	4.1	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	18-Mar-21	WB-2A	5.75	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	18-May-21	WB-1A	5.65	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	19-May-21	WB-2A	5.58	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
Trip Blanks	2-Sep-20	WB-1B	5.45	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	0.20
	3-Sep-20	WB-2B	5.45	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	0.11
	13-Oct-20	WB-2B	5.85	1.2	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	15-Mar-21	WB-1B	5.67	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	18-Mar-21	WB-2B	5.65	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	18-May-21	WB-1B	5.45	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	19-May-21	WB-2B	5.44	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10

Table A2-2. QA/QC results for metals and major ions (mg/L). Percent relative standard deviation (PRSD) values greater than 18 are indicated in red bold. Results for all blanks are less than five times the analytical detection limit.

Waterbody	Sampling Date	Site ID	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	L2497954-4	0.0037	0.0804	0.00015	0.00016	0.00215	0.00215	0.0442	0.0449
		REP 2A	L2497954-8	0.0050	0.0727	0.00021	0.00018	0.00215	0.00213	0.0452	0.0455
		REP 2B	L2497954-9	0.0032	0.0526	0.00017	0.00018	0.00209	0.00215	0.0461	0.0454
		Mean		0.0040	0.0686	0.00018	0.00017	0.00213	0.00214	0.0452	0.0453
		SD		0.00093	0.0144	0.000031	0.000012	0.000035	0.000012	0.00095	0.00032
		PRSD		-	**21**	-	-	2	1	2	1
Lake St. Martin	2-Sep-20	LSM1	L2498786-1	0.0038	0.0947	0.00016	0.00018	0.00226	0.00225	0.0383	0.0411
		REP-1A	L2498786-6	0.0040	0.0941	0.00016	0.00018	0.00230	0.00222	0.0377	0.0402
		REP-1B	L2498786-7	0.0045	0.0982	0.00017	0.00025	0.00235	0.00231	0.0378	0.0408
		Mean		0.0041	0.0957	0.00016	0.00020	0.00230	0.00226	0.0379	0.0407
		SD		0.00036	0.00221	0.000006	0.000040	0.000045	0.000046	0.00032	0.00046
		PRSD		-	2	-	-	2	2	1	1
Fairford River	13-Oct-20	FR1	L2516048-4	0.0086	0.220	0.00019	0.00021	0.00206	0.00213	0.0442	0.0475
		REP-2A	L2516048-6	0.0143	0.220	0.00019	0.00020	0.00205	0.00220	0.0450	0.0471
		REP-2B	L2516048-7	0.0155	0.206	0.00019	0.00020	0.00208	0.00219	0.0450	0.0479
		Mean		0.0128	0.215	0.00019	0.00020	0.00206	0.00217	0.0447	0.0475
		SD		0.00369	0.00808	0.000000	0.000006	0.000015	0.000038	0.00046	0.00040
		PRSD		**29**	4	-	-	1	2	1	1

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Winnipeg	18-Mar-21	SB1	L2568772-3	0.0362	0.224	0.00016	0.00023	0.00192	0.00188	0.0422	0.0446
		REP-1A	L2568772-5	0.0345	0.219	0.00015	0.00050	0.00184	0.00187	0.0421	0.0441
		REP-1B	L2568772-6	0.0379	0.209	0.00023	0.00053	0.00181	0.00188	0.0426	0.0440
		Mean		0.0362	0.217	0.00018	0.00042	0.00186	0.00188	0.0423	0.0442
		SD		0.00170	0.0076	0.000044	0.000165	0.000057	0.000006	0.000265	0.00032
		PRSD		5	4	-	-	3	0	1	1
Dauphin River	18-Mar-21	DR-B	L2568772-1	0.0021	0.0115	0.00024	0.00028	0.00261	0.00244	0.0568	0.0579
		REP-2A	L2568772-7	0.0013	0.0117	0.00026	0.00026	0.00238	0.00240	0.0575	0.0568
		REP-2B	L2568772-8	<0.0010	0.0121	0.00022	0.00027	0.00241	0.00245	0.0582	0.0575
		Mean		0.0013	0.0118	0.00024	0.00027	0.00247	0.00243	0.0575	0.0574
		SD		0.00080	0.00031	0.000020	0.000010	0.000125	0.000026	0.000700	0.00056
		PRSD		-	3	-	4	5	1	1	1
Lake St. Martin	19-May-21	REP-2A	L2590206-6	0.0033	0.057	0.00017	0.0002	0.00204	0.0020	0.0424	0.044
		REP-2B	L2590206-7	0.0030	0.061	0.00017	0.0002	0.00208	0.0020	0.0426	0.045
		LSM4	L2590206-1	0.0033	0.068	0.00020	0.0002	0.00208	0.0021	0.0427	0.045
		Mean		0.0032	0.062	0.0002	0.0002	0.00207	0.0020	0.0426	0.045
		SD		0.00017	0.0054	0.00002	0.00001	0.000023	0.00004	0.00015	0.0004
		PRSD		-	9	-	6	1	2	0	1
Fairford River	18-May-21	REP-1A	L2590207-4	0.0025	0.179	0.00017	0.00020	0.00187	0.0019	0.0411	0.045
		REP-1B	L2590207-5	0.0024	0.179	0.00017	0.00019	0.00195	0.0020	0.0413	0.046
		FR2	L2590207-2	0.0022	0.134	0.00017	0.00019	0.00198	0.0020	0.0415	0.044
		Mean		0.0024	0.164	0.00017	0.00019	0.00193	0.0020	0.0413	0.045
		SD		0.00015	0.0260	0.000000	0.000006	0.000057	0.00004	0.00020	0.0007
		PRSD		-	16	-	3	3	2	0	2

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Blanks											
Field Blanks	2-Sep-20	WB-1A	L2498786-5	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	0.00011	<0.00010	<0.00010
	3-Sep-20	WB-2A	L2498784-6	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	13-Oct-20	WB-2A	L2516048-8	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	15-Mar-21	WB-1A	L2567238-3	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	18-Mar-21	WB-2A	L2568772-9	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	18-May-21	WB-1A	L2590207-6	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	19-May-21	WB-2A	L2590206-8	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blanks	2-Sep-20	WB-1B	L2498784-8	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	3-Sep-20	WB-2B	L2498784-7	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	2-Sep-20	WB-1B	L2498784-8	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	13-Oct-20	WB-2B	L2516048-9	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	15-Mar-21	WB-1B	L2567238-4	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	18-Mar-21	WB-2B	L2568772-10	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	18-May-21	WB-1B	L2590207-7	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	19-May-21	WB-2B	L2590206-9	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Replicates										
Mercer Creek	1-Sep-20	MC-WB	<0.00010	<0.00010	<0.000050	<0.000050	0.096	0.085	<0.0000050	<0.0000050
		REP 2A	<0.00010	<0.00010	<0.000050	<0.000050	0.090	0.080	<0.0000050	<0.0000050
		REP 2B	<0.00010	<0.00010	<0.000050	<0.000050	0.091	0.084	<0.0000050	<0.0000050
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.092	0.083	<0.0000050	<0.0000050
		SD	-	-	-	-	0.0032	0.0026	-	-
		PRSD	-	-	-	-	3	3	-	-
Lake St. Martin	2-Sep-20	LSM1	<0.00010	<0.00010	<0.000050	<0.000050	0.088	0.089	<0.0000050	<0.0000050
		REP-1A	<0.00010	<0.00010	<0.000050	<0.000050	0.094	0.085	<0.0000050	<0.0000050
		REP-1B	<0.00010	<0.00010	<0.000050	<0.000050	0.094	0.091	<0.0000050	<0.0000050
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.092	0.088	<0.0000050	<0.0000050
		SD	-	-	-	-	0.0035	0.0031	-	-
		PRSD	-	-	-	-	4	3	-	-
Fairford River	13-Oct-20	FR1	<0.00010	<0.00010	<0.000050	<0.000050	0.113	0.110	<0.0000050	0.0000090
		REP-2A	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.110	<0.0000050	0.0000058
		REP-2B	<0.00010	<0.00010	<0.000050	<0.000050	0.111	0.113	<0.0000050	0.0000105
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.111	<0.0000050	0.0000084
		SD	-	-	-	-	0.0010	0.0017	-	0.00000240
		PRSD	-	-	-	-	1	2	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake Winnipeg	18-Mar-21	SB1	<0.00010	<0.00010	<0.000050	<0.000050	0.045	0.049	<0.0000050	0.0000066
		REP-1A	<0.00010	<0.00010	<0.000050	<0.000050	0.044	0.046	<0.0000050	<0.0000050
		REP-1B	<0.00010	<0.00010	<0.000050	<0.000050	0.048	0.046	0.0000073	0.0000079
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.0457	0.047	<0.0000050	0.0000057
		SD	-	-	-	-	0.0021	0.0017	-	0.0000028
		PRSD	-	-	-	-	5	4	-	-
Dauphin River	18-Mar-21	DR-B	<0.00010	<0.00010	<0.000050	<0.000050	0.135	0.142	<0.0000050	0.0000056
		REP-2A	<0.00010	<0.00010	<0.000050	<0.000050	0.155	0.145	0.0000057	<0.0000050
		REP-2B	<0.00010	<0.00010	<0.000050	<0.000050	0.158	0.144	<0.0000050	<0.0000050
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.149	0.144	<0.0000050	<0.0000050
		SD	-	-	-	-	0.0125	0.0015	-	-
		PRSD	-	-	-	-	8	1	-	-
Lake St. Martin	19-May-21	REP-2A	<0.00010	<0.00010	<0.000050	<0.000050	0.106	0.099	<0.0000050	<0.0000050
		REP-2B	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.098	<0.0000050	<0.0000050
		LSM4	<0.00010	<0.00010	<0.000050	<0.000050	0.103	0.100	<0.0000050	0.0000063
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.099	<0.0000050	<0.0000050
		SD	-	-	-	-	0.0015	0.0010	-	-
		PRSD	-	-	-	-	1	1	-	-
Fairford River	18-May-21	REP-1A	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.111	<0.0000050	0.0000074
		REP-1B	<0.00010	<0.00010	<0.000050	<0.000050	0.109	0.113	<0.0000050	0.0000063
		FR2	<0.00010	<0.00010	<0.000050	<0.000050	0.108	0.113	<0.0000050	0.0000062
		Mean	<0.00010	<0.00010	<0.000050	<0.000050	0.110	0.112	<0.0000050	0.0000066
		SD	-	-	-	-	0.0021	0.0012	-	0.0000007
		PRSD	-	-	-	-	2	1	-	10

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Blanks										
Field Blanks	2-Sep-20	WB-1A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	3-Sep-20	WB-2A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	13-Oct-20	WB-2A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	15-Mar-21	WB-1A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	18-Mar-21	WB-2A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	0.011	<0.0000050	<0.0000050
	18-May-21	WB-1A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	19-May-21	WB-2A	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
Trip Blanks	2-Sep-20	WB-1B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	3-Sep-20	WB-2B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	2-Sep-20	WB-1B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	13-Oct-20	WB-2B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	15-Mar-21	WB-1B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	18-Mar-21	WB-2B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	18-May-21	WB-1B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050
	19-May-21	WB-2B	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010	<0.0000050	<0.0000050

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical DL			*0.05*	*0.050*	*0.000010*	*0.000010*	*0.10/0.20*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	38.9	39.3	<0.000010	<0.000010	200	<0.00010	0.00021	<0.00010	<0.00010
		REP 2A	37.9	39.0	<0.000010	<0.000010	201	<0.00010	0.00018	<0.00010	<0.00010
		REP 2B	40.1	40.2	<0.000010	<0.000010	199	<0.00010	0.00014	<0.00010	<0.00010
		Mean	39.0	39.5	<0.000010	<0.000010	200	<0.00010	0.00018	<0.00010	<0.00010
		SD	1.10	0.62	-	-	1.0	-	0.000035	-	-
		PRSD	3	2	-	-	1	-	-	-	-
Lake St. Martin	2-Sep-20	LSM1	33.8	36.4	<0.000010	0.000010	198	<0.00010	0.00025	<0.00010	0.00012
		REP-1A	33.9	35.5	<0.000010	0.000012	200	<0.00010	0.00020	<0.00010	0.00010
		REP-1B	33.7	35.1	<0.000010	0.000028	200	<0.00010	0.00025	<0.00010	0.00012
		Mean	33.8	35.7	<0.000010	0.000017	199	<0.00010	0.00023	<0.00010	0.00011
		SD	0.10	0.67	-	0.0000099	1.2	-	0.000029	-	0.000012
		PRSD	0	2	-	-	1	-	-	-	-
Fairford River	13-Oct-20	FR1	44.3	44.8	<0.000010	0.000033	205	<0.00010	0.00053	<0.00010	0.00018
		REP-2A	42.4	44.2	<0.000010	0.000030	206	<0.00010	0.00049	<0.00010	0.00018
		REP-2B	41.4	45.7	<0.000010	0.000029	206	<0.00010	0.00046	<0.00010	0.00018
		Mean	42.7	44.9	<0.000010	0.000031	206	<0.00010	0.00049	<0.00010	0.00018
		SD	1.47	0.75	-	0.0000021	0.6	-	0.000035	-	0.000000
		PRSD	3	2	-	-	0	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical DL			*0.05*	*0.050*	*0.000010*	*0.000010*	*0.10/0.20*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Winnipeg	18-Mar-21	SB1	33.4	36.4	<0.000010	0.000012	49.9	<0.00010	0.00025	<0.00010	<0.00010
		REP-1A	32.7	35.7	<0.000010	0.000013	47.6	<0.00010	0.00026	<0.00010	<0.00010
		REP-1B	34.3	35.0	<0.000010	0.000013	51.4	<0.00010	0.00023	<0.00010	<0.00010
		Mean	33.5	35.7	<0.000010	0.000013	49.6	<0.00010	0.00025	<0.00010	<0.00010
		SD	0.80	0.70	-	0.0000006	1.91	-	0.000015	-	-
		PRSD	2	2	-	-	4	-	6	-	-
Dauphin River	18-Mar-21	DR-B	55.8	56.9	<0.000010	<0.000010	265	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2A	55.4	57.7	<0.000010	<0.000010	267	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2B	56.3	56.5	<0.000010	<0.000010	267	<0.00010	<0.00010	<0.00010	<0.00010
		Mean	55.8	57.0	<0.000010	<0.000010	266	<0.00010	<0.00010	<0.00010	<0.00010
		SD	0.45	0.61	-	-	1.15	-	-	-	-
		PRSD	1	1	-	-	0.4	-	-	-	-
Lake St. Martin	19-May-21	REP-2A	40.7	40.0	<0.000010	<0.000010	195	<0.00010	0.00010	<0.00010	<0.00010
		REP-2B	40.6	39.7	<0.000010	<0.000010	201	<0.00010	0.00013	<0.00010	<0.00010
		LSM4	41.5	40.6	<0.000010	<0.000010	196	<0.00010	0.00018	<0.00010	<0.00010
		Mean	40.9	40.1	<0.000010	<0.000010	197	<0.00010	0.00014	<0.00010	<0.00010
		SD	0.49	0.46	-	-	3.2	-	0.000040	-	-
		PRSD	1	1	-	-	2	-	-	-	-
Fairford River	18-May-21	REP-1A	41.5	45.0	<0.000010	0.000028	219	<0.00010	0.00045	<0.00010	0.00016
		REP-1B	40.4	45.1	<0.000010	0.000028	221	<0.00010	0.00044	<0.00010	0.00015
		FR2	41.2	44.4	<0.000010	0.000020	217	<0.00010	0.00033	<0.00010	0.00013
		Mean	41.0	44.8	<0.000010	0.000025	219	<0.00010	0.00041	<0.00010	0.00015
		SD	0.57	0.38	-	0.0000046	2.0	-	0.000067	-	0.0000153
		PRSD	1	1	-	-	1	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical DL			*0.05*	*0.050*	*0.000010*	*0.000010*	*0.10/0.20*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Blanks											
Field Blanks	2-Sep-20	WB-1A	<0.050	0.066	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	3-Sep-20	WB-2A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	13-Oct-20	WB-2A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	15-Mar-21	WB-1A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	18-Mar-21	WB-2A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	18-May-21	WB-1A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	19-May-21	WB-2A	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blanks	2-Sep-20	WB-1B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	0.00014	<0.00010	<0.00010
	3-Sep-20	WB-2B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	2-Sep-20	WB-1B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	0.00014	<0.00010	<0.00010
	13-Oct-20	WB-2B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	15-Mar-21	WB-1B	<0.050	<0.050	<0.000010	<0.000010	0.14	<0.00010	<0.00010	<0.00010	<0.00010
	18-Mar-21	WB-2B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	18-May-21	WB-1B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010
	19-May-21	WB-2B	<0.050	<0.050	<0.000010	<0.000010	<0.10	<0.00010	<0.00010	<0.00010	<0.00010

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*		*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	0.00020	<0.00050	0.154	<0.010	0.068	<0.000050	0.000101	0.0351	0.0309
		REP 2A	0.00021	<0.00050	0.155	<0.010	0.070	<0.000050	0.000094	0.0322	0.0308
		REP 2B	<0.00020	<0.00050	0.152	<0.010	0.047	<0.000050	0.000083	0.0326	0.0314
		Mean	<0.00020	<0.00050	0.154	<0.010	0.062	<0.000050	0.000093	0.0333	0.0310
		SD	0.000007	-	0.0015	-	0.0127	-	0.0000091	0.00157	0.00032
		PRSD	-	-	1	-	-	-	10	5	1
Lake St. Martin	2-Sep-20	LSM1	0.00026	<0.00050	0.156	<0.010	0.082	<0.000050	0.000201	0.0322	0.0325
		REP-1A	0.00026	<0.00050	0.160	<0.010	0.079	<0.000050	0.000198	0.0343	0.0312
		REP-1B	0.00026	<0.00050	0.158	<0.010	0.085	<0.000050	0.000223	0.0344	0.0328
		Mean	0.00026	<0.00050	0.158	<0.010	0.082	<0.000050	0.000207	0.0336	0.0322
		SD	0.000000	-	0.0020	-	0.0030	-	0.0000137	0.00124	0.00085
		PRSD	-	-	1	-	4	-	7	4	3
Fairford River	13-Oct-20	FR1	0.00032	0.00071	0.159	<0.010	0.246	<0.000050	0.000364	0.0387	0.0364
		REP-2A	0.00031	0.00067	0.160	<0.010	0.235	<0.000050	0.000348	0.0390	0.0368
		REP-2B	0.00033	0.00069	0.080	<0.010	0.232	<0.000050	0.000356	0.0383	0.0379
		Mean	0.00032	0.00069	0.133	<0.010	0.238	<0.000050	0.000356	0.0387	0.0370
		SD	0.000010	0.000020	0.046	-	0.0074	-	0.0000080	0.00035	0.00078
		PRSD	-	-	-	-	3	-	2	1	2

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.020*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake Winnipeg	18-Mar-21	SB1	0.00147	0.00193	0.132	<0.010	0.098	<0.000050	0.000077	0.016	0.0181
		REP-1A	0.00137	0.00177	0.132	<0.010	0.101	<0.000050	0.000078	0.0156	0.0172
		REP-1B	0.00156	0.00179	0.129	<0.010	0.098	<0.000050	0.000096	0.0165	0.0172
		Mean	0.00147	0.00183	0.131	<0.010	0.099	<0.000050	0.000084	0.0160	0.0175
		SD	0.000095	0.000087	0.0017	-	0.0017	-	0.0000107	0.00045	0.00052
		PRSD	6	-	1	-	2	-	-	3	3
Dauphin River	18-Mar-21	DR-B	0.00038	0.00057	0.218	<0.010	0.013	<0.000050	<0.000050	0.0454	0.0481
		REP-2A	0.00036	0.00080	0.224	<0.010	0.013	<0.000050	0.000054	0.0465	0.0509
		REP-2B	0.00037	<0.00050	0.212	<0.010	0.013	<0.000050	<0.000050	0.0485	0.0495
		Mean	0.00037	0.00054	0.218	<0.010	0.013	<0.000050	<0.000050	0.0468	0.0495
		SD	0.000010	0.000276	0.0060	-	0.000	-	-	0.00157	0.00140
		PRSD	-	-	3	-	-	-	-	3	3
Lake St. Martin	19-May-21	REP-2A	0.00032	<0.00050	0.162	<0.010	0.043	<0.000050	0.000110	0.0341	0.0333
		REP-2B	0.00033	<0.00050	0.166	<0.010	0.047	<0.000050	0.000119	0.0339	0.0318
		LSM4	0.00079	0.00072	0.163	<0.010	0.046	<0.000050	0.000122	0.0333	0.0340
		Mean	0.00048	<0.00050	0.164	<0.010	0.045	<0.000050	0.000117	0.0338	0.0330
		SD	0.000269	-	0.0021	-	0.0021	-	0.000006	0.00042	0.00112
		PRSD	-	-	1	-	-	-	5	1	3
Fairford River	18-May-21	REP-1A	0.00050	0.00086	0.156	<0.010	0.215	<0.000050	0.000198	0.0365	0.0381
		REP-1B	0.00040	0.00073	0.154	<0.010	0.220	<0.000050	0.000248	0.0358	0.0389
		FR2	0.00037	0.00067	0.160	<0.010	0.159	<0.000050	0.000169	0.0363	0.0378
		Mean	0.00042	0.00075	0.157	<0.010	0.198	<0.000050	0.000205	0.0362	0.0383
		SD	0.000068	0.00010	0.0031	-	0.0339	-	0.0000400	0.00036	0.00057
		PRSD	-	13	2	-	17	-	-	1	1

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*		*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Blanks											
Field Blanks	2-Sep-20	WB-1A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	3-Sep-20	WB-2A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	13-Oct-20	WB-2A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	15-Mar-21	WB-1A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	18-Mar-21	WB-2A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	18-May-21	WB-1A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	19-May-21	WB-2A	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
Trip Blanks	2-Sep-20	WB-1B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	3-Sep-20	WB-2B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	2-Sep-20	WB-1B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	13-Oct-20	WB-2B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	15-Mar-21	WB-1B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	18-Mar-21	WB-2B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	18-May-21	WB-1B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010
	19-May-21	WB-2B	<0.00020	<0.00050	<0.020	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.0050*	*0.0050*	*0.00010*	*0.00010*	*0.0000005*	*0.0000005*	*0.000050*	*0.000050*
Replicates										
Mercer Creek	1-Sep-20	MC-WB	38.3	38.9	0.00038	0.00759	<0.00000050	0.00000056	0.00218	0.00219
		REP 2A	37.8	38.8	<0.00010	0.00769	<0.00000050	0.00000060	0.00223	0.00219
		REP 2B	39.5	39.0	<0.00010	0.00726	<0.00000050	0.00000064	0.00210	0.00219
		Mean	38.5	38.9	0.00016	0.00751	<0.00000050	0.00000060	0.00217	0.00219
		SD	0.9	0.10	-	0.000225	-	0.00000004	0.000066	0.000000
		PRSD	2	0	-	3	-	-	3	0
Lake St. Martin	2-Sep-20	LSM1	36.4	36.3	<0.00010	0.00915	<0.00000050	0.00000081	0.00232	0.00229
		REP-1A	37.0	34.5	<0.00010	0.00891	<0.00000050	0.00000078	0.00234	0.00228
		REP-1B	38.0	36.7	<0.00010	0.00933	<0.00000050	0.00000082	0.00231	0.00238
		Mean	37.1	35.8	<0.00010	0.00913	<0.00000050	0.00000080	0.00232	0.00232
		SD	0.8	1.17	-	0.000211	-	0.00000002	0.000015	0.000055
		PRSD	2	3	-	2	-	-	1	2
Fairford River	13-Oct-20	FR1	34.4	39.8	0.00013	0.0161	<0.00000050	0.00000105	0.00228	0.00241
		REP-2A	33.3	40.4	0.00011	0.0156	<0.00000050	0.00000114	0.00221	0.00233
		REP-2B	33.6	40.2	<0.00010	0.0161	<0.00000050	0.00000116	0.00222	0.00240
		Mean	33.8	40.1	<0.00010	0.0159	<0.00000050	0.00000112	0.00224	0.00238
		SD	0.6	0.31	0.000042	0.00029	-	0.00000006	0.000038	0.000044
		PRSD	2	1	-	2	-	-	2	2

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.0050*	*0.0050*	*0.00010*	*0.00010*	*0.0000005*	*0.0000005*	*0.000050*	*0.000050*
Lake Winnipeg	18-Mar-21	SB1	21.8	22.3	<0.00010	0.00142	<0.00000050	0.00000066	0.00121	0.00123
		REP-1A	21.6	21.5	<0.00010	0.00137	<0.00000050	0.00000072	0.00118	0.00123
		REP-1B	21.5	21	<0.00010	0.00146	<0.00000050	0.00000132	0.00122	0.00124
		Mean	21.6	21.6	<0.00010	0.00142	<0.00000050	0.00000090	0.00120	0.00123
		SD	0.15	0.66	-	0.000045	-	0.000000365	0.000021	0.000006
		PRSD	1	3	-	3	-	-	2	0
Dauphin River	18-Mar-21	DR-B	51.5	51.3	0.00010	0.00558	<0.00000050	<0.00000050	0.00275	0.00285
		REP-2A	50.2	49.8	0.00013	0.00556	<0.00000050	<0.00000050	0.00280	0.00277
		REP-2B	49.8	50.2	<0.00010	0.00547	<0.00000050	<0.00000050	0.00280	0.00279
		Mean	50.5	50.4	<0.00010	0.00554	<0.00000050	<0.00000050	0.00278	0.00280
		SD	0.89	0.78	-	0.000059	-	-	0.000029	0.000042
		PRSD	2	2	-	1	-	-	1	1
Lake St. Martin	19-May-21	REP-2A	38.6	38.1	0.00015	0.00694	<0.00000050	0.00000057	0.00231	0.00223
		REP-2B	38.1	38.2	0.00011	0.00735	<0.00000050	<0.00000050	0.00227	0.00225
		LSM4	38.7	38.9	0.00011	0.00705	<0.00000050	0.00000063	0.00227	0.00228
		Mean	38.5	38.4	0.00012	0.00711	<0.00000050	<0.00000050	0.00228	0.00225
		SD	0.32	0.44	0.000023	0.000212	-	0.000000204	0.000023	0.000025
		PRSD	1	1	-	3	-	-	1	1
Fairford River	18-May-21	REP-1A	38.7	40.5	<0.00010	0.0110	0.00000067	0.00000080	0.00217	0.00220
		REP-1B	39.1	41.0	0.00011	0.0108	<0.00000050	0.00000076	0.0022	0.00226
		FR2	39.0	40.2	<0.00010	0.0089	<0.00000050	0.00000082	0.00218	0.00222
		Mean	38.9	40.6	<0.00010	0.0102	<0.00000050	0.00000079	0.00218	0.00223
		SD	0.21	0.40	-	0.00115	-	0.000000031	0.000015	0.000031
		PRSD	1	1	-	11	-	-	1	1

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.0050*	*0.0050*	*0.00010*	*0.00010*	*0.0000005*	*0.0000005*	*0.000050*	*0.000050*
Blanks										
Field Blanks	2-Sep-20	WB-1A	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	3-Sep-20	WB-2A	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	13-Oct-20	WB-2A	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	15-Mar-21	WB-1A	<0.0050	0.0064	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	18-Mar-21	WB-2A	<0.0050	0.0085	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	18-May-21	WB-1A	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	19-May-21	WB-2A	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
Trip Blanks	2-Sep-20	WB-1B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	3-Sep-20	WB-2B	<0.0050	0.0051	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	2-Sep-20	WB-1B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	13-Oct-20	WB-2B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	15-Mar-21	WB-1B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	18-Mar-21	WB-2B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	18-May-21	WB-1B	<0.0050	0.0057	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050
	19-May-21	WB-2B	<0.0050	<0.0050	<0.00010	<0.00010	<0.0000005	<0.00000050	<0.000050	<0.000050

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*
Replicates										
Mercer Creek	1-Sep-20	MC-WB	<0.00050	0.00069	9.90	9.89	0.00403	0.00401	0.000078	<0.000050
		REP 2A	0.00052	0.00063	10.1	10.1	0.00403	0.00406	0.000105	<0.000050
		REP 2B	0.00052	0.00063	9.94	10.0	0.00411	0.00399	0.000069	<0.000050
		Mean	<0.00050	0.00065	9.98	10.0	0.00406	0.00402	0.000084	<0.000050
		SD	0.000156	0.000035	0.106	0.11	0.000046	0.000036	0.0000187	-
		PRSD	-	-	1	1	1	1	-	-
Lake St. Martin	2-Sep-20	LSM1	<0.00050	0.00071	9.45	9.45	0.00427	0.00440	0.000076	0.000076
		REP-1A	<0.00050	0.00065	9.87	9.62	0.00410	0.00427	0.000073	0.000080
		REP-1B	<0.00050	0.00072	10.0	9.79	0.00423	0.00438	0.000079	0.000102
		Mean	<0.00050	0.00069	9.77	9.6	0.00420	0.00435	0.000076	0.000086
		SD	-	0.000038	0.287	0.17	0.000089	0.000070	0.0000030	0.0000140
		PRSD	-	-	3	2	2	2	-	-
Fairford River	13-Oct-20	FR1	0.00053	0.00109	10.4	10.3	0.00409	0.00451	0.000092	0.000101
		REP-2A	0.00051	0.00104	9.63	10.4	0.00402	0.00448	0.000058	0.000109
		REP-2B	<0.00050	0.00104	10.2	10.6	0.00406	0.00448	0.000056	0.000086
		Mean	<0.00050	0.00106	10.1	10.4	0.00406	0.00449	0.000069	0.000099
		SD	0.000156	0.000029	0.40	0.15	0.000035	0.000017	0.0000202	0.0000117
		PRSD	-	-	4	1	1	0	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*
Lake Winnipeg	18-Mar-21	SB1	0.00088	0.00114	4.8	4.83	0.00185	0.00214	0.000143	0.000135
		REP-1A	0.00085	0.00109	4.8	4.65	0.00174	0.00207	0.000162	0.000147
		REP-1B	0.00088	0.00105	4.9	4.66	0.00183	0.00196	0.000141	0.000091
		Mean	0.00087	0.00109	4.8	4.71	0.00181	0.00206	0.000149	0.000124
		SD	0.000017	0.000045	0.07	0.101	0.000059	0.0000907	0.0000116	0.0000295
		PRSD	2	4	1	2	3	4	-	-
Dauphin River	18-Mar-21	DR-B	0.00071	0.00081	13.2	13.1	0.00514	0.00510	0.000081	0.000097
		REP-2A	0.00070	0.00077	13.5	12.9	0.00525	0.00523	0.000154	0.000129
		REP-2B	0.00067	0.00085	13.6	13.0	0.00532	0.00512	0.000080	0.000101
		Mean	0.00069	0.00081	13.4	13.0	0.00524	0.00515	0.000105	0.000109
		SD	0.000021	0.000040	0.21	0.10	0.000091	0.000070	0.0000424	0.0000174
		PRSD	3	5	2	1	2	1	-	-
Lake St. Martin	19-May-21	REP-2A	0.00057	0.00072	10.3	10.3	0.00379	0.00392	0.000071	0.000054
		REP-2B	0.00054	0.00086	10.3	10.5	0.00387	0.00418	0.000061	0.000068
		LSM4	0.00058	0.00076	10.1	10.3	0.00391	0.00411	0.000081	<0.000050
		Mean	0.00056	0.00078	10.2	10.4	0.00386	0.00407	0.000071	<0.000050
		SD	0.000021	0.000072	0.12	0.12	0.000061	0.000135	0.0000100	-
		PRSD	4	9	1	1	2	3	-	-
Fairford River	18-May-21	REP-1A	0.00060	0.00102	10.5	10.3	0.0039	0.00446	0.000077	0.000094
		REP-1B	0.00063	0.00100	10.5	10.4	0.00395	0.00445	0.000079	0.000100
		FR2	0.00062	0.00094	10.7	10.4	0.00391	0.00427	0.000091	0.000118
		Mean	0.00062	0.00099	10.6	10.4	0.00392	0.00439	0.000082	0.000104
		SD	0.000015	0.000042	0.12	0.06	0.000026	0.000107	0.0000076	0.0000125
		PRSD	2	4	1	1	1	2	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*
Blanks										
Field Blanks	2-Sep-20	WB-1A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	3-Sep-20	WB-2A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	13-Oct-20	WB-2A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	15-Mar-21	WB-1A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	18-Mar-21	WB-2A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	18-May-21	WB-1A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	19-May-21	WB-2A	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
Trip Blanks	2-Sep-20	WB-1B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	3-Sep-20	WB-2B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	2-Sep-20	WB-1B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	13-Oct-20	WB-2B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	15-Mar-21	WB-1B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	18-Mar-21	WB-2B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	18-May-21	WB-1B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050
	19-May-21	WB-2B	<0.00050	<0.00050	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)		Sulphate (SO4)
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Analytical DL			*0.050*	*0.10*	*0.000010*	*0.000010*	*0.050*	*0.050*	*0.00010*	*0.00020*	*0.30/0.60*
Replicates											
Mercer Creek	1-Sep-20	MC-WB	3.88	4.04	<0.000010	<0.000010	133	127	0.257	0.257	97.5
		REP 2A	3.80	4.01	<0.000010	<0.000010	126	124	0.270	0.267	98.6
		REP 2B	3.70	3.80	<0.000010	<0.000010	126	127	0.258	0.258	97.6
		Mean	3.79	3.95	<0.000010	<0.000010	128	126	0.262	0.261	97.9
		SD	0.090	0.131	-	-	4.0	1.7	0.0072	0.0055	0.61
		PRSD	2	3	-	-	3	1	3	2	1
Lake St. Martin	2-Sep-20	LSM1	4.11	4.52	<0.000010	<0.000010	129	126	0.259	0.251	83.3
		REP-1A	4.26	4.36	<0.000010	<0.000010	131	125	0.252	0.255	83.3
		REP-1B	4.21	4.52	<0.000010	<0.000010	134	128	0.253	0.257	83.2
		Mean	4.19	4.47	<0.000010	<0.000010	131	126	0.255	0.254	83.3
		SD	0.076	0.092	-	-	2.5	1.5	0.0038	0.0031	0.06
		PRSD	2	2	-	-	2	1	1	1	0
Fairford River	13-Oct-20	FR1	4.55	4.90	<0.000010	<0.000010	133	141	0.265	0.296	92.1
		REP-2A	4.47	4.96	<0.000010	<0.000010	129	147	0.256	0.287	92.7
		REP-2B	4.58	4.93	<0.000010	<0.000010	128	149	0.255	0.295	92.5
		Mean	4.53	4.93	<0.000010	<0.000010	130	146	0.259	0.293	92.4
		SD	0.057	0.030	-	-	2.6	4.2	0.0055	0.0049	0.31
		PRSD	1	1	-	-	2	3	2	2	0

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)		Sulphate (SO4)
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Analytical DL			*0.050*	*0.10*	*0.000010*	*0.000010*	*0.050*	*0.050*	*0.00010*	*0.00020*	*0.30/0.60*
Lake Winnipeg	18-Mar-21	SB1	2.56	2.84	<0.000010	<0.000010	40.3	41.7	0.174	0.173	55.5
		REP-1A	2.47	2.78	<0.000010	<0.000010	39.6	40.8	0.172	0.173	55.1
		REP-1B	2.39	2.86	<0.000010	<0.000010	39.1	40.4	0.172	0.177	53.5
		Mean	2.47	2.83	<0.000010	<0.000010	39.7	41.0	0.173	0.174	54.7
		SD	0.085	0.042	-	-	0.60	0.67	0.0012	0.0023	1.06
		PRSD	3	1	-	-	2	2	1	1	2
Dauphin River	18-Mar-21	DR-B	5.15	5.20	<0.000010	<0.000010	186	187	0.379	0.397	119
		REP-2A	4.83	5.09	<0.000010	<0.000010	174	185	0.390	0.382	118
		REP-2B	4.95	5.20	<0.000010	<0.000010	177	185	0.383	0.384	115
		Mean	4.98	5.16	<0.000010	<0.000010	179	186	0.384	0.388	117
		SD	0.162	0.064	-	-	6.2	1.2	0.0056	0.0081	2.1
		PRSD	3	1	-	-	3	1	1	2	2
Lake St. Martin	19-May-21	REP-2A	1.37	1.49	<0.000010	<0.000010	142	142	0.278	0.285	85.2
		REP-2B	1.36	1.58	<0.000010	<0.000010	142	140	0.281	0.292	87.5
		LSM4	1.33	1.52	<0.000010	<0.000010	141	140	0.282	0.292	85.1
		Mean	1.35	1.53	<0.000010	<0.000010	142	141	0.280	0.290	85.9
		SD	0.021	0.046	-	-	0.6	1.2	0.0021	0.0040	1.36
		PRSD	2	3	-	-	0	1	1	1	2
Fairford River	18-May-21	REP-1A	2.51	2.90	<0.000010	<0.000010	149	153	0.279	0.294	92.8
		REP-1B	2.47	2.98	<0.000010	<0.000010	148	153	0.284	0.300	93.4
		FR2	2.43	2.80	<0.000010	<0.000010	148	153	0.291	0.298	92.1
		Mean	2.47	2.89	<0.000010	<0.000010	148	153	0.285	0.297	92.8
		SD	0.040	0.090	-	-	0.6	0.0	0.0060	0.0031	0.65
		PRSD	2	3	-	-	0	0	2	1	1

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)		Sulphate (SO4)
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Analytical DL			*0.050*	*0.10*	*0.000010*	*0.000010*	*0.050*	*0.050*	*0.00010*	*0.00020*	*0.30/0.60*
Blanks											
Field Blanks	2-Sep-20	WB-1A	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	0.00027	0.00037	<0.30
	3-Sep-20	WB-2A	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	0.00015	<0.00020	<0.30
	13-Oct-20	WB-2A	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	15-Mar-21	WB-1A	0.083	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	18-Mar-21	WB-2A	0.087	0.13	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	18-May-21	WB-1A	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	19-May-21	WB-2A	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
Trip Blanks	2-Sep-20	WB-1B	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	3-Sep-20	WB-2B	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	2-Sep-20	WB-1B	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	13-Oct-20	WB-2B	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	15-Mar-21	WB-1B	0.086	0.11	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	18-Mar-21	WB-2B	0.078	0.13	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30
	18-May-21	WB-1B	<0.050	<0.10	<0.000010	<0.000010	0.143	0.208	<0.00010	<0.00020	<0.30
	19-May-21	WB-2B	<0.050	<0.10	<0.000010	<0.000010	<0.050	<0.050	<0.00010	<0.00020	<0.30

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Sulphur (S)		Tellurium (Te)		Thallium (Tl)		Thorium (Th)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.50*	*0.50*	*0.00020*	*0.00020*	*0.000010*	*0.000010*	*0.00010*	*0.00010*
Replicates										
Mercer Creek	1-Sep-20	MC-WB	31.7	31.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP 2A	30.3	31.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP 2B	29.7	31.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	30.6	31.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	1.03	0.00	-	-	-	-	-	-
		PRSD	3	0	-	-	-	-	-	-
Lake St. Martin	2-Sep-20	LSM1	27.4	31.0	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-1A	28.5	30.1	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-1B	28.4	29.7	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	28.1	30.3	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	0.61	0.67	-	-	-	-	-	-
		PRSD	2	2	-	-	-	-	-	-
Fairford River	13-Oct-20	FR1	33.3	33.7	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-2A	34.0	33.8	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-2B	33.4	34.5	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	33.6	34.0	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	0.38	0.44	-	-	-	-	-	-
		PRSD	1	1	-	-	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Sulphur (S)		Tellurium (Te)		Thallium (Tl)		Thorium (Th)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.50*	*0.50*	*0.00020*	*0.00020*	*0.000010*	*0.000010*	*0.00010*	*0.00010*
Lake Winnipeg	18-Mar-21	SB1	20.1	20.7	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-1A	19.6	20.3	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-1B	18.4	20.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	19.4	20.5	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	0.87	0.21	-	-	-	-	-	-
		PRSD	5	1	-	-	-	-	-	-
Dauphin River	18-Mar-21	DR-B	44.5	45	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-2A	40.5	44.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-2B	41.5	45.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	42.2	45.1	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	2.08	0.50	-	-	-	-	-	-
		PRSD	5	1	-	-	-	-	-	-
Lake St. Martin	19-May-21	REP-2A	32.8	32.2	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-2B	32.5	32.9	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		LSM4	31.9	32.8	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	32.4	32.6	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	0.46	0.38	-	-	-	-	-	-
		PRSD	1	1	-	-	-	-	-	-
Fairford River	18-May-21	REP-1A	33.9	33.7	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		REP-1B	33.4	34.3	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		FR2	33.4	34.5	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		Mean	33.6	34.2	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
		SD	0.29	0.42	-	-	-	-	-	-
		PRSD	1	1	-	-	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Sulphur (S)		Tellurium (Te)		Thallium (Tl)		Thorium (Th)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.50*	*0.50*	*0.00020*	*0.00020*	*0.000010*	*0.000010*	*0.00010*	*0.00010*
Blanks										
Field Blanks	2-Sep-20	WB-1A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	3-Sep-20	WB-2A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	13-Oct-20	WB-2A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	15-Mar-21	WB-1A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	18-Mar-21	WB-2A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	18-May-21	WB-1A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	19-May-21	WB-2A	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
Trip Blanks	2-Sep-20	WB-1B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	3-Sep-20	WB-2B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	2-Sep-20	WB-1B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	13-Oct-20	WB-2B	<0.50	0.68	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	15-Mar-21	WB-1B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	18-Mar-21	WB-2B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	18-May-21	WB-1B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010
	19-May-21	WB-2B	<0.50	<0.50	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Tin (Sn)		Titanium (Ti)		Tungsten (W)		Uranium (U)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00030*	*0.00030*	*0.00010*	*0.00010*	*0.000010*	*0.000010*
Replicates										
Mercer Creek	1-Sep-20	MC-WB	<0.00010	<0.00010	<0.00030	0.00354	<0.00010	<0.00010	0.00167	0.00160
		REP 2A	<0.00010	<0.00010	<0.00030	0.00306	<0.00010	<0.00010	0.00168	0.00160
		REP 2B	<0.00010	<0.00010	<0.00030	0.00214	<0.00010	<0.00010	0.00170	0.00162
		Mean	<0.00010	<0.00010	<0.00030	0.00291	<0.00010	<0.00010	0.00168	0.00161
		SD	-	-	-	0.000711	-	-	0.000015	0.000012
		PRSD	-	-	-	**24**	-	-	1	1
Lake St. Martin	2-Sep-20	LSM1	<0.00010	<0.00010	<0.00030	0.00373	<0.00010	<0.00010	0.00168	0.00171
		REP-1A	<0.00010	<0.00010	<0.00030	0.00386	<0.00010	<0.00010	0.00163	0.00169
		REP-1B	<0.00010	<0.00010	<0.00030	0.00437	<0.00010	<0.00010	0.00163	0.00173
		Mean	<0.00010	<0.00010	<0.00030	0.00399	<0.00010	<0.00010	0.00165	0.00171
		SD	-	-	-	0.000338	-	-	0.000029	0.000020
		PRSD	-	-	-	8	-	-	2	1
Fairford River	13-Oct-20	FR1	<0.00010	<0.00010	<0.00030	0.00988	<0.00010	<0.00010	0.00185	0.00178
		REP-2A	<0.00010	<0.00010	<0.00030	0.00968	<0.00010	<0.00010	0.00189	0.00178
		REP-2B	<0.00010	<0.00010	<0.00030	0.00910	<0.00010	<0.00010	0.00184	0.00178
		Mean	<0.00010	<0.00010	<0.00030	0.00955	<0.00010	<0.00010	0.00186	0.00178
		SD	-	-	-	0.000405	-	-	0.000026	0.000000
		PRSD	-	-	-	4	-	-	1	0

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Tin (Sn)		Titanium (Ti)		Tungsten (W)		Uranium (U)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00030*	*0.00030*	*0.00010*	*0.00010*	*0.000010*	*0.000010*
Lake Winnipeg	18-Mar-21	SB1	<0.00010	<0.00010	0.00066	0.00466	<0.00010	<0.00010	0.00115	0.00119
		REP-1A	<0.00010	<0.00010	0.00059	0.00476	<0.00010	<0.00010	0.00110	0.00125
		REP-1B	<0.00010	<0.00010	0.00072	0.00475	<0.00010	<0.00010	0.00118	0.00119
		Mean	<0.00010	<0.00010	0.00066	0.00472	<0.00010	<0.00010	0.00114	0.00121
		SD	-	-	0.000065	0.000055	-	-	0.000040	0.000035
		PRSD	-	-	-	1	-	-	4	3
Dauphin River	18-Mar-21	DR-B	<0.00010	0.00013	<0.00030	0.00037	<0.00010	<0.00010	0.00218	0.00235
		REP-2A	<0.00010	<0.00010	<0.00030	0.00042	<0.00010	<0.00010	0.00221	0.00243
		REP-2B	<0.00010	<0.00010	<0.00030	0.00039	<0.00010	<0.00010	0.00220	0.00240
		Mean	<0.00010	<0.00010	<0.00030	0.00039	<0.00010	<0.00010	0.00220	0.00239
		SD	-	-	-	0.000025	-	-	0.000015	0.000040
		PRSD	-	-	-	6	-	-	1	2
Lake St. Martin	19-May-21	REP-2A	<0.00010	<0.00010	<0.00030	0.00178	<0.00010	<0.00010	0.0017	0.00163
		REP-2B	<0.00010	<0.00010	<0.00030	0.00204	<0.00010	<0.00010	0.00168	0.00168
		LSM4	<0.00010	<0.00010	<0.00030	0.00230	<0.00010	<0.00010	0.00166	0.00168
		Mean	<0.00010	<0.00010	<0.00030	0.00204	<0.00010	<0.00010	0.00168	0.00166
		SD	-	-	-	0.000260	-	-	0.00002	0.000029
		PRSD	-	-	-	13	-	-	1	2
Fairford River	18-May-21	REP-1A	<0.00010	<0.00010	<0.00030	0.00798	<0.00010	<0.00010	0.00166	0.00169
		REP-1B	<0.00010	<0.00010	<0.00030	0.00856	<0.00010	<0.00010	0.00167	0.00174
		FR2	<0.00010	<0.00010	<0.00030	0.00604	<0.00010	<0.00010	0.00168	0.00171
		Mean	<0.00010	<0.00010	<0.00030	0.00753	<0.00010	<0.00010	0.00167	0.00171
		SD	-	-	-	0.00132	-	-	0.00001	0.000025
		PRSD	-	-	-	18	-	-	1	1

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Tin (Sn)		Titanium (Ti)		Tungsten (W)		Uranium (U)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00030*	*0.00030*	*0.00010*	*0.00010*	*0.000010*	*0.000010*
Blanks										
Field Blanks	2-Sep-20	WB-1A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	3-Sep-20	WB-2A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	13-Oct-20	WB-2A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	15-Mar-21	WB-1A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	18-Mar-21	WB-2A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	18-May-21	WB-1A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	19-May-21	WB-2A	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
Trip Blanks	2-Sep-20	WB-1B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	3-Sep-20	WB-2B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	2-Sep-20	WB-1B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	13-Oct-20	WB-2B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	15-Mar-21	WB-1B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	18-Mar-21	WB-2B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	18-May-21	WB-1B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010
	19-May-21	WB-2B	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Replicates								
Mercer Creek	1-Sep-20	MC-WB	0.00130	0.00186	<0.0010	<0.0030	<0.00020	<0.00020
		REP 2A	0.00125	0.00179	<0.0010	<0.0030	<0.00020	<0.00020
		REP 2B	0.00123	0.00173	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00126	0.00179	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.000036	0.000065	-	-	-	-
		PRSD	-	-	-	-	-	-
Lake St. Martin	2-Sep-20	LSM1	0.00156	0.00217	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1A	0.00161	0.00209	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1B	0.00163	0.00225	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00160	0.00217	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.000036	0.000080	-	-	-	-
		PRSD	-	-	-	-	-	-
Fairford River	13-Oct-20	FR1	0.00126	0.00222	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2A	0.00123	0.00222	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2B	0.00125	0.00215	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00125	0.00220	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.000015	0.000040	-	-	-	-
		PRSD	-	-	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Lake Winnipeg	18-Mar-21	SB1	0.00145	0.00176	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1A	0.00143	0.00175	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1B	0.00142	0.00168	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00143	0.00173	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.000015	0.000044	-	-	-	-
		PRSD	1	3	-	-	-	-
Dauphin River	18-Mar-21	DR-B	0.0012	0.00129	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2A	0.00115	0.00131	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2B	0.00115	0.00135	<0.0010	<0.0030	<0.00020	0.00026
		Mean	0.00117	0.00132	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.000029	0.000031	-	-	-	-
		PRSD	2	2	-	-	-	-
Lake St. Martin	19-May-21	REP-2A	0.0011	0.00144	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2B	0.00113	0.00146	<0.0010	<0.0030	<0.00020	<0.00020
		LSM4	0.00112	0.00145	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00112	0.00145	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.00002	0.000010	-	-	-	-
		PRSD	1	1	-	-	-	-
Fairford River	18-May-21	REP-1A	0.00098	0.00163	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1B	0.00096	0.00164	<0.0010	<0.0030	<0.00020	0.00024
		FR2	0.00095	0.00150	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	0.00096	0.00159	<0.0010	<0.0030	<0.00020	<0.00020
		SD	0.00002	0.000078	-	-	-	-
		PRSD	2	5	-	-	-	-

Table A2-2. Continued.

Waterbody	Sampling Date	Site ID	Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Blanks								
Field Blanks	2-Sep-20	WB-1A	<0.00050	0.00051	<0.0010	<0.0030	<0.00020	<0.00020
	3-Sep-20	WB-2A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	13-Oct-20	WB-2A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	15-Mar-21	WB-1A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	18-Mar-21	WB-2A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	18-May-21	WB-1A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	19-May-21	WB-2A	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
Trip Blanks	2-Sep-20	WB-1B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	3-Sep-20	WB-2B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	2-Sep-20	WB-1B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	13-Oct-20	WB-2B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	15-Mar-21	WB-1B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	18-Mar-21	WB-2B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	18-May-21	WB-1B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020
	19-May-21	WB-2B	<0.00050	<0.00050	<0.0010	<0.0030	<0.00020	<0.00020

APPENDIX 3. RESULTS FOR ADDITIONAL PARAMETERS

Table A3-1. Laboratory results for additional parameters measured at selected sites in September 2020.

Parameter	Units	DL	BC-LSM L2497954-5 1-Sep-20	FR1 L2497954-6 1-Sep-20	DR-A L2497954-7 2-Sep-20
Escherichia Coli	MPN/100mL	1	9	308	2
Microcystin	µg/L	0.20	<0.20	<0.20	<0.20
Cyanobacteria cell count					
Anabaena (Cyanophyceae)	cells/mL	1	-	372	60
Aphanocapsa (Cyanophyceae)	cells/mL	1	-	29700	49500
Aphanothece (Cyanophyceae)	cells/mL	1	-	310	-
Chroococcus (Cyanophyceae)	cells/mL	1	-	336	64
Gomphosphaeria (Cyanophyceae)	cells/mL	1	-	1550	550
Merismopedia (Cyanophyceae)	cells/mL	1	-	31700	66500
Planktolyngbya (Cyanophyceae)	cells/mL	1	160	19800	7920
Planktothrix (Cyanophyceae)	cells/mL	1	30	-	60
Pseudanabaena (Cyanophyceae)	cells/mL	1	220	-	-
Other blue-greens	cells/mL	1	-	74300	233000
Total cyanobacterial cell count	cells/mL	1	410	158000	358000
Hydrocarbons					
Benzene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
Ethyl benzene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
Toluene	mg/L	0.0010	<0.0010	<0.0010	<0.0010
o-Xylene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
m+p-Xylenes	mg/L	0.00040	<0.00040	<0.00040	<0.00040
Xylenes (Total)	mg/L	0.00064	<0.00064	<0.00064	<0.00064
F1 (C6-C10)	mg/L	0.10	<0.10	<0.10	<0.10
F1-BTEX	mg/L	0.10	<0.10	<0.10	<0.10
F2-Naphth	mg/L	0.10	<0.10	<0.10	<0.10
F2 (C10-C16)	mg/L	0.10	<0.10	<0.10	<0.10
F3-PAH	mg/L	0.25	<0.25	<0.25	<0.25
F3 (C16-C34)	mg/L	0.25	<0.25	<0.25	<0.25
F4 (C34-C50)	mg/L	0.25	<0.25	<0.25	<0.25
Total Hydrocarbons (C6-C50)	mg/L	0.38	<0.38	<0.38	<0.38
Acenaphthene	mg/L	0.000020	0.000034	<0.000020	<0.000020
Acenaphthylene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Acridine	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Anthracene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)anthracene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)pyrene	mg/L	0.0000050	<0.0000050	<0.0000050	<0.0000050
Benzo(b&j)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(g,h,i)perylene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Benzo(k)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010

Table A3-1. continued.

Parameter	Units	DL	BC-LSM L2497954-5 1-Sep-20	FR1 L2497954-6 1-Sep-20	DR-A L2497954-7 2-Sep-20
Chrysene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Dibenzo(a,h)anthracene	mg/L	0.0000050	<0.0000050	<0.0000050	<0.0000050
Fluoranthene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Fluorene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Indeno(1,2,3-cd)pyrene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
1-Methyl Naphthalene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
2-Methyl Naphthalene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Naphthalene	mg/L	0.000050	<0.000050	<0.000050	<0.000050
Phenanthrene	mg/L	0.000050	<0.000050	<0.000050	<0.000050
Pyrene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Quinoline	mg/L	0.000020	<0.000020	<0.000020	<0.000020
B(a)P Total Potency Equivalent	mg/L	0.000030	<0.000030	<0.000030	<0.000030
Pesticides					
Aldrin	µg/L	0.0080	<0.0080	<0.0080	<0.0080
alpha-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
beta-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
gamma-hexachlorocyclohexane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
delta-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
a-chlordane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
g-chlordane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
o,p-DDD	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDD	µg/L	0.0040	<0.0040	<0.0040	<0.0040
o,p-DDE	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDE	µg/L	0.0040	<0.0040	<0.0040	<0.0040
op-DDT	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDT	µg/L	0.0040	<0.0040	<0.0040	<0.0040
Dieldrin	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Endosulfan I	µg/L	0.0070	<0.0070	<0.0070	<0.0070
Endosulfan II	µg/L	0.0070	<0.0070	<0.0070	<0.0070
Diclofop-methyl	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Triallate	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Trifluralin	mg/L	0.00010	<0.00010	<0.00010	<0.00010



Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring, Fall 2021 - Water Quality

REPORT

Prepared for Manitoba Transportation and Infrastructure
By North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4

Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring Fall 2021

Water Quality

A Data Report Prepared for

Manitoba Transportation and Infrastructure

By:

North/South Consultants Inc.

May 2022

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EXECUTIVE SUMMARY

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). A draft Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The AEMP also identified the need for the collection of data to supplement existing information that had been presented in the EIS.

A requirement for additional surface water quality data was identified in the AEMP and a monitoring program was developed. The monitoring program was designed to collect supplemental information to determine whether water quality conditions change due to channel operations and, more specifically, whether the proposed change in flow patterns would affect water quality. Subsequently, water quality sampling was conducted in early and late fall 2020 (NSC 2021; NSC 2022) and winter and spring 2021 (NSC 2022). Additional sampling was conducted during early and late fall 2021 (Fall 2021). This report provides results of the Fall 2021 sampling.

In situ water quality measurements and water samples were collected at 20 core sampling sites in the study area from Lake Manitoba to Lake Winnipeg during two sampling periods in Fall 2021. Sampling dates were as follows: August 29-September 3, and October 17-21, 2021. Additional sites were surveyed for the presence of water and *in situ* water quality, including: seven sites along the alignments of the proposed Lake Manitoba Outlet Channel (LMOC) and Lake St. Martin Outlet Channel (LSMOC) on September 3, 2021, and nine sites along the same routes on October 21, 2021.

Quality assurance/quality control (QA/QC) measures were incorporated into the monitoring program including standard sampling methods and QA/QC samples. All results were compared to the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) for the protection of aquatic life (PAL), as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for PAL.

Based on the results of the monitoring that was conducted in late-August/September and October 2021, the water quality of the study area can be described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and moderate- to well-oxygenated.

In general, water quality was similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River. However, differences in water quality between the sites sampled along the main flow path and Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay, were observed, including:

- Watchorn Creek had higher concentrations of alkalinity, total phosphorus (TP), colour, carbon, total dissolved solids (TDS), calcium, fluoride and silicon and lower total nitrogen (TN), antimony, arsenic, chloride and sodium;

- Mercer Creek had higher alkalinity, TP, colour, carbon, TDS and calcium and lower TN;
- Birch Creek had higher alkalinity, hardness, carbon, colour, as well as higher sulfur at the site sampled near PR 239, and lower turbidity, total suspended solids (TSS), conductivity, TDS, arsenic, antimony, chloride, fluoride, copper, lithium, magnesium, rubidium, silicon, sodium and strontium;
- Big Buffalo Lake had higher alkalinity, TP, TN, carbon, colour and silicon, and lower conductivity, TDS, arsenic, antimony, boron, chloride, fluoride, lithium, molybdenum, nickel, potassium, sodium, strontium, sulfur and uranium;
- Buffalo Creek had higher alkalinity, carbon, colour, aluminum, chromium, copper, iron, silicon, titanium and zirconium and lower conductivity, TDS, antimony, arsenic, barium, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, rubidium, sodium, strontium, sulfate, sulfur and uranium; and
- Sturgeon Bay had lower alkalinity, hardness, conductivity, TDS, TN, carbon, antimony, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, rubidium, sodium, strontium, sulfate, sulfur, and uranium, and higher TP, dissolved inorganic nitrogen, aluminum, chromium, copper, cesium, iron, nickel, titanium and vanadium than sites sampled along the flow path from Lake Manitoba through the Dauphin River.

Sampling for additional parameters conducted at sites in the Fairford and Dauphin rivers and Birch Creek in late-August/September 2021 showed that *Escherichia coli* concentrations were higher in Birch Creek than in the Dauphin and Fairford rivers and that blue-green algae (i.e., cyanobacteria) were most abundant in the Dauphin River and least abundant in Birch Creek. Sampling was also conducted at these locations for microcystin, hydrocarbons, and pesticides; all results were below analytical detection limits.

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths (0.025 mg/L) at several locations, including: Watchorn Bay; Watchorn Creek at Watchorn Bay; Mercer Creek at Watchorn Bay; Fairford River at Lake St. Martin; Birch Creek at Lake St. Martin; Lake St. Martin; Big Buffalo Lake; the Dauphin River at Sturgeon Bay; and Sturgeon Bay. TP was below the MWQSOG narrative guideline for rivers and streams (0.050 mg/L) in the Fairford and Dauphin rivers and in Birch and Buffalo creeks.

Dissolved oxygen (DO) was below the MWQSOGs 30-day objective for the protection of cool-water aquatic life (6.5 mg/L) in Birch Creek at PR 239 on August 29, 2021. This lower DO concentration was likely due to the low water level and lack of flow observed at the time of sampling. DO was within MWQSOG objectives for PAL at all other sites and times sampled in Fall 2021.

Additionally, DO concentrations were below the CCME guidelines for the protection of early life stages of cold-water biota (9.5 mg/L) at several sites sampled in late-August/September, 2021, including sites in Birch Creek, the Fairford and Dauphin rivers, Lake St. Martin, Big Buffalo Lake and Buffalo Creek. DO was within CCME guidelines for PAL at all other sites and time sampled in Fall 2021.

In situ pH was above the upper limit of the MWQSOG/CCME PAL guideline (6.5-9.0 pH units) in the eastern bay of Lake St. Martin on August 31, 2021; however, laboratory-measured pH was within PAL guidelines. All other pH values measured at core sites in Fall 2021 were within PAL guidelines.

Aluminum exceeded the MWQSOG and CCME guideline for PAL (0.1 mg/L) in approximately one quarter of samples collected in Fall 2021 including samples from Lake St. Martin, Buffalo Creek, the Dauphin River, and Sturgeon Bay. Iron exceeded the MWQSOG and CCME guideline for PAL (0.3 mg/L) in samples collected from Buffalo Creek and at the off-shore site in Sturgeon Bay in late-August/September. Chloride exceeded the CCME long-term guideline for PAL (120 mg/L) in all samples collected along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River, as well as in Watchorn and Mercer creeks (October only). Additionally, fluoride exceeded the CCME PAL (0.120 mg/L) at most sites and times sampled; the exception was Sturgeon Bay where only one sample collected exceeded the guideline. Exceedances of these parameters are common in the region.

All other water quality variables measured for which there are MWQSOG and CCME PAL objectives or guidelines were within PAL objectives and guidelines at all core sampling sites.

Surveys along the alignment of the proposed LMOC and LSMOC conducted on September 3 and October 21, 2021, found surface water to be present at all locations surveyed, although total depths did not exceed 0.5 m at most sites. Due to low water levels during the September survey, *in situ* water quality could not be measured at Goodison Lake and Woodale Drain. In general, sites along the alignment of the proposed LMOC were moderately- to well-oxygenated, alkaline, and low to moderately turbid and had moderate conductivity. Sites sampled along the alignment of the proposed LSMOC were circum-neutral to alkaline, had low turbidity, and lower specific conductance than sites along the alignment of the proposed LMOC. Additionally, sites along the alignment of the proposed LSMOC were generally well oxygenated; however, low oxygen conditions were found at the site located in Creek C on October 21, 2021.

At the time of the October survey, DO at a site sampled on Creek C was below the CCME guidelines for PAL (ranges from 5.5 mg/L to 9.5 mg/L depending on life-stage and biota), as well as applicable MWQSOG objectives, including: the MWQSOG 30-day averaging objective for cool-water aquatic life (5.5 mg/L); and the MWQSOG instantaneous objective for early life stages of cold-water aquatic life (8.0 mg/L). Furthermore, during the September survey, DO was below the CCME guideline for PAL for early life stages of cold-water (9.5 mg/L) at most sites sampled along the alignments of the proposed LMOC and LSMOC; however, it is unlikely that early life stages of cold-water species were present at the time the measurements were taken, as water temperatures were well above 5°C at the time. DO was within applicable MWQSOG and CCME PAL objectives/guidelines at all other sites and times sampled. Additionally, pH was within applicable MWQSOG and CCME for PAL objectives and guidelines at all sites along the proposed LSMOC and LMOC. There are no MWQSOG or CCME PAL guidelines for the other *in situ* parameters measured.

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ACRONYMS

AEMP	Aquatic Effects Monitoring Program
BCMELP	British Columbia Ministry of Environment, Lands, and Parks
BOD	Biological Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
DIN	Dissolved Inorganic Nitrogen
DL	Analytical Detection Limit
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EIS	Environmental Impact Statement
FRWCS	Fairford Water Control Structure
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MTI	Manitoba Transportation and Infrastructure
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
MWS	Manitoba Water Stewardship
NSC	North/South Consultants Inc.
PAL	Protection of Freshwater Aquatic Life
PRSD	Percent Standard Relative Deviation
PTH	Provincial Trunk Highway
QA/QC	Quality Assurance/Quality Control
SD	Standard Deviation
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids

1.0 INTRODUCTION

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). The proposed Project is designed to manage flood waters on Lake Manitoba and Lake St. Martin by providing a channel by which flood waters can be conveyed, in addition to the natural outflow via the Fairford and Dauphin rivers (Figure 1). The Project consists of two outlet channels that are intended to work together:

- The 24 km Lake Manitoba Outlet Channel (LMOC) will work in tandem with the existing water control structure on the Fairford River (the Fairford Water Control Structure or FRWCS) to help regulate water levels and mitigate flooding on Lake Manitoba; and
- The 24 km Lake St. Martin Outlet Channel (LSMOC) will restore a more natural water regime to Lake St. Martin and will also provide flood protection by mitigating increased inflows from operation of the FRWCS, as well as additional inflows from the planned outlet from Lake Manitoba.

A draft Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The specific objectives of the AEMP were to:

- Verify the predicted effects presented in the surface water quality and fish and fish habitat sections of the EIS;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation measures if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted measure(s); and
- Confirm compliance with regulatory requirements relevant to surface water quality and fish and fish habitat set out in the Project approvals (e.g., Manitoba Environment Act License; Fisheries Act Authorization).

Additionally, the AEMP identified the need for the collection of data to supplement existing information that had been presented in the EIS.

A requirement for additional surface water quality data was identified in the AEMP and a monitoring program was developed. The monitoring program was designed to collect supplemental information to determine whether water quality conditions change due to channel operations and, more specifically, whether the proposed change in flow patterns would affect water quality. Subsequently, water quality sampling was conducted in early and late fall 2020 (NSC 2021; NSC 2022) and winter and spring 2021 (NSC 2022). Additional sampling was conducted during early and late fall 2021 (Fall 2021). This report provides results of the Fall 2021 sampling.

2.0 METHODS

2.1 SAMPLING PERIODS

Water quality sampling was conducted two times from August to October 2021. Sampling periods were as follows:

- August 29 to September 3; and
- October 17-21.

2.2 SAMPLING SITES

The study area for the monitoring program is comprised of Lake Manitoba, the Fairford and Dauphin rivers, Lake St. Martin, creeks and drains along the proposed LMOC alignment, the Buffalo Creek watershed, and Sturgeon Bay in Lake Winnipeg. Water quality sampling was conducted at 20 core sites in the study area. Information on sampling locations is listed in Table 1 and illustrated in Figure 1 . Sampling sites were as follows:

- Two sites in Lake Manitoba in Watchorn Bay,
    - offshore of the proposed LMOC (WHB1), and
    - nearshore at the proposed LMOC (WHB2);
- One site in Watchorn Creek at Watchorn Bay (WHC-WB);
- One site in Mercer Creek at Watchorn Bay (MC-WB);
- Two sites in Birch Creek,
    - at PR 239 (BCD-2018-9), and
    - the outlet at Lake St. Martin (BC-LSM);
- Two sites in the Fairford River,
    - at Provincial Trunk Highway (PTH) 6 (FR1), and
    - near the outlet at Lake St. Martin (FR2);
- Five sites in Lake St. Martin,
    - Birch Bay (BB-LSM),
    - middle of the south basin (LSM5),
    - at the narrows (LSM4),
    - middle of the north basin (LSM1), and
    - the eastern bay near the proposed LSMOC (LSM3);
- Three sites in the Dauphin River,
    - at Lake St. Martin (DR-A),
    - near the provincial monitoring station at the “Big Bend” (DR-B), and
    - at Sturgeon Bay (DR-E);
- One site in Big Buffalo Lake (BBL);
- One site in Buffalo Creek at the Dauphin River (BC3); and

- Two sites in Lake Winnipeg in Sturgeon Bay,
    - nearshore at the proposed LSMOC (SB1), and
    - offshore of the proposed LSMOC (SB2).

In addition to the core sampling sites described above, locations along the alignments of the proposed LMOC and LSMOC were surveyed by helicopter to ascertain the presence of water and where possible, *in situ* water quality parameters were measured. Seven sites were visited on September 3, 2021, and ten sites were visited October 21, 2021. Due to low water levels, *in situ* water quality parameters could not be collected at some sites (Woodale Drain, Goodison Lake) in October. Location information for these sites is presented in Table 2 and Figure 1.

2.3 WATER QUALITY PARAMETERS

In situ measurements of physical and chemical parameters were collected at each sampling site, including: total depth; dissolved oxygen (DO); water temperature; specific conductance; pH; and turbidity. Secchi disk depth was also measured at sites with low water velocity.

At core sampling sites, water samples were collected for laboratory analysis of routine parameters (e.g., pH, conductivity), nutrients (e.g., nitrogen, phosphorus), chlorophyll *a*, water clarity (e.g., total suspended solids, turbidity), and metals and major ions (e.g., aluminum, iron, calcium). A detailed list of parameters analysed at core sampling sites is provided in Table 3.

In late-August/September, selected sites were also sampled for additional parameters, including: *Escherichia coli*; blue-green algae (i.e., cyanobacteria); microcystin; hydrocarbons; and pesticides. These additional parameters were analysed from samples collected at BC-LSM, FR1 and DR-A. Detailed lists of hydrocarbons and pesticides measured by the laboratory are presented in Tables 4 and 5, respectively.

In addition, samples for the laboratory analysis of biological oxygen demand (BOD) were collected from seven sites in late-August/September, including: WHC-WB; MC-WB; BCD-2018-9; BC-LSM; FR1; BBL; and BC3.

2.4 FIELD METHODS

Sampling sites were accessed by truck, boat, or helicopter. Sampling date and time were noted for each site. Sample locations were recorded using a handheld Garmin GPS receiver. Total water depth was recorded using a hand-held depth sounder where possible; at sites sampled from shore, total water depth was estimated.

In situ measurements of water quality parameters including pH, specific conductance, DO, turbidity, and water temperature were collected using a YSI EXO^{TM}2 sonde. At river sites and those accessed from shore, *in situ* parameters were measured at approximately 0.3 m below the water's surface. At lake sites, *in situ* profiles were taken such that measurements were recorded near the surface (i.e., at 0.3 m) and at increments of either 0.5 m (if total water depth was less than 5 m) or 1.0 m. Secchi disk depth was measured at low velocity sites and was defined as the average of two depth readings: (1) the depth

at which a circular black and white disk can no longer be seen when lowered into the water column; and (2) the depth at which the disk becomes visible again, when raised.

Grab samples were collected from approximately 0.3 m below the water's surface into clean sample bottles supplied by ALS Laboratories. Where necessary, samples were preserved according to instructions provided by the analytical laboratory. After collection, samples were placed in a cooler and kept cool using ice packs until submission (within 48 hours) to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory) for analysis.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program. Standard QA/QC measures were followed during sample collection (e.g., use of latex gloves, standard labelling practices, meter calibration, etc.). Additionally, QA/QC samples were collected for the list of parameters in Table 3 including field blanks, trip blanks, and replicate samples. Two field blanks, two trip blanks and two sets of triplicate samples were submitted to the analytical laboratory during each sampling period.

2.5.1 Field Blanks

Field blanks are intended to provide information on sample contamination from atmospheric exposure and sample handling techniques, as well as potential laboratory contamination and/or error (British Columbia Ministry of Environment, Lands, and Parks [BCMELP] 1998). Field blanks were prepared by filling sample bottles with deionized water (both provided by the analytical laboratory) in the field and submitting the blanks along with the environmental samples.

2.5.2 Trip Blanks

Trip blanks are used for evaluating the potential for sample contamination that may occur from the container or preservatives through transport and storage of the sample, as well as laboratory precision (BCMELP 1998). Trip blanks were prepared in the laboratory by filling sample bottles with deionized water. Trip blanks were transported to the field sampling sites, but remained sealed, and were then submitted to the analytical laboratory in conjunction with environmental samples for analysis.

2.5.3 Replicate Samples

Triplicate samples were collected at two sites (one lake site and one river site) during each sampling period (late-August/September and October). Replicate samples provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses.

2.6 QA/QC ASSESSMENT

All water quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as "suspect" and the laboratory was asked to verify the result.

QA/QC samples were assessed according to standard criteria to evaluate precision and identify potential sample contamination issues (BCMELP 1998). Percent relative standard deviation (PRSD) was calculated for triplicate samples as follows:

PRSD (%) = standard deviation (SD) of the triplicate values / mean of the triplicate values x 100

Precision of replicate samples was evaluated using the "rule of thumb" criteria for precision of 18% for triplicate samples (BCMELP 1998). Where one or more of the replicate values were less than five times the analytical detection limit (DL), an analysis of precision was not undertaken, in accordance with guidance provided in BCMELP (1998).

Field and trip blank results were also evaluated for evidence of sample contamination. Values for any parameter that exceeded five times the DL were considered to be indicative of sample contamination and/or laboratory error.

2.7 DATA ANALYSIS

All data analyses treated censured values (i.e., values reported as below the DL) as equal to one half the DL. In cases where triplicate samples were collected, sample means are presented. Dissolved inorganic nitrogen (DIN) was calculated as the sum of ammonia-N and nitrate/nitrite-N. Nitrogen to phosphorus molar ratios were also calculated.

2.8 COMPARISON TO WATER QUALITY OBJECTIVES AND GUIDELINES

Results were compared to the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG; Manitoba Water Stewardship [MWS] 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999; updated to 2022). In general, the MWQSOG for PAL are similar to the CCME guidelines for PAL for parameters measured; however, there are CCME guidelines for some parameters which lack a provincial guideline/objective and others for which the CCME and provincial guidelines are different. Typically, the CCME guideline is more stringent than the provincial guideline. A summary of relevant water quality objectives and guidelines is presented in Appendix 1.

3.0 RESULTS

3.1 QA/QC RESULTS

QA/QC results are presented in Appendix 2.

3.1.1 Field and Trip Blanks

Field and trip blank results generally indicated high precision and minimal sample contamination. Although some parameters were occasionally detected in blank samples, with one exception, all parameters were below the threshold of five times the DL. Total aluminum (0.0356 mg/L) was more than five times the DL (0.0030 mg/L) in one of the trip blanks submitted during the late-August/September sampling period; no other metals were detected in this sample.

3.1.2 Replicate Samples

PRSD values were not derived for several parameters due to low concentrations (i.e., concentrations less than five times the DL). In general, the results indicate good agreement between samples and acceptable levels of precision. The PRSD exceeded threshold values (18%) for six parameters, including: turbidity; colour; phaeophytin; total aluminum; total iron; and total titanium.

3.2 ROUTINE VARIABLES AND LIMNOLOGY

This section discusses the results for routine and *in situ* water quality parameters measured at the core water quality sampling sites; results of the *in situ* surveys, are presented separately (see Section 3.5 *In Situ* Survey Results). Results for *in situ* and routine water quality parameters measured at core sampling sites are presented in Tables 6 and 7, respectively; the following is a summary of these results.

Based on the results of the sampling that was conducted in late-August/September and October 2021, the water quality of the study area can be generally described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and moderate- to well-oxygenated. DO was relatively low at BCD-2018-9 on August 29, 2021 (6.23 mg/L), likely due to the low water level and lack of flow observed at the time of sampling. Additionally, BOD was low (<2.0 to 4.0 mg/L) at all seven sites where samples were collected in late-August/September, including: Watchorn (WHC-WB), Mercer (MC-WB), Birch (BCD-2018-9 and BC-LSM) and Buffalo (BC3) creeks; the Fairford River at PTH 6 (FR1), and Big Buffalo Lake (BBL).

In situ variables including, temperature, DO, turbidity, pH, and specific conductance were generally consistent across depth at sites where depth profiles could be collected. However, thermal stratification (i.e., >1 °C change within 1 m) was observed at the nearshore site in Sturgeon Bay (SB1) when sampled in August 2021. Slight increases in turbidity with depth were observed at some sites and times (i.e., BB-LSM, DR-E, and SB2, in late-August/September, and WHB2, FR1, and DR-E in October).

Total phosphorus (TP) concentrations in the study area were composed of a mix of dissolved and particulate forms. Phosphorus was predominately present in particulate form at most sites and times. However, the dissolved form was more prevalent at Watchorn Creek (WHC-WB), Birch Creek at PR 239 (BCD-2019-8) in late-August/September, and at both sites in Sturgeon Bay (SB1 and SB2) in late-August/September and at the nearshore site in Sturgeon Bay (SB1) in October. Most total nitrogen (TN) was present in organic form at all sites, with ammonia nitrogen generally comprising a greater amount of DIN than nitrate/nitrite nitrogen. Nitrate/nitrite-N comprised a greater proportion of the DIN than ammonia-N in Sturgeon Bay (SB1, SB2 [late-August/September only]) and at some sites and times in Lake St. Martin (LSM3 in late-August/September and BC-LSM in October). Based on TN:TP molar ratios, all waterbodies sampled were phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002).

Routine water quality was generally similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River, including WHB1, WHB2, FR1, FR2, BB-LSM, LSM5, LSM4, LSM1, LSM3, DR-A, DR-B and DR-E. However, differences in water quality were observed between the sites sampled along the main flow path and Watchorn, Mercer and Birch creeks, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay. The following spatial differences in routine water quality were observed:

- Watchorn and Mercer creeks (WHC-WB and MC-WB, respectively), had higher alkalinity, TP, colour, carbon, TDS (total dissolved solids), and lower TN;
- Birch Creek (BCD-2018-9 and BC-LSM) had higher alkalinity, hardness, carbon and colour, and lower turbidity, TSS (total suspended solids), conductivity and TDS than sites along the main flow;
- Big Buffalo Lake (BBL) had higher alkalinity, TP, TN, carbon, and colour, and lower conductivity, and TDS;
- Buffalo Creek (BC3) had higher alkalinity, carbon and colour, and lower conductivity and TDS; and
- Sturgeon Bay (SB1 and SB2) had lower alkalinity, hardness, conductivity, TDS, TN, and carbon, and had higher TP and DIN, than upstream sites along the main flow path.

3.2.1 Comparison to Water Quality Guidelines and Objectives

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths (i.e., 0.025 mg/L) at several sites and times sampled,including the following:

- Watchorn Creek at Watchorn Bay (WHC-WB);
- Mercer Creek at Watchorn Bay (MC-WB)
- Fairford River at Lake St. Martin (FR2);
- Birch Creek at Lake St. Martin (BC-LSM);
- Lake St. Martin, at Birch Bay (BB-LSM), at the south basin (LSM5), and eastern bay (LSM3);
- Big Buffalo Lake (BBL);
- the Dauphin River at Sturgeon Bay (DR-E); and
- Sturgeon Bay (SB1 and SB2).

TP was below the MWQSOG narrative guideline for rivers and streams (0.05 mg/L) in all samples collected from sites where the guideline applies, including FR1, BCD-2018-9, DR-A, DR-B and BC3.

With one exception, DO was within MWQSOG objectives for PAL at all sites and times sampled in Fall 2021. The exception occurred at BDC-2018-9 on August 29, 2021 (6.23 mg/L) where the DO was below the MWQSOGs 30-day objective for the protection of cool-water aquatic life (6.5 mg/L). This lower DO concentration was likely due to the low water level and lack of flow observed at the time of sampling.

Additionally, DO was below the CCME guideline for PAL for early life stages of cold-water biota (9.5 mg/L) at several sites sampled in late-August/September (BCD-2018-9, FR1, FR2, LSM4, DR-A, BBL, BC3, and SB2). However, it is unlikely that early life stages of cold-water species were present at the time the measurements were taken, as water temperatures were above 5°C in these cases. DO was within CCME guidelines for PAL at all other sites and times sampled in Fall 2021.

In situ pH exceeded the MWQSOG/CCME PAL (6.5-9.0 pH units) in the eastern bay of Lake St. Martin (LSM3; 9.27 pH units) on August 31, 2021, and was at the upper limit of the PAL range in the Dauphin River at Big Bend (DR-B; 9.0 pH units) during the same sampling period. However, laboratory measured pH was within PAL guidelines in samples collected (8.95 at LSM3 and 8.75 at DR-B). All other pH values measured at core sites in Fall 2021 were within PAL guidelines.

All other routine water quality parameters for which there are MWQSOG and CCME PAL objectives/guidelines, including, ammonia (sample specific based on pH and temperature), nitrate (2.93 mg N/L and 3.0 mg/L for MWQSOG and CCME, respectively) and nitrite (0.60 mg N/L), were within PAL objectives and guidelines.

3.3 METALS AND MAJOR IONS

Metal and major ion concentrations measured in the study area are presented in Table 8.

Beryllium, bismuth, tellurium, tin, and tungsten were not detected at any site. Additionally, some metals were not detected in dissolved form at any site, including: cesium; lead; thallium; and thorium. Total aluminum, total antimony, arsenic, barium, boron, calcium, dissolved chloride, lithium, magnesium, total manganese, molybdenum, potassium, rubidium, silicon, sodium, strontium, dissolved sulphate, sulphur, uranium, and total vanadium were consistently detected. The remaining metals and major ions were detected in some samples.

Metals and major ions were similar at sites sampled along the main flow from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River. However, in late-August/September, Birch Bay (BB-LSM) had higher concentrations of some metals than other sites sampled along the main flow path.

Similar to routine water quality, differences were observed between the sites along the main flow path and Watchorn, Mercer and Birch creeks, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay. Concentrations of chloride, antimony, lithium, rubidium, sodium, and strontium were greater along the

main flow path than in Birch Creek, Big Buffalo Lake, Buffalo Creek, and Sturgeon Bay. Additional spatial differences in metals and major ions were also observed, including:

- Watchorn Creek (WHC-WB) had lower antimony, arsenic, chloride and sodium, and higher calcium, fluoride and silicon;
- Mercer Creek (MC-WB) had higher calcium;
- Birch Creek (BCD-2018-9 and BC-LSM) had lower arsenic, and higher calcium, fluoride, copper, magnesium and silicon, as well as higher sulfur at the drain site (BCD-2018-9);
- Big Buffalo Lake (BBL) had lower arsenic, boron, fluoride, molybdenum, nickel, potassium, sulfur and uranium, and higher silicon;
- Buffalo Creek (BC3) had lower arsenic, barium, boron, fluoride, magnesium, molybdenum, potassium, sulfate, sulfur and uranium, and higher aluminum, chromium, copper, iron, silicon, titanium and zirconium; and
- Sturgeon Bay (SB1 and SB2) had lower boron, fluoride, magnesium, molybdenum, potassium, sulfate, sulfur and uranium, and higher aluminum, chromium, copper, cesium, iron, nickel, titanium and vanadium than sites sampled along the flow path from Lake Manitoba through the Dauphin River.

3.3.1 Comparison to Water Quality Guidelines and Objectives

Metals and major ions for which there are MWQSOG or CCME guidelines for PAL were, with few exceptions, within objectives and guidelines at sites sampled in late-August/September and October, 2021; PAL exceedances occurred for aluminum, iron, chloride, and fluoride, as described below. Exceedance of PAL guidelines for aluminum and iron are common in waterbodies throughout Manitoba (CAMP 2017) and exceedance of the CCME PAL guidelines for chloride and fluoride was regularly observed in the study area during the monitoring studies conducted for the Lake St. Martin Emergency Outlet Channel project (NSC and KGS Group 2016).

Aluminum exceeded the MWQSOG and CCME guideline for PAL (0.1 mg/L) in 10 of 40 samples collected, including samples from Lake St. Martin (BB-LSM and LSM1), Buffalo Creek (BC3), Dauphin River (DR-B and DR-E), and Sturgeon Bay (SB1 and SB2).

Iron exceeded the MWQSOG and CCME guideline for PAL (0.3 mg/L) in the samples collected from Buffalo Creek (BC3) and the off-shore site in Sturgeon Bay (SB2) in late-August/September. Iron was below PAL guidelines at all other sites and times sampled.

Chloride exceeded the CCME long-term guideline (120 mg/L) in all samples collected from Watchorn Bay (WHB1 and WHB2), Watchorn and Mercer creeks (WHC-WB and MC-WB; October only), Lake St. Martin (BB-LSM, LSM5, LSM4, LSM1 and LSM3), and the Fairford (FR1 and FR2) and Dauphin (DR-A, DR-B and DR-E) rivers. Chloride was consistently below the CCME long-term guideline in Birch Creek, Big Buffalo Lake, and Sturgeon Bay. All concentrations were below the CCME short-term guideline (640 mg/L). There are no MWOSOG for PAL for chloride.

Fluoride exceeded the CCME PAL (0.120 mg/L) in most samples collected. The exceptions were samples collected from the nearshore site in Sturgeon Bay (SB1) in late-August/September and samples collected from both sites in Sturgeon Bay (SB1 and SB2) in October.

3.4 ADDITIONAL PARAMETERS

This section presents the results for the additional parameters that were analyzed in samples collected from Birch Creek at Lake St. Martin (BC-LSM), the Fairford River at PTH 6 (FR1), and the Dauphin River at Lake St. Martin (DR-A) during the late-August/September sampling period, including: *E. coli*; blue-green algae; microcystin; hydrocarbons; and pesticides. Detailed results are available in Appendix 3, the following is a summary of these results:

- *E. coli* was detected at all three sites sampled and concentrations were higher in Birch Creek (152 MPN/100mL) than in the Dauphin River (49 MPN/100mL) and the Fairford River (14 MPN/100mL).
- blue-green algae were most abundant in the Dauphin River and least abundant in Birch Creek (Figure 2);
- microcystin was not detected (DL = 0.20 µg/L) at any of the three sites;
- hydrocarbons and were not detected at any of the three sites; and
- pesticides were not detected at any of the three sites.

For a list of hydrocarbons and pesticides measured including DLs, see Tables 4 and 5, respectively.

3.4.1 Comparison to Water Quality Guidelines and Objectives

As all results for hydrocarbons and pesticides were below detection and the DLs were lower than MWQSOG and CCME PAL guidelines, all measurements were also within the PAL guidelines.

There are no MWQSOG or CCME guidelines for PAL for *E. coli*, blue-green algae, or microcystin.

3.5 *IN SITU* SURVEY RESULTS

This section presents the results of the *in situ* measurements taken at locations along the proposed LMOC and LSMOC to support fish habitat assessments. Results from these surveys are presented in Table 9.

Of the four locations surveyed along the alignment of the proposed LMOC on September 3, 2021, all sites were less than 0.4 m in depth. Sites were moderately oxygenated (7.18 to 9.04 mg/L; 74.2 to 96.5 % saturation), alkaline (pH ranged from 8.04 to 8.78), with moderate conductivity (593–1284 µS/cm), and relatively low turbidity (0.80 to 11.17 NTU). On October 21, 2021, seven sites were surveyed and water levels were low at all sites; total depths ranged from <0.1 m to 0.5 m. Due to low water levels at Goodison Lake and Woodale Drain *in situ* parameters could not be accurately measured at these sites. At the sites where *in situ* measurements were collected, conditions were similar to those during the September survey; moderate- to well- oxygenated (9.77 to 14.70 mg/L; 78.1 to 116.3 % saturation),

alkaline (pH ranged from 8.24 to 8.91), with moderate conductivity (571–1252 µS/cm), and relatively low turbidity (3.36 to 15.42 NTU). Turbidity was higher at Clear Lake (38.19 NTU) than at the other sites sampled; likely due to low water levels and disturbance from the helicopter during sampling.

Three sites were sampled along the proposed LSMOC during each of the surveys in Fall 2021. Total depths ranged from 0.4 m to 1.2 m at the time of the surveys. All sites were circum-neutral to alkaline, with moderately low conductivity (220-346 µS/cm), and low turbidity (0.11 to 3.92 NTU). DO varied between sites and sampling periods and ranged from 4.19 mg/L (32.4 % saturation; Creek C on September 3, 2021) to 11.41 mg/L (91.6 % saturation; Unnamed Creek 2 on October 21, 2021).

3.5.1 Comparison to Water Quality Guidelines and Objectives

DO was below the CCME PAL guidelines for both warm water biota (5.5-6.0 mg/L) and cold water biota (6.5-9.5 mg/L), as well as the MWQSOG 30-day averaging objective for cool-water aquatic life (5.5 mg/L, when temperatures ≤ 5°C), and the MWQSOG instantaneous objective for early life stages of cold-water aquatic life (8.0 mg/L, when temperatures ≤ 5°C) at the site sampled on Creek C on October 21, 2021.

DO was below the CCME PAL for early life stages of cold-water biota (9.5 mg/L) at all but one site sampled on September 3, 2021; the exception was Unnamed Creek 1 where DO was 10.12 mg/L. However, it is unlikely that early life stages of cold-water species were present the time the measurements were taken (i.e., water temperatures were above 5°C in all instances where DO was less than 9.5 mg/L). DO was within all other applicable MWQSOG objectives and CCME guidelines for PAL at all other sites and times sampled.

In situ pH was within MWQSOG/CCME PAL guidelines (6.5-9.0 pH units) at all sites and sampling times.

There are no MWQSOG/CCME PAL guidelines for the other *in situ* parameters measured.

4.0 SUMMARY

Based on the results of the monitoring that was conducted in Fall 2021, the water quality of the study area can be described as moderately nutrient-rich to nutrient-rich, low to moderately turbid, slightly alkaline, hard to very hard, and moderate- to well-oxygenated.

In general, water quality was similar at sites sampled along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River. However, differences in water quality between the sites sampled along the main flow path and Watchorn, Mercer, Birch and Buffalo creeks, Big Buffalo Lake, and Sturgeon Bay, were observed, including:

- Watchorn Creek had higher concentrations of alkalinity, TP, colour, carbon, TDS, calcium, fluoride and silicon and lower TN, antimony, arsenic, chloride and sodium;
- Mercer Creek had higher alkalinity, TP, colour, carbon, TDS and calcium, and lower TN;
- Birch Creek had higher alkalinity, hardness, carbon, colour, as well as higher sulfur at the site near PR 239, and lower turbidity, TSS, conductivity, TDS, arsenic, antimony, chloride, fluoride, copper, lithium, magnesium, rubidium, silicon, sodium and strontium;
- Big Buffalo Lake had higher alkalinity, TP, TN, carbon, colour and silicon, and lower conductivity, TDS, arsenic, antimony, boron, chloride, fluoride, lithium, molybdenum, nickel, potassium, sodium, strontium, sulfur, and uranium;
- Buffalo Creek had higher alkalinity, carbon, colour, aluminum, chromium, copper, iron, silicon, titanium and zirconium and lower conductivity, TDS, antimony, arsenic, barium, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, rubidium, sodium, strontium, sulfate, sulfur and uranium; and
- Sturgeon Bay had lower alkalinity, hardness, conductivity, TDS, TN, carbon, antimony, boron, chloride, fluoride, lithium, magnesium, molybdenum, potassium, rubidium, sodium, strontium, sulfate, sulfur, and uranium, and higher TP, DIN, aluminum, chromium, copper, cesium, iron, nickel, titanium and vanadium than sites sampled along the flow path from Lake Manitoba through the Dauphin River.

The results of the additional sampling that was conducted in the Fairford and Dauphin rivers, and Birch Creek in late-August/September showed that *E. coli* concentrations were higher in Birch Creek than in the Dauphin River and the Fairford River and that blue-green algae were most abundant in the Dauphin River and least abundant in Birch Creek. Microcystin, hydrocarbons, and pesticides were not detected.

TP exceeded the MWQSOG narrative guideline for phosphorus for lakes and river mouths at several locations, including: Watchorn Creek at Watchorn Bay; Mercer Creek at Watchorn Bay; Fairford River at Lake St. Martin; Birch Creek at Lake St. Martin; Lake St. Martin; Big Buffalo Lake; the Dauphin River at Sturgeon Bay; and Sturgeon Bay. TP was below the MWQSOG narrative guideline for rivers and streams in the Fairford and Dauphin rivers and in Birch and Buffalo creeks at the sites where this guideline applies.

DO was below the MWQSOGs 30-day objective for the protection of cool-water aquatic life in Birch Creek at PR 239 on August 29, 2021. This lower DO concentration was likely due to the low water level and lack of flow observed at the time of sampling. DO was also below the CCME guideline for PAL for early life stages of cold-water biota at several sites sampled in late-August/September; however, it is unlikely that early life stages of cold-water species were present at the time the measurements were taken, as water temperatures were above 5°C in these cases.

In situ pH exceeded the MWQSOG/CCME PAL guidelines in the eastern bay of Lake St. Martin during the August sampling period; however, laboratory-measured pH was within PAL guidelines. All other pH values measured at core sites in Fall 2021 were within PAL guidelines.

Aluminum exceeded the MWQSOG and CCME guideline for PAL in approximately one quarter of samples collected, including samples from Lake St. Martin, Buffalo Creek, the Dauphin River and Sturgeon Bay. Iron exceeded the MWQSOG and CCME guideline for PAL in samples collected from Buffalo Creek and the off-shore site in Sturgeon Bay in late-August/September. Chloride exceeded the CCME long-term guideline for PAL in all samples collected along the main flow path from Lake Manitoba through the Fairford River to Lake St. Martin and into the Dauphin River, as well as in Watchorn and Mercer creeks (October only). Additionally, fluoride exceeded the CCME PAL at most sites and times sampled; the exception was Sturgeon Bay where only one sample collected exceeded the guideline. Exceedances of these parameters are common in the region.

All other water quality variables measured for which there are MWQSOG and CCME objectives or guidelines were within PAL objectives and guidelines at all core sampling sites.

Surveys along the alignment of the proposed LMOC and LSMOC conducted on September 3 and October 21, 2021, found surface water to be present at all locations surveyed, although total depths did not exceed 0.5 m at most sites. Due to low water levels during the September survey, *in situ* water quality could not be measured at Goodison Lake and Woodale Drain. In general, sites along the alignment of the proposed LMOC were moderately- to well-oxygenated, alkaline, and low to moderately turbid and had moderate conductivity. Sites sampled along the alignment of the proposed LSMOC were circum-neutral to alkaline, had low turbidity, and lower specific conductance than sites along the alignment of the proposed LMOC. Additionally, sites along the alignment of the proposed LSMOC were generally well oxygenated; however, low oxygen conditions were observed at the site located in Creek C on October 21, 2021.

At the time of the October survey, DO at the site sampled on Creek C was below the CCME guidelines for PAL, as well as applicable MWQSOG objectives, including: the MWQSOG 30-day averaging objective for cool-water aquatic life; and the MWQSOG instantaneous objective for early life stages of cold-water aquatic life. Furthermore, during the September survey, DO was below the CCME guideline for PAL for early life stages of cold-water at most sites sampled along the alignments of the proposed LMOC and LSMOC; however, it is unlikely that early life stages of cold-water species were present at the time the measurements were taken, as water temperatures were well above 5°C at the time. DO was within applicable MWQSOG and CCME PAL objectives/guidelines at all other sites and times sampled.

Additionally, pH was within applicable MWQSOG and CCME for PAL objectives and guidelines at all sites along the proposed LSMOC and LMOC. There are no MWQSOG or CCME PAL guidelines for the other *in situ* parameters measured.

5.0 REFERENCES

Armstrong, N. 2012. Manitoba Conservation and Water Stewardship, Water Stewardship Division, Water Science and Management Branch. Suite 160, 123 Main Street, Winnipeg MB, R3C 1A5.

British Columbia Ministry of Environment, Lands, and Parks (BCMELP). 1998. Guidelines for interpreting water quality data. Version 1, May 1998. Prepared for the Land Use Task Force Resource Inventory Committee.

Canadian Council of Ministers of the Environment (CCME). 1999 (Updated to 2022). Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Coordinated Aquatic Monitoring Program (CAMP). 2017. Six year summary report (2008-2013). Report prepared for Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB.

Kalff, J. 2002. Limnology: inland water ecosystems. Prentice Hall, New Jersey. 572 pp.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. July 4, 2011. 68 pp.

North/South Consultants Inc. (NSC). 2021. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Water Quality. A data report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. v + 75 pp.

NSC. 2022. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020 to Spring 2021. Water Quality. A report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. vi + 123 p.

NSC and KGS Group. 2016. Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation – 2011-2015. Volume 3 – Water Quality. A draft report prepared for Manitoba Infrastructure and Transportation. 546 pp.

Table 1. Core water quality sampling sites, Fall 2021.

Waterbody	Location Description	Site ID	Sampling Date	UTM coordinates			AEMP
				Zone	Easting	Northing	Site [1]
Lake Manitoba	offshore at proposed LMOC	WHB1	29-Aug-21	14U	529003	5680779	-
	nearshore at proposed LMOC	WHB2	29-Aug-21	14U	529746	5681362	Yes
Watchorn Creek	at Watchorn Bay	WHC-WB	29-Aug-21	14U	530461	5681184	-
Mercer Creek	at Watchorn Bay	MC-WB	29-Aug-21	14U	528716	5682146	-
Birch Creek	at PR 239	BCD-2018-9	29-Aug-21	14U	531731	5697489	-
	at Lake St. Martin	BC-LSM	29-Aug-21	14U	533228	5702332	Yes
Fairford River	at Highway 6 bridge	FR1	30-Aug-21	14U	578787	5715310	Yes
	at Lake St. Martin	FR2	30-Aug-21	14U	526633	5718273	-
Lake St. Martin	Birch Bay	BB-LSM	29-Aug-21	14U	534215	5704378	Yes
	middle of south basin	LSM5	31-Aug-21	14U	536280	5724434	Yes
	at the narrows	LSM4	30-Aug-21	14U	541798	5733633	Yes
	middle of north basin	LSM1	31-Aug-21	14U	549959	5736743	-
	eastern bay near proposed LSMOC	LSM3	31-Aug-21	14U	555678	5737343	Yes
Dauphin River	at Lake St. Martin	DR-A	31-Aug-21	14U	546567	5744301	Yes
	at Big Bend	DR-B	30-Aug-21	14U	546031	5757487	-
	at Sturgeon Bay	DR-E	30-Aug-21	14U	565033	5756994	Yes
Buffalo Creek	at the Dauphin River	BC3	3-Sep-21	14U	562212	5754561	-
Big Buffalo Lake	Big Buffalo Lake	BBL	3-Sep-21	14U	558065	5745510	-
Lake Winnipeg	nearshore at LSMOC outlet	SB1	30-Aug-21	14U	574526	5757724	Yes
	offshore at LSMOC outlet	SB2	30-Aug-21	14U	576248	5753657	Yes

Table 1. Continued.

Waterbody	Location Description	Site ID	Sampling Date	UTM coordinates			AEMP
				Zone	Easting	Northing	Site [1]
Lake Manitoba	offshore at proposed LMOC	WHB1	18-Oct-21	14U	529062	5680743	-
	nearshore at proposed LMOC	WHB2	18-Oct-21	14U	529827	5681390	Yes
Watchorn Creek	at Watchorn Bay	WHC-WB	18-Oct-21	14U	530463	5681187	-
Mercer Creek	at Watchorn Bay	MC-WB	18-Oct-21	14U	528716	5682149	-
Birch Creek	at PR 239	BCD-2018-9	18-Oct-21	14U	531724	5697498	-
	at Lake St. Martin	BC-LSM	18-Oct-21	14U	533234	5702353	Yes
Fairford River	at Highway 6 bridge	FR1	19-Oct-21	14U	518788	5715304	Yes
	at Lake St. Martin	FR2	19-Oct-21	14U	527044	5717629	-
Lake St. Martin	Birch Bay	BB-LSM	18-Oct-21	14U	534243	5704273	Yes
	middle of south basin	LSM5	20-Oct-21	14U	536267	5724373	Yes
	at the narrows	LSM4	19-Oct-21	14U	541796	5733631	Yes
	middle of north basin	LSM1	20-Oct-21	14U	549803	5736449	-
	eastern bay near proposed LSMOC	LSM3	20-Oct-21	14U	555894	5737228	Yes
Dauphin River	at Lake St. Martin	DR-A	17-Oct-21	14U	546556	5744278	Yes
	at Big Bend	DR-B	17-Oct-21	14U	546033	5757490	-
	at Sturgeon Bay	DR-E	17-Oct-21	14U	564919	5757106	Yes
Buffalo Creek	at the Dauphin River	BC3	21-Oct-21	14U	562214	5754625	-
Big Buffalo Lake	Big Buffalo Lake	BBL	21-Oct-21	14U	558341	5745547	-
Lake Winnipeg	nearshore at LSMOC outlet	SB1	17-Oct-21	14U	574370	5751488	Yes
	offshore at LSMOC outlet	SB2	17-Oct-21	14U	576862	5753525	Yes

1 - Sampling sites that were identified for surface water quality monitoring in the AEMP.

Table 2. Locations surveyed for the presence of water and *in situ* parameters.

Waterbody	Sampling Date	UTM coordinates		
		Zone	Easting	Northing
Reed Lake	3-Sep-21	14U	531730	5697484
Clear Lake	3-Sep-21	14U	531172	5690006
Water Lake	3-Sep-21	14U	531082	5692398
Goodison Lake	3-Sep-21	14U	531841	5695504
Creek C upstream of LSMOC alignment	3-Sep-21	14U	567225	5748751
Unnamed Creek at LSMOC alignment	3-Sep-21	14U	561830	5742967
Unnamed Creek at Buffalo Creek	3-Sep-21	14U	559927	5740683
Reed Lake	21-Oct-21	14U	531960	5687216
Clear Lake	21-Oct-21	14U	531190	5690259
Water Lake	21-Oct-21	14U	531019	5692166
Goodison Lake	21-Oct-21	14U	531852	5695526
Clarks Drain	21-Oct-21	14U	532971	5699465
Woodale Drain	21-Oct-21	14U	532868	5699905
Creek C upstream of LSMOC alignment	21-Oct-21	14U	566688	5748944
Unnamed Creek at Buffalo Creek	21-Oct-21	14U	559949	5740653
Unnamed Creek at LSMOC alignment	21-Oct-21	14U	561572	5743057

Table 3. Laboratory parameters measured at core water quality sampling sites.

Routine Parameters	Metals (total and dissolved) and Major Ions	
Routine Chemistry	Aluminum	Nickel
Total alkalinity, as $CaCO_3$	Antimony	Phosphorus
Bicarbonate alkalinity as HCO_3	Arsenic	Potassium
Carbonate alkalinity, as CO_3	Barium	Rubidium
Hydroxide alkalinity, as OH	Beryllium	Selenium
pH	Bismuth	Silicon
Conductivity	Boron	Silver
Total Dissolved Solids	Cadmium	Sodium
Hardness, as $CaCO_3$	Calcium	Strontium
Nutrients	Cesium	Sulfate, dissolved
Total Ammonia (as N)	Chloride, dissolved	Sulfur
Nitrate (as N)	Chromium	Tellurium
Nitrite (as N)	Cobalt	Thallium
Nitrate and Nitrite (as N)	Copper	Thorium
Total Kjeldahl Nitrogen	Fluoride, dissolved	Tin
Total Nitrogen	Iron	Titanium
Dissolved Phosphorus	Lead	Tungsten
Total Particulate Phosphorus	Lithium	Uranium
Total Phosphorus	Magnesium	Vanadium
Total Inorganic Carbon	Manganese	Zinc
Total Organic Carbon	Mercury	Zirconium
Dissolved Organic Carbon	Molybdenum	
Total Carbon		
Water Clarity		
Total Suspended Solids		
Turbidity		
True Colour		
Algal Pigments		
Chlorophyll *a*		
Phaeophytin *a*		

Table 4. Hydrocarbon parameters measured at selected water quality sampling sites in Fall 2021.

Parameter	Unit	DL
Benzene	mg/L	0.00050
Ethyl benzene	mg/L	0.00050
Toluene	mg/L	0.0010
o-Xylene	mg/L	0.00050
m+p-Xylenes	mg/L	0.00040
Xylenes (Total)	mg/L	0.00064
F1 (C6-C10)	mg/L	0.10
F1-BTEX	mg/L	0.10
F2-Naphth	mg/L	0.10
F2 (C10-C16)	mg/L	0.10
F3-PAH	mg/L	0.25
F3 (C16-C34)	mg/L	0.25
F4 (C34-C50)	mg/L	0.25
Total Hydrocarbons (C6-C50)	mg/L	0.38
Acenaphthene	mg/L	0.000020
Acenaphthylene	mg/L	0.000020
Acridine	mg/L	0.000020
Anthracene	mg/L	0.000010
Benzo(a)anthracene	mg/L	0.000010
Benzo(a)pyrene	mg/L	0.0000050
Benzo(b&j)fluoranthene	mg/L	0.000010
Benzo(g,h,i)perylene	mg/L	0.000020
Benzo(k)fluoranthene	mg/L	0.000010
Chrysene	mg/L	0.000020
Dibenzo(a,h)anthracene	mg/L	0.0000050
Fluoranthene	mg/L	0.000020
Fluorene	mg/L	0.000020
Indeno(1,2,3-cd)pyrene	mg/L	0.000010
1-Methyl Naphthalene	mg/L	0.000020
2-Methyl Naphthalene	mg/L	0.000020
Naphthalene	mg/L	0.000050
Phenanthrene	mg/L	0.000050
Pyrene	mg/L	0.000010
Quinoline	mg/L	0.000020
B(a)P Total Potency Equivalent	mg/L	0.000030

Table 5. Pesticides measured at selected water quality sampling sites in Fall 2021.

Parameter	Unit	DL	Parameter	Unit	DL
Aldrin	µg/L	0.0080	Bromoxynil	mg/L	0.00010
alpha-BHC	µg/L	0.0080	Clopyralid	mg/L	0.00010
beta-BHC	µg/L	0.0080	2,4-D	mg/L	0.00010
gamma-hexachlorocyclohexane	µg/L	0.0080	Dicamba	mg/L	0.00010
delta-BHC	µg/L	0.0080	2,4-DB	mg/L	0.00010
a-chlordane	µg/L	0.0080	2,4-DP	mg/L	0.00010
g-chlordane	µg/L	0.0080	Dinoseb	mg/L	0.00010
o,p-DDD	µg/L	0.0040	MCPA	mg/L	0.00010
pp-DDD	µg/L	0.0040	MCPB	mg/L	0.00010
o,p-DDE	µg/L	0.0040	Mecoprop	mg/L	0.00010
pp-DDE	µg/L	0.0040	Picloram	mg/L	0.00010
op-DDT	µg/L	0.0040	2,4,5-T	mg/L	0.00010
pp-DDT	µg/L	0.0040	2,4,5-TP	mg/L	0.00010
Dieldrin	µg/L	0.0080	Triclopyr	mg/L	0.00010
Endosulfan I	µg/L	0.0070	Atrazine	µg/L	0.10
Endosulfan II	µg/L	0.0070	Atrazine+N-Dealkylated Metabolites	µg/L	0.20
Endosulfan Sulfate	µg/L	0.0070	Ethalfluralin	mg/L	0.00010
Endrin	µg/L	0.010	Atrazine Desethyl	µg/L	0.10
Endrin Aldehyde	µg/L	0.010	Fluazifop-p-butyl	mg/L	0.00010
Heptachlor	µg/L	0.0080	Glyphosate	µg/L	0.20
Heptachlor Epoxide	µg/L	0.0080	Diclofop-methyl	mg/L	0.00010
Hexachlorobenzene	µg/L	0.0080	Triallate	mg/L	0.00010
Hexachlorobutadiene	µg/L	0.0080	Trifluralin	mg/L	0.00010
Hexachloroethane	µg/L	0.0080			
Methoxychlor	µg/L	0.0080			
Mirex	µg/L	0.0080			
trans-Nonachlor	µg/L	0.010			
Oxychlordane	µg/L	0.0080			
Pentachloronitrobenzene	µg/L	0.010			
AMPA	µg/L	0.50			

Table 6. Results for *in situ* parameters measured at core sampling sites.

Waterbody	Site ID	Sampling Date	Sampling Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth (m)
Watchorn Bay	WHB1	29-Aug-21	17:45	2.2	0.3	17.60	9.84	103.4	1119	4.17	8.37	0.80
					0.5	17.60	9.85	103.4	1120	4.17	8.36	
					1.0	17.60	9.88	103.8	1120	4.15	8.36	
					1.5	17.60	9.93	104.3	1120	4.10	8.36	
					2.0	17.50	10.07	105.1	1121	4.03	8.39	
	WHB2	29-Aug-21	17:30	1.3	0.3	18.00	9.98	105.9	1113	4.66	8.40	0.80
					0.5	18.00	9.98	105.8	1112	4.68	8.39	
					1.0	18.00	10.01	106.2	1112	4.82	8.39	
	WHC-WB	29-Aug-21	17:00	0.6	0.3	18.90	9.95	107.3	688	0.18	8.09	>0.6
					0.5	18.90	9.94	107.2	671	0.39	8.08	
Mercer Creek	MC-WB	29-Aug-21	18:15	0.4	0.3	18.10	10.15	107.7	1215	2.03	7.63	>0.4
Birch Creek	BCD-2018-9	29-Aug-21	11:45	0.3	0.3	15.90	6.23	63.2	820	0.16	7.34	>0.3
	BC-LSM	29-Aug-21	12:21	0.4	0.3	16.50	10.17	104.2	635	0.28	7.85	>0.20
Fairford River	FR1	30-Aug-21	7:45	1.8	0.3	16.20	9.02	92.2	1157	5.34	8.26	0.85
	FR2	30-Aug-21	8:45	0.4	0.3	16.30	9.28	95.0	1155	6.05	8.21	>0.4
Lake St. Martin	BB-LSM	29-Aug-21	13:30	2.3	0.3	16.50	9.83	100.9	1125	8.22	8.27	0.65
					0.5	16.50	9.86	101.2	1124	8.11	8.24	
					1.0	16.40	9.84	101.0	1126	12.98	8.28	
					1.5	16.40	9.84	101.0	1125	13.36	8.27	
					2.0	16.40	9.83	100.7	1125	14.72	8.27	
	LSM5	31-Aug-21	10:00	3.5	0.3	17.00	10.20	106.9	1120	2.85	8.73	1.05
					1.0	16.90	10.20	106.1	1120	2.86	8.73	
					1.5	16.90	10.22	106.1	1120	2.86	8.73	
					2.0	16.90	10.23	106.1	1120	2.87	8.73	
					2.5	16.90	10.22	106.0	1120	2.93	8.73	
					3.0	16.90	10.22	106.0	1120	2.96	8.68	

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth (m)
Lake St. Martin	LSM4	30-Aug-21	10:30	0.4	0.3	17.42	8.28	86.9	1124	4.72	8.50	>0.4
	LSM1	31-Aug-21	12:45	0.9	0.3	18.60	10.46	117.5	1050	4.79	8.84	0.85
					0.6	18.60	11.02	118.2	1050	6.90	8.80	
	LSM3	31-Aug-21	13:15	0.9	0.3	18.80	11.59	124.6	1113	3.29	9.27	0.80
					0.7	18.70	11.94	128.5	1110	3.78	9.27	
Dauphin River	DR-A	31-Aug-21	8:12	1.2	0.3	16.90	8.12	84.3	1121	8.58	8.88	0.40
	DR-B	30-Aug-21	16:00	0.5	0.3	18.60	10.27	110.0	1080	9.36	9.00	>0.5
	DR-E	30-Aug-21	18:30	3.3	0.3	18.50	10.97	117.2	1064	6.90	8.84	0.65
					1.0	18.50	10.92	117.0	1066	6.89	8.83	
					1.5	18.50	10.69	114.4	1057	6.84	8.83	
					2.0	18.20	10.45	111.1	1063	6.91	8.84	
					2.5	17.50	10.16	106.5	1062	9.20	8.81	
Big Buffalo Lake	BBL	3-Sep-21	12:01	1.0	0.3	18.42	9.30	96.5	559	3.07	8.70	>0.70
Buffalo Creek	BC3	3-Sep-21	12:30	0.6	0.3	18.70	8.81	94.6	393	11.37	7.97	>0.60
Sturgeon Bay	SB1	30-Aug-21	18:00	3.8	0.3	17.90	10.50	107.3	540	10.90	8.38	0.65
					1.0	17.90	10.20	107.9	539	10.86	8.36	
					1.5	17.90	10.16	107.4	540	10.64	8.35	
					2.0	17.90	10.11	106.7	543	9.52	8.34	
					2.5	16.10	10.13	103.0	552	7.52	8.20	
	SB2	30-Aug-21	17:30	6.2	0.3	17.50	9.86	103.3	438	11.39	8.34	0.65
					1.0	17.40	9.91	103.7	441	11.35	8.32	
					2.0	16.50	9.94	102.0	491	13.98	8.31	
					3.0	15.90	9.60	97.5	520	15.02	8.21	
					4.0	15.90	9.40	95.2	525	14.79	8.07	
					5.0	15.90	9.40	95.2	524	14.94	8.07	
					6.0	15.90	9.16	93.3	529	17.34	8.02	

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth (m)
Watchorn Bay	WHB1	18-Oct-21	15:30	2.3	0.3	9.83	10.96	97.1	1149	6.95	8.57	0.53
					1.0	9.83	10.98	97.2	1149	6.92	8.56	
					1.5	9.83	10.99	97.3	1149	7.28	8.56	
					2.0	9.83	10.99	97.3	1149	7.53	8.56	
	WHB2	18-Oct-21	16:41	1.2	0.3	10.64	11.14	100.6	1149	5.85	8.58	0.57
					0.6	10.65	11.15	100.6	1150	5.83	8.57	
					0.9	10.65	11.15	100.6	1149	5.86	8.57	
	WHC-WB	18-Oct-21	14:09	0.8	0.3	9.84	12.77	112.3	1144	1.94	8.41	>0.8
Mercer Creek	MC-WB	18-Oct-21	16:14	0.4	0.2	11.79	9.76	90.4	1288	4.04	7.93	>0.4
Birch Creek	BCD-2018-9	18-Oct-21	12:53	0.6	0.3	9.15	10.44	90.9	1035	1.94	8.40	-
	BC-LSM	18-Oct-21	12:27	0.4	0.2	8.49	10.04	86.0	723	2.00	8.50	-
Fairford River	FR1	19-Oct-21	15:22	1.3	0.3	8.35	11.03	94.2	1178	8.39	8.46	-
					0.6	8.34	11.02	94.2	1178	8.59	8.46	
					0.9	8.18	11.05	94.1	1177	8.86	8.46	
	FR2	19-Oct-21	14:51	0.7	0.3	8.24	11.49	97.9	1176	8.26	8.42	-
Lake St. Martin	BB-LSM	18-Oct-21	11:03	2.1	0.3	9.01	10.76	93.5	1166	5.92	8.48	0.78
					1.0	8.99	10.76	93.4	1167	5.87	8.48	
					1.5	9.01	10.74	93.3	1166	5.84	8.48	
					1.8	9.01	10.74	93.3	1167	5.82	8.48	
	LSM5	20-Oct-21	14:11	3.4	0.3	8.67	11.60	95.4	1157	6.22	8.54	0.60
					1.0	8.68	11.03	95.0	1157	6.22	8.54	
					1.5	8.68	11.00	94.8	1157	6.27	8.54	
					2.0	8.68	10.99	94.7	1157	6.08	8.53	
					2.5	8.68	10.97	94.5	1157	6.09	8.46	
					3.0	8.68	10.97	94.5	1157	5.96	8.46	

Table 6. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH	Secchi Disk Depth (m)
Lake St. Martin	LSM4	19-Oct-21	9:15	0.6	0.3	7.91	10.85	91.8	1165	3.84	8.52	0.48
	LSM1	20-Oct-21	10:57	0.9	0.3	6.26	11.28	91.6	1175	12.64	8.46	0.31
					0.6	6.22	11.28	91.5	1176	12.74	8.47	
	LSM3	20-Oct-21	10:26	0.9	0.3	6.53	11.13	90.9	1154	7.50	8.42	0.51
					0.6	6.54	11.41	91.0	1155	7.64	8.42	
Dauphin River	DR-A	17-Oct-21	16:03	0.9	0.3	9.45	11.45	100.6	1163	10.16	8.65	-
					0.6	9.47	11.46	100.6	1163	10.47	8.65	
	DR-B	17-Oct-21	15:21	0.6	0.3	8.08	11.41	96.8	1162	8.32	8.57	>0.6
	DR-E	17-Oct-21	14:00	2.1	0.3	7.29	10.97	91.4	1150	7.33	8.43	0.83
					1.0	7.25	10.94	91.7	1150	7.46	8.42	
					1.5	7.19	10.87	90.3	1150	7.80	8.42	
Big Buffalo Lake	BBL	21-Oct-21	12:31	0.5	0.3	5.70	11.25	90.1	604	4.75	8.63	>0.5
Buffalo Creek	BC3	21-Oct-21	12:50	0.8	0.3	5.48	11.88	94.3	466	6.74	8.29	>0.8
Sturgeon Bay	SB1	17-Oct-21	13:17	3.5	0.3	10.26	10.38	92.7	438	6.37	8.34	0.88
					1.0	10.24	10.37	92.5	438	6.58	8.33	
					1.5	10.25	10.36	92.5	438	6.84	8.33	
					2.0	10.25	10.36	92.5	438	6.55	8.32	
					2.5	10.26	10.36	92.4	438	6.54	8.28	
					3.0	10.26	10.35	92.4	438	6.62	8.32	
	SB2	17-Oct-21	12:37	5.6	0.3	10.40	10.79	96.6	420	9.57	8.43	0.78
					1.0	10.41	10.80	96.7	409	9.82	8.44	
					2.0	10.40	10.79	96.6	419	9.96	8.44	
					3.0	10.40	10.78	96.5	419	9.91	8.44	
					4.0	10.40	10.76	96.4	419	9.81	8.43	
					5.0	10.39	10.75	96.2	419	9.96	8.28	
					5.3	10.39	10.75	96.3	419	9.93	8.25	

Table 7. Laboratory results for routine parameters measured at core sampling sites.

Waterbody	Site ID	Sampling Date	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Analytical DL				*1.0*	*1.2*	*0.60*	*0.34*	*0.010*	*0.0050 /0.010*	*0.0010 /0.0020*	*0.0051 /0.010*
Lake Manitoba	WHB1	29-Aug-21	L2633558-13	167	187	8.04	<0.34	0.012	<0.010	<0.0020	<0.010
	WHB2	29-Aug-21	L2633558-14	167	188	7.56	<0.34	0.013	<0.010	<0.0020	<0.010
Watchorn Creek	WHC-WB	29-Aug-21	L2633558-15	230	264	8.04	<0.34	0.020	<0.0050	<0.0010	<0.0051
Mercer Creek	MC-WB	29-Aug-21	L2633558-16	191	233	<0.60	<0.34	0.010	<0.010	<0.0020	<0.010
Birch Creek	BCD-2018-9	29-Aug-21	L2633060-3	214	261	<0.60	<0.34	0.024	<0.0050	<0.0010	<0.0051
	BC-LSM	29-Aug-21	L2633060-1	249	293	5.04	<0.34	0.025	<0.0050	<0.0010	<0.0051
Fairford River	FR1	30-Aug-21	L2633558-9	172	196	6.96	<0.34	<0.010	<0.010	<0.0020	<0.010
	FR2	30-Aug-21	Mean	172	197	6.36	<0.34	0.016	<0.010	<0.0020	<0.010
Lake St. Martin	BB-LSM	29-Aug-21	L2633060-2	172	193	8.28	<0.34	0.015	<0.010	<0.0020	<0.010
	LSM5	31-Aug-21	L2634301-5	163	181	8.88	<0.34	0.018	<0.010	<0.0020	<0.010
	LSM4	30-Aug-21	Mean	164	188	5.40	<0.34	0.025	<0.010	<0.0020	<0.010
	LSM1	31-Aug-21	L2634301-6	150	162	9.96	<0.34	0.033	<0.010	<0.0020	<0.010
	LSM3	31-Aug-21	L2634301-7	156	155	17.8	<0.34	0.012	0.031	<0.0020	0.031
Dauphin River	DR-A	31-Aug-21	L2634301-8	150	166	8.52	<0.34	0.024	<0.010	<0.0020	<0.010
	DR-B	30-Aug-21	L2634301-4	148	156	11.8	<0.34	0.016	<0.010	<0.0020	<0.010
	DR-E	30-Aug-21	L2634301-3	149	162	10.1	<0.34	0.016	<0.010	<0.0020	<0.010
Big Buffalo Lake	BBL	3-Sep-21	L2635892-1	237	263	13.2	<0.34	0.037	<0.0050	<0.0010	<0.0051
Buffalo Creek	BC3	3-Sep-21	L2635892-2	162	194	1.56	<0.34	0.020	0.0055	<0.0010	0.0055
Lake Winnipeg	SB1	30-Aug-21	L2634301-2	125	149	1.68	<0.34	0.021	0.0669	<0.0010	0.0669
	SB2	30-Aug-21	L2634301-1	115	139	<0.60	<0.34	0.011	0.0881	<0.0010	0.0881

Table 7. Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Lake Manitoba	WHB1	18-Oct-21	Mean	172	204	3.16	<0.34	<0.010	<0.010	<0.0020	<0.010
	WHB2	18-Oct-21	L2652497-6	172	203	3.24	<0.34	<0.010	<0.010	<0.0020	<0.010
Watchorn Creek	WHC-WB	18-Oct-21	L2652497-4	243	294	0.96	<0.34	0.010	<0.010	<0.0020	<0.010
Mercer Creek	MC-WB	18-Oct-21	L2652497-7	212	259	<0.60	<0.34	0.098	0.010	<0.0020	0.0100
Birch Creek	BCD-2018-9	18-Oct-21	L2652497-1	357	425	5.28	<0.34	0.017	<0.010	<0.0020	<0.010
	BC-LSM	18-Oct-21	L2652497-2	310	368	4.68	<0.34	0.042	0.152	0.0061	0.158
Fairford River	FR1	19-Oct-21	L2653142-1	178	208	4.44	<0.34	0.013	<0.010	<0.0020	<0.010
	FR2	19-Oct-21	Mean	178	208	4.44	<0.34	0.026	<0.010	<0.0020	<0.010
Lake St. Martin	BB-LSM	18-Oct-21	L2652497-3	180	215	2.40	<0.34	0.041	<0.010	<0.0020	<0.010
	LSM5	20-Oct-21	L2653742-3	180	207	6.12	<0.34	<0.010	<0.010	<0.0020	<0.010
	LSM4	19-Oct-21	L2653142-3	178	206	5.16	<0.34	0.024	<0.010	<0.0020	<0.010
	LSM1	20-Oct-21	L2653742-1	182	214	3.60	<0.34	0.037	<0.010	<0.0020	<0.010
	LSM3	20-Oct-21	L2653742-2	186	217	4.92	<0.34	0.017	<0.010	<0.0020	<0.010
Dauphin River	DR-A	17-Oct-21	L2652045-7	171	204	2.64	<0.34	0.034	<0.010	<0.0020	<0.010
	DR-B	17-Oct-21	L2652045-6	173	207	2.04	<0.34	0.038	<0.010	<0.0020	<0.010
	DR-E	17-Oct-21	L2652045-3	174	212	<0.60	<0.34	0.046	0.0130	<0.0020	0.0130
Big Buffalo Lake	BBL	21-Oct-21	L2654247-1	260	304	6.48	<0.34	0.033	0.0159	<0.0010	0.0159
Buffalo Creek	BC3	21-Oct-21	L2654247-2	212	254	2.52	<0.34	0.010	<0.0050	<0.0010	<0.0051
Lake Winnipeg	SB1	17-Oct-21	L2652045-2	119	146	<0.60	<0.34	0.013	0.0384	<0.0010	0.0384
	SB2	17-Oct-21	L2652045-1	116	141	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Nitrogen			Phosphorus				Molar N:P Ratios		
			Dissolved Inorganic Nitrogen (mg/L)[1]	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Dissolved Fraction (%)	TN:TP	DIN:DP	DIN:TP
Analytical DL			*0.010*	*0.20*	*0.20*	*0.0010 /0.0030*	*0.0028 /0.0042*	*0.0010 /0.0030*				
Lake Manitoba	WHB1	29-Aug-21	0.017	0.66	0.66	0.0068	0.0156	0.0224	30.4	65.2	5.53	1.68
	WHB2	29-Aug-21	0.018	1.25	1.25	0.0074	0.0130	0.0204	36.3	135	5.38	1.95
Watchorn Creek	WHC-WB	29-Aug-21	0.023	1.02	1.02	0.0171	0.0042	0.0213	80.3	106	2.92	2.34
Mercer Creek	MC-WB	29-Aug-21	0.015	1.37	1.37	0.0232	0.0259	0.0491	47.3	61.7	1.43	0.68
Birch Creek	BCD-2018-9	29-Aug-21	0.027	1.14	1.14	0.0110	0.0090	0.0200	55.0	126	5.34	2.94
	BC-LSM	29-Aug-21	0.028	1.09	1.09	0.0102	0.0104	0.0205	49.8	118	5.97	2.97
Fairford River	FR1	30-Aug-21	0.010	1.19	1.19	0.0067	0.0154	0.0221	30.3	119	3.30	1.00
	FR2	30-Aug-21	0.021	0.81	0.81	0.0072	0.0168	0.0240	30.2	74.4	6.42	1.94
Lake St. Martin	BB-LSM	29-Aug-21	0.020	1.06	1.06	0.0071	0.0329	0.0400	17.8	58.6	6.23	1.11
	LSM5	31-Aug-21	0.023	0.91	0.91	0.0076	0.0155	0.0231	32.9	87.1	6.69	2.20
	LSM4	30-Aug-21	0.030	1.38	1.38	0.0085	0.0148	0.0233	36.3	131	7.75	2.82
	LSM1	31-Aug-21	0.038	1.14	1.14	0.0081	0.0140	0.0221	36.7	114	10.4	3.80
	LSM3	31-Aug-21	0.043	1.55	1.58	0.0099	0.0171	0.0271	36.5	129	9.60	3.51
Dauphin River	DR-A	31-Aug-21	0.029	1.76	1.76	0.0095	0.0250	0.0345	27.5	113	6.75	1.86
	DR-B	30-Aug-21	0.021	1.41	1.41	0.0106	0.0240	0.0346	30.6	90.1	4.38	1.34
	DR-E	30-Aug-21	0.021	1.40	1.40	0.0107	0.0257	0.0364	29.4	85.1	4.34	1.28
Big Buffalo Lake	BBL	3-Sep-21	0.040	1.74	1.74	0.0099	0.0283	0.0382	25.9	101	8.83	2.29
Buffalo Creek	BC3	3-Sep-21	0.026	1.02	1.02	0.0093	0.0159	0.0252	36.9	89.5	6.06	2.24
Lake Winnipeg	SB1	30-Aug-21	0.088	0.55	0.62	0.0177	0.0144	0.0321	55.1	42.7	11.0	6.06
	SB2	30-Aug-21	0.099	0.40	0.49	0.0215	0.0162	0.0376	57.2	28.8	10.2	5.83

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Nitrogen			Phosphorus				Molar N:P Ratios		
			Dissolved Inorganic Nitrogen (mg/L)[1]	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Dissolved Fraction (%)	TN:TP	DIN:DP	DIN:TP
Lake Manitoba	WHB1	18-Oct-21	0.012	1.09	1.09	0.0060	0.0179	0.0239	25.2	101	4.28	1.08
	WHB2	18-Oct-21	0.010	1.16	1.16	0.0067	0.0152	0.0219	30.6	117	3.30	1.01
Watchorn Creek	WHC-WB	18-Oct-21	0.015	2.14	2.14	0.0224	0.0183	0.0407	55.0	116	1.48	0.81
Mercer Creek	MC-WB	18-Oct-21	0.108	1.53	1.54	0.0189	0.0241	0.0429	44.1	79.4	12.6	5.57
Birch Creek	BCD-2018-9	18-Oct-21	0.022	1.65	1.65	0.0095	0.0116	0.0211	45.0	173	5.12	2.31
	BC-LSM	18-Oct-21	0.200	1.24	1.39	0.0200	0.0222	0.0422	47.4	72.8	22.1	10.5
Fairford River	FR1	19-Oct-21	0.018	1.09	1.09	0.0081	0.0177	0.0258	31.4	93.4	4.91	1.54
	FR2	19-Oct-21	0.031	0.93	0.93	0.0073	0.0215	0.0288	25.5	71.2	9.45	2.41
Lake St. Martin	BB-LSM	18-Oct-21	0.046	0.95	0.95	0.0069	0.0170	0.0239	28.9	87.9	14.7	4.26
	LSM5	20-Oct-21	0.010	1.57	1.57	0.0075	0.0200	0.0276	27.2	126	2.95	0.80
	LSM4	19-Oct-21	0.029	1.05	1.05	0.0078	0.0164	0.0242	32.2	95.9	8.22	2.65
	LSM1	20-Oct-21	0.042	1.38	1.38	0.0096	0.0112	0.0207	46.4	147	9.67	4.49
	LSM3	20-Oct-21	0.022	1.57	1.57	0.0095	0.0180	0.0275	34.5	126	5.12	1.77
Dauphin River	DR-A	17-Oct-21	0.039	1.17	1.17	0.0094	0.0174	0.0268	35.1	96.5	9.17	3.22
	DR-B	17-Oct-21	0.043	1.45	1.45	0.0086	0.0163	0.0249	34.5	129	11.1	3.82
	DR-E	17-Oct-21	0.059	1.40	1.41	0.0096	0.0176	0.0272	35.3	115	13.6	4.80
Big Buffalo Lake	BBL	21-Oct-21	0.049	1.87	1.89	0.0114	0.0291	0.0405	28.1	103	9.49	2.67
Buffalo Creek	BC3	21-Oct-21	0.013	0.84	0.84	0.0074	0.0145	0.0218	33.9	85.2	3.75	1.27
Lake Winnipeg	SB1	17-Oct-21	0.051	0.45	0.49	0.0188	<0.0042	0.0228	82.5	47.5	6.05	4.99
	SB2	17-Oct-21	<0.010	0.52	0.52	0.0101	0.0213	0.0314	32.2	36.6	1.09	0.35

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Carbon				Routine Chemistry				
			Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)	Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Biochemical Oxygen Demand $(mg/L)^2$
Analytical DL			*0.50*	*0.50*	*0.50*	*1.0*	*0.10*	*1*	*20*	*0.2*	*2.0*
Lake Manitoba	WHB1	29-Aug-21	31.5	15.0	13.9	46.5	8.49	1130	652	247	-
	WHB2	29-Aug-21	32.0	15.2	14.8	47.1	8.48	1120	610	246	-
Watchorn Creek	WHC-WB	29-Aug-21	46.7	19.8	20.7	66.4	8.42	689	448	327	<2.0
Mercer Creek	MC-WB	29-Aug-21	37.9	18.3	17.7	56.3	8.21	1220	733	312	4.0
Birch Creek	BCD-2018-9	29-Aug-21	42.2	27.4	26.2	69.5	8.02	863	609	496	<2.0
	BC-LSM	29-Aug-21	48.4	26.5	27.0	74.9	8.33	672	458	358	<2.0
Fairford River	FR1	30-Aug-21	31.5	15.1	14.8	46.6	8.44	1170	620	252	<2.0
	FR2	30-Aug-21	33.4	15.8	15.0	49.2	8.44	1170	630	274	-
Lake St. Martin	BB-LSM	29-Aug-21	34.7	17.0	15.3	51.7	8.48	1190	619	266	-
	LSM5	31-Aug-21	33.5	14.1	13.6	47.6	8.56	1130	634	243	-
	LSM4	30-Aug-21	32.6	16.2	15.9	48.9	8.41	1137	615	266	-
	LSM1	31-Aug-21	29.1	13.9	13.0	43.0	8.66	1050	618	228	-
	LSM3	31-Aug-21	31.7	19.1	17.2	50.8	8.95	1130	654	248	-
Dauphin River	DR-A	31-Aug-21	28.4	16.4	15.7	44.8	8.65	1130	640	232	-
	DR-B	30-Aug-21	28.5	16.9	19.7	45.4	8.75	1080	620	227	-
	DR-E	30-Aug-21	29.2	15.0	14.6	44.1	8.66	1070	608	229	-
Big Buffalo Lake	BBL	3-Sep-21	50.7	21.6	22.9	72.2	8.58	568	378	251	<2.0
Buffalo Creek	BC3	3-Sep-21	32.7	22.8	26.1	55.5	8.30	390	285	201	<2.0
Lake Winnipeg	SB1	30-Aug-21	22.6	8.34	8.25	31.0	8.30	547	322	161	-
	SB2	30-Aug-21	23.7	7.32	8.02	31.0	8.30	458	273	147	-

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Carbon				Routine Chemistry				
			Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)	Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Biochemical Oxygen Demand $(mg/L)^2$
Lake Manitoba	WHB1	18-Oct-21	35.6	14.5	14.2	50.1	8.35	1170	667	268	-
	WHB2	18-Oct-21	34.8	14.5	14.3	49.2	8.35	1160	664	264	-
Watchorn Creek	WHC-WB	18-Oct-21	50.4	18.4	17.7	68.8	8.29	1160	687	349	-
Mercer Creek	MC-WB	18-Oct-21	43.9	15.5	15.5	59.3	8.17	1280	745	330	-
Birch Creek	BCD-2018-9	18-Oct-21	74.6	30.7	30.1	105	8.34	1040	743	645	-
	BC-LSM	18-Oct-21	56.8	25.5	25.4	82.3	8.35	734	488	439	-
Fairford River	FR1	19-Oct-21	36.9	14.9	14.5	51.8	8.39	1220	511	266	-
	FR2	19-Oct-21	37.1	15.1	14.6	52.2	8.39	1217	660	273	-
Lake St. Martin	BB-LSM	18-Oct-21	38.7	16.3	15.3	55.0	8.31	1180	682	282	-
	LSM5	20-Oct-21	37.2	15.9	15.6	53.2	8.45	1190	663	267	-
	LSM4	19-Oct-21	34.6	16.1	15.6	50.7	8.43	1200	678	271	-
	LSM1	20-Oct-21	35.3	16.5	16.2	51.8	8.4	1200	687	276	-
	LSM3	20-Oct-21	38.8	18.0	18.6	56.8	8.42	1190	600	288	-
Dauphin River	DR-A	17-Oct-21	36.0	17.0	16.6	53.0	8.32	1200	684	261	-
	DR-B	17-Oct-21	37.9	17.3	16.6	55.2	8.31	1190	617	267	-
	DR-E	17-Oct-21	36.5	16.5	16.5	53.0	8.29	1170	693	262	-
Big Buffalo Lake	BBL	21-Oct-21	54.5	24.0	23.3	78.5	8.46	618	316	308	-
Buffalo Creek	BC3	21-Oct-21	45.1	23.8	24.1	68.8	8.35	472	272	252	-
Lake Winnipeg	SB1	17-Oct-21	24.9	8.36	8.34	33.3	8.17	449	256	160	-
	SB2	17-Oct-21	24.3	7.97	8.29	32.2	8.21	429	259	151	-

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Water Clarity			Algal Pigments	
			Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Analytical DL			*1.0*	*0.1*	*5.0*	*0.10*	*0.10*
Lake Manitoba	WHB1	29-Aug-21	10.9	6.18	<5.0	7.72	1.66
	WHB2	29-Aug-21	10.5	6.75	<5.0	7.06	1.57
Watchorn Creek	WHC-WB	29-Aug-21	<1.0	0.61	90	3.56	4.88
Mercer Creek	MC-WB	29-Aug-21	6.3	3.12	29.4	51.3	10.5
Birch Creek	BCD-2018-9	29-Aug-21	<1.0	0.51	121	1.89	2.12
	BC-LSM	29-Aug-21	<1.0	0.75	109	3.77	3.54
Fairford River	FR1	30-Aug-21	12.5	8.57	7.0	6.48	1.41
	FR2	30-Aug-21	12.8	9.10	<5.0	7.13	1.78
Lake St. Martin	BB-LSM	29-Aug-21	33.7	22.5	5.3	15.4	4.29
	LSM5	31-Aug-21	7.8	4.04	<5.0	7.83	1.66
	LSM4	30-Aug-21	7.7	5.15	8.7	6.45	2.10
	LSM1	31-Aug-21	8.0	6.05	<5.0	7.75	1.45
	LSM3	31-Aug-21	8.6	4.40	9.0	8.87	1.54
Dauphin River	DR-A	31-Aug-21	13.7	11.4	8.0	11.1	2.98
	DR-B	30-Aug-21	17.1	14.3	<5.0	10.7	2.19
	DR-E	30-Aug-21	11.9	9.01	7.0	11.7	2.22
Big Buffalo Lake	BBL	3-Sep-21	9.4	3.77	47.3	9.94	3.75
Buffalo Creek	BC3	3-Sep-21	8.5	11.4	78.4	2.93	2.54
Lake Winnipeg	SB1	30-Aug-21	6.0	11.1	5.6	6.93	1.49
	SB2	30-Aug-21	6.9	13.2	5.1	4.26	1.44

Table 7. Continued.

Waterbody	Site ID	Sampling Date	Water Clarity			Algal Pigments	
			Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Lake Manitoba	WHB1	18-Oct-21	14.5	9.61	7.1	9.46	2.05
	WHB2	18-Oct-21	12.3	7.89	7.1	8.59	1.97
Watchorn Creek	WHC-WB	18-Oct-21	4.2	2.09	34.1	25.5	7.30
Mercer Creek	MC-WB	18-Oct-21	9.1	6.36	25.5	16.7	6.12
Birch Creek	BCD-2018-9	18-Oct-21	2.4	2.10	83.6	2.30	2.10
	BC-LSM	18-Oct-21	2.5	2.40	75.6	5.24	4.86
Fairford River	FR1	19-Oct-21	15.0	12.1	<5.0	5.91	1.30
	FR2	19-Oct-21	15.3	12.13	<5.0	6.01	2.25
Lake St. Martin	BB-LSM	18-Oct-21	10.7	7.74	9.0	10.3	2.59
	LSM5	20-Oct-21	13.4	8.32	<5.0	14.0	3.54
	LSM4	19-Oct-21	6.8	4.87	<5.0	5.87	1.62
	LSM1	20-Oct-21	19.4	17.4	39.1	8.33	2.79
	LSM3	20-Oct-21	12.3	10.1	64.6	7.27	2.20
Dauphin River	DR-A	17-Oct-21	16.1	12.8	9.0	7.12	2.28
	DR-B	17-Oct-21	13.1	11.3	8.4	7.72	2.69
	DR-E	17-Oct-21	10.8	8.24	6.4	6.91	2.66
Big Buffalo Lake	BBL	21-Oct-21	11.8	6.26	44.5	11.7	4.72
Buffalo Creek	BC3	21-Oct-21	4.3	7.49	59.8	2.88	1.72
Lake Winnipeg	SB1	17-Oct-21	2.5	6.66	7.1	5.33	1.21
	SB2	17-Oct-21	5.0	10.8	8.9	19.6	3.18

1 - Calculated as the sum of total ammonia and nitrate/nitrite

2 - Samples for BOD were only collected during the late-August/September sampling period and only from selected sites.

Table 8. Laboratory results for metals and major ions measured at core sampling sites. All units are mg/L.

Waterbody	Site ID	Sampling Date	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	29-Aug-21	L2633558-13	0.0024	0.0369	0.00019	0.00016	0.00215	0.00210	0.0406	0.0385
	WHB2	29-Aug-21	L2633558-14	0.0030	0.0381	0.00018	0.00017	0.00206	0.00209	0.0410	0.0384
Watchorn Creek	WHC-WB	29-Aug-21	L2633558-15	0.0021	0.0131	0.00015	0.00014	0.00146	0.00135	0.0397	0.0366
Mercer Creek	MC-WB	29-Aug-21	L2633558-16	0.0036	0.0204	0.00018	0.00020	0.00215	0.00204	0.0490	0.0459
Birch Creek	BCD-2018-9	29-Aug-21	L2633060-3	0.0010	0.0046	0.00023	0.00019	0.00165	0.00167	0.0347	0.0357
	BC-LSM	29-Aug-21	L2633060-1	0.0034	0.0187	0.00012	0.00013	0.00140	0.00130	0.0425	0.0411
Fairford River	FR1	30-Aug-21	L2633558-9	0.0039	0.0569	0.00021	0.00018	0.00212	0.00209	0.0419	0.0405
	FR2	30-Aug-21	Mean	0.00387	0.0469	0.00022	0.00023	0.00216	0.00205	0.0413	0.0399
Lake St. Martin	BB-LSM	29-Aug-21	L2633060-2	0.0075	0.232	0.00024	0.00020	0.00232	0.00249	0.0408	0.0453
	LSM5	31-Aug-21	L2634301-5	0.0025	0.0075 [1]	0.00027	0.00021	0.00220	0.00226	0.0397	0.0390
	LSM4	30-Aug-21	Mean	0.00637	0.0763	0.00021	0.00022	0.00233	0.00233	0.0391	0.0392
	LSM1	31-Aug-21	L2634301-6	0.0073	0.0643	0.00018	0.00029	0.00213	0.00231	0.0354	0.0348
	LSM3	31-Aug-21	L2634301-7	0.0075	0.0275	0.00020	0.00022	0.00251	0.00252	0.0276	0.0274
Dauphin River	DR-A	31-Aug-21	L2634301-8	0.0110	0.092	0.00022	0.00022	0.00261	0.00254	0.0316	0.0326
	DR-B	30-Aug-21	L2634301-4	0.0081	0.105	0.00019	0.00022	0.00231	0.00233	0.0296	0.0311
	DR-E	30-Aug-21	L2634301-3	0.0124	0.0621	0.00020	0.00021	0.00223	0.00237	0.0308	0.0307
Big Buffalo Lake	BBL	3-Sep-21	L2635892-1	0.0059	0.0512	0.00011	0.00011	0.00163	0.00162	0.0357	0.0360
Buffalo Creek	BC3	3-Sep-21	L2635892-2	0.0238	0.540	<0.00010	<0.00010	0.00117	0.00128	0.0223	0.0252
Lake Winnipeg	SB1	30-Aug-21	L2634301-2	0.0591	0.295	0.00015	0.00016	0.00191	0.00187	0.0386	0.0394
	SB2	30-Aug-21	L2634301-1	0.0716	0.606	0.00015	0.00017	0.00184	0.00185	0.0369	0.0397

Table 8. Continued.

Waterbody	Site ID	Sampling Date	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)		Barium (Ba)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	Mean	0.00310	0.0498	0.00017	0.00018	0.00215	0.00216	0.0428	0.0434
	WHB2	18-Oct-21	L2652497-6	0.0030	0.0322	0.00017	0.00018	0.00205	0.00225	0.0421	0.0430
Watchorn Creek	WHC-WB	18-Oct-21	L2652497-4	0.0026	0.0178	0.00013	0.00014	0.00182	0.00179	0.0428	0.0433
Mercer Creek	MC-WB	18-Oct-21	L2652497-7	0.0052	0.0370	0.00017	0.00018	0.00214	0.00206	0.0522	0.0520
Birch Creek	BCD-2018-9	18-Oct-21	L2652497-1	0.0041	0.0855	0.00013	0.00016	0.00203	0.00190	0.0436	0.0428
	BC-LSM	18-Oct-21	L2652497-2	0.0014	0.0436	0.00012	0.00012	0.00165	0.00165	0.0399	0.0399
Fairford River	FR1	19-Oct-21	L2653142-1	0.0040	0.0548	0.00018	0.00018	0.00205	0.00203	0.0437	0.0429
	FR2	19-Oct-21	Mean	0.00353	0.0493	0.00018	0.00018	0.00204	0.00202	0.0444	0.0431
Lake St. Martin	BB-LSM	18-Oct-21	L2652497-3	0.0055	0.0308	0.00020	0.00022	0.00230	0.00219	0.0471	0.0458
	LSM5	20-Oct-21	L2653742-3	0.0030	0.0476	0.00021	0.00021	0.00228	0.00227	0.0428	0.0446
	LSM4	19-Oct-21	L2653142-3	0.0024	0.0317	0.00019	0.00019	0.00214	0.00223	0.0427	0.0415
	LSM1	20-Oct-21	L2653742-1	0.0093	0.131	0.00020	0.00020	0.00202	0.00211	0.0437	0.0460
	LSM3	20-Oct-21	L2653742-2	0.0097	0.0479	0.00019	0.00019	0.00195	0.00192	0.0395	0.0393
Dauphin River	DR-A	17-Oct-21	L2652045-7	0.0063	0.0947	0.00019	0.00022	0.00204	0.00223	0.0346	0.0413
	DR-B	17-Oct-21	L2652045-6	0.0060	0.0490	0.00019	0.00021	0.00198	0.00214	0.0360	0.0418
	DR-E	17-Oct-21	L2652045-3	0.0066	0.103	0.00020	0.00028	0.00199	0.00210	0.0367	0.0420
Big Buffalo Lake	BBL	21-Oct-21	L2654247-1	0.0030	0.0750	<0.00010	0.00010	0.00152	0.00150	0.0350	0.0369
Buffalo Creek	BC3	21-Oct-21	L2654247-2	0.0135	0.295	<0.00010	<0.00010	0.00098	0.00100	0.0204	0.0243
Lake Winnipeg	SB1	17-Oct-21	L2652045-2	0.0457	0.272	0.00014	0.00014	0.00180	0.00194	0.0376	0.0419
	SB2	17-Oct-21	L2652045-1	0.0493	0.353	0.00011	0.00014	0.00164	0.00190	0.0346	0.0426

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake Manitoba	WHB1	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.106	0.102	<0.0000050	<0.0000050
	WHB2	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.099	<0.0000050	<0.0000050
Watchorn Creek	WHC-WB	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.133	0.128	<0.0000050	<0.0000050
Mercer Creek	MC-WB	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.110	0.106	<0.0000050	<0.0000050
Birch Creek	BCD-2018-9	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.177	0.163	<0.0000050	<0.0000050
	BC-LSM	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.114	0.110	<0.0000050	<0.0000050
Fairford River	FR1	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.106	0.108	<0.0000050	0.0000054
	FR2	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.119	0.105	<0.0000050	<0.0000050
Lake St. Martin	BB-LSM	29-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.112	0.108	<0.0000050	0.0000067
	LSM5	31-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.109	0.108	<0.0000050	<0.0000050
	LSM4	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.115	0.102	<0.0000050	<0.0000050
	LSM1	31-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.100	0.091	<0.0000050	<0.0000050
	LSM3	31-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.113	0.106	<0.0000050	<0.0000050
Dauphin River	DR-A	31-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.102	0.102	<0.0000050	0.0000060
	DR-B	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.102	0.102	<0.0000050	<0.0000050
	DR-E	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.099	0.100	<0.0000050	<0.0000050
Big Buffalo Lake	BBL	3-Sep-21	<0.00010	<0.00010	<0.000050	<0.000050	0.082	0.088	0.0000130	0.0000233
Buffalo Creek	BC3	3-Sep-21	<0.00010	<0.00010	<0.000050	<0.000050	0.056	0.047	<0.0000050	0.0000053
Lake Winnipeg	SB1	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.053	0.055	<0.0000050	<0.0000050
	SB2	30-Aug-21	<0.00010	<0.00010	<0.000050	<0.000050	0.044	0.059	<0.0000050	<0.0000050

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Beryllium (Be)		Bismuth (Bi)		Boron (B)		Cadmium (Cd)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*	*0.0000050*	*0.0000050*
Lake Manitoba	WHB1	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.130	0.124	<0.0000050	<0.0000050
	WHB2	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.126	0.122	<0.0000050	<0.0000050
Watchorn Creek	WHC-WB	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.135	0.129	<0.0000050	<0.0000050
Mercer Creek	MC-WB	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.132	0.121	<0.0000050	<0.0000050
Birch Creek	BCD-2018-9	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.168	0.158	<0.0000050	<0.0000050
	BC-LSM	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.117	0.103	<0.0000050	<0.0000050
Fairford River	FR1	19-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.119	0.113	<0.0000050	<0.0000050
	FR2	19-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.121	0.103	<0.0000050	<0.0000050
Lake St. Martin	BB-LSM	18-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.138	0.133	<0.0000050	<0.0000050
	LSM5	20-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.123	<0.0000050	0.0000116
	LSM4	19-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.124	0.096	<0.0000050	<0.0000050
	LSM1	20-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.118	0.114	<0.0000050	<0.0000050
	LSM3	20-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.116	0.108	<0.0000050	0.0000072
Dauphin River	DR-A	17-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.124	0.125	<0.0000050	<0.0000050
	DR-B	17-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.124	0.121	<0.0000050	<0.0000050
	DR-E	17-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.119	0.117	<0.0000050	<0.0000050
Big Buffalo Lake	BBL	21-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.086	0.078	<0.0000050	<0.0000050
Buffalo Creek	BC3	21-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.056	0.049	<0.0000050	<0.0000050
Lake Winnipeg	SB1	17-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.050	0.044	<0.0000050	<0.0000050
	SB2	17-Oct-21	<0.00010	<0.00010	<0.000050	<0.000050	0.040	0.044	<0.0000050	<0.0000050

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Analytical DL			*0.05*	*0.050*	*0.000010*	*0.000010*	*0.20*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	29-Aug-21	33.7	33.5	<0.000010	<0.000010	216	<0.00010	<0.00010	<0.00010	<0.00010
	WHB2	29-Aug-21	32.8	32.5	<0.000010	<0.000010	217	<0.00010	<0.00010	<0.00010	<0.00010
Watchorn Creek	WHC-WB	29-Aug-21	48.2	46.3	<0.000010	<0.000010	49.6	0.00014	0.00026	0.00013	0.00013
Mercer Creek	MC-WB	29-Aug-21	47.8	47.5	<0.000010	<0.000010	207	<0.00010	<0.00010	<0.00010	<0.00010
Birch Creek	BCD-2018-9	29-Aug-21	65.7	58.2	<0.000010	<0.000010	11.0	<0.00010	0.00012	<0.00010	0.00011
	BC-LSM	29-Aug-21	54.1	52.6	<0.000010	<0.000010	7.27	0.00014	0.00020	0.00012	0.00012
Fairford River	FR1	30-Aug-21	35.4	35.6	<0.000010	<0.000010	226	<0.00010	0.00016	<0.00010	<0.00010
	FR2	30-Aug-21	38.1	34.9	<0.000010	<0.000010	228	<0.00010	0.00028	<0.00010	<0.00010
Lake St. Martin	BB-LSM	29-Aug-21	36.9	36.2	<0.000010	0.000036	203	<0.00010	0.00053	<0.00010	0.00022
	LSM5	31-Aug-21	31.5	33.7	<0.000010	<0.000010	212	<0.00010	<0.00010	<0.00010	<0.00010
	LSM4	30-Aug-21	35.8	31.2	<0.000010	0.000011	219	<0.00010	0.00021	<0.00010	<0.00010
	LSM1	31-Aug-21	28.7	29.3	<0.000010	<0.000010	201	<0.00010	0.00013	<0.00010	<0.00010
	LSM3	31-Aug-21	25.7	25.0	<0.000010	<0.000010	215	<0.00010	<0.00010	<0.00010	0.00011
Dauphin River	DR-A	31-Aug-21	27.6	28.7	<0.000010	0.000013	217	<0.00010	0.00017	<0.00010	0.00014
	DR-B	30-Aug-21	26.5	29.5	<0.000010	0.000016	210	<0.00010	0.00021	<0.00010	0.00013
	DR-E	30-Aug-21	27.3	28.1	<0.000010	<0.000010	204	<0.00010	0.00013	<0.00010	0.00012
Big Buffalo Lake	BBL	3-Sep-21	36.5	42.2	<0.000010	<0.000010	21.5	<0.00010	0.00015	<0.00010	<0.00010
Buffalo Creek	BC3	3-Sep-21	39.8	37.8	<0.000010	<0.000010	7.89	<0.00010	0.00092	<0.00010	0.00033
Lake Winnipeg	SB1	30-Aug-21	28.1	29.3	<0.000010	0.000025	65.6	<0.00010	0.00037	<0.00010	0.00013
	SB2	30-Aug-21	26.9	28.0	<0.000010	0.000059	44.4	<0.00010	0.00107	<0.00010	0.00024

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Calcium (Ca)		Cesium (Cs)		Chloride (Cl)	Chromium (Cr)		Cobalt (Co)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	39.2	40.8	<0.000010	<0.000010	221	<0.00010	0.00010	<0.00010	<0.00010
	WHB2	18-Oct-21	38.1	39.9	<0.000010	<0.000010	221	<0.00010	0.00011	<0.00010	<0.00010
Watchorn Creek	WHC-WB	18-Oct-21	54.5	56.1	<0.000010	<0.000010	182	<0.00010	<0.00010	<0.00010	<0.00010
Mercer Creek	MC-WB	18-Oct-21	55.7	57.0	<0.000010	<0.000010	233	<0.00010	0.00011	<0.00010	0.00010
Birch Creek	BCD-2018-9	18-Oct-21	81.4	83.3	<0.000010	<0.000010	23.7	<0.00010	0.00031	0.00010	0.00014
	BC-LSM	18-Oct-21	55.8	56.8	<0.000010	<0.000010	9.25	0.00014	0.00026	0.00016	0.00021
Fairford River	FR1	19-Oct-21	38.6	40.5	<0.000010	0.000013	226	<0.00010	0.00023	<0.00010	0.00010
	FR2	19-Oct-21	40.1	40.9	<0.000010	<0.000010	225	<0.00010	0.00010	<0.00010	<0.00010
Lake St. Martin	BB-LSM	18-Oct-21	41.6	41.6	<0.000010	<0.000010	222	<0.00010	0.00011	<0.00010	<0.00010
	LSM5	20-Oct-21	36.7	38.8	<0.000010	<0.000010	210	<0.00010	0.00026	<0.00010	<0.00010
	LSM4	19-Oct-21	38.3	37.8	<0.000010	<0.000010	222	<0.00010	0.00018	<0.00010	<0.00010
	LSM1	20-Oct-21	37.5	40.9	<0.000010	0.000017	216	<0.00010	0.00031	<0.00010	0.00013
	LSM3	20-Oct-21	38.6	38.8	<0.000010	<0.000010	206	<0.00010	0.00012	<0.00010	0.00010
Dauphin River	DR-A	17-Oct-21	35.3	39.4	<0.000010	0.000014	226	<0.00010	0.00016	<0.00010	0.00012
	DR-B	17-Oct-21	37.0	39.8	<0.000010	<0.000010	223	<0.00010	<0.00010	<0.00010	<0.00010
	DR-E	17-Oct-21	36.0	38.0	<0.000010	0.000015	218	<0.00010	0.00017	<0.00010	0.00012
Big Buffalo Lake	BBL	21-Oct-21	46.0	43.7	<0.000010	0.000012	22.9	<0.00010	0.00016	<0.00010	<0.00010
Buffalo Creek	BC3	21-Oct-21	47.1	44.9	<0.000010	0.000029	8.41	<0.00010	0.00049	<0.00010	0.00016
Lake Winnipeg	SB1	17-Oct-21	31.1	31.7	<0.000010	0.000019	42.8	<0.00010	0.00027	<0.00010	<0.00010
	SB2	17-Oct-21	28.9	32.1	<0.000010	0.000033	38.3	<0.00010	0.00043	<0.00010	0.00015

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.040*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake Manitoba	WHB1	29-Aug-21	0.00022	<0.00050	0.144	<0.010	0.028	<0.000050	0.000115	0.0349	0.0346
	WHB2	29-Aug-21	0.00023	<0.00050	0.145	<0.010	0.036	<0.000050	0.000118	0.0351	0.0343
Watchorn Creek	WHC-WB	29-Aug-21	0.00117	0.00125	0.231	0.026	0.034	<0.000050	<0.000050	0.0357	0.0371
Mercer Creek	MC-WB	29-Aug-21	0.00030	<0.00050	0.147	<0.010	0.028	<0.000050	0.000052	0.0363	0.0374
Birch Creek	BCD-2018-9	29-Aug-21	0.00062	0.00072	0.285	0.030	0.039	<0.000050	<0.000050	0.0251	0.0241
	BC-LSM	29-Aug-21	0.00135	0.00139	0.314	0.030	0.044	<0.000050	<0.000050	0.0163	0.0170
Fairford River	FR1	30-Aug-21	0.00026	<0.00050	0.153	<0.010	0.059	<0.000050	0.000155	0.0353	0.0363
	FR2	30-Aug-21	0.00026	<0.00050	0.153	<0.010	0.050	<0.000050	0.000169	0.0388	0.0354
Lake St. Martin	BB-LSM	29-Aug-21	0.00030	0.00065	0.160	<0.010	0.249	<0.000050	0.000413	0.0368	0.0367
	LSM5	31-Aug-21	0.00022	<0.00050	0.166	<0.010	0.011 [1]	<0.000050	0.000101	0.0347	0.0355
	LSM4	30-Aug-21	0.00026	<0.00050	0.153	<0.010	0.063	<0.000050	0.000162	0.0368	0.0352
	LSM1	31-Aug-21	0.00028	<0.00050	0.158	<0.010	0.034	<0.000050	0.000145	0.0325	0.0326
	LSM3	31-Aug-21	0.00038	<0.00050	0.178	<0.010	0.031	<0.000050	0.000156	0.0370	0.0369
Dauphin River	DR-A	31-Aug-21	0.00032	<0.00050	0.162	<0.010	0.080	<0.000050	0.000234	0.0352	0.0361
	DR-B	30-Aug-21	0.00029	<0.00050	0.163	<0.010	0.093	<0.000050	0.000221	0.0339	0.0347
	DR-E	30-Aug-21	0.00036	0.00052	0.157	<0.010	0.067	<0.000050	0.000196	0.0336	0.0334
Big Buffalo Lake	BBL	3-Sep-21	0.00031	0.00051	0.192	<0.010	0.056	<0.000050	0.000080	0.0171	0.0191
Buffalo Creek	BC3	3-Sep-21	0.00068	0.00108	0.140	0.048	0.543	<0.000050	0.000241	0.0165	0.0127
Lake Winnipeg	SB1	30-Aug-21	0.00107	0.00137	0.125	<0.010	0.176	<0.000050	0.000136	0.0170	0.0178
	SB2	30-Aug-21	0.00118	0.00190	0.115	<0.010	0.454	<0.000050	0.000291	0.0141	0.0160

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Copper (Cu)		Fluoride (F)	Iron (Fe)		Lead (Pb)		Lithium (Li)	
			Dissolved	Total	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00050*	*0.040*	*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*
Lake Manitoba	WHB1	18-Oct-21	0.00028	<0.00050	0.163	<0.010	0.044	<0.000050	0.000162	0.0402	0.0420
	WHB2	18-Oct-21	0.00028	0.00052	0.162	<0.010	0.039	<0.000050	0.000147	0.0394	0.0420
Watchorn Creek	WHC-WB	18-Oct-21	0.00024	<0.00050	0.193	<0.010	0.018	<0.000050	<0.000050	0.0414	0.0459
Mercer Creek	MC-WB	18-Oct-21	0.00034	<0.00050	0.168	<0.010	0.048	<0.000050	0.000087	0.0415	0.0441
Birch Creek	BCD-2018-9	18-Oct-21	0.00057	0.00072	0.343	0.020	0.096	<0.000050	0.000061	0.0321	0.0357
	BC-LSM	18-Oct-21	0.00150	0.00172	0.349	0.015	0.058	<0.000050	<0.000050	0.0207	0.0226
Fairford River	FR1	19-Oct-21	0.00029	0.00055	0.168	<0.010	0.070	<0.000050	0.000193	0.0399	0.0380
	FR2	19-Oct-21	0.00029	<0.00050	0.166	<0.010	0.061	<0.000050	0.000191	0.0398	0.0378
Lake St. Martin	BB-LSM	18-Oct-21	0.00045	<0.00050	0.176	<0.010	0.036	<0.000050	0.000236	0.0408	0.0433
	LSM5	20-Oct-21	0.00024	<0.00050	0.167	<0.010	0.049	<0.000050	0.000205	0.0367	0.0398
	LSM4	19-Oct-21	0.00025	<0.00050	0.169	<0.010	0.033	<0.000050	0.000133	0.0403	0.0381
	LSM1	20-Oct-21	0.00032	0.00051	0.171	<0.010	0.115	<0.000050	0.000270	0.0412	0.0409
	LSM3	20-Oct-21	0.00036	<0.00050	0.175	<0.010	0.049	<0.000050	0.000278	0.0408	0.0386
Dauphin River	DR-A	17-Oct-21	0.00027	0.00054	0.168	<0.010	0.087	<0.000050	0.000233	0.0392	0.0435
	DR-B	17-Oct-21	0.00034	<0.00050	0.170	<0.010	0.046	<0.000050	0.000201	0.0396	0.0429
	DR-E	17-Oct-21	0.00028	<0.00050	0.168	<0.010	0.091	<0.000050	0.000205	0.0380	0.0408
Big Buffalo Lake	BBL	21-Oct-21	0.00041	0.00061	0.194	<0.010	0.083	<0.000050	0.000075	0.0188	0.0177
Buffalo Creek	BC3	21-Oct-21	0.00053	0.00073	0.157	0.026	0.283	<0.000050	0.000121	0.0122	0.0124
Lake Winnipeg	SB1	17-Oct-21	0.00122	0.00150	0.119	<0.010	0.129	<0.000050	0.000108	0.0153	0.0166
	SB2	17-Oct-21	0.00116	0.00152	0.119	<0.010	0.226	<0.000050	0.000172	0.0120	0.0165

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.0050*	*0.0050*	*0.00010*	*0.00010*	*0.00000050*	*0.00000050*	*0.000050*	*0.000050*
Lake Manitoba	WHB1	29-Aug-21	39.5	37.9	<0.00010	0.00518	*<0.00000050*	0.00000054	0.00220	0.00225
	WHB2	29-Aug-21	40.0	38.8	<0.00010	0.00543	*<0.00000050*	0.00000062	0.00223	0.00231
Watchorn Creek	WHC-WB	29-Aug-21	50.3	48.8	0.00154	0.00612	*<0.00000050*	0.00000056	0.00194	0.00195
Mercer Creek	MC-WB	29-Aug-21	46.7	46.2	0.00051	0.00734	*<0.00000050*	0.00000062	0.00305	0.00296
Birch Creek	BCD-2018-9	29-Aug-21	80.5	75.2	0.00182	0.0143	0.00000109	*<0.00000050*	0.00484	0.00456
	BC-LSM	29-Aug-21	54.1	54.4	0.00389	0.00623	0.00000117	0.00000112	0.00233	0.00233
Fairford River	FR1	30-Aug-21	39.8	39.1	<0.00010	0.00651	*<0.00000050*	0.00000057	0.00233	0.00245
	FR2	30-Aug-21	43.3	39.0	<0.00010	0.00654	*<0.00000050*	0.00000059	0.00247	0.00236
Lake St. Martin	BB-LSM	29-Aug-21	42.3	41.1	<0.00010	0.0182	0.00000071	0.00000120	0.00252	0.00235
	LSM5	31-Aug-21	39.8	39.7	<0.00010	0.00505	*<0.00000050*	*<0.00000050*	0.00242	0.00241
	LSM4	30-Aug-21	43.0	38.7	0.00022	0.00779	*<0.00000050*	0.00000061	0.00274	0.00254
	LSM1	31-Aug-21	37.9	37.2	<0.00010	0.00664	*<0.00000050*	0.00000057	0.00247	0.00251
	LSM3	31-Aug-21	44.7	43.9	0.00013	0.00883	*<0.00000050*	0.00000087	0.00241	0.00240
Dauphin River	DR-A	31-Aug-21	39.5	40.4	0.00022	0.0115	*<0.00000050*	0.00000088	0.00269	0.00264
	DR-B	30-Aug-21	39.1	38.9	0.00015	0.0106	*<0.00000050*	0.00000083	0.00249	0.00251
	DR-E	30-Aug-21	39.1	37.6	0.00019	0.00952	*<0.00000050*	0.00000072	0.00243	0.00240
Big Buffalo Lake	BBL	3-Sep-21	38.7	42.3	0.00051	0.0110	0.00000064	0.00000106	0.000822	0.000817
Buffalo Creek	BC3	3-Sep-21	24.7	25.4	0.00246	0.0398	0.00000096	0.00000132	0.000402	0.000397
Lake Winnipeg	SB1	30-Aug-21	22.0	21.8	0.00020	0.00385	*<0.00000050*	*<0.00000050*	0.00122	0.00118
	SB2	30-Aug-21	19.4	19.2	0.00018	0.00709	*<0.00000050*	*<0.00000050*	0.00104	0.00108

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Magnesium (Mg)		Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	41.3	41.7	<0.00010	0.00694	*<0.00000050*	0.00000070	0.00234	0.00222
	WHB2	18-Oct-21	40.9	42.0	<0.00010	0.00574	*<0.00000050*	0.00000069	0.00228	0.00223
Watchorn Creek	WHC-WB	18-Oct-21	51.8	54.9	0.00050	0.0131	*<0.00000050*	0.00000061	0.00145	0.00130
Mercer Creek	MC-WB	18-Oct-21	46.5	47.1	0.00036	0.0165	*<0.00000050*	0.00000096	0.00223	0.00212
Birch Creek	BCD-2018-9	18-Oct-21	107	107	0.00454	0.0294	*<0.00000050*	0.00000123	0.00117	0.00110
	BC-LSM	18-Oct-21	72.7	73.8	0.00046	0.0229	0.00000076	0.00000195	0.00149	0.00146
Fairford River	FR1	19-Oct-21	41.2	40.7	<0.00010	0.00734	*<0.00000050*	0.00000081	0.00236	0.00231
	FR2	19-Oct-21	42.1	40.7	<0.00010	0.00719	*<0.00000050*	0.00000072	0.00251	0.00234
Lake St. Martin	BB-LSM	18-Oct-21	43.3	42.4	<0.00010	0.00970	*<0.00000050*	0.00000060	0.00275	0.00262
	LSM5	20-Oct-21	42.6	41.5	0.00010	0.00892	*<0.00000050*	0.00000079	0.00231	0.00249
	LSM4	19-Oct-21	42.5	42.2	0.00011	0.00583	*<0.00000050*	0.00000069	0.00250	0.00251
	LSM1	20-Oct-21	44.4	43.3	0.00010	0.0109	*<0.00000050*	0.00000079	0.00265	0.00270
	LSM3	20-Oct-21	46.4	46.5	0.00012	0.0118	*<0.00000050*	0.00000081	0.00274	0.00265
Dauphin River	DR-A	17-Oct-21	42.0	45.9	0.00011	0.00992	*<0.00000050*	0.00000085	0.00274	0.00289
	DR-B	17-Oct-21	42.5	45.5	0.00017	0.00905	*<0.00000050*	0.00000060	0.00266	0.00280
	DR-E	17-Oct-21	41.9	44.0	0.00012	0.00898	*<0.00000050*	0.00000075	0.00259	0.00274
Big Buffalo Lake	BBL	21-Oct-21	46.9	45.5	0.00026	0.0103	*<0.00000050*	0.00000055	0.000777	0.000836
Buffalo Creek	BC3	21-Oct-21	32.6	32.3	0.00055	0.0157	0.00000052	0.00000084	0.000209	0.000214
Lake Winnipeg	SB1	17-Oct-21	19.9	20.4	0.00011	0.00248	*<0.00000050*	*<0.00000050*	0.00109	0.00113
	SB2	17-Oct-21	19.2	19.8	0.00011	0.00535	*<0.00000050*	0.00000062	0.000951	0.00103

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00050*	*0.00050*	*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*
Lake Manitoba	WHB1	29-Aug-21	<0.00050	0.00054	11.4	9.67	0.00420	0.00392	0.000071	0.000074
	WHB2	29-Aug-21	<0.00050	0.00058	11.7	10.0	0.00429	0.00404	0.000087	<0.000050
Watchorn Creek	WHC-WB	29-Aug-21	0.00112	0.00114	9.87	8.62	0.00358	0.00335	0.000232	0.000192
Mercer Creek	MC-WB	29-Aug-21	0.00057	0.00062	11.5	10.0	0.00431	0.00399	0.000095	0.000073
Birch Creek	BCD-2018-9	29-Aug-21	0.00056	0.00063	8.52	8.41	0.00349	0.00344	0.000169	0.000126
	BC-LSM	29-Aug-21	0.00091	0.00097	5.32	5.07	0.00219	0.00205	0.000212	0.000185
Fairford River	FR1	30-Aug-21	<0.00050	0.00063	11.5	9.92	0.00429	0.00417	0.000099	0.000071
	FR2	30-Aug-21	<0.00050	0.00064	11.5	9.81	0.00425	0.00411	0.000080	0.000072
Lake St. Martin	BB-LSM	29-Aug-21	<0.00050	0.00100	10.5	10.4	0.00429	0.00473	0.000084	0.000106
	LSM5	31-Aug-21	<0.00050	0.00054	11.4	10.7	0.00419	0.00393	0.000068	0.000079
	LSM4	30-Aug-21	<0.00050	0.00073	11.0	10.0	0.00417	0.00417	0.000094	0.000082
	LSM1	31-Aug-21	<0.00050	0.00058	10.6	10.0	0.00395	0.00372	0.000096	0.000126
	LSM3	31-Aug-21	0.00050	0.00059	11.5	10.8	0.00470	0.00438	0.000099	0.000110
Dauphin River	DR-A	31-Aug-21	0.00053	0.00072	11.4	11.0	0.00428	0.00412	0.000103	0.000105
	DR-B	30-Aug-21	<0.00050	0.00072	11.0	10.3	0.00415	0.00411	0.000082	0.000100
	DR-E	30-Aug-21	0.00052	0.00068	10.7	10.0	0.00402	0.00393	0.000107	0.000110
Big Buffalo Lake	BBL	3-Sep-21	<0.00050	<0.00050	4.29	4.32	0.00324	0.00289	0.000148	0.000105
Buffalo Creek	BC3	3-Sep-21	0.00056	0.00124	2.04	2.26	0.00213	0.00343	0.000127	0.000126
Lake Winnipeg	SB1	30-Aug-21	0.00066	0.00104	5.47	5.32	0.00202	0.00238	0.000146	0.000116
	SB2	30-Aug-21	0.00071	0.00149	4.59	4.51	0.00173	0.00274	0.000144	0.000149

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Nickel (Ni)		Potassium (K)		Rubidium (Rb)		Selenium (Se)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	<0.00050	0.00064	11.8	10.9	0.00431	0.00408	0.000065	0.000121
	WHB2	18-Oct-21	<0.00050	0.00062	11.4	10.9	0.00429	0.00417	0.000106	0.000108
Watchorn Creek	WHC-WB	18-Oct-21	0.00053	0.00059	13.1	12.7	0.00424	0.00412	0.000083	0.000121
Mercer Creek	MC-WB	18-Oct-21	0.00062	0.00075	14.9	13.9	0.00473	0.00461	0.000091	0.000136
Birch Creek	BCD-2018-9	18-Oct-21	0.00089	0.00100	11.2	10.2	0.00386	0.00371	0.000206	0.000200
	BC-LSM	18-Oct-21	0.00101	0.00121	8.78	8.19	0.00240	0.00242	0.000194	0.000217
Fairford River	FR1	19-Oct-21	<0.00050	0.00077	11.1	10.9	0.00442	0.00417	0.000095	0.000085
	FR2	19-Oct-21	<0.00050	0.00067	11.2	10.6	0.00446	0.00415	0.000072	0.000075
Lake St. Martin	BB-LSM	18-Oct-21	0.00060	0.00068	11.9	11.2	0.00451	0.00413	0.000077	0.000095
	LSM5	20-Oct-21	<0.00050	0.00066	11.0	10.7	0.00426	0.00431	0.000106	0.000087
	LSM4	19-Oct-21	<0.00050	0.00069	11.3	10.8	0.00435	0.00416	<0.000050	0.000076
	LSM1	20-Oct-21	0.00058	0.00083	11.4	10.9	0.00435	0.00438	0.000086	0.000091
	LSM3	20-Oct-21	0.00067	0.00063	10.8	10.5	0.00432	0.00415	0.000077	0.000096
Dauphin River	DR-A	17-Oct-21	0.00052	0.00074	11.2	11.4	0.00386	0.00449	0.000102	0.000110
	DR-B	17-Oct-21	0.00057	0.00065	11.4	11.1	0.00406	0.00439	0.000094	0.000101
	DR-E	17-Oct-21	0.00051	0.00074	11.0	10.7	0.00389	0.00429	0.000092	0.000103
Big Buffalo Lake	BBL	21-Oct-21	<0.00050	<0.00050	4.63	4.57	0.00262	0.00276	0.000101	0.000088
Buffalo Creek	BC3	21-Oct-21	<0.00050	0.00079	2.50	2.57	0.00174	0.00236	0.000117	0.000081
Lake Winnipeg	SB1	17-Oct-21	0.00076	0.00094	4.23	4.39	0.00163	0.00228	0.000177	0.000131
	SB2	17-Oct-21	0.00067	0.00110	3.97	4.22	0.00165	0.00221	0.000138	0.000136

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.050*	*0.10*	*0.000010*	*0.000010*	*0.050*	*0.050*	*0.00010*	*0.00020*
Lake Manitoba	WHB1	29-Aug-21	3.16	3.16	<0.000010	<0.000010	152	139	0.302	0.259
	WHB2	29-Aug-21	3.02	3.18	<0.000010	<0.000010	151	139	0.290	0.258
Watchorn Creek	WHC-WB	29-Aug-21	6.89	7.00	<0.000010	<0.000010	29.6	27.7	0.187	0.160
Mercer Creek	MC-WB	29-Aug-21	3.32	3.29	<0.000010	<0.000010	142	134	0.320	0.278
Birch Creek	BCD-2018-9	29-Aug-21	6.28	6.87	<0.000010	<0.000010	15.5	15.5	0.209	0.190
	BC-LSM	29-Aug-21	8.39	8.74	<0.000010	<0.000010	11.2	11.2	0.141	0.138
Fairford River	FR1	30-Aug-21	3.40	3.64	<0.000010	<0.000010	153	145	0.306	0.270
	FR2	30-Aug-21	3.25	3.40	<0.000010	<0.000010	160	142	0.312	0.269
Lake St. Martin	BB-LSM	29-Aug-21	3.02	3.80	<0.000010	<0.000010	150	149	0.274	0.251
	LSM5	31-Aug-21	2.55	2.66	<0.000010	<0.000010	149	150	0.284	0.271
	LSM4	30-Aug-21	2.02	2.43	<0.000010	0.000025	156	143	0.275	0.242
	LSM1	31-Aug-21	2.38	2.63	<0.000010	<0.000010	141	141	0.254	0.229
	LSM3	31-Aug-21	2.36	2.47	<0.000010	<0.000010	158	152	0.213	0.196
Dauphin River	DR-A	31-Aug-21	1.98	2.28	<0.000010	<0.000010	151	153	0.233	0.218
	DR-B	30-Aug-21	2.13	2.54	<0.000010	<0.000010	149	148	0.230	0.217
	DR-E	30-Aug-21	2.10	2.23	<0.000010	<0.000010	142	141	0.229	0.209
Big Buffalo Lake	BBL	3-Sep-21	7.64	8.55	<0.000010	<0.000010	28.4	30.7	0.157	0.155
Buffalo Creek	BC3	3-Sep-21	5.27	6.70	<0.000010	<0.000010	14.9	14.8	0.105	0.0951
Lake Winnipeg	SB1	30-Aug-21	3.07	3.68	<0.000010	<0.000010	51.9	52.3	0.175	0.163
	SB2	30-Aug-21	3.42	4.52	<0.000010	<0.000010	37.3	38.1	0.162	0.149

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Silicon (Si)		Silver (Ag)		Sodium (Na)		Strontium (Sr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	3.72	3.91	<0.000010	<0.000010	156	159	0.294	0.276
	WHB2	18-Oct-21	3.54	3.75	<0.000010	<0.000010	154	161	0.284	0.275
Watchorn Creek	WHC-WB	18-Oct-21	4.79	5.10	<0.000010	<0.000010	120	129	0.283	0.273
Mercer Creek	MC-WB	18-Oct-21	2.41	2.61	<0.000010	<0.000010	159	165	0.319	0.309
Birch Creek	BCD-2018-9	18-Oct-21	5.31	5.70	<0.000010	<0.000010	25.6	26.2	0.276	0.261
	BC-LSM	18-Oct-21	6.81	7.40	<0.000010	<0.000010	11.6	12.1	0.170	0.162
Fairford River	FR1	19-Oct-21	3.72	3.64	<0.000010	<0.000010	153	153	0.294	0.282
	FR2	19-Oct-21	3.65	3.55	<0.000010	<0.000010	156	154	0.305	0.285
Lake St. Martin	BB-LSM	18-Oct-21	3.32	3.36	<0.000010	<0.000010	156	160	0.295	0.284
	LSM5	20-Oct-21	2.77	3.05	<0.000010	<0.000010	161	151	0.263	0.281
	LSM4	19-Oct-21	2.15	2.17	<0.000010	<0.000010	151	158	0.284	0.279
	LSM1	20-Oct-21	2.42	2.71	<0.000010	<0.000010	154	153	0.285	0.285
	LSM3	20-Oct-21	2.08	2.15	<0.000010	<0.000010	147	147	0.249	0.243
Dauphin River	DR-A	17-Oct-21	2.26	2.81	<0.000010	<0.000010	149	161	0.248	0.279
	DR-B	17-Oct-21	2.33	2.73	<0.000010	<0.000010	154	159	0.257	0.276
	DR-E	17-Oct-21	2.18	2.72	<0.000010	<0.000010	145	152	0.249	0.268
Big Buffalo Lake	BBL	21-Oct-21	9.36	9.40	<0.000010	<0.000010	36.1	33.2	0.170	0.176
Buffalo Creek	BC3	21-Oct-21	4.53	5.07	<0.000010	<0.000010	19.6	19.1	0.112	0.114
Lake Winnipeg	SB1	17-Oct-21	3.04	3.75	<0.000010	<0.000010	36.0	36.1	0.150	0.162
	SB2	17-Oct-21	2.66	3.84	<0.000010	<0.000010	31.2	32.9	0.144	0.160

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Sulphate (SO4)	Sulphur (S)		Tellurium (Te)		Thallium (Tl)	
			Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.60*	*0.50*	*0.50*	*0.00020*	*0.00020*	*0.000010*	*0.000010*
Lake Manitoba	WHB1	29-Aug-21	92.0	32.5	33.4	<0.00020	<0.00020	<0.000010	<0.000010
	WHB2	29-Aug-21	94.5	32.4	36.1	<0.00020	<0.00020	<0.000010	<0.000010
Watchorn Creek	WHC-WB	29-Aug-21	80.8	28.7	30.8	<0.00020	<0.00020	<0.000010	<0.000010
Mercer Creek	MC-WB	29-Aug-21	141	49.9	53.5	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek	BCD-2018-9	29-Aug-21	225	80.6	92.0	<0.00020	<0.00020	<0.000010	<0.000010
	BC-LSM	29-Aug-21	104	38.7	41.2	<0.00020	<0.00020	<0.000010	<0.000010
Fairford River	FR1	30-Aug-21	94.5	32.9	35.6	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	30-Aug-21	95.6	33.4	35.6	<0.00020	<0.00020	<0.000010	<0.000010
Lake St. Martin	BB-LSM	29-Aug-21	86.7	31.8	36.1	<0.00020	<0.00020	<0.000010	<0.000010
	LSM5	31-Aug-21	91.8	33.0	34.4	<0.00020	<0.00020	<0.000010	<0.000010
	LSM4	30-Aug-21	94.1	33.2	36.3	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	31-Aug-21	88.4	32.0	33.0	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	31-Aug-21	96.6	35.9	37.2	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	31-Aug-21	96.0	33.9	37.0	<0.00020	<0.00020	<0.000010	<0.000010
	DR-B	30-Aug-21	92.9	33.3	34.1	<0.00020	<0.00020	<0.000010	<0.000010
	DR-E	30-Aug-21	92.4	32.1	33.7	<0.00020	<0.00020	<0.000010	<0.000010
Big Buffalo Lake	BBL	3-Sep-21	51.7	18.1	21.2	<0.00020	<0.00020	<0.000010	<0.000010
Buffalo Creek	BC3	3-Sep-21	42.0	13.8	15.7	<0.00020	<0.00020	<0.000010	0.000010
Lake Winnipeg	SB1	30-Aug-21	54.2	18.7	19.6	<0.00020	<0.00020	<0.000010	<0.000010
	SB2	30-Aug-21	48.7	17.1	17.6	<0.00020	<0.00020	<0.000010	<0.000010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Sulphate (SO4)	Sulphur (S)		Tellurium (Te)		Thallium (Tl)	
			Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	93.8	33.9	36.0	<0.00020	<0.00020	<0.000010	<0.000010
	WHB2	18-Oct-21	94.2	33.2	35.8	<0.00020	<0.00020	<0.000010	<0.000010
Watchorn Creek	WHC-WB	18-Oct-21	99.5	36.7	38.7	<0.00020	<0.00020	<0.000010	<0.000010
Mercer Creek	MC-WB	18-Oct-21	99.9	36.2	38.3	<0.00020	<0.00020	<0.000010	<0.000010
Birch Creek	BCD-2018-9	18-Oct-21	242	87.0	88.7	<0.00020	<0.00020	<0.000010	<0.000010
	BC-LSM	18-Oct-21	114	38.5	42.6	<0.00020	<0.00020	<0.000010	<0.000010
Fairford River	FR1	19-Oct-21	93.8	34.0	33.7	<0.00020	<0.00020	<0.000010	<0.000010
	FR2	19-Oct-21	93.2	34.0	35.0	<0.00020	<0.00020	<0.000010	<0.000010
Lake St. Martin	BB-LSM	18-Oct-21	96.1	34.6	35.8	<0.00020	<0.00020	<0.000010	<0.000010
	LSM5	20-Oct-21	91.0	33.5	34.8	<0.00020	<0.00020	<0.000010	<0.000010
	LSM4	19-Oct-21	94.1	34.6	37.0	<0.00020	<0.00020	<0.000010	<0.000010
	LSM1	20-Oct-21	94.4	34.6	37.2	<0.00020	<0.00020	<0.000010	<0.000010
	LSM3	20-Oct-21	97.2	35.8	37.1	<0.00020	<0.00020	<0.000010	<0.000010
Dauphin River	DR-A	17-Oct-21	98.3	34.3	39.7	<0.00020	<0.00020	<0.000010	<0.000010
	DR-B	17-Oct-21	98.2	33.9	38.5	<0.00020	<0.00020	<0.000010	<0.000010
	DR-E	17-Oct-21	97.8	34.0	38.6	<0.00020	<0.00020	<0.000010	<0.000010
Big Buffalo Lake	BBL	21-Oct-21	54.5	20.9	20.7	<0.00020	<0.00020	<0.000010	<0.000010
Buffalo Creek	BC3	21-Oct-21	40.2	14.9	15.4	<0.00020	<0.00020	<0.000010	<0.000010
Lake Winnipeg	SB1	17-Oct-21	49.5	17.0	18.0	<0.00020	<0.00020	<0.000010	<0.000010
	SB2	17-Oct-21	48.4	14.8	18.1	<0.00020	<0.00020	<0.000010	<0.000010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Thorium (Th)		Tin (Sn)		Titanium (Ti)		Tungsten (W)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00030*	*0.00030*	*0.00010*	*0.00010*
Lake Manitoba	WHB1	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00267	<0.00010	<0.00010
	WHB2	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00141	<0.00010	<0.00010
Watchorn Creek	WHC-WB	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00041	0.00081	<0.00010	<0.00010
Mercer Creek	MC-WB	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00074	<0.00010	<0.00010
Birch Creek	BCD-2018-9	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
	BC-LSM	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00043	0.00096	<0.00010	<0.00010
Fairford River	FR1	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00227	<0.00010	<0.00010
	FR2	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00198	<0.00010	<0.00010
Lake St. Martin	BB-LSM	29-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.01010	<0.00010	<0.00010
	LSM5	31-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	<0.00030	<0.00010	<0.00010
	LSM4	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00288	<0.00010	<0.00010
	LSM1	31-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00173	<0.00010	<0.00010
	LSM3	31-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00086	<0.00010	<0.00010
Dauphin River	DR-A	31-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00347	<0.00010	<0.00010
	DR-B	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00429	<0.00010	<0.00010
	DR-E	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00245	<0.00010	<0.00010
Big Buffalo Lake	BBL	3-Sep-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00141	<0.00010	<0.00010
Buffalo Creek	BC3	3-Sep-21	<0.00010	0.00013	<0.00010	<0.00010	0.00142	0.0219	<0.00010	<0.00010
Lake Winnipeg	SB1	30-Aug-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00100	0.00888	<0.00010	<0.00010
	SB2	30-Aug-21	<0.00010	0.00013	<0.00010	<0.00010	0.00122	0.0204	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Thorium (Th)		Tin (Sn)		Titanium (Ti)		Tungsten (W)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00145	<0.00010	<0.00010
	WHB2	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00131	<0.00010	<0.00010
Watchorn Creek	WHC-WB	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00069	<0.00010	<0.00010
Mercer Creek	MC-WB	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00162	<0.00010	<0.00010
Birch Creek	BCD-2018-9	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00039	0.00373	<0.00010	<0.00010
	BC-LSM	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00191	<0.00010	<0.00010
Fairford River	FR1	19-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00247	<0.00010	<0.00010
	FR2	19-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00205	<0.00010	<0.00010
Lake St. Martin	BB-LSM	18-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00129	<0.00010	<0.00010
	LSM5	20-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00186	<0.00010	<0.00010
	LSM4	19-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00120	<0.00010	<0.00010
	LSM1	20-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00515	<0.00010	<0.00010
	LSM3	20-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00165	<0.00010	<0.00010
Dauphin River	DR-A	17-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00326	<0.00010	<0.00010
	DR-B	17-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00162	<0.00010	<0.00010
	DR-E	17-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00350	<0.00010	<0.00010
Big Buffalo Lake	BBL	21-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	<0.00030	0.00275	<0.00010	<0.00010
Buffalo Creek	BC3	21-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00076	0.0116	<0.00010	<0.00010
Lake Winnipeg	SB1	17-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00067	0.00609	<0.00010	<0.00010
	SB2	17-Oct-21	<0.00010	<0.00010	<0.00010	<0.00010	0.00082	0.0100	<0.00010	<0.00010

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Uranium (U)		Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.000010*	*0.000010*	*0.00050*	*0.00050*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Lake Manitoba	WHB1	29-Aug-21	0.00148	0.00153	0.00124	0.00158	<0.0010	<0.0030	<0.00020	<0.00020
	WHB2	29-Aug-21	0.00151	0.00149	0.00126	0.00158	<0.0010	<0.0030	<0.00020	<0.00020
Watchorn Creek	WHC-WB	29-Aug-21	0.00232	0.00241	0.00122	0.00146	<0.0010	<0.0030	0.00025	<0.00020
Mercer Creek	MC-WB	29-Aug-21	0.00147	0.00156	0.00124	0.00147	<0.0010	<0.0030	<0.00020	<0.00020
Birch Creek	BCD-2018-9	29-Aug-21	0.00177	0.00191	0.00064	0.00098	<0.0010	<0.0030	<0.00020	<0.00020
	BC-LSM	29-Aug-21	0.00236	0.00234	0.00123	0.00144	0.0010	<0.0030	0.00022	0.00021
Fairford River	FR1	30-Aug-21	0.00157	0.00166	0.00129	0.00156	<0.0010	<0.0030	<0.00020	<0.00020
	FR2	30-Aug-21	0.00158	0.00156	0.00126	0.00152	<0.0010	<0.0030	<0.00020	<0.00020
Lake St. Martin	BB-LSM	29-Aug-21	0.00173	0.00181	0.00148	0.00234	<0.0010	<0.0030	<0.00020	0.00031
	LSM5	31-Aug-21	0.00157	0.00148	0.00141	0.00168	<0.0010	<0.0030	<0.00020	<0.00020
	LSM4	30-Aug-21	0.00175	0.00182	0.00149	0.00203	<0.0010	<0.0030	<0.00020	<0.00020
	LSM1	31-Aug-21	0.00159	0.00158	0.00138	0.00175	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	31-Aug-21	0.00143	0.00142	0.00149	0.00185	<0.0010	<0.0030	<0.00020	<0.00020
Dauphin River	DR-A	31-Aug-21	0.00170	0.00170	0.00167	0.00214	<0.0010	<0.0030	<0.00020	<0.00020
	DR-B	30-Aug-21	0.00154	0.00164	0.00154	0.00205	<0.0010	<0.0030	<0.00020	0.00020
	DR-E	30-Aug-21	0.00149	0.00150	0.00157	0.00189	<0.0010	<0.0030	<0.00020	<0.00020
Big Buffalo Lake	BBL	3-Sep-21	0.00100	0.000893	0.00074	0.00114	0.0022	0.0044	<0.00020	<0.00020
Buffalo Creek	BC3	3-Sep-21	0.000301	0.000305	0.00072	0.00187	<0.0010	<0.0030	0.00021	0.00044
Lake Winnipeg	SB1	30-Aug-21	0.000964	0.00101	0.00200	0.00250	<0.0010	<0.0030	<0.00020	0.00023
	SB2	30-Aug-21	0.000868	0.000967	0.00186	0.00282	<0.0010	0.0070	<0.00020	0.00033

Table 8. Continued.

Waterbody	Site ID	Sampling Date	Uranium (U)		Vanadium (V)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Lake Manitoba	WHB1	18-Oct-21	0.00175	0.00156	0.00116	0.00166	<0.0010	<0.0030	<0.00020	<0.00020
	WHB2	18-Oct-21	0.00171	0.00157	0.00111	0.00167	<0.0010	<0.0030	<0.00020	<0.00020
Watchorn Creek	WHC-WB	18-Oct-21	0.00167	0.00135	0.00077	0.00121	<0.0010	<0.0030	<0.00020	<0.00020
Mercer Creek	MC-WB	18-Oct-21	0.00198	0.00182	0.00097	0.00148	<0.0010	<0.0030	<0.00020	<0.00020
Birch Creek	BCD-2018-9	18-Oct-21	0.00285	0.00273	<0.00050	0.00090	<0.0010	<0.0030	<0.00020	0.00020
	BC-LSM	18-Oct-21	0.00279	0.00281	0.00114	0.00172	<0.0010	<0.0030	0.00031	0.00029
Fairford River	FR1	19-Oct-21	0.00181	0.00166	0.00108	0.00140	<0.0010	<0.0030	<0.00020	<0.00020
	FR2	19-Oct-21	0.00188	0.00167	0.00116	0.00149	<0.0010	<0.0030	<0.00020	<0.00020
Lake St. Martin	BB-LSM	18-Oct-21	0.00203	0.00167	0.00133	0.00186	<0.0010	<0.0030	<0.00020	<0.00020
	LSM5	20-Oct-21	0.00160	0.00181	0.00132	0.00164	<0.0010	<0.0030	<0.00020	<0.00020
	LSM4	19-Oct-21	0.00182	0.00194	0.00119	0.00154	<0.0010	<0.0030	<0.00020	<0.00020
	LSM1	20-Oct-21	0.00198	0.00207	0.00104	0.00166	<0.0010	<0.0030	<0.00020	<0.00020
	LSM3	20-Oct-21	0.00190	0.00178	0.00079	0.00122	<0.0010	<0.0030	<0.00020	<0.00020
Dauphin River	DR-A	17-Oct-21	0.00188	0.00210	0.00113	0.00183	<0.0010	<0.0030	<0.00020	<0.00020
	DR-B	17-Oct-21	0.00189	0.00195	0.00102	0.00162	<0.0010	<0.0030	<0.00020	<0.00020
	DR-E	17-Oct-21	0.00185	0.00205	0.00097	0.00161	<0.0010	<0.0030	<0.00020	<0.00020
Big Buffalo Lake	BBL	21-Oct-21	0.000864	0.000899	0.00076	0.00120	<0.0010	<0.0030	<0.00020	<0.00020
Buffalo Creek	BC3	21-Oct-21	0.000260	0.000274	<0.00050	0.00128	<0.0010	<0.0030	<0.00020	0.00036
Lake Winnipeg	SB1	17-Oct-21	0.000967	0.00104	0.00177	0.00252	<0.0010	<0.0030	<0.00020	<0.00020
	SB2	17-Oct-21	0.000810	0.00104	0.00176	0.00270	<0.0010	<0.0030	<0.00020	0.00028

1 - Result verified by the analytical laboratory.

Table 9. *In situ* survey results. Values in blue italics are considered suspect.

Waterbody	Sampling Date	Sampling Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Reed Lake	3-Sep-21	10:33	0.4	0.3	17.17	8.14	85.0	966	6.37	8.78
Clear Lake	3-Sep-21	10:36	0.3	0.3	18.18	9.04	96.5	593	0.80	8.67
Water Lake	3-Sep-21	10:39	0.2	0.3	17.13	7.86	81.6	885	11.17	8.21
Goodison Lake	3-Sep-21	10:42	0.2	0.3	16.80	7.18	74.2	1284	4.30	8.04
Creek C upstream of LSMOC alignment	3-Sep-21	12:10	0.4	0.3	18.06	8.16	86.7	222	0.11	7.38
Unnamed Creek										
at LSMOC alignment	3-Sep-21	12:29	0.4	0.3	19.48	10.12	110.2	343	0.20	7.68
at Buffalo Creek	3-Sep-21	12:39	1.2	0.3	18.50	8.35	88.5	310	0.62	7.79
Reed Lake	21-Oct-21	13:56	0.5	0.3	5.61	12.24	97.6	1095	5.94	8.89
Clear Lake	21-Oct-21	13:52	0.5	0.3	5.63	9.77	78.1	739	38.19	8.24
Water Lake	21-Oct-21	13:48	0.3	0.3	5.21	13.08	103.9	1252	15.42	8.78
Goodison Lake	21-Oct-21	13:43	0.2	0.2	*5.40* [1]	*14.70* [1]	*116.3* [1]	*1572* [1]	- [1]	*8.91* [1]
Creek C upstream of LSMOC alignment	21-Oct-21	13:06	0.5	0.3	4.98	4.19	32.4	220	1.25	7.08
Unnamed Creek										
at LSMOC alignment	21-Oct-21	13:11	0.4	0.3	4.32	10.83	84.0	346	3.92	7.62
at Buffalo Creek	21-Oct-21	13:15	1.0	0.3	5.94	11.41	91.6	323	0.53	8.26
Woodale Drain	21-Oct-21	13:35	<0.10	0.3	- [1]	- [1]	- [1]	- [1]	- [1]	- [1]
Clarks Drain	21-Oct-21	13:39	0.2	0.2	3.84	13.07	98.9	571	3.36	8.52

1 - Insufficient water for accurate *in situ* measurements.

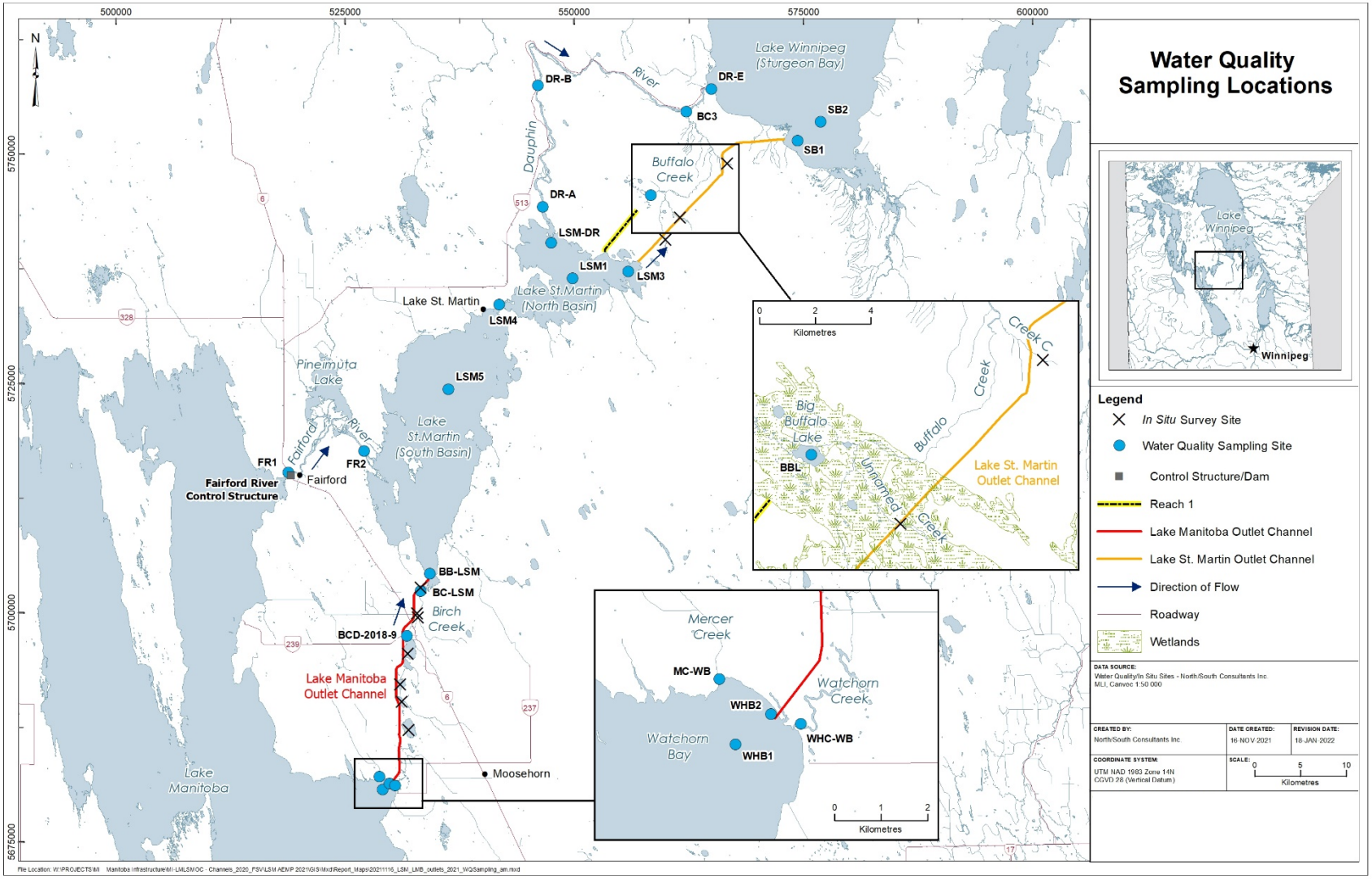


Figure 1. Water quality sampling locations.

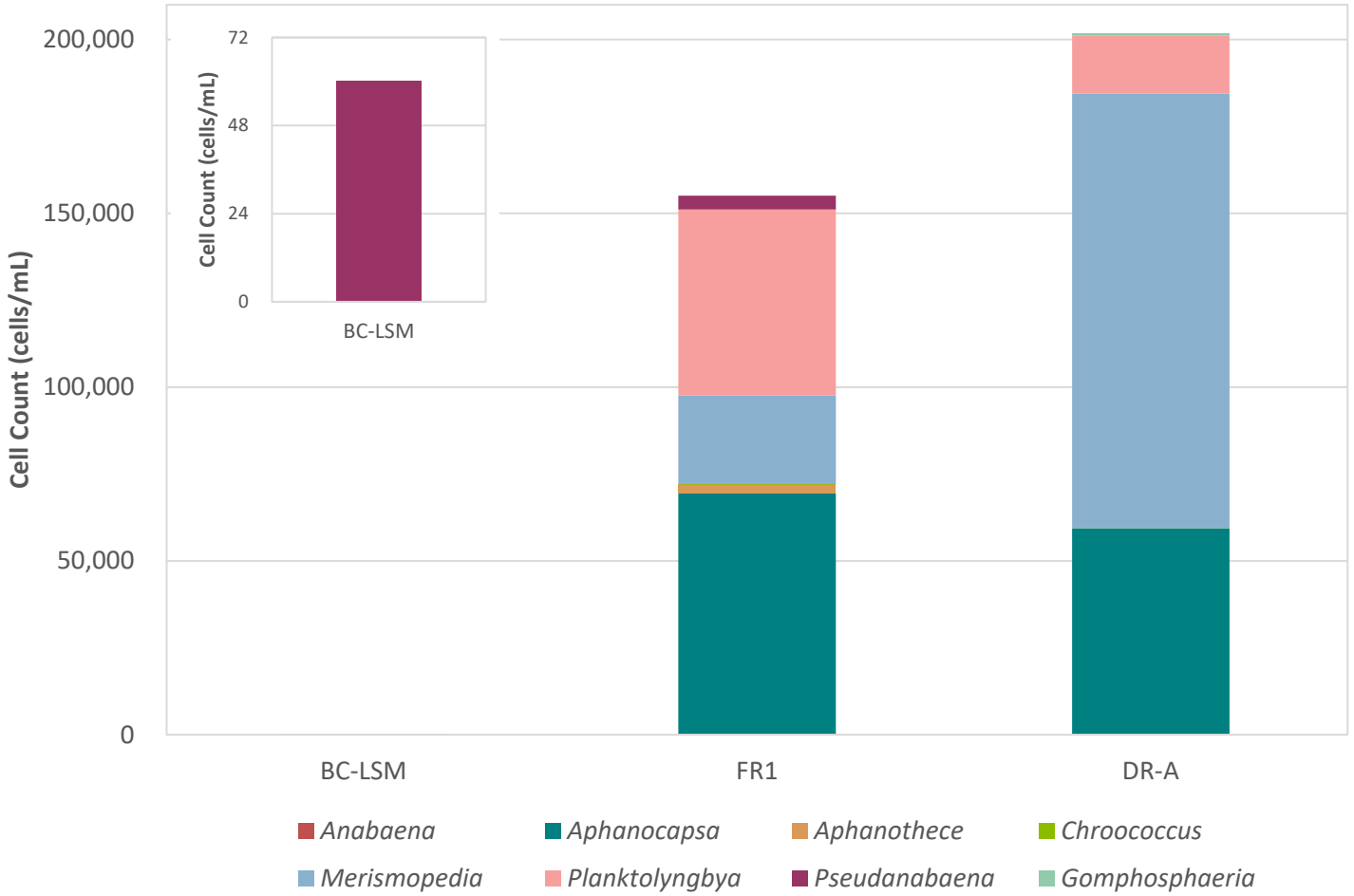


Figure 2. Abundance of blue-green algae at selected sampling sites in late-August 2021. Inset shows details for site BC-LSM where a lower abundance of blue-green algae was observed compared to the other sites.

APPENDIX 1. WATER QUALITY OBJECTIVES AND GUIDELINES

WATER QUALITY OBJECTIVES AND GUIDELINES

The following is a summary of applicable water quality objectives and guidelines for evaluation of water chemistry data collected in the study area, including: the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for the protection of aquatic life (PAL; MWS 2011); and the Canadian Council of Ministers for the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999, updated to 2022).

AMMONIA

Both MWQ objectives and CCME guidelines for PAL exist for ammonia; these criteria are dependent upon water temperature and pH. A representative range of Manitoba water quality objectives and CCME guidelines for ammonia appropriate for the range of pH and temperature measured in the study area (i.e., site-specific objectives) in Fall 2021 are presented in Tables A1-1 and A1-2, respectively.

Table A1-1. Range of applicable Manitoba Water Quality Objectives for ammonia, for the protection of cool-water and cold-water aquatic life and wildlife.

Water Use	pH	Temperature (°C)	Manitoba Water Quality Objective (mg N/L) [1]		
			30-day	4-day	1-hour
Cool water aquatic life, early life stages present					
	7.34	5.48	4.94	12.4	24.9
		18.9	3.73	9.32	24.9
	9.27	5.48	0.49	0.90	0.90
		18.9	0.37	0.90	0.90
Cool water aquatic life, early life stages absent					
	7.34	5.48	8.03	20.1	24.9
		18.9	3.73	9.32	24.9
	9.27	5.48	0.79	0.90	0.90
		18.9	0.37	0.90	0.90
Cold water aquatic life, early life stages present					
	7.34	5.48	4.94	12.4	16.6
		18.9	3.73	9.32	16.6
	9.27	5.48	0.49	0.60	0.60
		18.9	0.37	0.60	0.60
Cold water aquatic life, early life stages absent					
	7.34	5.48	8.03	16.6	16.6
		18.9	3.73	9.32	16.6
	9.27	5.48	0.79	0.60	0.60
		18.9	0.37	0.60	0.60

1 - Values calculated from algorithms provided in MWS (2011) and the range of pH and water temperature measured during the study. The most stringent objective is indicated in red.

Table A1-2. CCME water quality guidelines for total ammonia for the protection of freshwater aquatic life.

Temperature (°C)	CCME water quality guideline (mg N/L) [1]					
	pH					
	7.0	7.5	8.0	8.5	9.0	10
0	19.0 [2]	6.02 [2]	1.92 [2]	0.616[2]	0.206 [2]	0.035 [2]
5	12.6	3.98	1.27	0.413	0.141	0.028 [2]
10	8.47	2.68	0.855	0.282	0.100	0.024 [2]
15	5.74	1.83	0.588	0.197	0.073	0.021 [2]
20	3.96	1.27	0.410	0.141	0.055	0.020 [2]

[1] - Guidelines presented are for the range of pH and water temperature measured in the study area in Fall 2021. The most stringent guideline is indicated in red.

[2] - Values should be used with caution

DISSOLVED OXYGEN

Manitoba objectives for dissolved oxygen (DO) are dependent upon water temperature, the presence of early life stages, and the presence of sensitive fish species (e.g., cool-water fish such as Northern Pike and Walleye or cold-water fish species such as Lake Whitefish, MWS 2011). Objectives, which are specific for early life stages and mature life stages and vary according to the averaging duration, are presented in Table A1-3. Similarly, the CCME lowest acceptable level of DO varies by warm/cold water biota and life stage, as shown in Table A1-4.

Table A1-3. Manitoba Water Quality Objectives for dissolved oxygen.

Applicable Conditions	Dissolved Oxygen Objective (mg/L)			
	Averaging Duration			
	Instantaneous Minimum	7 Day Minimum	7 Days	30 Days
Cold-Water Aquatic Life and Wildlife				
Water Temperature ≤ 5°C and Early Life Stages Present	8.0	-	9.5	-
Water Temperature > 5°C and Mature Life Stages Present	4.0	5.0	-	6.5
Cool-Water Aquatic Life and Wildlife				
Water Temperature ≤ 5°C and Mature Life Stages Present	3.0	4.0	-	5.5
Water Temperature > 5°C and Early Life Stages Present	5.0	-	6.0	-

Table A1-4. CCME lowest acceptable concentration of dissolved oxygen for the protection of freshwater aquatic life.

	Dissolved Oxygen Value (mg/L)	
	Early life stages	Other life stages
Warm water biota	6.0	5.5
Cold water biota	9.5	6.5

TOTAL SUSPENDED SOLIDS AND TURBIDITY

MWQSOG and CCME guidelines for PAL for total suspended solids (TSS) are similar and allow the following: a maximum increase of 25 mg/L from background for short term exposure (up to 24 hrs.); an average increase of 5 mg/L from background for long term exposure (i.e., 1 to 30 days); a maximum increase of 25 mg/L from background when background TSS is between 25 mg/L and 250 mg/L; and a maximum change of 10% from background when TSS greater than 250 mg/L.

There are different criteria for turbidity for the MWQSOG and CCME guidelines for PAL. The Manitoba objective for turbidity for PAL is for "equivalent induced levels of change as calculated from site-specific or regional-specific correlation between total suspended solids and turbidity" (MWS 2011). The CCME guideline is more definitive and allows for the following (CCME 1999, updated to 2022) a maximum increase of 8 NTU from background for short term exposure (up to 24 hrs.); an average increase of 2 NTU from background for long term exposure (i.e., 1 to 30 days); a maximum increase of 8 NTU from background when background TSS is between 8 NTU and 80 NTU; and a maximum change of 10 % from background when background is greater than 80 NTU.

There is also a MWQSOG maximum acceptable concentration of 1.0 NTU for drinking water. However, this guideline, as with all drinking water guidelines/objectives, is to be applied to finished drinking water; and, since the majority of natural surface waters will exceed this guideline, it has not been included in this assessment.

PHOSPHORUS

MWQSOG include narrative guidelines for total phosphorus (TP) which state: "[TP] should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, [TP] should not exceed 0.05 mg/L" (MWS 2011).

CCME guidelines for the protection of freshwater aquatic life provide a guidance framework for the development of site-specific guidelines; this is a detailed process that requires sufficient baseline data for guideline development and is beyond the scope of this report.

OTHER ROUTINE PARAMETERS

Table A1-5 presents water quality criteria for other routine parameters not discussed above.

METALS AND MAJOR IONS

Table A1-6 presents water quality criteria for select metals and major ions.

HYDROCARBONS

Table A1-7 presents water quality criteria for select hydrocarbons.

PESTICIDES

Table A1-8 presents water quality criteria for select pesticides.

Table A1-5. Manitoba and CCME guidelines for the protection of aquatic life for other routine parameters measured.

Parameter	Guidelines/Objectives for PAL		
	MWQSOG [1]	CCME [2]	
		Short Term	Long Term
Nitrate	2.93 mg N/L[3]	124 mg N/L	3.0 mg N/L
Nitrite	0.060 mg N/L	-	0.060 mg N/L
pH	6.5 to 9.0	-	6.5 to 9.0

1 - Manitoba Water Quality Standards, Objectives, and Guidelines (MWS 2011).

2 - CCME guidelines for the protection of freshwater aquatic life (CCME 1999, updated to 2022).

3 - The Manitoba PAL guideline for nitrate indicated in MWS (2011) was incorrectly identified as 13 mg N/L. The PAL guideline should read 2.93 mg N/L (N. Armstrong, Pers. Comm.).

Table A1-6. Manitoba and CCME guidelines for the protection of aquatic life for metals and major ions.

Parameter	Manitoba Objectives and Guidelines (mg/L)					CCME Guidelines (mg/L)		
	Tier II Objectives		Tier III Guidelines					
	Acute [1]	Chronic [2]	MWQG	Short-term	Long-term	CWQG	Short-term	Long-term
Aluminum	-	-	0.1 [3]	-	-	0.1 [3]	-	-
Arsenic, dissolved	0.34	0.15	-	-	-	-	-	-
Arsenic, total	-	-	-	-	-	0.005	-	-
Boron	-	-	-	29	1.5	-	29	1.5
Cadmium, dissolved	0.00293 to 0.0123 [4]	0.000321 to 0.000895 [4]	-	-	-	-	0.00310 to 0.00770 [4]	0.000222 to 0.000370 [4]
Chloride	-	-	-	-	-	-	640	120
Chromium (III), dissolved	0.781 to 2.62 [4]	0.102 to 0.341 [4]	-	-	-	0.0089 [5]	-	-
Copper, dissolved	0.0193 to 0.0778 [4]	0.0124 to 0.0440 [4]	-	-	-	0.00329 to 0.004 [4]	-	-
Fluoride	-	-	-	-	-	0.12 [5]		
Iron	-	-	≤0.3	-	-	0.3	-	-
Lead, dissolved	0.0980 to 0.455 [4]	0.00381 to 0.0177 [4]	-	-	-	0.00520 to 0.007 [4]	-	-
Manganese, dissolved	-	-	-	-	-	-	9.3 to 14.8 [6]	0.120 to 0.770 [6]
Mercury	-	-	0.000026	-	-	0.000026 [5]	-	-
Molybdenum	-	-	0.073	-	-	0.073 [5]	-	-
Nickel, dissolved	0.649 to 2.27 [4]	0.0720 to 0.252 [4]	-	-	-	0.128 to 0.150 [4]	-	-
Selenium, total	-	-	0.001	-	-	0.001	-	-
Silver, total	-	-	0.0001	-	-	-	-	0.00025
Thallium	-	-	0.0008	-	-	0.0008	-	-
Uranium	-	-	-	0.033	0.015	-	0.033	0.015
Zinc, dissolved	0.162 to 0.569 [4]	0.164 to 0.537 [4]	-	-	-	-	0.198 to 0.333 [7]	0.0156 to 0.261 [8]

1 - 1-hour averaging objective.

2 - 4-day averaging objective.

3 - Value represents the guideline where pH > 6.5.

4 - Calculated based on the range of hardness (147-645 mg/L) observed in all samples collected.

5 - Interim guideline.

6 - Calculated based on the range of hardness (167-645 mg/L) and pH (7.34-9.27) observed in all samples collected.

7 - Calculated based on the range of hardness (167-645 mg/L) and dissolved organic carbon (DOC; 8.02-30.1 mg/L) observed in all samples collected.

8 - Calculated based on the range of hardness (147-645 mg/L), DOC (8.02-30.1 mg/L) and pH (7.34-9.27) observed in all samples collected.

Table A1-7. Manitoba and CCME guidelines for the protection of aquatic life for hydrocarbons.

Parameter	Units	PAL Guideline [1]
Benzene	mg/L	0.370
Ethyl benzene	mg/L	0.090
Toluene	mg/L	0.002
Acenaphthene	mg/L	0.0058
Acridine	mg/L	0.0044
Anthracene	mg/L	0.000012
Benzo(a)anthracene	mg/L	0.000018
Benzo(a)pyrene	mg/L	0.000015
Fluoranthene	mg/L	0.00004
Fluorene	mg/L	0.003
Naphthalene	mg/L	0.0011
Phenanthrene	mg/L	0.0004
Pyrene	mg/L	0.000025
Quinoline	mg/L	0.0034

1 - MWQSOG and CCME guidelines are the same for these parameters.

Table A1-8. Manitoba and CCME guidelines for the protection of aquatic life for pesticides.

Parameter	Unit	MWQSOG			CCME Guidelines		
		MWQG	Short-term	Long-term	CWQG	Short-term	Long-term
Aldrin	µg/L	-	-	-	-	-	0.004
alpha-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
beta-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
gamma-hexachlorocyclohexane	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
delta-BHC	µg/L	0.01 [1]	-	-	-	-	0.01 [1]
a-chlordane	µg/L	-	-	-	-	-	0.006 [2]
g-chlordane	µg/L	-	-	-	-	-	0.006 [2]
Endosulfan	µg/L	-	0.06	0.003	-	0.06	0.003
Hexachlorobutadiene	µg/L	1.3	-	-	1.3	-	-
Bromoxynil	mg/L	0.005	-	-	-	-	0.005
2,4-D	mg/L	-	-	-	-	-	0.004
Dicamba	mg/L	0.01	-	-	-	-	0.01
Dinoseb	mg/L	0.00005	-	-	-	-	0.00005
MCPA	mg/L	0.0026	-	-	-	-	0.0026
Picloram	mg/L	0.029	-	-	-	-	0.029
Atrazine	µg/L	1.8 [3]	-	-	-	-	1.8
Atrazine+N-Dealkylated Metabolites	µg/L	1.8 [3]	-	-	-	-	-
Glyphosate	µg/L	65	-	-	-	27000	800
Diclofop-methyl	mg/L	0.0061	-	-	-	-	0.0061
Triallate	mg/L	0.00024	-	-	-	-	0.00024
Trifluralin	mg/L	0.00020	-	-	-	-	0.0002

1 - Guideline for hexachlorocyclohexane (i.e., Lindane).

2 - Guideline for chlordane.

3 - Guideline for atrazine + metabolites.

APPENDIX 2. QUALITY ASSURANCE / QUALITY CONTROL RESULTS

Table A2-1. QA/QC results for routine parameters. Percent relative standard deviation (PRSD) values greater than 18 are indicated in red bold. Results for all blanks are less than five times the analytical detection limit (DL).

				Alkalinity				Nitrogen			
Waterbody	Sampling Date	Sample ID	ALS ID	Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Analytical DL				*1.0*	*1.2*	*0.60*	*0.34*	*0.010*	*0.0050 /0.010*	*0.0010 /0.0020*	*0.0051 /0.010*
Replicates											
Lake St. Martin	30-Aug-21	LSM4	L2633558-11	164	188	5.64	<0.34	0.029	<0.010	<0.0020	<0.010
		REP-1A	L2633558-1	164	189	5.04	<0.34	0.020	<0.010	<0.0020	<0.010
		REP-1B	L2633558-2	163	188	5.52	<0.34	0.025	<0.010	<0.0020	<0.010
		Mean		164	188	5.40	<0.34	0.025	<0.010	<0.0020	<0.010
		SD		0.6	0.6	0.317	-	-	-	-	-
		PRSD		0	0	6	-	-	-	-	-
Fairford River	30-Aug-21	FR2	L2633558-10	172	197	6.24	<0.34	0.020	<0.010	<0.0020	<0.010
		REP-2A	L2633558-3	171	196	6.48	<0.34	0.016	<0.010	<0.0020	<0.010
		REP-2B	L2633558-4	172	197	6.36	<0.34	0.012	<0.010	<0.0020	<0.010
		Mean		172	197	6.36	<0.34	0.016	<0.010	<0.0020	<0.010
		SD		0.6	0.6	0.120	-	-	-	-	-
		PRSD		0	0	2	-	-	-	-	-
Lake Manitoba	18-Oct-21	WHB1	L2652497-5	174	206	3.12	<0.34	0.010	<0.010	<0.0020	<0.010
		REP-1A	L2652497-8	173	205	3.00	<0.34	<0.010	<0.010	<0.0020	<0.010
		REP-1B	L2652497-9	170	200	3.36	<0.34	<0.010	<0.010	<0.0020	<0.010
		Mean		172	204	3.16	<0.34	<0.010	<0.010	<0.0020	<0.010
		SD		2.1	3.2	0.183	-	-	-	-	-
		PRSD		1	2	6	-	-	-	-	-
Fairford River	19-Oct-21	FR2	L2653142-2	179	209	4.20	<0.34	0.027	<0.010	<0.0020	<0.010
		REP-2A	L2653142-4	178	208	4.68	<0.34	0.025	<0.010	<0.0020	<0.010
		REP-2B	L2653142-5	177	207	4.44	<0.34	0.027	<0.010	<0.0020	<0.010
		Mean		178	208	4.44	<0.34	0.026	<0.010	<0.0020	<0.010
		SD		1.0	1.0	0.240	-	-	-	-	-
		PRSD		1	0	5	-	-	-	-	-

Table A2-1. Continued.

Waterbody	Sampling Date	Sample ID	ALS ID	Alkalinity				Nitrogen			
				Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate, HCO_3 (mg/L)	Carbonate, CO_3 (mg/L)	Hydroxide, OH (mg/L)	Total Ammonia (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ nitrite (mg N/L)
Analytical DL				*1.0*	*1.2*	*0.60*	*0.34*	*0.010*	*0.0050 /0.010*	*0.0010 /0.0020*	*0.0051 /0.010*
Blanks											
Field Blank	30-Aug-21	WB-1A	L2633558-5	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	30-Aug-21	WB-2A	L2633558-7	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	17-Oct-21	WB-1B	L2652045-4	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	20-Oct-21	WB-2A	L2653742-4	2.6	3.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
Trip Blank	30-Aug-21	WB-1B	L2633558-6	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	30-Aug-21	WB-2B	L2633558-8	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	17-Oct-21	WB-1A	L2652045-5	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051
	20-Oct-21	WB-2B	L2653742-5	<1.0	<1.2	<0.60	<0.34	<0.010	<0.0050	<0.0010	<0.0051

Table A2-1. Continued.

Waterbody	Sampling Date	Sample ID			Phosphorus			Carbon			
			Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)
Analytical DL			*0.20*	*0.20*	*0.0010 /0.0030*	*0.0028 /0.0042*	*0.0010 /0.0030*	*0.50*	*0.50*	*0.50*	*1.0*
Replicates											
Lake St. Martin	30-Aug-21	LSM4	1.34 [3]	1.34	0.0088	0.0165	0.0254	30.9	16.5	15.9	47.4
		REP-1A	1.43	1.43	0.0088	0.0151	0.0239	32.7	16.3	16.0	49.1
		REP-1B	1.37	1.37	0.0078	0.0129	0.0206	34.2	15.9	15.9	50.1
		Mean	1.38	1.38	0.0085	0.0148	0.0233	32.6	16.2	15.9	48.9
		SD	0.046	0.046	-	-	0.00246	1.65	0.31	0.06	1.37
		PRSD	3	3	-	-	11	5	2	0	3
Fairford River	30-Aug-21	FR2	0.77	0.77	0.0066	0.0187	0.0252	35.0	15.5	15.1	50.5
		REP-2A	0.88	0.88	0.0079	0.0149	0.0228	31.7	15.6	15.0	47.3
		REP-2B	0.77	0.77	0.0072	0.0168	0.0239	33.6	16.2	14.8	49.9
		Mean	0.81	0.81	0.0072	0.0168	0.0240	33.4	15.8	15.0	49.2
		SD	0.064	-	-	-	0.00120	1.66	0.38	0.15	1.70
		PRSD	8	-	-	-	5	5	2	1	3
Lake Manitoba	18-Oct-21	WHB1	1.17	1.17	0.0058	0.0180	0.0237	36.7	15.1	14.4	51.8
		REP-1A	0.92	0.92	0.0057	0.0185	0.0242	35.5	15.0	14.0	50.5
		REP-1B	1.19	1.19	0.0066	0.0172	0.0238	34.5	13.5	14.2	48.0
		Mean	1.09	1.09	0.0060	0.0179	0.0239	35.6	14.5	14.2	50.1
		SD	0.150	0.150	-	-	0.00026	1.10	0.90	0.20	1.93
		PRSD	14	14	-	-	1	3	6	1	4
Fairford River	19-Oct-21	FR2	0.91	0.91	0.0075	0.0211	0.0286	37.3	15.2	14.5	52.5
		REP-2A	0.88	0.88	0.0077	0.0202	0.0279	37.2	15.3	14.7	52.5
		REP-2B	0.99	0.99	0.0068	0.0231	0.0299	36.7	14.8	14.5	51.6
		Mean	0.93	0.93	0.0073	0.0215	0.0288	37.1	15.1	14.6	52.2
		SD	0.057	-	-	0.00148	0.00101	0.32	0.26	0.12	0.52
		PRSD	6	-	-	7	4	1	2	1	1

Table A2-1. Continued.

Waterbody	Sampling Date	Sample ID			Phosphorus			Carbon			
			Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Dissolved Phosphorus (mg/L)	Total Particulate Phosphorus (mg/L)	Total Phosphorus (mg/L)	Total Inorganic Carbon (mg/L)	Total Organic Carbon (mg/L)	Dissolved Organic Carbon (mg/L)	Total Carbon (mg/L)
Analytical DL			*0.20*	*0.20*	*0.0010 /0.0030*	*0.0028 /0.0042*	*0.0010 /0.0030*	*0.50*	*0.50*	*0.50*	*1.0*
Blanks											
Field Blank	30-Aug-21	WB-1A	<0.20	<0.20	<0.0010	<0.0028	0.0010	<0.50	<0.50	<0.50	<1.0
	30-Aug-21	WB-2A	<0.20	<0.20	0.0012	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	17-Oct-21	WB-1B	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	20-Oct-21	WB-2A	<0.20	<0.20	<0.0010	<0.0028	0.0012	<0.50	0.73	<0.50	<1.0
Trip Blank	30-Aug-21	WB-1B	<0.20	<0.20	0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	30-Aug-21	WB-2B	<0.20	<0.20	0.0011	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	17-Oct-21	WB-1A	<0.20	<0.20	<0.0010	<0.0028	<0.0010	<0.50	<0.50	<0.50	<1.0
	20-Oct-21	WB-2B	<0.20	<0.20	<0.0010	<0.0028	0.0017	<0.50	<0.50	<0.50	<1.0

Table A2-1. Continued.

Waterbody	Sampling Date	Sample ID	Routine Chemistry				Water Clarity			Algal Pigments	
			Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Analytical DL			*0.10*	*1*	*4.0 / 20*	*0.2*	*1.0*	*0.1*	*5.0*	*0.10*	*0.10*
Replicates											
Lake St. Martin	30-Aug-21	LSM4	8.42	1130	557	240	7.9	6.13	7.8	6.67	2.17
		REP-1A	8.40	1140	638	283	7.6	5.39	8.4	5.94	1.96
		REP-1B	8.40	1140	649	276	7.5	3.92	10	6.73	2.17
		Mean	8.41	1137	615	266	7.7	5.15	8.7	6.45	2.10
		SD	0.012	5.8	50.2	23.1	0.21	1.12	1.14	0.440	0.121
		PRSD	0	1	8	9	3	**22**	13	7	6
Fairford River	30-Aug-21	FR2	8.44	1170	670	250	13.1	10.6	6.6	7.20	1.72
		REP-2A	8.44	1170	558	291	12.7	8.28	5.2	7.03	1.82
		REP-2B	8.43	1170	662	280	12.5	8.42	<5.0	7.17	1.79
		Mean	8.44	1170	630	274	12.8	9.10	<5.0	7.13	1.78
		SD	0.006	0.0	62.5	21.2	0.31	1.30	-	0.091	0.051
		PRSD	0	0	10	8	2	14	-	1	3
Lake Manitoba	18-Oct-21	WHB1	8.35	1170	663	259	14.7	9.38	7.1	9.79	1.83
		REP-1A	8.35	1170	670	270	14.5	9.16	8.7	9.55	2.11
		REP-1B	8.34	1170	668	275	14.4	10.3	5.6	9.05	2.21
		Mean	8.35	1170	667	268	14.5	9.61	7.1	9.46	2.05
		SD	0.006	0.0	3.6	8.2	0.15	0.605	1.55	0.378	0.197
		PRSD	0	0	1	3	1	6	**22**	4	10
Fairford River	19-Oct-21	FR2	8.39	1220	599	269	15.8	12.3	<5.0	5.71	1.79
		REP-2A	8.40	1210	695	274	14.8	11.4	<5.0	6.01	2.73
		REP-2B	8.39	1220	686	277	15.4	12.7	<5.0	6.31	2.23
		Mean	8.39	1217	660	273	15.3	12.13	<5.0	6.01	2.25
		SD	0.006	5.8	53.0	4.0	0.50	0.666	-	0.300	0.470
		PRSD	0	0	8	1	3	5	-	5	**21**

Table A2-1. Continued.

Waterbody	Sampling Date	Sample ID	Routine Chemistry				Water Clarity			Algal Pigments	
			Laboratory pH (pH units)	Laboratory Conductivity (µmhos/cm)	Total Dissolved Solids (mg/L)	Hardness, as $CaCO_3$ (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	True Colour (CU)	Chlorophyll a (µg/L)	Phaeophytin a (µg/L)
Analytical DL			*0.10*	*1*	*4.0/ 20*	*0.2*	*1.0*	*0.1*	*5.0*	*0.10*	*0.10*
Blanks											
Field Blank	30-Aug-21	WB-1A	5.59	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	30-Aug-21	WB-2A	5.49	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	17-Oct-21	WB-1B	5.61	1.2	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	20-Oct-21	WB-2A	5.83	1.0	<4.0	<0.20	<1.0	0.27	<5.0	<0.10	<0.10
Trip Blank	30-Aug-21	WB-1B	5.51	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	30-Aug-21	WB-2B	5.47	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	17-Oct-21	WB-1A	5.44	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10
	20-Oct-21	WB-2B	5.30	<1.0	<4.0	<0.20	<1.0	<0.10	<5.0	<0.10	<0.10

Table A2-2. QA/QC results for metals and major ions (mg/L). Percent relative standard deviation (PRSD) values greater than 18 and blank results greater than five times the analytical detection limit (DL) are indicated in red bold.

Waterbody	Sampling Date	Sample ID	ALS ID	Aluminum (Al)		Antimony (Sb)		Arsenic (As)	
				Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL				*0.0010*	*0.0030*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Replicates									
Lake St. Martin	30-Aug-21	LSM 4	L2633558-11	0.0058	0.0863	0.00022	0.00020	0.00230	0.00224
		REP - 1A	L2633558-1	0.0066	0.0739	0.00020	0.00021	0.00242	0.00237
		REP - 1B	L2633558-2	0.0067	0.0688	0.00020	0.00025	0.00227	0.00239
		Mean		0.00637	0.0763	0.00021	0.00022	0.00233	0.00233
		SD		0.000493	0.00900	0.000012	-	0.000079	0.000081
		PRSD		8	12	6	-	3	3
Fairford River	30-Aug-21	FR 2	L2633558-10	0.0039	0.0488	0.00021	0.00018	0.00211	0.00208
		REP - 2A	L2633558-3	0.0039	0.0406	0.00026	0.00033	0.00218	0.00206
		REP - 2B	L2633558-4	0.0038	0.0513	0.00019	0.00018	0.00218	0.00202
		Mean		0.00387	0.0469	0.00022	0.00023	0.00216	0.00205
		SD		0.000058	0.00560	0.000036	-	0.000040	0.000031
		PRSD		1	12	16	-	2	1
Lake Manitoba	18-Oct-21	WHB1	L2652497-5	0.0030	0.0963	0.00017	0.00018	0.00215	0.00222
		REP-1A	L2652497-8	0.0030	0.0281	0.00017	0.00017	0.00213	0.00216
		REP-1B	L2652497-9	0.0033	0.0250	0.00018	0.00018	0.00217	0.00209
		Mean		0.00310	0.0498	0.00017	0.00018	0.00215	0.00216
		SD		0.000173	0.0403	0.000006	-	0.000020	0.000065
		PRSD		6	**81**	3	-	1	3
Fairford River	19-Oct-21	FR2	L2653142-2	0.0034	0.0393	0.00018	0.00018	0.00203	0.00197
		REP-2A	L2653142-4	0.0033	0.0176	0.00019	0.00017	0.00204	0.00208
		REP-2B	L2653142-5	0.0039	0.0910	0.00018	0.00018	0.00206	0.00201
		Mean		0.00353	0.0493	0.00018	0.00018	0.00204	0.00202
		SD		0.000321	0.0377	0.000006	-	0.000015	0.000056
		PRSD		9	**76**	3	-	1	3
Blanks									
Field Blank	30-Aug-21	WB - 1A	L2633558-5	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Field Blank	30-Aug-21	WB - 2A	L2633558-7	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Field Blank	17-Oct-21	WB-1B	L2652045-4	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Field Blank	20-Oct-21	WB-2A	L2653742-4	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blank	30-Aug-21	WB - 1B	L2633558-6	<0.0010	**0.0356**	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blank	30-Aug-21	WB - 2B	L2633558-8	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blank	17-Oct-21	WB-1A	L2652045-5	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blank	20-Oct-21	WB-2B	L2653742-5	<0.0010	<0.0030	<0.00010	<0.00010	<0.00010	<0.00010

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Barium (Ba)		Beryllium (Be)		Bismuth (Bi)		Boron (B)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.000050*	*0.000050*	*0.010*	*0.010*
Replicates										
Lake St. Martin	30-Aug-21	LSM 4	0.0395	0.0383	<0.00010	<0.00010	<0.000050	<0.000050	0.105	0.105
		REP - 1A	0.0387	0.0400	<0.00010	<0.00010	<0.000050	<0.000050	0.121	0.100
		REP - 1B	0.0390	0.0392	<0.00010	<0.00010	<0.000050	<0.000050	0.118	0.100
		Mean	0.0391	0.0392	<0.00010	<0.00010	<0.000050	<0.000050	0.115	0.102
		SD	0.00040	0.00085	-	-	-	-	0.0085	0.0029
		PRSD	1	2	-	-	-	-	7	3
Fairford River	30-Aug-21	FR 2	0.0408	0.0397	<0.00010	<0.00010	<0.000050	<0.000050	0.110	0.107
		REP - 2A	0.0420	0.0400	<0.00010	<0.00010	<0.000050	<0.000050	0.125	0.103
		REP - 2B	0.0412	0.0400	<0.00010	<0.00010	<0.000050	<0.000050	0.122	0.105
		Mean	0.0413	0.0399	<0.00010	<0.00010	<0.000050	<0.000050	0.119	0.105
		SD	0.00061	0.00017	-	-	-	-	0.0079	0.0020
		PRSD	1	0	-	-	-	-	7	2
Lake Manitoba	18-Oct-21	WHB1	0.0417	0.0440	<0.00010	<0.00010	<0.000050	<0.000050	0.124	0.123
		REP-1A	0.0431	0.0433	<0.00010	<0.00010	<0.000050	<0.000050	0.131	0.122
		REP-1B	0.0437	0.0429	<0.00010	<0.00010	<0.000050	<0.000050	0.135	0.126
		Mean	0.0428	0.0434	<0.00010	<0.00010	<0.000050	<0.000050	0.130	0.124
		SD	0.00103	0.00056	-	-	-	-	0.0056	0.0021
		PRSD	2	1	-	-	-	-	4	2
Fairford River	19-Oct-21	FR2	0.0442	0.0433	<0.00010	<0.00010	<0.000050	<0.000050	0.119	0.114
		REP-2A	0.0443	0.0430	<0.00010	<0.00010	<0.000050	<0.000050	0.120	0.093
		REP-2B	0.0447	0.0430	<0.00010	<0.00010	<0.000050	<0.000050	0.124	0.102
		Mean	0.0444	0.0431	<0.00010	<0.00010	<0.000050	<0.000050	0.121	0.103
		SD	0.00026	0.00017	-	-	-	-	0.0026	0.0105
		PRSD	1	0	-	-	-	-	2	10
Blanks										
Field Blank	30-Aug-21	WB - 1A	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	30-Aug-21	WB - 2A	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	17-Oct-21	WB-1B	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	20-Oct-21	WB-2A	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	0.000103	<0.010	<0.010
Trip Blank	30-Aug-21	WB - 1B	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	30-Aug-21	WB - 2B	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	17-Oct-21	WB-1A	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010
	20-Oct-21	WB-2B	<0.00010	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.010	<0.010

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Cadmium (Cd)		Calcium (Ca)		Cesium (Cs)		Chloride (Cl)
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Analytical DL			*0.0000050*	*0.0000050*	*0.05*	*0.050*	*0.000010*	*0.000010*	*0.20/0.10*
Replicates									
Lake St. Martin	30-Aug-21	LSM4	<0.0000050	<0.0000050	31.3	31.7	<0.000010	0.000011	218
		REP-1A	<0.0000050	0.0000051	39.3	31.2	<0.000010	0.000012	219
		REP-1B	<0.0000050	<0.0000050	36.7	30.6	<0.000010	0.000010	219
		Mean	<0.0000050	<0.0000050	35.8	31.2	<0.000010	0.000011	219
		SD	-	-	4.08	0.55	-	-	0.6
		PRSD	-	-	11	2	-	-	0
Fairford River	30-Aug-21	FR2	<0.0000050	<0.0000050	34.2	35.1	<0.000010	<0.000010	228
		REP-2A	<0.0000050	<0.0000050	40.4	34.8	<0.000010	<0.000010	227
		REP-2B	<0.0000050	<0.0000050	39.7	34.9	<0.000010	<0.000010	228
		Mean	<0.0000050	<0.0000050	38.1	34.9	<0.000010	<0.000010	228
		SD	-	-	3.40	0.15	-	-	0.6
		PRSD	-	-	9	0	-	-	0
Lake Manitoba	18-Oct-21	WHB1	<0.0000050	<0.0000050	37.8	40.8	<0.000010	0.000011	219
		REP-1A	<0.0000050	<0.0000050	39.1	40.3	<0.000010	<0.000010	222
		REP-1B	<0.0000050	<0.0000050	40.7	41.4	<0.000010	<0.000010	221
		Mean	<0.0000050	<0.0000050	39.2	40.8	<0.000010	<0.000010	221
		SD	-	-	1.45	0.55	-	-	1.5
		PRSD	-	-	4	1	-	-	1
Fairford River	19-Oct-21	FR2	<0.0000050	<0.0000050	39.5	41.3	<0.000010	<0.000010	224
		REP-2A	<0.0000050	<0.0000050	39.3	40.7	<0.000010	<0.000010	225
		REP-2B	<0.0000050	<0.0000050	41.5	40.6	<0.000010	0.000010	225
		Mean	<0.0000050	<0.0000050	40.1	40.9	<0.000010	<0.000010	225
		SD	-	-	1.22	0.38	-	-	0.6
		PRSD	-	-	3	1	-	-	0
Blanks									
Field Blank	30-Aug-21	WB-1A	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	30-Aug-21	WB-2A	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	17-Oct-21	WB-1B	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	20-Oct-21	WB-2A	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
Trip Blank	30-Aug-21	WB-1B	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	30-Aug-21	WB-2B	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	17-Oct-21	WB-1A	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10
	20-Oct-21	WB-2B	<0.0000050	<0.0000050	<0.050	<0.050	<0.000010	<0.000010	<0.10

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Chromium (Cr)		Cobalt (Co)		Copper (Cu)		Fluoride
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Analytical DL			*0.00010*	*0.00010*	*0.00010*	*0.00010*	*0.00020*	*0.00050*	*0.040/0.020*
Replicates									
Lake St. Martin	30-Aug-21	LSM4	<0.00010	0.00014	<0.00010	<0.00010	0.00025	<0.00050	0.147
		REP-1A	<0.00010	0.00033	<0.00010	0.00011	0.00027	0.00060	0.161
		REP-1B	<0.00010	0.00017	<0.00010	<0.00010	0.00026	<0.00050	0.152
		Mean	<0.00010	0.00021	<0.00010	<0.00010	0.00026	<0.00050	0.153
		SD	-	-	-	-	-	-	0.0071
		PRSD	-	-	-	-	-	-	5
Fairford River	30-Aug-21	FR2	<0.00010	0.00019	<0.00010	<0.00010	0.00025	<0.00050	0.153
		REP-2A	<0.00010	<0.00010	<0.00010	<0.00010	0.00027	<0.00050	0.155
		REP-2B	<0.00010	0.00037	<0.00010	<0.00010	0.00026	<0.00050	0.151
		Mean	<0.00010	0.00028	<0.00010	<0.00010	0.00026	<0.00050	0.153
		SD	-	-	-	-	-	-	0.0020
		PRSD	-	-	-	-	-	-	1
Lake Manitoba	18-Oct-21	WHB1	<0.00010	0.00015	<0.00010	<0.00010	0.00024	<0.00050	0.162
		REP-1A	<0.00010	<0.00010	<0.00010	<0.00010	0.00033	<0.00050	0.164
		REP-1B	<0.00010	0.00010	<0.00010	<0.00010	0.00028	<0.00050	0.162
		Mean	<0.00010	0.00010	<0.00010	<0.00010	0.00028	<0.00050	0.163
		SD	-	-	-	-	-	-	0.0012
		PRSD	-	-	-	-	-	-	1
Fairford River	19-Oct-21	FR2	<0.00010	0.00012	<0.00010	<0.00010	0.00030	<0.00050	0.166
		REP-2A	<0.00010	<0.00010	<0.00010	<0.00010	0.00028	<0.00050	0.166
		REP-2B	<0.00010	0.00014	<0.00010	<0.00010	0.00029	<0.00050	0.165
		Mean	<0.00010	0.00010	<0.00010	<0.00010	0.00029	<0.00050	0.166
		SD	-	-	-	-	-	-	0.0006
		PRSD	-	-	-	-	-	-	0
Blanks									
Field Blank	30-Aug-21	WB-1A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	30-Aug-21	WB-2A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	17-Oct-21	WB-1B	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	20-Oct-21	WB-2A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	0.00132	<0.020
Trip Blank	30-Aug-21	WB-1B	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	30-Aug-21	WB-2B	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	17-Oct-21	WB-1A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020
	20-Oct-21	WB-2B	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050	<0.020

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Iron (Fe)		Lead (Pb)		Lithium (Li)		Magnesium (Mg)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.010*	*0.010*	*0.000050*	*0.000050*	*0.0010*	*0.0010*	*0.0050*	*0.0050*
Replicates										
Lake St. Martin	30-Aug-21	LSM4	<0.010	0.053	<0.000050	0.000145	0.0344	0.0356	39.2	38.5
		REP-1A	<0.010	0.080	<0.000050	0.000204	0.0359	0.0348	45.0	38.8
		REP-1B	<0.010	0.055	<0.000050	0.000136	0.0400	0.0352	44.9	38.8
		Mean	<0.010	0.063	<0.000050	0.000162	0.0368	0.0352	43.0	38.7
		SD	-	0.0150	-	-	0.00290	0.00040	3.32	0.17
		PRSD	-	24	-	-	8	1	8	0
Fairford River	30-Aug-21	FR2	<0.010	0.056	<0.000050	0.000158	0.0348	0.0356	40.0	39.8
		REP-2A	<0.010	0.043	<0.000050	0.000160	0.0410	0.0351	46.1	38.9
		REP-2B	<0.010	0.052	<0.000050	0.000189	0.0407	0.0355	43.9	38.2
		Mean	<0.010	0.050	<0.000050	0.000169	0.0388	0.0354	43.3	39.0
		SD	-	0.0067	-	-	0.00350	0.00026	3.09	0.80
		PRSD	-	13	-	-	9	1	7	2
Lake Manitoba	18-Oct-21	WHB1	<0.010	0.061	<0.000050	0.000165	0.0381	0.0418	40.0	42.6
		REP-1A	<0.010	0.037	<0.000050	0.000162	0.0406	0.0416	42.0	41.6
		REP-1B	<0.010	0.035	<0.000050	0.000158	0.0418	0.0426	42.0	41.0
		Mean	<0.010	0.044	<0.000050	0.000162	0.0402	0.0420	41.3	41.7
		SD	-	-	-	-	0.00189	0.00053	1.15	0.81
		PRSD	-	-	-	-	5	1	3	2
Fairford River	19-Oct-21	FR2	<0.010	0.051	<0.000050	0.000189	0.0397	0.0386	41.4	40.6
		REP-2A	<0.010	0.031	<0.000050	0.000193	0.0394	0.0372	42.8	40.7
		REP-2B	<0.010	0.102	<0.000050	0.000192	0.0404	0.0377	42.0	40.8
		Mean	<0.010	0.061	<0.000050	0.000191	0.0398	0.0378	42.1	40.7
		SD	-	0.0366	-	-	0.00051	0.00071	0.70	0.10
		PRSD	-	-	-	-	1	2	2	0
Blanks										
Field Blank	30-Aug-21	WB-1A	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	0.0065	<0.0050
	30-Aug-21	WB-2A	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
	17-Oct-21	WB-1B	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
	20-Oct-21	WB-2A	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
Trip Blank	30-Aug-21	WB-1B	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
	30-Aug-21	WB-2B	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
	17-Oct-21	WB-1A	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050
	20-Oct-21	WB-2B	<0.010	<0.010	<0.000050	<0.000050	<0.0010	<0.0010	<0.0050	<0.0050

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Manganese (Mn)		Mercury (Hg)		Molybdenum (Mo)		Nickel (Ni)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00010*	*0.00010*	*0.00000050*	*0.00000050*	*0.000050*	*0.000050*	*0.00050*	*0.00050*
Replicates										
Lake St. Martin	30-Aug-21	LSM4	0.00017	0.00725	*<0.00000050*	0.000000560	0.00262	0.00262	<0.00050	0.00064
		REP-1A	0.00026	0.00884	*<0.00000050*	0.000000670	0.00285	0.00254	0.00051	0.00091
		REP-1B	0.00024	0.00729	*<0.00000050*	0.000000590	0.00275	0.00247	0.00051	0.00063
		Mean	0.00022	0.00779	*<0.00000050*	0.000000607	0.00274	0.00254	<0.00050	0.00073
		SD	-	0.000907	-	0.000000057	0.000115	0.000075	-	-
		PRSD	-	12	-	9	4	3	-	-
Fairford River	30-Aug-21	FR2	<0.00010	0.00650	*<0.00000050*	0.000000600	0.00235	0.00245	<0.00050	0.00062
		REP-2A	<0.00010	0.00657	*<0.00000050*	0.000000600	0.00251	0.00234	<0.00050	0.00059
		REP-2B	<0.00010	0.00656	*<0.00000050*	0.000000580	0.00255	0.00230	<0.00050	0.00072
		Mean	<0.00010	0.00654	*<0.00000050*	0.000000593	0.00247	0.00236	<0.00050	0.00064
		SD	-	0.000038	-	0.000000012	0.000106	0.000078	-	-
		PRSD	-	1	-	2	4	3	-	-
Lake Manitoba	18-Oct-21	WHB1	<0.00010	0.00709	*<0.00000050*	0.000000710	0.00228	0.00226	<0.00050	0.00069
		REP-1A	<0.00010	0.00687	*<0.00000050*	0.000000720	0.00236	0.00218	<0.00050	0.00061
		REP-1B	<0.00010	0.00685	*<0.00000050*	0.000000670	0.00239	0.00221	<0.00050	0.00062
		Mean	<0.00010	0.00694	*<0.00000050*	0.000000700	0.00234	0.00222	<0.00050	0.00064
		SD	-	0.000133	-	0.000000026	0.000057	0.000040	-	-
		PRSD	-	2	-	4	2	2	-	-
Fairford River	19-Oct-21	FR2	<0.00010	0.00712	*<0.00000050*	0.000000770	0.00250	0.00239	<0.00050	0.00067
		REP-2A	<0.00010	0.00703	*<0.00000050*	0.000000710	0.00255	0.00233	<0.00050	0.00064
		REP-2B	0.00010	0.00742	*<0.00000050*	0.000000690	0.00249	0.00231	<0.00050	0.00069
		Mean	<0.00010	0.00719	*<0.00000050*	0.000000723	0.00251	0.00234	<0.00050	0.00067
		SD	-	0.000204	-	0.000000042	0.000032	0.000042	-	-
		PRSD	-	3	-	6	1	2	-	-
Blanks										
Field Blank	30-Aug-21	WB-1A	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	30-Aug-21	WB-2A	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	17-Oct-21	WB-1B	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	20-Oct-21	WB-2A	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
Trip Blank	30-Aug-21	WB-1B	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	30-Aug-21	WB-2B	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	17-Oct-21	WB-1A	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050
	20-Oct-21	WB-2B	<0.00010	<0.00010	*<0.00000050*	*<0.00000050*	<0.000050	<0.000050	<0.00050	<0.00050

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Potassium (K)		Rubidium (Rb)		Selenium (Se)		Silicon (Si)		Silver (Ag)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.050*	*0.050*	*0.00020*	*0.00020*	*0.000050*	*0.000050*	*0.050*	*0.10*	*0.000010*	*0.000010*
Replicates												
Lake St. Martin	30-Aug-21	LSM4	11.0	9.75	0.00418	0.00410	0.000081	0.000097	2.00	2.51	<0.000010	<0.000010
		REP-1A	11.0	10.0	0.00403	0.00413	0.000109	0.000084	2.02	2.29	<0.000010	*0.000066*
		REP-1B	10.9	10.3	0.00431	0.00427	0.000091	0.000064	2.04	2.48	<0.000010	<0.000010
		Mean	11.0	10.0	0.00417	0.00417	0.000094	0.000082	2.02	2.43	<0.000010	0.000025
		SD	0.06	0.28	0.000140	0.000091	-	-	0.020	0.119	-	-
		PRSD	1	3	3	2	-	-	1	5	-	-
Fairford River	30-Aug-21	FR2	11.6	9.99	0.00422	0.00419	0.000124	0.000073	3.28	3.48	<0.000010	<0.000010
		REP-2A	11.5	9.78	0.00444	0.00409	0.000058	0.000063	3.27	3.39	<0.000010	<0.000010
		REP-2B	11.3	9.66	0.00408	0.00405	0.000059	0.000080	3.21	3.32	<0.000010	<0.000010
		Mean	11.5	9.81	0.00425	0.00411	0.000080	0.000072	3.25	3.40	<0.000010	<0.000010
		SD	0.15	0.17	0.000181	0.000072	-	-	0.038	0.080	-	-
		PRSD	1	2	4	2	-	-	1	2	-	-
Lake Manitoba	18-Oct-21	WHB1	11.3	11.2	0.00404	0.00425	0.000078	0.000105	3.59	3.99	<0.000010	<0.000010
		REP-1A	12.1	10.8	0.00446	0.00387	0.000054	0.000146	3.75	3.85	<0.000010	<0.000010
		REP-1B	11.9	10.7	0.00442	0.00411	0.000063	0.000111	3.82	3.88	<0.000010	<0.000010
		Mean	11.8	10.9	0.00431	0.00408	0.000065	0.000121	3.72	3.91	<0.000010	<0.000010
		SD	0.42	0.26	0.000232	0.000192	-	-	0.118	0.074	-	-
		PRSD	4	2	5	5	-	-	3	2	-	-
Fairford River	19-Oct-21	FR2	11.0	10.8	0.00431	0.00416	0.000071	0.000088	3.64	3.47	<0.000010	<0.000010
		REP-2A	11.4	10.7	0.00448	0.00405	0.000066	0.000068	3.66	3.56	<0.000010	<0.000010
		REP-2B	11.3	10.4	0.00460	0.00424	0.000079	0.000070	3.66	3.62	<0.000010	<0.000010
		Mean	11.2	10.6	0.00446	0.00415	0.000072	0.000075	3.65	3.55	<0.000010	<0.000010
		SD	0.21	0.21	0.000146	0.000095	-	-	0.012	0.075	-	-
		PRSD	2	2	3	2	-	-	0	2	-	-
Blanks												
Field Blank	30-Aug-21	WB-1A	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	30-Aug-21	WB-2A	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	17-Oct-21	WB-1B	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	20-Oct-21	WB-2A	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
Trip Blank	30-Aug-21	WB-1B	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	30-Aug-21	WB-2B	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	17-Oct-21	WB-1A	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010
	20-Oct-21	WB-2B	<0.050	<0.050	<0.00020	<0.00020	<0.000050	<0.000050	<0.050	<0.10	<0.000010	<0.000010

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Sodium (Na)		Strontium (Sr)		Sulphate (SO4)	Sulphur (S)	
			Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total
Analytical DL			*0.050*	*0.050*	*0.00010*	*0.00020*	*0.30/0.60*	*0.50*	*0.50*
Replicates									
Lake St. Martin	30-Aug-21	LSM4	150	140	0.277	0.243	92.7	33.2	35.7
		REP-1A	160	144	0.282	0.244	94.8	33.6	36.8
		REP-1B	157	146	0.266	0.239	94.8	32.8	36.4
		Mean	156	143	0.275	0.242	94.1	33.2	36.3
		SD	5.1	3.1	0.0082	0.0026	1.21	0.40	0.56
		PRSD	3	2	3	1	1	1	2
Fairford River	30-Aug-21	FR2	155	145	0.309	0.280	95.6	33.7	36.1
		REP-2A	164	141	0.320	0.264	95.3	33.5	36.0
		REP-2B	160	141	0.306	0.263	95.8	33.1	34.7
		Mean	160	142	0.312	0.269	95.6	33.4	35.6
		SD	4.5	2.3	0.0074	0.0095	0.25	0.31	0.78
		PRSD	3	2	2	4	0	1	2
Lake Manitoba	18-Oct-21	WHB1	150	160	0.288	0.279	93.1	32.8	36.6
		REP-1A	160	158	0.292	0.275	94.3	33.8	35.5
		REP-1B	159	159	0.302	0.275	93.9	35.2	35.8
		Mean	156	159	0.294	0.276	93.8	33.9	36.0
		SD	5.5	1.0	0.0072	0.0023	0.61	1.21	0.57
		PRSD	4	1	2	1	1	4	2
Fairford River	19-Oct-21	FR2	155	151	0.304	0.282	93.1	33.9	33.3
		REP-2A	155	159	0.311	0.291	93.3	34.0	36.0
		REP-2B	157	153	0.300	0.281	93.2	34.0	35.8
		Mean	156	154	0.305	0.285	93.2	34.0	35.0
		SD	1.2	4.2	0.0056	0.0055	0.10	0.06	1.50
		PRSD	1	3	2	2	0	0	4
Blanks									
Field Blank	30-Aug-21	WB-1A	0.061	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
	30-Aug-21	WB-2A	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
	17-Oct-21	WB-1B	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	0.51
	20-Oct-21	WB-2A	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
Trip Blank	30-Aug-21	WB-1B	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
	30-Aug-21	WB-2B	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
	17-Oct-21	WB-1A	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50
	20-Oct-21	WB-2B	<0.050	<0.050	<0.00010	<0.00020	<0.30	<0.50	<0.50

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Tellurium (Te)		Thallium (Tl)		Thorium (Th)		Tin (Sn)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00020*	*0.00020*	*0.000010*	*0.000010*	*0.00010*	*0.00010*	*0.00010*	*0.00010*
Replicates										
Lake St. Martin	30-Aug-21	LSM4	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-1A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-1B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		Mean	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		SD	-	-	-	-	-	-	-	-
		PRSD	-	-	-	-	-	-	-	-
Fairford River	30-Aug-21	FR2	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		Mean	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		SD	-	-	-	-	-	-	-	-
		PRSD	-	-	-	-	-	-	-	-
Lake Manitoba	18-Oct-21	WHB1	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-1A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-1B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		Mean	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		SD	-	-	-	-	-	-	-	-
		PRSD	-	-	-	-	-	-	-	-
Fairford River	19-Oct-21	FR2	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		REP-2B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		Mean	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
		SD	-	-	-	-	-	-	-	-
		PRSD	-	-	-	-	-	-	-	-
Blanks										
Field Blank	30-Aug-21	WB-1A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	30-Aug-21	WB-2A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	17-Oct-21	WB-1B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	20-Oct-21	WB-2A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
Trip Blank	30-Aug-21	WB-1B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	30-Aug-21	WB-2B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	17-Oct-21	WB-1A	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010
	20-Oct-21	WB-2B	<0.00020	<0.00020	<0.000010	<0.000010	<0.00010	<0.00010	<0.00010	<0.00010

Table A2-2. Continued.

Waterbody	Sampling Date	Sample ID	Titanium (Ti)		Tungsten (W)		Uranium (U)		Zinc (Zn)		Zirconium (Zr)	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Analytical DL			*0.00030*	*0.00030*	*0.00010*	*0.00010*	*0.000010*	*0.000010*	*0.0010*	*0.0030*	*0.00020*	*0.00020*
Replicates												
Lake St. Martin	30-Aug-21	LSM4	<0.00030	0.00272	<0.00010	<0.00010	0.00168	0.00180	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1A	<0.00030	0.00297	<0.00010	<0.00010	0.00181	0.00179	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1B	<0.00030	0.00295	<0.00010	<0.00010	0.00176	0.00186	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	<0.00030	0.00288	<0.00010	<0.00010	0.00175	0.00182	<0.0010	<0.0030	<0.00020	<0.00020
		SD	-	0.000139	-	-	0.000066	0.000038	-	-	-	-
		PRSD	-	5	-	-	4	2	-	-	-	-
Fairford River	30-Aug-21	FR2	<0.00030	0.00231	<0.00010	<0.00010	0.00150	0.00157	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2A	<0.00030	0.00155	<0.00010	<0.00010	0.00161	0.00156	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2B	<0.00030	0.00209	<0.00010	<0.00010	0.00162	0.00156	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	<0.00030	0.00198	<0.00010	<0.00010	0.00158	0.00156	<0.0010	<0.0030	<0.00020	<0.00020
		SD	-	0.000391	-	-	0.000067	0.000006	-	-	-	-
		PRSD	-	**20**	-	-	4	0	-	-	-	-
Lake Manitoba	18-Oct-21	WHB1	<0.00030	0.00221	<0.00010	<0.00010	0.00170	0.00164	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1A	<0.00030	0.00115	<0.00010	<0.00010	0.00173	0.00155	<0.0010	<0.0030	<0.00020	<0.00020
		REP-1B	<0.00030	0.00100	<0.00010	<0.00010	0.00183	0.00150	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	<0.00030	0.00145	<0.00010	<0.00010	0.00175	0.00156	<0.0010	<0.0030	<0.00020	<0.00020
		SD	-	-	-	-	0.000068	0.000071	-	-	-	-
		PRSD	-	-	-	-	4	5	-	-	-	-
Fairford River	19-Oct-21	FR2	<0.00030	0.00168	<0.00010	<0.00010	0.00188	0.00170	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2A	<0.00030	0.00058	<0.00010	<0.00010	0.00188	0.00158	<0.0010	<0.0030	<0.00020	<0.00020
		REP-2B	<0.00030	0.00388	<0.00010	<0.00010	0.00189	0.00173	<0.0010	<0.0030	<0.00020	<0.00020
		Mean	<0.00030	0.00205	<0.00010	<0.00010	0.00188	0.00167	<0.0010	<0.0030	<0.00020	<0.00020
		SD	-	0.00168	-	-	0.000006	0.000079	-	-	-	-
		PRSD	-	-	-	-	0	5	-	-	-	-
Blanks												
Field Blank	30-Aug-21	WB-1A	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	30-Aug-21	WB-2A	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	17-Oct-21	WB-1B	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	20-Oct-21	WB-2A	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
Trip Blank	30-Aug-21	WB - 1B	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	30-Aug-21	WB - 2B	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	17-Oct-21	WB-1A	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020
	20-Oct-21	WB-2B	<0.00030	<0.00030	<0.00010	<0.00010	<0.000010	<0.000010	<0.0010	<0.0030	<0.00020	<0.00020

APPENDIX 3. RESULTS FOR ADDITIONAL PARAMETERS

Table A3-1. Laboratory results for additional parameters measured at selected sites in late-August/September 2021.

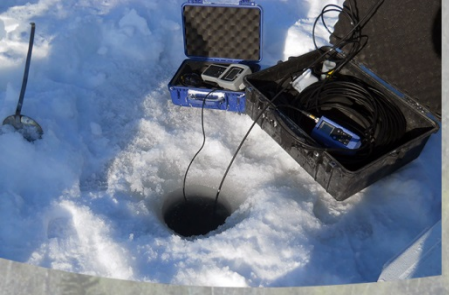
Parameter	Units	DL	BC-LSM L2633060-1 29-Aug-21	FR1 L2633558-9 30-Aug-21	DR-A L2634301-8 31-Aug-21
Escherichia coli	MPN/100mL	1	152	14	49
Microcystin	µg/L	0.20	<0.20	<0.20	<0.20
Cyanobacteria cell count					
Anabaena (Cyanophyceae)	cells/mL	1	-	130	10
Aphanocapsa (Cyanophyceae)	cells/mL	1	-	69300	59400
Aphanothece (Cyanophyceae)	cells/mL	1	-	2480	-
Chroococcus (Cyanophyceae)	cells/mL	1	-	396	12
Gomphosphaeria (Cyanophyceae)	cells/mL	1	-	-	500
Merismopedia (Cyanophyceae)	cells/mL	1	-	25300	125000
Microcystis (Cyanophyceae)	cells/mL	1	-	-	150
Planktolyngbya (Cyanophyceae)	cells/mL	1	-	53500	16800
Pseudanabaena (Cyanophyceae)	cells/mL	1	60	3960	-
Total cyanobacterial cell count	cells/mL	1	60	155000	202000
Hydrocarbons					
Benzene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
Ethyl benzene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
Toluene	mg/L	0.0010	<0.0010	<0.0010	<0.0010
o-Xylene	mg/L	0.00050	<0.00050	<0.00050	<0.00050
m+p-Xylenes	mg/L	0.00040	<0.00040	<0.00040	<0.00040
Xylenes (Total)	mg/L	0.00064	<0.00064	<0.00064	<0.00064
F1 (C6-C10)	mg/L	0.10	<0.10	<0.10	<0.10
F1-BTEX	mg/L	0.10	<0.10	<0.10	<0.10
F2-Naphth	mg/L	0.10	<0.10	<0.10	<0.10
F2 (C10-C16)	mg/L	0.100	<100	<100	<100
F3-PAH	mg/L	0.25	<0.25	<0.25	<0.25
F3 (C16-C34)	mg/L	0.250	<250	<250	<250
F4 (C34-C50)	mg/L	0.250	<250	<250	<250
Total Hydrocarbons (C6-C50)	mg/L	0.38	<0.38	<0.38	<0.38
Acenaphthene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Acenaphthylene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Acridine	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Anthracene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)anthracene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)pyrene	mg/L	0.0000050	<0.0000050	<0.0000050	<0.0000050
Benzo(b&j)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(g,h,i)perylene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Benzo(k)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010

Table A3-1. Continued.

Parameter	Units	DL	BC-LSM L2633060-1 29-Aug-21	FR1 L2633558-9 30-Aug-21	DR-A L2634301-8 31-Aug-21
Benzo(b&j)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Benzo(g,h,i)perylene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Benzo(k)fluoranthene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Chrysene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Dibenzo(a,h)anthracene	mg/L	0.0000050	<0.0000050	<0.0000050	<0.0000050
Fluoranthene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Fluorene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Indeno(1,2,3-cd)pyrene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
1-Methyl Naphthalene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
2-Methyl Naphthalene	mg/L	0.000020	<0.000020	<0.000020	<0.000020
Naphthalene	mg/L	0.000050	<0.000050	<0.000050	<0.000050
Phenanthrene	mg/L	0.000050	<0.000050	<0.000050	<0.000050
Pyrene	mg/L	0.000010	<0.000010	<0.000010	<0.000010
Quinoline	mg/L	0.000020	<0.000020	<0.000020	<0.000020
B(a)P Total Potency Equivalent	mg/L	0.000030	<0.000030	<0.000030	<0.000030
Pesticides					
Aldrin	µg/L	0.0080	<0.0080	<0.0080	<0.0080
alpha-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
beta-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
gamma-hexachlorocyclohexane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
delta-BHC	µg/L	0.0080	<0.0080	<0.0080	<0.0080
a-chlordane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
g-chlordane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
o,p-DDD	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDD	µg/L	0.0040	<0.0040	<0.0040	<0.0040
o,p-DDE	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDE	µg/L	0.0040	<0.0040	<0.0040	<0.0040
op-DDT	µg/L	0.0040	<0.0040	<0.0040	<0.0040
pp-DDT	µg/L	0.0040	<0.0040	<0.0040	<0.0040
Dieldrin	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Endosulfan I	µg/L	0.0070	<0.0070	<0.0070	<0.0070
Endosulfan II	µg/L	0.0070	<0.0070	<0.0070	<0.0070
Endosulfan Sulfate	µg/L	0.0070	<0.0070	<0.0070	<0.0070
Endrin	µg/L	0.010	<0.010	<0.010	<0.010
Endrin Aldehyde	µg/L	0.010	<0.010	<0.010	<0.010

Table A3-1. Continued.

Parameter	Units	DL	BC-LSM L2633060-1 29-Aug-21	FR1 L2633558-9 30-Aug-21	DR-A L2634301-8 31-Aug-21
Heptachlor	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Heptachlor Epoxide	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Hexachlorobenzene	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Hexachlorobutadiene	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Hexachloroethane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Methoxychlor	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Mirex	µg/L	0.0080	<0.0080	<0.0080	<0.0080
trans-Nonachlor	µg/L	0.010	<0.010	<0.010	<0.010
Oxychlordane	µg/L	0.0080	<0.0080	<0.0080	<0.0080
Pentachloronitrobenzene	µg/L	0.010	<0.010	<0.010	<0.010
AMPA	µg/L	0.50	<0.50	<0.50	<0.50
Bromoxynil	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Clopyralid	mg/L	0.00010	<0.00010	<0.00010	<0.00010
2,4-D	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Dicamba	mg/L	0.00010	<0.00010	<0.00010	<0.00010
2,4-DB	mg/L	0.00010	<0.00010	<0.00010	<0.00010
2,4-DP	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Dinoseb	mg/L	0.00010	<0.00010	<0.00010	<0.00010
MCPA	mg/L	0.00010	<0.00010	<0.00010	<0.00010
MCPB	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Mecoprop	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Picloram	mg/L	0.00010	<0.00010	<0.00010	<0.00010
2,4,5-T	mg/L	0.00010	<0.00010	<0.00010	<0.00010
2,4,5-TP	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Triclopyr	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Atrazine	µg/L	0.10	<0.10	<0.10	<0.10
Atrazine+N-Dealkylated Metabolites	µg/L	0.20	<0.20	<0.20	<0.20
Ethalfluralin	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Atrazine Desethyl	µg/L	0.10	<0.10	<0.10	<0.10
Fluazifop-p-butyl	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Glyphosate	µg/L	0.20	<0.20	<0.20	<0.20
Diclofop-methyl	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Triallate	mg/L	0.00010	<0.00010	<0.00010	<0.00010
Trifluralin	mg/L	0.00010	<0.00010	<0.00010	<0.00010











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Lake St. Martin Emergency Relief Channel
Monitoring and Development of Habitat Compensation
Volume 3 - Water Quality

REPORT

Prepared for Manitoba Infrastructure and Transportation · November 2016
North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4
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Lake St. Martin Emergency Relief Channel
Monitoring and Development of Habitat Compensation

2011-2015

Volume 3 – Water Quality

Draft

A Draft Report Prepared for

Manitoba Infrastructure and Transportation

By:

North/South Consultants Inc.
and
KGS Group

November 2016

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EXECUTIVE SUMMARY

Widespread record flooding throughout southern Manitoba during 2011 led to water levels in Lake Manitoba and Lake St. Martin that were several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin. As part of emergency relief measures, the Province of Manitoba, through Manitoba Infrastructure and Transportation (MIT), constructed the Lake St. Martin Emergency Outlet Channel System, which is comprised of two emergency channels. The Reach 1 Emergency Outlet Channel (Reach 1) begins at the northeast shore of the north basin of Lake St. Martin and extends approximately 6 km to the bog area surrounding Big Buffalo Lake. Water from Reach 1 inundates the bog area and then follows the natural Buffalo Creek Drainage System until flowing into the lower Dauphin River and ultimately into Sturgeon Bay. Water began to flow through Reach 1 on November 1, 2011 and the channel was operated until November 21, 2012.

Computer models of potential water levels at the mouth of the Dauphin River indicated that there was a significant risk of major flooding of the Dauphin River communities in spring 2012. Consequently, a second channel (Reach 3 Emergency Channel; Reach 3) was constructed during winter 2012. Reach 3 was designed to divert excess flow from Reach 1 and Buffalo Creek and away from the lower Dauphin River. It was determined that operation of Reach 3 prior to the spring break up, in combination with the construction of dikes along the banks of the Dauphin River, would be likely to substantially reduce the risk of flooding for the Dauphin River communities.

Due to extremely mild winter conditions in 2011/2012, ice effects on both Reach 1 and the Dauphin River were much less severe than forecasted. With the continuous extreme mild conditions, updated flood forecasts indicated that the estimated discharge in the lower Dauphin River during ice break up would be well below the capacity of the Dauphin River community dikes. Consequently, the proposed operation of Reach 3 was no longer required.

Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, prompting MIT to re-open Reach 1 at the beginning of July 2014. The channel was re-opened in two stages. The first occurred during July 2014 when approximately 35 m of the berm closing Reach 1 was removed. The second stage occurred in November 2014, when an additional 10 m of the closure berm were removed to allow additional flow into the channel. Flow into Reach 1 was halted in late August 2015.

Collectively, construction and operation of Reach 1, as well as construction of Reach 3, are referred to hereafter as “the Project”.

Concurrent with construction of Reach 1 in summer 2011, MIT initiated studies and monitoring to help describe and assess environmental effects arising from the Project. These included studies to document changes to the physical environment (*e.g.*, measurement of water flow through Reach 1 and the

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Dauphin River; sedimentation and erosion studies) and possible subsequent effects to the biological environment (*e.g.*, possible change to fish community in Buffalo Creek). Environmental studies began in August 2011 and continued until September 2015.

This report provides an overview of the water quality monitoring programs including a summary of Project related effects to water quality in Lake St. Martin, the Buffalo Creek watershed, the lower Dauphin River, and Sturgeon Bay (Lake Winnipeg). Water quality is also compared to: the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOGs) for the Protection of Aquatic Life (PAL) and drinking water; and the federal Canadian Council of Ministers of the Environment (CCME) guidelines for PAL. This report also compiles all raw data collected for the Project from September 2011 to September 2015.

Lake St. Martin

Sites located in Lake St. Martin upstream of the Project exhibited natural variability in water quality parameters over the course of the monitoring program. Although conditions fluctuated seasonally and between years, there was no linkage between operation of Reach 1 and water quality in Lake St. Martin, with the following exception:

- During dredging in October 2011, total suspended solids (TSS) in the vicinity of the Reach 1 inlet exceeded the 30 day Manitoba water quality objectives / CCME long-term guideline for PAL (average of 5 mg/L above background), and periodically exceeded the 1-day Manitoba PAL objective/CCME short-term PAL guideline (25 mg/L above background).

Reach 1 and the Buffalo Creek Watershed

The water quality of the Buffalo Creek watershed changed during each Project phase, reflecting the influence of the chemistry of water from Lake St. Martin as well as Project activities, as follows:

- Routine water quality parameters (conductivity [i.e., specific conductance], total dissolved solids [TDS], pH, hardness, and colour) varied in part as a result of the input of water from Lake St. Martin:
    - During the two periods when Reach 1 was operational (November 2011-November 2012, July 2014-August 2015), conductivity, TDS, pH, and hardness increased (relative to conditions measured during flood conditions in 2011), and colour decreased.
    - While Reach 1 was closed from November 2012 to July 2014, conductivity, TDS, hardness, and pH declined, though conductivity and TDS levels remained above those measured during the 2011 Flood. These parameters were not measured after closure in August 2015.

- Dissolved oxygen (DO) generally met the Manitoba objectives for the protection of cool and cold-water aquatic life, though it declined below the objectives at various points during the monitoring program:

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  - At the onset of 2014/2015 Operation, DO temporarily (for 1-10 days depending upon location) decreased below the Manitoba/CCME PALs throughout the watershed (this was not observed at the onset of 2011/2012 Operation).
  - Concentrations measured in August 2015 at the onset of closure also temporarily decreased below the PALs.
  - DO concentrations below the Manitoba guidelines and CCME objectives were also observed prior to Reach 1 operation. However, baseline data are too limited to determine whether declines observed during the Project were as a result of the Project or natural conditions.

- TSS concentrations were affected at the onset of both Project operation and closure periods:
  - At the onset of the 2011/2012 and 2014/2015 Operation periods, TSS concentrations in the Buffalo Creek watershed increased 5 to 30 times compared to the 2011 flood. TSS increases at the downstream end of Buffalo Creek were three times greater in 2014 than in 2011.
  - During closure after November 2012, spring TSS was approximately four times higher than pre-Project levels; concentrations subsequently declined but remained higher than baseline at the downstream end of Buffalo Creek. A similar increase in TSS was observed following closure activities in August 2015, and levels remained elevated at the end of the monitoring program in September 2015.
  - The increases in TSS described above resulted in exceedances of both the short and long term MSWQSOGs.

- Nutrients and chlorophyll *a* fluctuated during the Project, but the limited baseline data do not allow Project effects to be distinguished from natural variation:
  - At the onset of operation in 2011 and 2014, total phosphorus (TP) in Buffalo Creek increased above the MWQSOGs narrative guideline for streams (0.050 mg/L), but returned to pre-Project concentrations within a week in both years.
  - In winter and spring 2012 following the closure of Reach 1, TP and total nitrogen (TN) increased beyond the concentrations measured during 2011/2012 Operation and pre-Project phases. Following the freshet, both nutrients returned to baseline in most of the watershed, but TP remained high at the downstream end of Buffalo Creek throughout 2013. In spring 2014, there was another spike in TP, and TP increased again immediately following closure in August 2015.
  - TP occasionally exceeded the narrative guideline for streams during closures from November 2012-July 2014 and after August 2015.
  - During closure, ammonia occasionally exceeded the CCME PAL guideline in Big Buffalo Lake.
  - Chlorophyll *a* concentrations in Buffalo Creek were consistently higher than baseline from spring 2012 to August 2015, though baseline data are limited. There are no MWQSOGs or CCME guidelines for chlorophyll *a*.

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- Concentrations of several metals and ions were affected by Project operation/closure, likely due to the influence of water from Lake St. Martin. However, due to limited baseline data, the extent of exceedance of guidelines under natural conditions is not known:
    - Several metals and major ions increased relative to baseline conditions in Buffalo Creek during operation in 2011/2012 and 2014/2015, including: arsenic, barium, boron, calcium, chloride, fluoride, magnesium, molybdenum, potassium, sodium, sulphate, and uranium. These metals all decreased during closure from November 2012-July 2014 to concentrations near pre-Project levels.
    - Copper increased during 2011/2012 Operation, but decreased during 2014/2015 Operation.
    - At the onset of 2014/2015 Operation there was a small increase in mercury and methylmercury in Buffalo Creek, but both returned to baseline by October 2014. Comparable data were not collected during the 2011/2012 Operation.
    - During operation in 2011/2012 and 2013/2014, chloride and fluoride exceeded the CCME PAL guidelines (120 and 0.12 mg/L, respectively) in the Buffalo Creek watershed. These guidelines were occasionally exceeded in Big Buffalo Lake during the closure from November 2012-July 2014, but not in Buffalo Creek.
    - During 2011/2012 Operation, selenium was frequently above the MWQSOGs/CCME PAL (0.001 mg/L) in the Buffalo Creek watershed.
    - During closure from November 2012-July 2014, iron frequently exceeded the PAL (0.3 mg/L), and chromium occasionally exceeded the CCME PAL (0.0089 mg/L) at the downstream end of Buffalo Creek.

Lower Dauphin River

Temporary changes in some water chemistry parameters in the lower Dauphin River were observed during Project operation and closure periods:

- No changes to routine water quality of the Dauphin River were observed that were attributable to the Project:
    - Conductivity, TDS, laboratory pH, true colour and hardness were similar in the Dauphin River upstream and downstream of Buffalo Creek during baseline, operation, and closure.
    - Although conductivity and TDS in the Dauphin River did not vary as a result of operation, conditions measured during each operation and closure period were lower than those recorded in October 2011.
- The Dauphin River was generally well-oxygenated and DO generally met the Manitoba objectives and CCME guidelines for the protection of cool and cold-water aquatic life, though it declined below the PALs at various points during the monitoring program:
    - A small decrease (<2 mg/L) in DO was observed downstream of Buffalo Creek during operation in 2015.
    - DO concentrations below the MWQSOGs objectives/CCME PAL guidelines were periodically observed both upstream and downstream of Buffalo Creek during both the

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open-water and ice cover seasons. Reductions below the guidelines were also observed historically in the river during the ice-cover period.

- TSS concentrations increased at various times during both operation and closure:
    - At the onset of operation in 2011 and 2014, TSS increased and a sediment plume was visible along the left shoreline. After approximately one month of operation in 2011 and two weeks of operation in 2014, TSS returned to background (i.e., similar to conditions observed concurrently upstream of Buffalo Creek).
    - During March of the 2014/2015 Operation, TSS was again elevated downstream of Buffalo Creek.
    - TSS increased along the Dauphin River left-hand bank downstream of Buffalo Creek in spring 2013 during closure.
    - At the onset of operation in both 2011 and 2014, TSS concentrations exceeded the MWQSOGs /CCME short-term PAL as far downstream as Sturgeon Bay.
    - TSS was also consistently above the MWQSOGs 30 day/CCME long-term PAL from 04-25 November 2011, 05-16 July 2014, 27 March 2015; and, along the left shoreline downstream of Buffalo Creek 01 May 2015 and 11 June 2015.

- Phosphorous concentrations increased at various points during monitoring but no other changes to nutrient or chlorophyll *a* concentrations can be attributed to Project-related activities:
    - Phosphorus concentrations between the confluence and Sturgeon Bay increased at the onset of operation in 2011 and 2014, in the spring of 2013, and in March of 2015.
    - At the onset of each operation period, TP exceeded the MWQSOGs narrative guidelines.

- There were no observed changes to most metals or major ions, with the exception of mercury and methylmercury, that can be attributed to the Project:
    - Mercury and methylmercury increased downstream of Buffalo Creek at the onset of 2014/2015 Operation. Comparable data were not collected during the 2011/2012 Operation.
    - Both mercury compounds remained well below the MWQSOGs/CCME PAL guidelines (26 and 4 ng/L, respectively) during 2014/2015 Operation.

Sturgeon Bay

Some changes in water quality parameters in Sturgeon Bay were observed during Project operation and closure periods:

- Routine water quality parameters were variable during operation and closure periods:
    - Conductivity and TDS concentrations in the water entering Sturgeon Bay from the Dauphin River were not affected by operation; however, the spatial extent of the influence of the Dauphin River outflow in Sturgeon Bay would have been altered as a result of changes to its discharge during the operation and closure of the Project.
    - During 2011/2012 Operation, conductivity and TDS at sites distant from the Dauphin River increased compared to conditions measured during the 2011 Flood.

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  - After closure in November 2012, conductivity and TDS at some sites distant from the Dauphin River remained higher compared to October 2011 while conductivity and TDS at sites closer to the Dauphin River were lower than measured during the 2011 Flood.
  - pH, colour, and hardness measured during operation and closure were generally similar to conditions measured in October 2011.
- No changes to DO were observed that can be attributed to the Project.
  - Sturgeon Bay was well-oxygenated during baseline, operation and closure.
  - DO was generally within PAL and objectives for cool and cold-water species; the exceptions occurred at two sites in March 2015.

- Project activities resulted in increases in TSS concentrations during operation periods:
  - During 2011/2012 Operation, TSS increased in spring 2012 near the mouth of the Dauphin River; however, data are not available at the onset of the period, so the duration and magnitude of effects is unknown.
  - At the onset of 2014/2015 Operation, TSS increased near the Dauphin River mouth and remained elevated for about a month.
  - No changes to TSS were observed during the closure from November 2012-July 2014 that can be attributed to the Project.

- Temporary increases in nutrient and chlorophyll *a* concentrations were observed:
  - In the spring of 2011/2012 Operation, nitrogen and phosphorus near the mouth of the Dauphin River increased above concentrations measured in October 2011.
  - No other changes to nutrient concentrations in Sturgeon Bay were observed that can be attributed to the Project.
  - Chlorophyll *a* concentrations near the Dauphin River were higher in spring 2012 and lower in October 2014, compared with the rest of Sturgeon Bay. At other times, chlorophyll *a* was generally similar throughout the bay. Baseline data are too limited to determine if changes to chlorophyll *a* concentrations occurred as a result of the Project.

- There were no observed changes to most metals or major ions, with the exception of mercury and methylmercury, that can be attributed to the Project:
  - During 2011/2012 Operation, methylmercury was more frequently detected and at higher concentrations near the Dauphin River than in the rest of Sturgeon Bay. Similarly, in March 2015, during 2014/2015 Operation, methylmercury was detected near the Dauphin River and Willow Point but not at other sites in Sturgeon Bay. However, concentrations were consistently well below the MWQSOGs/CCME PAL guideline (4 ng/L).

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1.0 INTRODUCTION

Widespread record flooding throughout southern Manitoba during 2011 (Figure 1) led to water levels in Lake Manitoba and Lake St. Martin that were several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin. As part of emergency relief measures, the Province of Manitoba, through Manitoba Infrastructure and Transportation (MIT), constructed the Lake St. Martin Emergency Outlet Channel (LSMEOC) System, which is comprised of two emergency channels (Figure 2). The Reach 1 Emergency Outlet Channel (Reach 1) begins at the northeast shore of the north basin of Lake St. Martin and extends approximately 6 km to the bog area surrounding Big Buffalo Lake. Water from Reach 1 inundates the bog area and then follows the natural Buffalo Creek Drainage System until flowing into the lower Dauphin River and ultimately into Sturgeon Bay (Figure 2). Water began to flow through Reach 1 on 01 November 2011 and the channel was operated until 21 November 2012.

Computer models of potential water levels at the mouth of the Dauphin River indicated that there was a significant risk of major flooding of the Dauphin River communities in spring 2012. This risk was due to the potential formation of frazil ice jams combined with unprecedented winter flows that resulted from the Fairford River Water Control Structure running at full capacity all winter. Consequently, a second channel (Reach 3 Emergency Channel; Reach 3) was constructed during winter 2011/2012. Reach 3 was designed to divert excess flow from Reach 1 and Buffalo Creek and away from the lower Dauphin River. Due to extremely mild winter conditions in 2011/2012, ice effects on both Reach 1 and the Dauphin River were much less severe than forecasted. Consequently, the proposed operation of Reach 3 was no longer required. Collectively, construction and operation of Reach 1, as well as construction of Reach 3, are referred to hereafter as “the Project”.

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Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, prompting MIT to re-open Reach 1 at the beginning of July 2014. Reach 1 remained in operation until August 2015.

Concurrent with construction of Reach 1 in summer 2011, MIT initiated studies and monitoring to help describe and assess environmental effects arising from the Project. These included studies to document changes to the physical environment (e.g., measurement of water flow through Reach 1 and the Dauphin River; sedimentation and erosion studies) and possible subsequent effects to the biological environment (e.g., possible change to fish community in Buffalo Creek). Environmental studies began in August 2011 and concluded in September 2015.

Aquatic environment monitoring for the Project included two main water quality monitoring programs: (1) a Regional Water Quality Monitoring Program (RWQMP), which collected water quality information from all major waterbodies and waterways within the study area that were affected by flooding; and, (2) water quality monitoring within the LSMEOC System. Water quality data gathered during the conduct of these programs are the major sources of information used in this report. Additionally, water quality

data collected by Manitoba Conservation and Water Stewardship (MCWS) are included in order to provide historical context and to supplement data collected by the RWQMP.

This report provides an overview of the water quality monitoring programs, including a summary of Project-related effects to water quality in Lake St. Martin, the Buffalo Creek watershed, the lower Dauphin River, and Sturgeon Bay. All water quality data collected for the Project from September 2011 to September 2015 are appended.

It should be noted that a detailed presentation of water quality effects was previously provided as a supporting volume for an Offsetting Plan to Fisheries and Oceans Canada, submitted in May 2015. This report builds upon that submission and incorporates data collected subsequent to May 2015.

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2.0 PROJECT DESCRIPTION AND STUDY AREA

2.1 PROJECT DESCRIPTION

Infrastructure constructed to support the emergency reduction of Lake Manitoba and Lake St. Martin water levels included two channels designed to increase flow from Lake St. Martin to Sturgeon Bay. The first channel, the Reach 1 Emergency Outlet Channel, was completed in fall 2011. The second channel, the Reach 3 Emergency Channel, was constructed during winter 2011/2012 but was not operated. Additional details pertinent to each of the channels are presented in the following sections.

2.1.1 Reach 1 Emergency Outlet Channel

As previously stated, Reach 1 was constructed to increase the flow of water from Lake St. Martin to Sturgeon Bay. The inlet to Reach 1 is located along the northeast shore of the Lake St. Martin north basin. The channel extends north east for approximately 6 km to a bog area surrounding Big Buffalo Lake. Drainage water from Reach 1 flowed through the bog area and Big Buffalo Lake into Buffalo Creek, and then flowed down Buffalo Creek to its confluence with the lower Dauphin River, approximately 4 km upstream of Sturgeon Bay.

The inlet of Reach 1 consisted of a fixed-level invert with a sill at an elevation of 243.1 m above sea level (mASL). The sill was designed to convey the desired flow of 142 m^3/s at 244.1 mASL and was 120 m in length, had a bottom width of 60 m, and 3:1 side slopes. At the onset of operation, flow through Reach 1 was estimated to be 255 m^3/s based on Lake St. Martin water level at that time.

2.1.2 Reach 3 Emergency Channel

Water level projections indicated that there was a substantial risk for major flooding in the Dauphin River communities in spring 2012 due to unprecedented flows along the Dauphin River downstream of Buffalo Creek and the increased potential for frazil ice jamming at the mouth of the Dauphin River. It was determined that the construction of an additional channel to divert Reach 1 flows away from the Dauphin River, and construction of dikes along the banks of the lower Dauphin River prior to spring break up was necessary to reduce the risk of flooding in the communities.

Following a review of configuration options, the Reach 3 Emergency Channel was constructed. Reach 3 originates at Buffalo Creek about 8 km downstream of Big Buffalo Lake (Figure 2), is approximately 6 km in length, and terminates in a lowland area 3 km inland of Sturgeon Bay. From the outlet of Reach 3, water would flow overland towards Sturgeon Bay, entering the bay through a proposed shoreline breach structure which was to be constructed through the beach ridge to the west of Willow Point.

It was expected that Reach 3 would only operate for a short period of time during the spring freshet in 2012 to limit the threat of flooding along the lower Dauphin River. However, an exceptionally mild winter in 2011/2012 allowed sufficient drainage from Lake Manitoba and Lake St. Martin to reduce water levels to a point where the risk of frazil ice jamming and flooding at Dauphin River communities became negligible. Consequently, Reach 3 was not operated.

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2.1.3 Project Schedule

Construction of Reach 1 was initiated in mid-July 2011. The channel was completed and water began to flow through it by November 01, 2011. Closure of Reach 1 was initiated on November 15, 2012. Closure operations included constructing a dike across the Reach 1 inlet at Lake St. Martin to prevent water from flowing into the channel. By November 21, construction had progressed to where no flow was entering Reach 1 (Table 1).

Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, prompting MIT to re-open Reach 1 at the beginning of July 2014 (Table 1). The channel was re-opened in two stages. The first occurred during in July 2014 when approximately 35 m of the berm closing Reach 1 was removed. The second stage occurred in November 2014, when an additional 10 m of the closure berm were removed to allow additional flow into the channel. Flow into Reach 1 was halted in late August 2015.

2.2 STUDY AREA

The emphasis of aquatic monitoring is to determine what effects construction and operation of Reach 1 may have had on waterways downstream of the channel. These include the Buffalo Creek watershed, the lower Dauphin River, and Sturgeon Bay. However, these waterways are also affected by conditions occurring upstream of Reach 1 and, in some instances, fish move between areas upstream and downstream of Reach 1. Consequently, some components of the aquatic monitoring program (water quality monitoring and fisheries investigations) include waterways upstream of Reach 1.

Local hydrology is affected by water flow from across the province. The main water inflows into Lake Manitoba are from the Whitemud River, the Waterhen River (including Lake Winnipegosis and Dauphin Lake), and the Portage Diversion, which routes excess flows from the Assiniboine River into the south end of Lake Manitoba (Figure 1). Water flows out of Lake Manitoba through the Fairford River and Lake Pineimuta into Lake St. Martin, and then through the Dauphin River to Sturgeon Bay.

The Buffalo Creek watershed is situated between Lake St. Martin to the south and the Dauphin River and Sturgeon Bay to the north. Prior to operation of Reach 1, the watershed was isolated and did not receive water from other waterways; all flow was due to local run off. The headwaters of the watershed are comprised of a bog complex including Big Buffalo Lake (0.55 km^2) and several other ponds. Buffalo Creek originates in Big Buffalo Lake and flows through the bog complex before entering into a more defined creek channel with greater gradient and greater habitat diversity. The creek discharges into the Dauphin River approximately 4 km upstream of Sturgeon Bay.

Additional descriptions of the biophysical environments and flow regulation on Lake Manitoba, Fairford River, Lake Pineimuta, Lake St. Martin, Dauphin River and Sturgeon Bay are provided in North/South Consultants Inc. (NSC; 2013).

For the purpose of this report, monitoring data were grouped, as follows:

- Upstream areas, including the Fairford River and Lake St. Martin;

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- The Buffalo Creek watershed, including Reach 1, Big Buffalo Lake, and Buffalo Creek;
- The Dauphin River, including areas upstream and downstream of Buffalo Creek; and,
- Sturgeon Bay.

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Table 1. Timing of Reach 1 Construction and Operation milestones.

Project Component and Phase	Date	Comments
Construction		
Site Preparation	• Initiated in mid- July 2011	-
Channel Construction	• Initiated late August 2011; • Completed 01 November 2011	-
2011/2012 Operation		
	• 01 November 2011 - 21 November 2012	• Closure activities initiated on 15 November; and, • Flow into Reach 1 halted 21 November.
2011/2012 Closure		
	• 22 November 2012 - 04 July 2014	
2014/2015 Operation		
Stage 1 Opening	• 02-06 July 2014	• Flow into Reach 1 began on 04 July; • Construction halted on 06 July; and, • Opening of approximately 35 m excavated.
Stage 2 Opening	• 14-17 November 2014	• Additional 10 m excavated; and, • Total opening width approximately 45 m.
2014/2015 Closure		
	• 13-23 August 2015	• Closure activities initiated on 13 August; • inlet opening was infilled with rock over the next several days; and, • all flow into Reach 1 stopped by 20 August.

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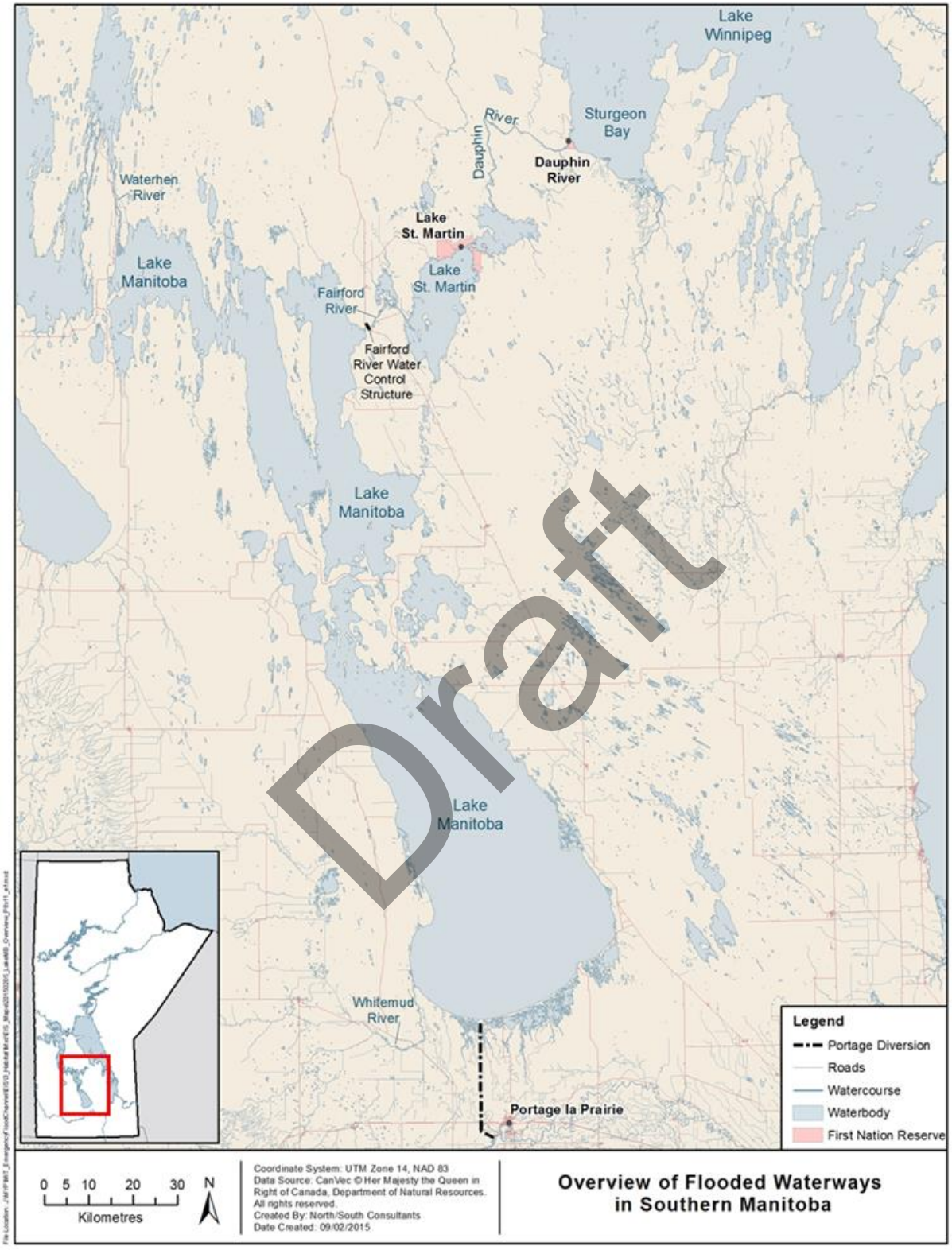


Figure 1. The location of major waterbodies and waterways affected by flooding in southern Manitoba during spring 2011.

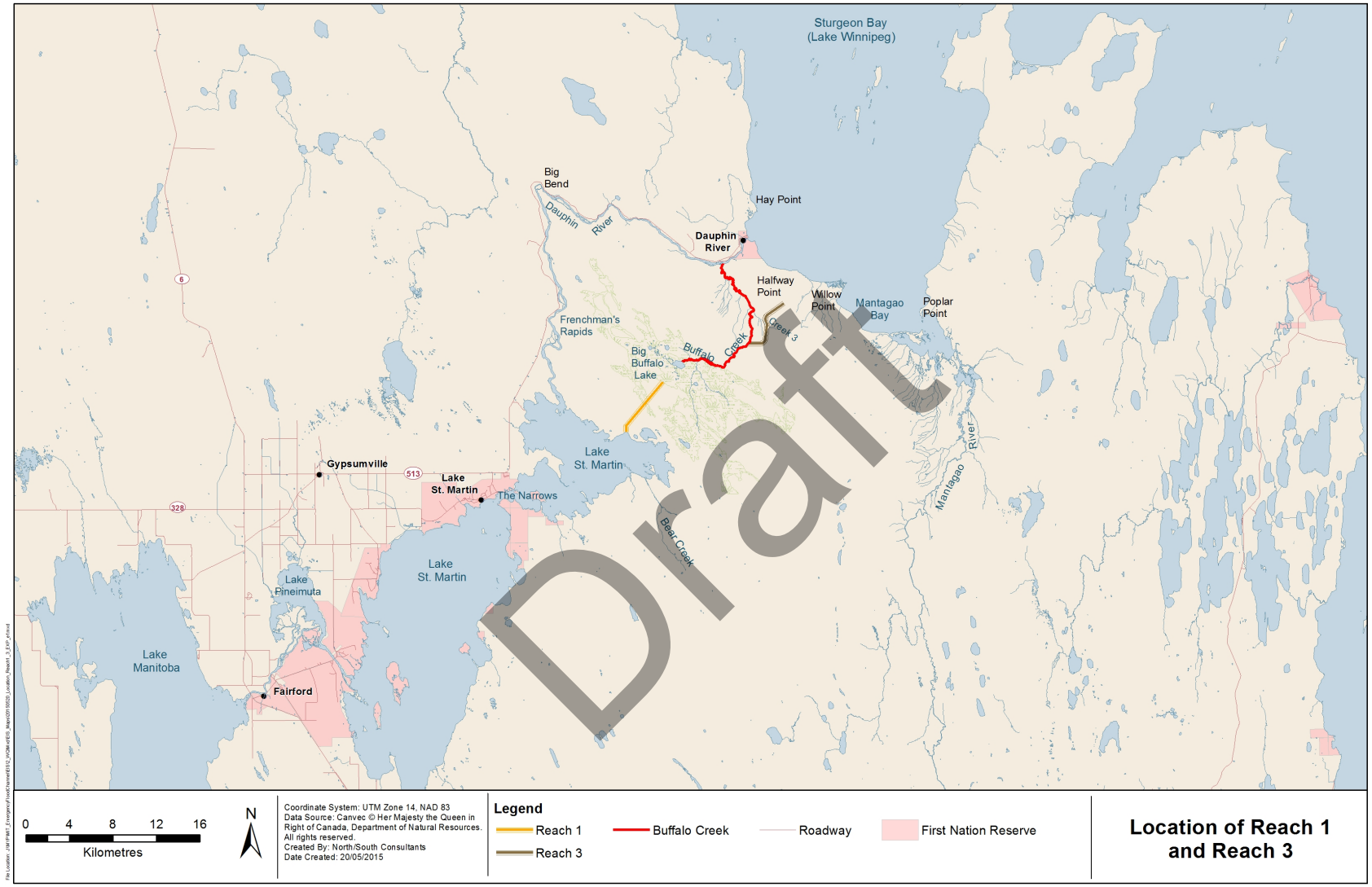


Figure 2. Location of the Reach 1 Emergency Outlet Channel, the Reach 3 Emergency Channel, and the Buffalo Creek watershed in relation to Lake St. Martin, the Dauphin River and Sturgeon Bay.

3.0 METHODS

Data collection and analytical methods are presented in the following sections.

3.1 LSMEOC MONITORING PROGRAM

LSMEOC monitoring was initiated during the early construction of Reach 1 and provided additional and targeted temporal and spatial water quality monitoring in Reach 1 and the Buffalo Creek watershed. This program continued until September 2015. Waterbodies sampled included Lake St. Martin, Reach 1, the Buffalo Creek watershed and the lower Dauphin River; details on sampling site locations are provided in Figure 3. This program included special consideration of total suspended solids (TSS) and dissolved oxygen (DO) to determine potential changes due to project activities. Other parameters analyzed included nutrients, mercury, and petroleum hydrocarbons. A complete list of laboratory analysed parameters is provided in Table 2. *In situ* measurements of water quality parameters including turbidity, DO, temperature, pH, and specific conductance were also collected. Sampling was typically more frequent than the RWQMP but varied with Project phase; a list of sampling dates and parameters measured is provided in Table 3.

3.1.1 Sampling Sites

Sampling sites were added or removed as appropriate for each Project phase; however, in general, sampling was conducted at 12 sites within the LSMEOC system as follows:

- Lake St. Martin – one of two sites, including one site near the centre of the north basin (LSM1), and one site near the Reach 1 inlet (LSM2);
- Reach 1 – three sites, including one site at the upstream end of the channel (EC1), one at the downstream end of the channel (EC2), and one downstream of the channel where the water entered the wetland area surrounding Big Buffalo Lake (EC3);
- Buffalo Creek – five sites, including one site at the upstream most end of the creek (BC1), one site near the upstream end of the creek (BC2), one site downstream of the proposed entrance to Reach 3 (BC4), one site downstream of Creek 3 (BC5), and one site at the mouth of the creek (BC3); and,
- Dauphin River – three sites, one site upstream of the confluence of Buffalo Creek, one site immediately downstream of the confluence of Buffalo Creek, and one site in the mouth of the Dauphin River upstream of Sturgeon Bay.

Additionally, two sites in Lake St. Martin near the Reach 1 inlet (LSM03 and LSM04) were monitored for TSS and turbidity during the construction phase of the Project; one site was sampled in Big Buffalo Lake (BBL) in 2013 and 2014; and, water samples for analysis of TSS and turbidity were also collected at the turbidity monitoring station in Buffalo Creek (BC-TM).

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3.1.2 Sampling Frequency

In general, sampling frequency changed in response to Project phase as follows:

- Baseline monitoring was approximately every two weeks;
- Construction monitoring was almost daily from 05 October to 07 November 2011;
- During operation, sampling was approximately monthly;
- During closure, sampling was conducted seasonally; and,
- When it was expected that there would be an increase in sediment transport (e.g., channel opening, spring freshet) more frequent (e.g., daily, every 2-3 days, or weekly, as appropriate) sampling occurred.

3.1.3 Sampling Methods

In situ water quality data was measured during each sample event at each sample site using a handheld multi-meter (YSI or Horiba). *In situ* turbidity was also measured during each sampling event using a handheld Oakton turbidity meter. The handheld multi-meter was calibrated prior to each sample event to maximize accuracy. However, these probes do not always function properly when operated under freezing conditions. On several occasions during the winter months, the probe froze and/or became encased in ice and it was not possible to complete *in situ* data collections. In 2011, samples were collected from the water's edge, whereas in 2012, 2013, and 2014 most samples were collected by a device lowered from a helicopter. Exceptions included: winter sampling when all sites were accessed by snowmobile and samples collected from holes drilled in the ice; and, the Lake St. Martin which was sampled by boat during open water periods.

When sampling from helicopter, one staff harnessed into the helicopter lowered a weighted sampling device to the water surface. Samples were retrieved from just below the surface of the water (approximately 0.3 m) and examined to ensure water was free of excess sediment resulting from sampling error. Water from the sampler was used to fill sample bottles and take *in situ* measurements. The weighted sampler was rinsed at each site prior to sample collection.

When sampling through the ice, a hole was drilled using a hand auger. Samples were collected by lowering a Kemmerer sampler approximately 1.0 m below the ice. The Kemmerer was site rinsed before samples were collected. *In situ* measurements were collected from under the ice. When sampling from a boat, samples were collected from just below the surface (0.3 m) directly into laboratory supplied sample bottles.

Where necessary, samples were preserved according to instructions provided by the analytical laboratory. After collection, samples were placed in a cooler and kept cool using ice packs until submission (within 48 hours) to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. [CALA] accredited laboratory) for analysis.

Standard Quality Assurance/Quality Control (QA/QC) samples were included during each sampling event, including: an equipment and/or field blank; a trip blank provided by the laboratory; and, a duplicate sample. Results were regularly examined upon receipt and any spikes or anomalous

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concentrations were assessed to protect against sampling error and to ensure appropriate sampling procedures during future sampling events.

3.2 REGIONAL WATER QUALITY MONITORING PROGRAM

The RWQMP was initiated in October 2011, prior to the operation of Reach 1, and continued until May 2015. The intent of this program was to provide a regional perspective on water quality conditions both upstream and downstream of Reach 1. Water quality in all major waterbodies and waterways within the study area were sampled. Water quality parameters included in the RWQMP were identified based on potential linkages between the Project and water quality, including potential effects on TSS and related variables (e.g., nutrients and metals), effects related to diversion, and potential effects of flooding and/or diversion on water quality (i.e., nutrients, DO, pH and metals), and/or variables that provide supporting information for interpretation of other data. Ultra-trace mercury and methyl-mercury were included to facilitate comparison to the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs; MWS 2011) and because both may be affected by flooding. A complete list of water quality parameters selected for laboratory analysis and *in situ* measurements are provided in Table 4. In general, four sampling periods occurred during each year. Details on sampling site locations and sampling periods are provided in Table 5 and Figure 4.

3.2.1 Sample Sites

In general, sampling was conducted at 17 sites throughout the study area, as follows:

- Waterhen River – one site at the bridge on PR # 328 (at MWS site MB05LHS002);
- Lake Manitoba – one site at Lake Manitoba Narrows (at MWS site MB05LKS009);
- Fairford River – one site at the PTH # 6 bridge (at MWS site MB05LMS001);
- Lake St. Martin – one site in the north basin;
- Dauphin River – four sites, including one site near the outflow from Lake St. Martin, one site near the existing MWS site (MWS Site MB05LMS003), one site upstream of the confluence of Buffalo Creek, and one site in the mouth of the Dauphin River upstream of Sturgeon Bay;
- Buffalo Creek – one site at the creek mouth; and,
- Sturgeon Bay – eight sites.

However, not all sites were sampled during all sampling periods. The following exceptions occurred:

- Sampling at the Waterhen River and Lake Manitoba Narrows was discontinued after 2012 as it was felt that the site in the Fairford River captured the condition of the water quality entering the Lake St. Martin/Dauphin River system;
- The eighth site in Sturgeon Bay, LKW3B (near the Dauphin River mouth), was added in spring 2012; and,
- During winter sampling, some sites were not accessible due to ice/snow conditions and were therefore either relocated to a more accessible location or not sampled at all.

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Additionally, occasional RWQMP sampling was conducted at sites within the LSMEOC system, including:

- Lake St. Martin - near the Reach 1 inlet (October 2011);
- Big Buffalo Lake –in the middle of the basin (March and May 2013; and, April and June 2014);
- Buffalo Creek - in the upper reaches of the creek (October 2011, January 2012, and May 2013); and,
- Dauphin River - immediately downstream of the confluence with Buffalo Creek (October 2011 and August 2014).

3.2.2 Sampling Methods

Sampling sites were accessed by truck, boat, helicopter, or snowmobile depending on site accessibility and season. Sample locations were recorded using a handheld Garmin GPS receiver. Sampling date and time were noted for each sampling site. Measurements of effective water depth (using a handheld depth sounder) and of ice thickness (if appropriate) were recorded at each site. In winter, where necessary, holes were drilled through the ice using a power auger.

In situ measurements of water quality parameters including pH, specific conductance, DO, turbidity, and water temperature were collected using a handheld water quality meter. At river sites and those accessed from shore, *in situ* parameters were measured at approximately 0.3 m below the water surface. At lake sites, *in situ* profiles were taken in one of two ways: measurements were recorded near the surface (i.e., at 0.3 m) and then at either 0.5 m (if total water depth was less than 5.0 m) or 1.0 m increments, or measurements were recorded both near the surface (about 0.3 m beneath the bottom surface of the ice) and at approximately 0.3 m above the lake bottom. Due to several water quality meter malfunctions, *in situ* measurements were not consistently measured with one brand of device throughout the sampling program (see Project data reports for details).

At each sampling site, grab samples were collected from approximately 0.3 m below the water surface into clean sample bottles supplied by ALS Laboratories. Under ice-cover, samples were collected from 0.5 m below the ice using a Kemmerer sampler. If thermal stratification was evident at lake sampling sites, water samples were also collected from approximately 1.0 m above the sediments using a Kemmerer sampler. Where necessary, samples were preserved according to instructions provided by the analytical laboratory. After collection, samples were placed in a cooler and kept cool using ice packs until submission (within 48 hours) to ALS Laboratories in Winnipeg for analysis.

Standard QA/QC measures were followed during sample collection (e.g., use of latex gloves, standard labelling practices, meter calibration, etc.). Additionally, QA/QC samples were collected, including field blanks, trip blanks, and replicate samples. All water quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. In general, QA/QC samples indicated high precision and no sample contamination; details are available in Project data reports.

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3.3 *IN SITU* MONITORING PROGRAM

The *in situ* monitoring program was conducted in Sturgeon Bay in fall 2011, and in February and March, 2012. The primary objective of the program was to gather spatial information on the water quality of Sturgeon Bay This program included the collection of *in situ* measurements of pH, specific conductance, DO, turbidity, and water temperature; as well as, sample collection for laboratory analysis of TSS and turbidity.

3.4 MANITOBA CONSERVATION AND WATER STEWARDSHIP

MCWS has monitored water quality at 28 sites in Lake Manitoba, in the Fairford River at PTH #6 west of Fairford (MB05LMS001), in the Dauphin River near Anama Bay (MB05LMS003), and in Sturgeon Bay (MB05SES012) over various time periods since 1973 (MCWS 2014). The frequency of sampling has varied over the monitoring period and monitoring in Sturgeon Bay has only been recently initiated (since 2008). The list of water quality parameters measured varies with time and in some instances only a limited number of parameters have been measured. For the purposes of this assessment, the data collected from Lake Manitoba have been excluded because it was felt that the site in the Fairford River captures the condition of the water quality entering the Lake St. Martin/Dauphin River system. Figure 5 shows the locations of the MCWS sampling sites in the Fairford River, Dauphin River and Sturgeon Bay.

MCWS data presented herein were provided to NSC by the Water Quality Management Section (MCWS 2014). All data were reviewed for errors and potential outliers prior to use.

3.5 ANALYSIS

3.5.1 Quality Assurance and Quality Control (QA/QC)

For both the RWQMP and LSMEOC monitoring program standard QA/QC measures were followed during sample collection (e.g., use of latex gloves, standard labelling practices, meter calibration, etc.). Additionally, QA/QC samples were collected, including field blanks, trip blanks, and replicate samples.

3.5.1.1 Field Blanks

Field blanks are intended to provide information on sample contamination from atmospheric exposure and sample handling techniques (i.e., cleanliness of sampling equipment, carry-over contamination from site to site), as well as potential laboratory contamination and/or error (British Columbia Ministry of Environment, Lands, and Parks (BCMELP) 1998). Field blanks were prepared by filling sample bottles with deionized water (both provided by the analytical laboratory) in the field and submitting the blanks along with the environmental samples.

3.5.1.2 Trip Blanks

Trip blanks are used for evaluating the potential for sample contamination that may occur from the container or preservatives through transport and storage of the sample, as well as laboratory precision (BCMELP 1998). Trip blanks were prepared in the laboratory by filling sample bottles with deionized

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water. Trip blanks were transported to the field sampling sites, but remained sealed, and were then submitted to the analytical laboratory in conjunction with environmental samples for analysis.

3.5.1.3 Replicate Samples

Replicate samples were collected at randomly selected sites to provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses.

3.5.1.4 QA/QC Assessment

All water quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as "suspect".

QA/QC samples were assessed according to standard criteria to evaluate precision and identify potential sample contamination issues (BCMELP 1998). Percent relative standard deviation (PRSD) was calculated for triplicate samples as follows:

$$\text{PRSD (\%)} = \text{standard deviation of the triplicate values} / \text{mean of the triplicate values} \times 100$$

The relative percent mean difference (RPMD) was calculated for duplicate samples as follows:

$$\text{RPMD (\%)} = \left| (\text{value 1} - \text{value 2}) / ((\text{value 1} + \text{value 2}) / 2) \right| \times 100$$

Precision of replicate samples was evaluated using the "rule of thumb" criteria for precision of 18% for triplicate samples and 25% for duplicate samples (BCMELP 1998). Where one or more of the replicate values were less than five times the analytical detection limit (DL), an analysis of precision was not undertaken, in accordance with guidance provided in BCMELP (1998).

Field and trip blank results were also evaluated for evidence of sample contamination. Values for any parameter that exceeded five times the DL were considered to be indicative of sample contamination and/or laboratory error.

3.6 DATA SELECTION AND INTEGRATION

In 2015, an Effects Assessment of the Project was completed and included analysis of changes in water quality in the Study Area associated with the Project (NSC and KGS 2015). For the assessment, available water quality data were reduced to include only the sampling sites and parameters that would provide the most meaningful information from which to assess the effects of the Project on water quality. For consistency, the current analysis follows the methods developed for the Effects Assessment; the analysis is described in the following sections. Data that may have been collected but not included in the subsequent analyses are included in the appendices attached to this report.

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3.6.1 Sites Selected

Sampling sites were considered based on their location and parameters sampled. The sites used in the effects assessment and current analysis are shown in Figure 6 and were as follows:

- All sampling sites upstream of the Fairford River were omitted as it was felt that the Fairford site captures the condition of the water quality entering the Lake St. Martin/Dauphin River system;
- Fairford River (i.e., FR1) – this site is located at the Fairford River control structure at PTH #6 and includes data collected by both the RWQMP and MCWS at MB05LMS001;
- Lake St. Martin – two sampling sites were included, LSM1 in the middle of the north basin and LSM2 near the inlet to Reach 1. Additional sampling was conducted in Lake St. Martin by the LSMEOC monitoring program during 2011/2012 Closure, however site location varied considerably. Because sampling was conducted at LSM1 by the RWQMP, and Reach 1 was closed and therefore background information was not needed for Reach1, data from these sites were not included in this assessment;
- Reach 1 – two sites were included, EC1 at the upstream end, and EC2 at the downstream end;
- Big Buffalo Lake – one site located approximately in the middle of the lake (BBL) was included;
- Buffalo Creek – three sites were included, BC1 at the upstream end of the creek and BC3 at the downstream end of the creek, plus BC2 near the upstream end of the creek, for which additional mercury data were available;
- Dauphin River – five sites were included from the inlet at Lake St. Martin to the river mouth at Sturgeon Bay. Site IDs for sampling locations along the Dauphin River had varied in reporting from 2011-2013 due to differences in monitoring programs and sampling agencies. To eliminate confusion for this assessment and going forward, sites along the Dauphin River have been renamed from DR-A to DR-E based on their upstream to downstream location as indicated in Table 6 and shown in Figure 6; and,
- Sturgeon Bay – all eight sites from the RWQMP were included (LKW1 to LKW7 plus LKW3B). The MCWS sampling site (MB05SES012) was excluded from the effects assessment as the data are limited and the location of the sampling site is at least 10 km farther into Lake Winnipeg than the nearest Project sampling site.

3.6.2 Parameters Selected

In order to further streamline the assessment of possible changes in water quality, the available data were reduced to a set of key parameters. Key parameters chosen include selected routine parameters and those metals and major ions for which there are Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOGs, MWS 2011) for the protection of aquatic life (PAL), Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (PAL; CCME 1999; updated to 2015), or MWQSOGs or Health Canada (Health Canada 2014) guidelines for drinking water. Additional parameters that could potentially have been affected by the Project were also chosen. The list of the key parameters includes:

- Dissolved Oxygen (DO);

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- Conductivity and total dissolved solids (TDS);
- pH;
- Total suspended solids (TSS) and turbidity;
- Nitrogen;
- Phosphorus;
- Carbon;
- Chlorophyll *a*;
- Metals and major ions with MWQSOGs or CCME guidelines for PAL, or MWQSOGs or Health Canada Guidelines for drinking water; and,
- Petroleum hydrocarbons.

Metals and major ions on the list include: aluminum, antimony, arsenic, barium; boron, cadmium, chloride, chromium, copper, fluoride, iron, lead, manganese, mercury, methyl mercury, molybdenum, nickel, selenium, silver, sodium, sulphate, thallium, uranium, and, zinc. Hardness was also included as it is necessary for the determination of MWQSOGs/CCME PAL for some metals.

3.6.3 Data Integration

After the available data were reduced based on the sites and parameters selected, data from all three sources (i.e., RWQMP, LSMEOC monitoring program, and MCWS) were combined into a single dataset that was used in the effects assessment. A summary of data included is provided in Table 7.

3.6.4 Data Analysis

3.6.4.1 Time Periods

Water quality data were divided into five time periods based on the 2011 flood and operation of Reach 1. These periods were defined as follows:

- Historical – The 10-year period prior to the 2011 flood;
- 2011 Flood – April 2011 to 31 October 2011;
- 2011/2012 Operation – 01 November 2011 to 27 November 2012;
- 2011/2012 Closure – 28 November 2012 to 30 June 2014;
- 2014/2015 Operation – 01 July 2014 to 31 December 2014; and,
- 2014/2015 Closure – August 13, 2015-end of Project monitoring.

The intent of the historical period is to give information on “normal” water quality conditions and to provide historical context on conditions prior to the Project. Data from this period are restricted to those collected by MCWS. Additionally, because water quality is typically affected during flood events, it was expected that water quality in 2011 would differ from historical conditions. Data from prior to 2011/2012 Operation were therefore divided into two time periods: those collected during what could be considered “normal” historical conditions; and, those collected during flood stage in 2011.

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Although operation of Reach 1 ended on 21 November 2012, water quality data collected from 22-27 November 2012 (i.e., six days after the closure of Reach 1) were included herein in the 2011/2012 Operation period, as there may have been remnant effects from closure activities.

3.6.5 Analytical Methods

To assist in data interpretation and presentation, summary statistics including mean, median, minimum, maximum, standard error (SE), number of samples (n), and percent of samples above the analytical detection limit (DL) were calculated. Summary statistics were calculated for water quality variables at each site during each time period (i.e., Historical [10-years prior to 2011]; 2011 Flood; 2011/2012 Operation; 2011/2012 Closure; 2014/2015 Operation; and 2014/2015 Closure). All data analyses treated censured values (i.e., values reported as below the DL) as equal to one half the DL. In cases where replicate samples were collected, or when more than one sample was collected across the stream channel (i.e., additional TSS samples), sample means were used for the calculation of summary statistics. Scatter plots were created to graphically represent the data and to show trends in water quality over time.

The high-level mercury data collected by the LSMEOC monitoring program in 2011 have been excluded from the analysis. The analytical detection limit (50 ng/L) used for these samples was 50 times higher than the analytical detection limit (1 ng/L) used for other samples collected for the Project making comparisons with the data problematic. Additionally, confidence in these data is low as the sampling method used is prone to contamination.

Due to inconsistencies in the water quality meters used between and within sampling periods and programs, and due to occasional malfunctions of the water quality meters, confidence in any comparisons (between sampling periods and/or sites) made with these data would be low. Because, with the exception of DO, laboratory analysed data were available for each of the *in situ* variables, including, pH, specific conductance, and turbidity, the choice was made to exclude the *in situ* data where possible. As a result, *in situ* DO data were included, but all other *in situ* data were excluded from analyses presented here.

Nitrogen to phosphorus (TN:TP) molar ratios were calculated to assist in estimating the limiting nutrient. Ratios less than 10 were considered indicative of nitrogen limitation and values greater than 20 were considered indicative of phosphorus limitation. Ratios between 10 and 20 were considered to indicate co-limitation.

Total organic carbon to organic nitrogen (TOC:ON) molar ratios were derived to provide an indication of the key source of carbon in each waterbody. Ratios greater than 50:1 were considered indicative of organic matter that is primarily allochthonous and ratios less than 12:1 were considered indicative of organic matter that is primarily autochthonous (Wetzel 1983).

Key water quality parameters were assessed qualitatively (both temporally and spatially) to identify Project-related effects. Temporal comparisons were made by assessing similarities and differences in water quality conditions during different Project phases. Spatial comparisons assessed differences in

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key water quality parameters between sampling sites, with a focus on comparing water quality conditions upstream and downstream of Reach 1 and Buffalo Creek.

3.6.6 Comparison to Water Quality Objectives and Guidelines

Results were compared to the MWQSOGs (MWS 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 1999; updated to 2015). In general, the MWQSOGs for PAL are similar to the CCME guidelines for PAL for parameters measured; however, there are CCME guidelines for some parameters which lack a provincial guideline/objective and others for which the CCME guideline is different from the provincial one; typically the CCME guideline is more stringent than the MWQSOGs.

Drinking water quality objectives and guidelines are intended to be applied to treated or finished water as it emerges from the tap and "are not intended to be applied directly to source waters" (CCME 1999, updated to 2015). However, comparison of water quality in the study area to drinking water quality objectives and guidelines is included to provide context. The MWQSOGs indicate that "all surface waters…are susceptible to uncontrolled microbiological contamination... [and] it is therefore assumed that all raw surface water supplies will be disinfected as the minimum level of treatment prior to consumption" (MWS 2011). Furthermore, it is indicated that the MWQSOGs "apply to finished drinking water, but can be extrapolated to provide protection to raw drinking water sources."

In general, water quality objectives and guidelines are more stringent for the protection of aquatic life and wildlife, relative to those established to protect various human usages (e.g., drinking water). A summary of relevant water quality objectives and guidelines is presented in Appendix A.

3.6.6.1 Estimation of Background Conditions

MWQSOGs (MWS 2011) and CCME guidelines (CCME 1999, updated to 2015) for PAL for TSS and turbidity are based on changes from a background condition. Background conditions were estimated as follows:

- For Reach 1, the conditions observed during the same sampling event upstream in Lake St. Martin (i.e., LSM1 or LSM2) were considered to represent background conditions (Note: Assessment of background was only considered during Reach 1 operation);
- For Big Buffalo Lake, the average conditions in the lake in 2014 prior to 2014/2015 Operation were considered to represent background conditions (Note: this was only applicable for 2014/2015 Operation because Big Buffalo Lake was not sampled prior to 2013);
- For Buffalo Creek, the average conditions in the creek prior to operation of Reach 1 (i.e., between 02 September and 28 October 2011) were considered to represent background conditions; and,
- For the lower Dauphin River (i.e., DR-D and DR-E), the conditions observed during the sample sampling event upstream of Buffalo Creek (i.e., DR-C) were considered to represent background conditions.

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Table 2. Laboratory analysed parameters measured as part of the LSMEOC monitoring program, 2011-2015.

Parameter	Units	Analytical Detection Limit 2011	Analytical Detection Limit 2012-2015
Total suspended solids	mg/L	5	2
Turbidity [1]	NTU	Not sampled	0.1
Routine			
Ammonia	mg N/L	0.050 [2]	0.010
Nitrate and nitrite	mg N/L	0.071 (0.0051) [2]	0.071 (0.0051) [2]
Nitrate	mg N/L	0.050 (0.005) [2]	0.050 (0.005) [2]
Nitrite	mg N/L	0.050 (0.001) [2]	0.050 (0.001) [2]
Total Kjeldahl nitrogen	mg/L	0.2	0.2
Total nitrogen	mg/L	0.2	0.2
Total dissolved phosphorus	mg/L	0.010	0.010
Total phosphorus	mg/L	0.010	0.010
Petroleum Hydrocarbons			
Benzene	mg/L	0.0005	0.0005
Ethyl-benzene	mg/L	0.0005	0.0005
Toluene	mg/L	0.001	0.001
o-xylene	mg/L	0.0005	0.0005
m+p-Xylenes	mg/L	0.0005	0.0005
Xylenes	mg/L	0.0015	0.0015
Total hydrocarbons (C6-C50)	mg/L	0.44	0.44
Fraction F1 (C6-C10)	mg/L	0.1	0.1
Fraction F2 (C10-C15)	mg/L	0.25	0.25
Fraction F3 (C16-C34)	mg/L	0.25	0.25
Fraction F4 (C35-C50)	mg/L	0.25	0.25
Mercury			
Mercury, total	ng/L	50 (1.0) [2]	1.0
Mercury, dissolved	ng/L	50 (1.0) [2]	1.0
Methyl Mercury			
Methyl mercury, total	ng/L	0.5	0.5
Methyl mercury, dissolved	ng/L	0.5	0.5

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1 - Turbidity was added to the program in 2012 to provide an alternate estimation of impacts from suspended solids and to correlate with *in situ* data.

2 - A lower detection limit (as indicated in brackets) was used when sampling was conducted in conjunction with the RWQMP.

Table 3. Samples collected for the LSMEOC monitoring program, 2011-2015

Sampling Date(s)	*In Situ* Measurements	TSS	Routine	Mercury [1]	Methyl Mercury [1]	Petroleum Hydrocarbons [2]
2011 Flood						
02 Sep 2011	✓	✓	✓	✓	-	✓
07 Sep 2011	✓	-	-	-	-	-
14 Sep 2011	-	-	-	-	-	✓
26 Sep 2011	✓	✓	✓	✓	-	✓
29 Sep 2011	-	-	-	-	-	✓
14 Oct 2011	✓	✓	✓	✓	-	✓
21 Oct 2011	✓	-	-	-	-	-
29 Oct 2011	✓	✓	✓	✓	-	✓
2011/2012 Operation						
02 Nov 2011	✓	✓	✓	✓	-	✓
04 Nov 2011	✓	✓	✓	✓	-	✓
07 Nov 2011	✓	✓	✓	✓	-	✓
10 Nov 2011	✓	✓	✓	✓	-	✓
14 Nov 2011	✓	✓	✓	✓	-	✓
17 Nov 2011	✓	✓	✓	✓	-	✓
25 Nov 2011	✓	✓	✓	✓	-	✓
29 Nov 2011	-	-	-	-	-	✓
17-18 Jan 2012	-	✓	✓	✓	✓	-
07-09 Feb 2012	-	✓	✓	-	-	✓
21 Feb 2012		✓	✓			-
16 Mar 2012	✓	✓	✓	✓	✓	-
17 Apr 2012	✓	✓	✓	-	-	-
16-17 May 2012	✓	✓	✓	✓	✓	-
13 Jun 2012	✓	✓	✓	-	-	-
09 Aug 2012	✓	✓	✓	-	-	-
12 Sep 2012	✓	✓	✓	-	-	-
19 Oct 2012	✓	✓	✓	-	-	-
13 Nov 2012	✓	✓	✓	-	-	✓
19 Nov 2012	✓	✓	✓	-	-	✓
22 Nov 2012	✓	✓	✓	-	-	✓
27 Nov 2012	✓	✓	✓	-	-	✓
2011/2012 Closure						
24-27 Mar 2013	✓	✓	✓	✓	✓	-
02 May 2013	✓	✓	✓	-	-	-
14 May 2013	✓	✓	✓	-	-	-
28 May 2013	✓	✓	✓	-	-	-
24 Jul 2013	✓	✓	✓	-	-	-
09-16 Oct 2013	✓	✓	✓	-	-	-
07 April 2014	✓	✓	✓	-	-	-
02 May 2014	✓	✓	✓	-	-	-
15 May 2014	✓	✓	✓	-	-	-
29 May 2014	✓	✓	✓	-	-	-
18-20 Jun 2014	✓	✓	✓	-	-	✓

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Table 3. Continued.

Sampling Date(s)	*In Situ* Measurements	TSS	Routine	Mercury [1]	Methyl Mercury [1]	Petroleum Hydrocarbons [2]
2014/2015 Operation						
03 Jul 2014	✓	✓	-	-	-	-
04 Jul 2014	✓	✓	✓	-	-	✓
05 Jul 2014	✓	✓	-	-	-	-
06 Jul 2014	✓	✓	✓	-	-	✓
07 Jul 2014	✓	✓	-	-	-	-
08 Jul 2014	✓	✓	✓	✓	✓	✓
11 Jul 2014	✓	✓	✓	-	-	-
16 Jul 2014	✓	✓	✓	✓	✓	-
Aug 26-27, 2014	✓	✓	✓	✓	✓	-
22 Sep 2014	✓	✓	✓	-	-	-
23 Oct 2014	✓	✓	✓	-	-	-
17 Nov 2014	✓	✓	✓	-	-	✓
18 Nov 2014	✓	✓	-	-	-	-
01 May 2015	✓	✓	✓	-	-	-
11 Jun 2015	-	✓	-	-	-	-
30 Jul 2015	✓	✓	✓	-	-	-
2014/2015 Closure						
13 Aug 2015	✓	✓	✓	-	-	-
19 Aug 2015	✓	✓	✓	-	-	-
14 Sep 2015	✓	✓	✓	-	-	-

1 - Sampling was occasional and only occurred only when the parameter was not sufficiently monitored by the RWQMP or to supplement data collected by the RWQMP.

2 - Petroleum hydrocarbons were sampled during construction, closure and re-opening activities.

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Table 4. Water quality parameters measured as part of the RWQMP, 2011-2015.

Parameters	Parameters
Routine Parameters	Metals (Total and Dissolved) and Major Ions
Alkalinity	Antimony (Sb)
Dissolved Organic Carbon	Arsenic (As)
Total Inorganic Carbon	Barium (Ba)
Total Organic Carbon	Beryllium (Be)
Colour, True	Bismuth (Bi)
Conductivity (at 25°C)	Boron (B)
Hardness (Calculated from metals)	Cadmium (Cd)
Total Kjeldahl Nitrogen	Calcium (Ca)
Ammonia-N	Cesium (Cs)
Nitrate+Nitrite- N	Chromium (Cr)
Nitrite-N	Chloride (dissolved)
Nitrate-N	Cobalt (Co)
Phosphorus, Total	Copper (Cu)
Phosphorus, Total Dissolved	Fluoride (dissolved)
Phosphorus Total Particulate (Calculated)	Iron (Fe)
pH	Lead (Pb)
Total Dissolved Solids	Lithium (Li)
Total Suspended Solids	Magnesium (Mg)
Turbidity	Manganese (Mn)
	Molybdenum (Mo)
In Situ Parameters	Mercury (Hg)
pH	Nickel (Ni)
Temperature	Potassium (K)
Dissolved oxygen	Rubidium (Rb)
Turbidity	Selenium (Se)
Specific Conductance	Silicon (Si)
	Silver (Ag)
Occasional Parameters	Sodium (Na)
Escherichia coli (not included herein)	Strontium (Sr)
Pesticides (not included herein)	Tellurium (Te)
	Sulphate (dissolved)
	Thallium (Tl)
	Thorium (Th)
	Tin (Sn)
	Titanium (Ti)
	Tungsten (W)
	Uranium (U)
	Vanadium (V)
	Zinc (Zn)
	Zirconium (Zr)
	Methyl mercury

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Table 5. Main sites and sampling periods for the RWQMP, 2011-2015

Waterbody	Site ID	Flood	2011/2012 Operation				2011/2012 Closure							2014/2015 Operation				
		Oct 28-29	Jan 16-19	May 16-21	Jul 16-17	Oct 15-16	Mar 24-27	Jun 10-12	Jul 21-22	Oct 6-7	Apr 7-10	May 28-29	Jun 18-20	Jul 24-25	Aug 26-27	Oct 16-20	Mar 24-27	May 3-4
		2011	2012	2012	2012	2012	2013	2013	2013	2013	2014	2014	2014	2014	2014	2014	2015	2015
Waterhen River	WHR1	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Lake Manitoba	NARR1	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Fairford River	FR1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Lake St. Martin	LSM1	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
Dauphin River	DR1.1	X	-	X	X	X	X[1]	X	X	X	X	X	X	X	-	X	X	-
	DR1.3	X	X[1]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	DR1 (NOTE 2)	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Buffalo Creek	BC3	X	X	X	X	X	-	X	X	X	-	X	X	X	X	X	X	X
Dauphin River	DR2C	X[2]	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lake Winnipeg	LKW3B	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	LKW3	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW2	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	LKW4	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW5	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	LKW7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-

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Table 6. Standardized site identification for sampling locations on the Dauphin River.

Site ID	Location Description	KGS Name	AECOM Name	NSC Name	MCWS Name
DR-A	Inlet at Lake St. Martin	-	-	DR1, DR1.1, DR1.0	-
DR-B	Upstream of the Big Bend	-	-	DR2, DR1.3, DR1.2	MB05LMS003
DR-C	Immediately upstream of Buffalo Creek	DR1	DR01	DR1(Note2), DR2.1	-
DR-D	Immediately downstream of Buffalo Creek	DR3	-	-	-
DR-E	Mouth at Sturgeon Bay	DR2C	DR02	DR2C, DR-3	-

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Table 7. Summary of water quality data used in the effects assessment.

Location	Period	Number of Sampling Events [1]			Key Parameters Sampled by Combined Programs					
		LSMEOC	RWQMP	MCWS	Routine	TSS and Turbidity	Nutrients	Chlorophyll *a*	Metals and Major Ions	Petroleum Hydrocarbons
Fairford River	Historic	-	-	34	✓	✓	✓	✓	✓	-
	2011 Flood	-	1	15	✓	✓	✓	✓	✓	-
	2011/2012 Operation	-	4	11	✓	✓	✓	✓	✓	-
	2011/2012 Closure	-	7	10	✓	✓	✓	✓	✓	-
	2014/2015 Operation	-	3	5	✓	✓	✓	✓	✓	-
Lake St. Martin	Historic	-	-	-	-	-	-	-	-	
	2011 Flood	4	1	-	✓	✓	✓	✓	✓	-
	2011/2012 Operation	16	4	-	✓	✓	✓	✓	✓	✓
	2011/2012 Closure	3 [2]	7	-	✓	✓	✓	✓	✓	✓
	2014/2015 Operation	12	2 [3]	-	✓	✓	✓	✓	✓	-
										✓
Reach 1	Historic	-	-	-	-	-	-	-	-	
	2011 Flood	-	-	-	-	-	-	-	-	-
	2011/2012 Operation	20	1	-	✓	✓	✓	✓	✓	-
	2011/2012 Closure	10	1	-	✓	✓	✓	✓	✓	✓
	2014/2015 Operation	12	-	-	✓	✓	✓	✓	✓	-
										✓
Big Buffalo Lake	Historic	-	-	-	-	-	-	-	-	
	2011 Flood	-	-	-	-	-	-	-	-	-
	2011/2012 Operation	-	-	-	-	-	-	-	-	-
	2011/2012 Closure	9	3	-	✓	✓	✓	✓	✓	-
	2014/2015 Operation	9	-	-	✓	✓	✓	✓	✓	-
										-
Buffalo Creek	Historic	-	-	-	-	-	-	-	-	
	2011 Flood	6	1	-	✓	✓	✓	✓	✓	-
	2011/2012 Operation	21	3 [4]	-	✓	✓	✓	✓	✓	✓
	2011/2012 Closure	10	5 [4]	-	✓	✓	✓	✓	✓	✓
	2014/2015 Operation	13	3	-	✓	✓	✓	✓	✓	-

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Table 7. Continued.

Location	Period	Number of Sampling Events[1]			Key Parameters Sampled by Combined Programs					
		LSMEOC	RWQMP	MCWS	Routine	TSS and Turbidity	Nutrients	Chlorophyll *a*	Metals and Major Ions	Petroleum Hydrocarbons
Upper Dauphin River	Historic	-	-	24	✓	✓	✓	✓	✓	-
	2011 Flood	6	1	1	✓	✓	✓	✓	✓	✓
	2011/2012 Operation	20	4	7	✓	✓	✓	✓	✓	✓
	2011/2012 Closure	10	7	10	✓	✓	✓	✓	✓	-
	2014/2015 Operation	12	3	15	✓	✓	✓	✓	✓	✓
Lower Dauphin River	Historic	-	-	-	-	-	-	-	-	-
	2011 Flood	6	1	-	✓	✓	✓	✓	✓	✓
	2011/2012 Operation	23	3[4]	-	✓	✓	✓	✓	✓	✓
	2011/2012 Closure	10	7	-	✓	✓	✓	✓	✓	-
	2014/2015 Operation	12	3	-	✓	✓	✓	✓	✓	✓
Sturgeon Bay	Historic	-	-	-	-	-	-	-	-	-
	2011 Flood	-	1	-	✓	✓	✓	✓	✓	-
	2011/2012 Operation	-	4	-	✓	✓	✓	✓	✓	-
	2011/2012 Closure	-	7	-	✓	✓	✓	✓	✓	-
	2014/2015 Operation	5	3	-	✓	✓	✓	✓	✓	-

1 - Not all parameters were sampled during each sampling event.

2 - Additional sampling was conducted in Lake St. Martin by the LSMEOC program during 2011/2012 Closure, however site location varied considerably. Because sampling was conducted at LSM1 by the RWQMP, and because the channel was closed and therefore background information was not needed for Reach1, these data were not included in this assessment.

3 - Sampling was conducted at a limited number of sites in August 2014. Lake St. Martin was not included in this program.

4 - Area was not accessible in winter and was, therefore, not sampled.

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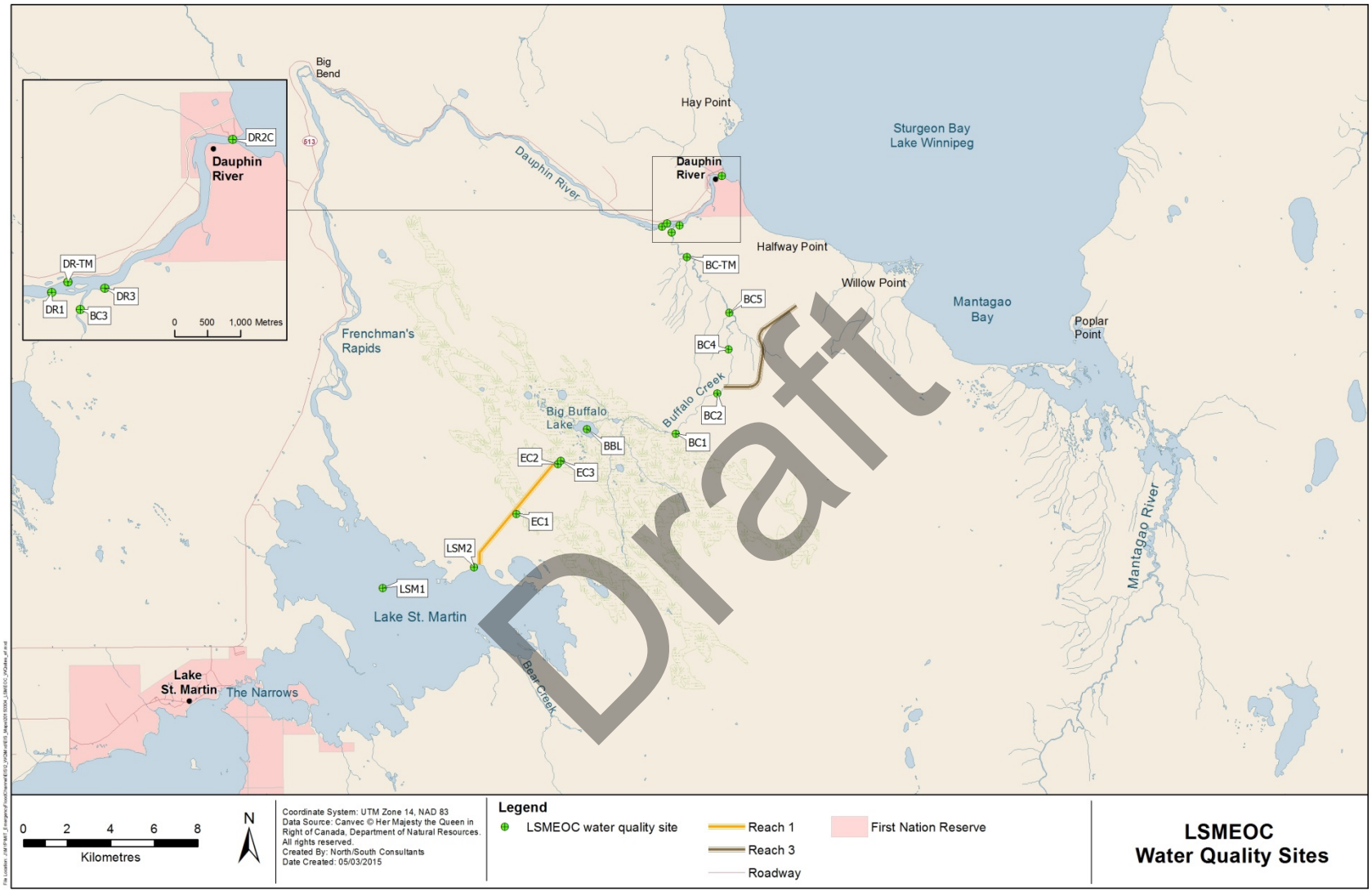


Figure 3. Water quality sampling sites that were part of the LSMEOC monitoring program, 2011-2015.

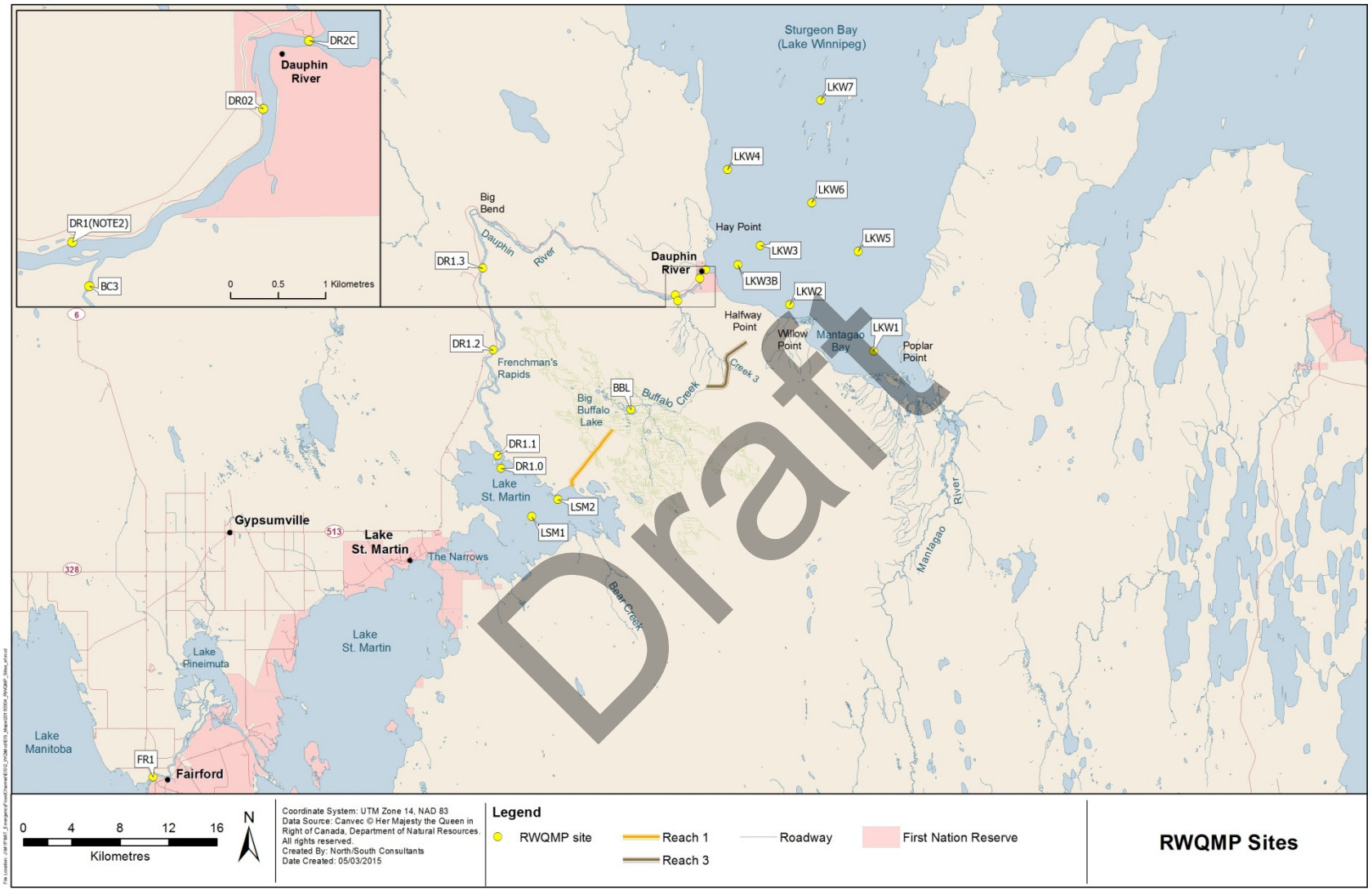


Figure 4. Water quality sampling sites that were part of the RWQMP, 2011-2015.

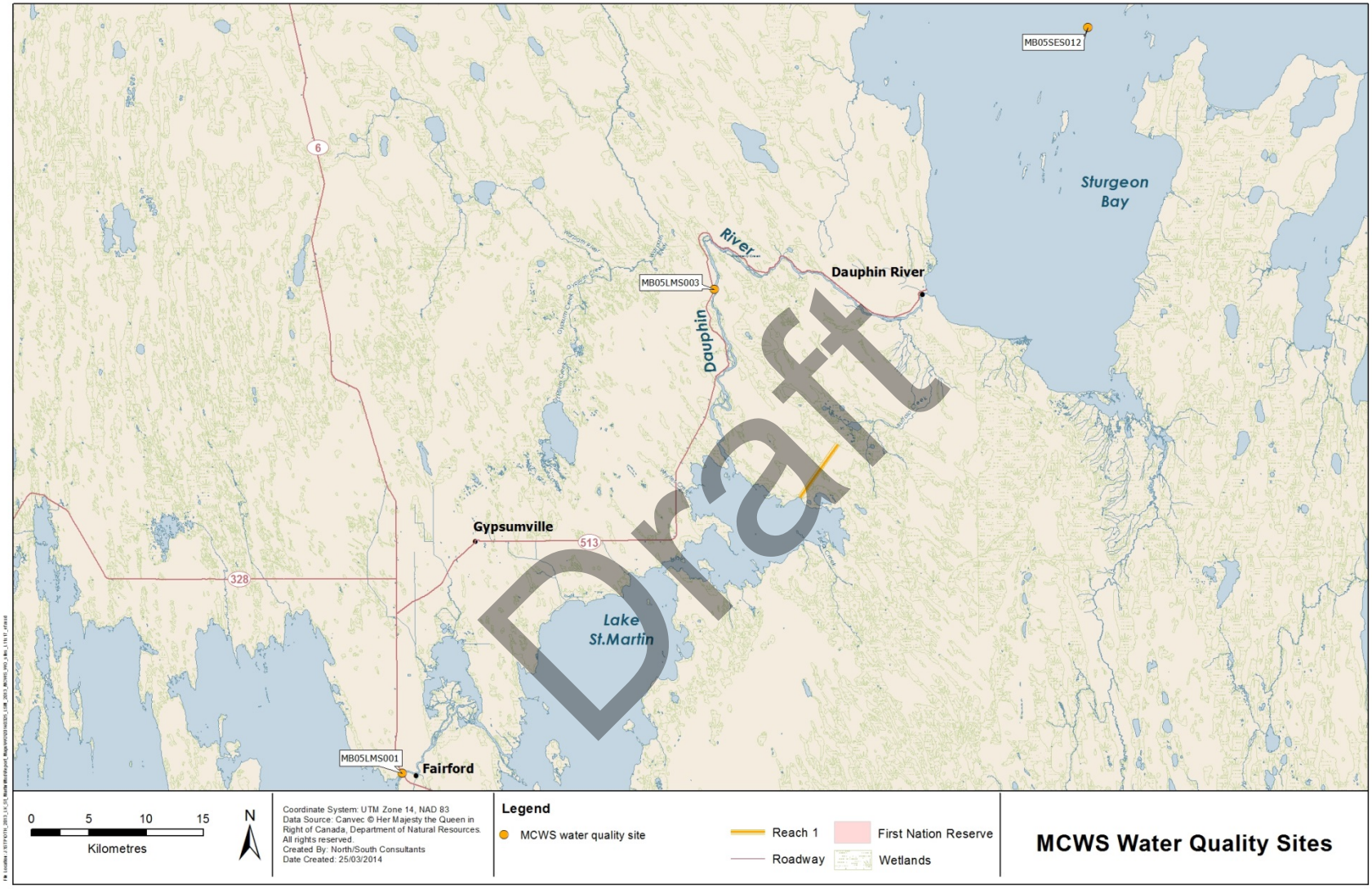


Figure 5. MCWS water quality monitoring sites in the Fairford and Dauphin rivers, and Sturgeon Bay.

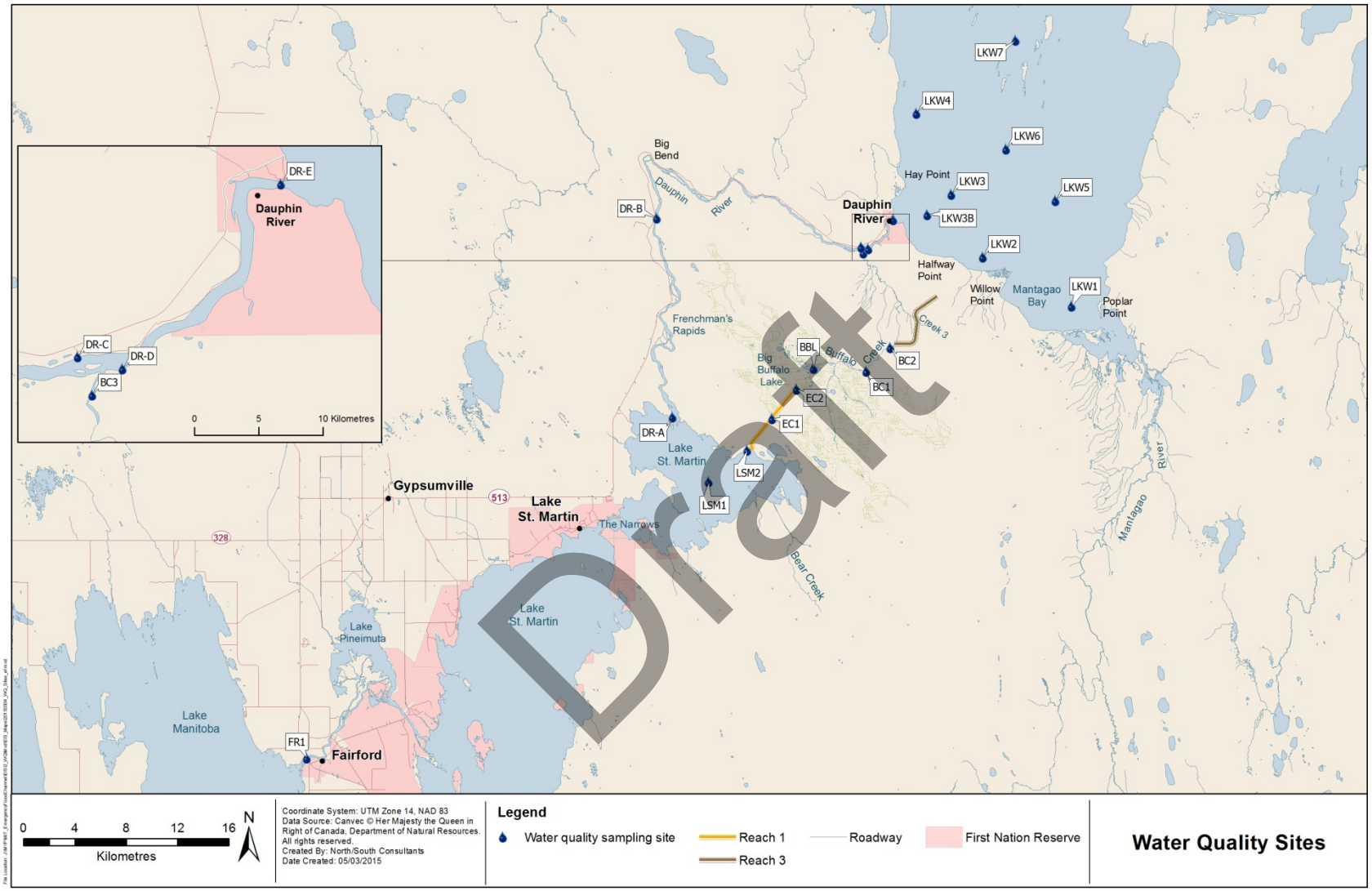


Figure 6. Water quality sampling sites included in the project.

4.0 RESULTS

The following section provides a summary of the results of the water quality monitoring programs conducted since 2011. Raw laboratory and *in situ* results from the RWQMP are provided in Appendices B-F; measurements from the *in situ* sampling programs in Sturgeon Bay and Dauphin River are presented in Appendices G and H, and results of the LSMEOC program are included in Appendix I.

4.1 UPSTREAM AREAS MONITORING RESULTS

This section presents the assessment of change/lack of change to water quality within upstream areas from 2011 through 2015. Upstream conditions are represented with data collected from a site on the Fairford River (FR1 at PTH #6) and two sites on Lake St. Martin, LSM1 in the middle of the north basin and LSM2 at the inlet to Reach1 (Figure 6). Summary statistics for key water quality parameters for each time period are presented in Table 8 and Figures 7 to 31 show patterns in water quality from through time at sites sampled on the Fairford River and Lake St. Martin.

4.1.1 Pre-Operation

Water quality data for Upstream Areas prior to the Project include Historic and 2011 Flood data collected by MCWS (2004-2011) and the Project (2011) at a site on the Fairford River (FR1), and 2011 Flood data collected by the Project at two sites on Lake St. Martin (LSM1 and LSM2) in fall 2011. Based on these data, the water quality of the Fairford River and Lake St. Martin could be generally described as moderately nutrient rich, low to moderately turbid, slightly alkaline, very hard, and well-oxygenated (Table 8).

Historically, TSS concentrations averaged 10 mg/L and ranged from < 5.0 to 32 mg/L (Figure 7) in the Fairford River. Laboratory pH ranged from 7.59 to 8.67 (Figure 8) and true colour from < 5.0 to 20.0 CU (Table 8). Conductivity and TDS in the Fairford River ranged from 1280-2000 µmhos/cm and 724-1480 mg/L, respectively (Figure 9 and Figure 10). Water in the Fairford River was very hard (236-321 mg/L; Figure 11) and well oxygenated (7.3-13.2 mg/L; Figure 12). TN ranged from 0.68 to 2.96 mg/L and was mostly composed of organic forms (Figure 13); however, DIN tended to increase during the winter months (Figure 14). TP concentrations at FR1 averaged 0.02 mg/L, ranging between 0.002 and 0.045 mg/L, and were composed of a mix of particulate and dissolved forms (Figure 15 and Figure 16). Carbon was predominantly concentrated as inorganic forms (Table 8). Based on TN:TP molar ratios, the Fairford River was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002). TOC:TN molar ratios indicate that the organic matter in the Fairford River was composed of a mix of autochthonous (within the river) and allochthonous (outside the river) sources (Wetzel 1983). Chlorophyll *a* concentrations ranged between < 0.50 and 19.5 µg/L with a mean of 5.84 µg/L, indicating that primary productivity was moderate (Figure 17).

During the flood conditions of 2011, water quality of the Fairford River was generally similar to what was measured historically; however, conductivity (i.e., specific conductance),, TDS, chloride, and sodium were lower during the 2011 Flood period than they were during the Historic period, particularly in fall

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2011 (Table 8; Figure 9 and Figure 10), and TSS, total aluminum, total manganese, true colour, and chlorophyll *a* appeared to increase somewhat during 2011 Flood, again during fall (Table 8; Figures 7, 16, 18, and 19). During 2011 Flood, conductivity and TDS ranged from 964-1440 µmhos/cm and 626-860 mg/L, respectively. TN was also lower during 2011 Flood than it was on average during the Historic period, but TN appears to have been somewhat lower in the Fairford River since 2009 and may have increased marginally during 2011 Flood (Figure 13). Under 2011 Flood conditions, TSS in the river averaged 18 mg/L and ranged from < 5.0-44 mg/L (Figure 7), while chlorophyll *a* concentrations averaged 8.61 µg/L and ranged from 1.53-14.5 µg/L (Figure 17).

Water quality was generally similar throughout Lake St. Martin (LSM1 and LSM2) during the 2011 Flood period (fall 2011 data only) (Table 8). TSS concentrations ranged from 4 to 10 mg/L (Figure 20) in Lake St. Martin. Laboratory pH ranged from 8.46 to 8.47 (Figure 21) and true colour from 6.9 to 8.4 CU (Table 8). Conductivity and TDS in Lake St. Martin ranged from 1060-1080 µmhos/cm and 652-704 mg/L, respectively (Figure 22 and Figure 23). Water in Lake St. Martin was very hard (328-341 mg/L; Figure 24) and well oxygenated (9.9-13.1 mg/L; Figure 25). TN ranged from 1.06 to 2.33 mg/L and was mostly composed of organic forms (Figure 26). TP concentrations ranged between 0.013 and 0.024 mg/L, and were composed of a mix of particulate and dissolved forms (Figure 27 and Figure 28). Carbon was predominantly concentrated as inorganic forms and organic carbon was primarily dissolved (Table 8). Based on TN:TP molar ratios, Lake St. Martin was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002). TOC:TN molar ratios indicate that the organic matter in Lake St. Martin was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983). Chlorophyll *a* concentrations ranged between 6.85 and 6.98 µg/L in fall 2011, indicating that primary productivity was moderate (Figure 29).

Historically, DO was occasionally (two out of 14 measurements) below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) when water temperatures were ≤ 5°C in the Fairford River (Table 9). DO was consistently within the MWQSOGs/CCME PAL objectives at all other times sampled during the Historic period in the river and during 2011 Flood in both the river and Lake St. Martin. All other routine parameters (ammonia, TP, nitrate, nitrite, and pH) measured during the Historic and 2011 Flood periods were within MWQSOGs/CCME guidelines or objectives for PAL.

TDS consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) in the Fairford River during the Historic and 2011 Flood periods and in Lake St. Martin during the 2011 Flood period (Figure 10 and Figure 23). True colour rarely (one out of 26 measurements) exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 15 CU) in the Fairford River during the Historic period. True colour occasionally (two out of 16 measurements) exceeded this objective in the river during 2011 Flood; however, true colour was consistently within this objective in Lake St. Martin during 2011 Flood. Laboratory pH was occasionally (four out of 31 measurements) above the MWQSOGs/Health Canada aesthetic objective (6.5-8.5) upper limit in the river during the Historic period. During 2011 Flood, laboratory pH frequently (12 out of 16 measurements) exceeded this objective in the river (Figure 8); however, pH was consistently within this objective in Lake St. Martin (Figure 21). All other routine parameters (nitrate, nitrite) measured during the Historic and 2011 Flood periods were within MWQSOGs/CCME guidelines for PAL.

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Total aluminum rarely exceeded the MWQSOGs/CCME guideline for PAL (0.1 mg/L) in the Fairford River during the Historic period, but occasionally exceeded it during 2011 Flood (Figure 18); total aluminum was consistently within this objective in Lake St. Martin during 2011 Flood (Table 10). Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) during the Historic and 2011 Flood periods in the river and the 2011 Flood period in the lake (Table 10). Additionally, chloride frequently exceeded the MWQSOGs/Health Canada aesthetic objective (≤ 250 mg/L) in the Fairford River during the Historic period, but only occasionally during 2011 Flood (Table 11). Fluoride consistently exceeded the CCME interim PAL (0.12 mg/L) in the Fairford River and Lake St. Martin during the 2011 Flood period; no historical data for fluoride are available (Table 10). Selenium occasionally exceeded the MWQSOGs/CCME PAL (0.001 mg/L) in the Fairford River during Historic and 2011 Flood periods and silver (0.0001 mg/L) occasionally during the Historic period. Selenium and silver concentrations were near the analytical detection limits and measurements that are at or near detection limits are associated with relatively high uncertainty and there is subsequently low confidence that an actual exceedance of a PAL guideline has occurred. Sodium frequently exceeded the MWQSOGs/Health Canada aesthetic objective (≤ 200 mg/L) in the Fairford River during the Historic Period; sodium only rarely exceeded this objective during 2011 Flood. All other metals and major ions were within guidelines for PAL (Table 10) and drinking water (Table 11).

Petroleum hydrocarbons were not detected in Lake St. Martin during 2011 Flood; they were not monitored at the Fairford River (Figure 30). Analytical detection limits for hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

4.1.1.1 Construction of Reach 1

During dredging related to construction activities in October 2011, TSS increased in the vicinity of the Reach 1 inlet (Appendix J). TSS periodically exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure objective of 25 mg/L above background. Additionally, TSS exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure objective of 5 mg/L above background from 05 October to 03 November 2011.

4.1.2 2011/2012 Operation

Water quality data for Upstream Areas during 2011/2012 Operation are limited to the Fairford River (FR1) and LSM1 in the middle of the north basin of Lake St. Martin. During 2011/2012 Operation, the water quality at FR1 and LSM1 remained generally consistent with that observed during the 2011 Flood period (Table 8). The following sections highlight any qualitative changes observed.

4.1.2.1 Routine

Conductivity and TDS in the Fairford River were lower in concentration during the 2011 Flood period than they were during the Historic period and remained comparable to 2011 Flood concentrations during 2011/2012 Operation (Figure 9 and Figure 10). True colour appeared to increase in the Fairford River during fall 2011 (2011 Flood), but had returned to levels during 2011/2012 Operation that were more comparable to Historic conditions (Table 8). During 2011/2012 Operation, conductivity and TDS in

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Lake St. Martin were comparable to 2011 Flood conditions (Figure 22 and Figure 23); true colour in October 2012 (< 5.0 CU) was notably lower than measured during flood conditions in October 2011 (6.9 CU) (Table 8).

As during 2011 Flood, TDS consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water in both the Fairford River and Lake St. Martin during 2011/2012 Operation (Figure 10 and Figure 23). Laboratory pH frequently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water in both the Fairford River and Lake St. Martin.

4.1.2.2 Dissolved Oxygen

During 2011/2012 Operation, the Fairford River and Lake St. Martin were well oxygenated, with concentrations ranging from 7.6-14.8 mg/L and 8.2-14.4 mg/L, respectively (Figure 12 and Figure 25). DO concentrations in the Fairford River were consistently above objectives for PAL, whereas DO in Lake St. Martin at LSM1 was occasionally below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) when water temperatures were ≤5 °C (Table 9).

4.1.2.3 TSS

At the onset of 2011/2012 Operation in November 2011, TSS concentrations remained elevated in the Fairford River through to the beginning of December (Figure 7). TSS remained at background levels at this site until mid-May 2012 when it measured 8.0-10.1 mg/L. Elevated concentrations ranging from 20.8-24.0 mg/L were measured in early October 2012; this may have been related to heavy wind conditions that occurred in the watershed in mid-September. Similar to the Fairford River, TSS in Lake St. Martin was elevated at the onset of 2011/2012 Operation, but quickly declined and remained at background levels until mid-April 2012; an increase in TSS in the lake at this time likely coincided with spring melt conditions (Figure 20). TSS was somewhat elevated in mid-October (15.4 mg/L) and, again, may have been a residual effect of the heavy wind conditions that occurred in September 2012.

4.1.2.4 Nutrients

TN appears to have been somewhat lower in the Fairford River since 2009 and may have increased marginally during 2011 Flood conditions (Figure 13). In winter 2011, TN concentration in the river quickly declined and remained comparable to these earlier data for the remainder of the monitoring period. TN in Lake St. Martin during 2011/2012 Operation was, on average, lower (1.06 mg/L) than that measured during the 2011 Flood period (1.41 mg/L) (Table 8). The highest concentration of TN was observed in February 2012 and may be attributed to an increase in ammonia during this time (Figures 26 and 31).

4.1.2.5 Chlorophyll *a*

During 2011/2012 Operation, chlorophyll *a* concentrations in the Fairford River averaged 7.22 mg/L and ranged from 1.07-15.30 mg/L (Figure 17). In Lake St. Martin, chlorophyll *a* concentrations averaged 4.86 mg/L and ranged between 3.48 and 7.14 mg/L (Figure 29). For both waterbodies, chlorophyll *a* concentrations declined during winter 2012 and increased through the following open-water season.

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4.1.2.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Similar to the 2011 Flood period, total aluminum occasionally exceeded the MWQSOGs/CCME guideline for PAL (0.1 mg/L) in the Fairford River during 2011/2012 Operation (Figure 18); total aluminum was consistently within this objective in Lake St. Martin during 2011/2012 Operation (Table 10). Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) during the 2011/2012 Operation period in both the river and the lake (Table 10). Fluoride consistently exceeded the CCME interim PAL (0.12 mg/L) in the Fairford River and Lake St. Martin during 2011/2012 Operation (Table 10). As during 2011 Flood, selenium occasionally exceeded the MWQSOGs/CCME PAL (0.001 mg/L) in the Fairford River during 2011/2012 Operation, but concentrations were near the analytical detection limit and as previously mentioned when results are near the analytical detection limit there is low confidence that an exceedance has occurred. All other metals and major ions were within guidelines for PAL (Table 10) and drinking water (Table 11) in the Fairford River and Lake St. Martin during 2011/2012 Operation.

4.1.2.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in Lake St. Martin at the onset of 2011/2012 Operation or during closure activities in November 2012 (Figure 30). Analytical detection limits for hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12). Petroleum hydrocarbons were not monitored at the Fairford River.

4.1.3 2011/2012 Closure

Complete water quality data for Upstream Areas during 2011/2012 Closure are limited to the Fairford River (FR1) and LSM1 in the middle of the north basin of Lake St. Martin; limited data are available for LSM2 at the inlet to Reach 1. During 2011/2012 Closure, water quality conditions of the Fairford River and Lake St. Martin remained generally consistent with those observed during 2011 Flood and 2011/2012 Operation (Table 8). The following sections highlight any changes observed.

4.1.3.1 Routine

During 2011/2012 Closure, conductivity and TDS in the Fairford River remained comparable to 2011 Flood and 2011/2012 Operation (Figure 9 and Figure 10); true colour remained comparable to Historic and 2011/2012 Operation conditions (Table 8). Conductivity, TDS, and true colour in Lake St. Martin remained similar to previously measured conditions (Table 4.1.1; Figure 22 and Figure 23).

As during previous periods, TDS consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water in the Fairford River during 2011/2012 Closure; the aesthetic objective was only frequently exceeded in Lake St. Martin (Figure 10 and Figure 23). True colour rarely exceeded the MWQSOGs/Health Canada objective for drinking water in the Fairford River. Laboratory pH continued to frequently exceed the MWQSOGs/Health Canada aesthetic objective for drinking water in both the Fairford River and Lake St. Martin.

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4.1.3.2 Dissolved Oxygen

During 2011/2012 Closure, DO concentrations were somewhat lower in the Fairford River and Lake St. Martin compared to 2011/2012 Operation concentrations, with concentrations ranging from 4.4-12.5 mg/L and 6.9-11.5 mg/L, respectively (Figure 12 and Figure 25). DO concentrations in the Fairford River and Lake St. Martin were frequently below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) when water temperatures were ≤ 5°C (Table 9). Additionally, DO concentrations in the Fairford River were occasionally below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cool-water mature-life/warm-water other-life stages (5.5 mg/L) when water temperatures were ≤ 5°C.

4.1.3.3 TSS

TSS concentrations in the Fairford River during 2011/2012 Closure ranged from < 2 to 16 mg/L (Figure 7). With increasing discharge during the 2013 open-water season, there was a corresponding increase in TSS concentration measured. For Lake St. Martin, TSS concentrations during 2011/2012 Closure closely resembled those observed during 2011/2012 Operation, with the exception of a single high TSS measurement recorded at LSM2 (inlet to Reach 1) on 20 June 2014 (47 mg/L), just prior to the onset of 2014/2015 Operation (Figure 20).

4.1.3.4 Nutrients

TN measured in the Fairford River during 2011/2012 Closure (0.97 mg/L) was on average somewhat lower than during 2011/2012 Operation (1.05 mg/L) and 2011 Flood (1.15 mg/L) periods (Figure 13). Ammonia and nitrate/nitrate concentrations were both elevated during the winters of 2013 and 2014 (Figure 31 and Figure 32). TN in Lake St. Martin during 2011/2012 Closure was, on average, lower than measured previously (Table 8). Limited data from LSM2 indicated that TP exceeded the MWQSOGs narrative guideline for lakes (0.025 mg/L) on two occasions during 2011/2012 Closure, 14 May 2013 (0.043 mg/L) and 20 June 2014 (0.054 mg/L).

4.1.3.5 Chlorophyll *a*

During 2011/2012 Closure, chlorophyll *a* concentration in the Fairford River averaged 3.41 mg/L and ranged from 0.90-8.29 mg/L (Figure 17). In Lake St. Martin, chlorophyll *a* concentration averaged 4.10 mg/L and ranged between 0.50 and 6.86 mg/L (Figure 29). For both waterbodies, chlorophyll *a* was lowest in spring 2013 and 2014 and increased through the following open-water season.

4.1.3.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Similar to previous monitoring periods, total aluminum rarely exceeded the MWQSOGs/CCME guideline for PAL (0.1 mg/L) in the Fairford River during 2011/2012 Closure (Figure 18); total aluminum was consistently within this objective in Lake St. Martin during 2011/2012 Closure (Table 10). Again, chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) during the 2011/2012 Closure period in both the river and the lake (Table 10); additionally, chloride rarely exceeded the MWQSOGs/Health Canada aesthetic objective (≤ 250 mg/L) in the Fairford River during 2011/2012 Closure. Fluoride frequently exceeded the CCME interim PAL (0.12 mg/L) in the Fairford River and Lake

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St. Martin during 2011/2012 Closure (Table 10). Silver occasionally exceeded the MWQSOGs/CCME PAL (0.0001 mg/L) in Lake St. Martin during 2011/2012 Closure, but concentration was near the analytical detection limit. All other metals and major ions were within guidelines for PAL (Table 10) and drinking water (Table 11) in the Fairford River and Lake St. Martin during 2011/2012 Closure.

4.1.3.7 Petroleum Hydrocarbons

During 2011/2012 Closure, petroleum hydrocarbons were only sampled prior to the onset of 2014/2015 Operation; they were not detected in Lake St. Martin at this time (Figure 30). Analytical detection limits for hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12). Petroleum hydrocarbons were not monitored at the Fairford River.

4.1.4 2014/2015 Operation

Complete water quality data for Upstream Areas during 2014/2015 Operation are limited to the Fairford River (FR1) and in the middle of the north basin of Lake St. Martin (LSM1); limited data are available for Lake St. Martin at the inlet to Reach 1 (LSM2). During 2014/2015 Operation, water quality conditions of the Fairford River and Lake St. Martin remained generally consistent with those observed during from 2011-2013 (Table 8). The following sections highlight any qualitative changes observed.

4.1.4.1 Routine

During 2014/2015 Operation, conductivity and TDS in both the Fairford River and Lake St. Martin were, on average, lower than those concentrations observed during 2011/2012 Operation and Closure (Table 8; Figures 9, 10, 22, and 23). However, it should be noted that this is likely due to the protracted sampling period for 2014 in comparison to previous years, which did not include spring and winter sampling dates where both of these parameters tend to be higher. True colour was, on average, higher in the river and lake during 2014/2015 Operation in comparison to other monitoring periods, but this again may be an artefact of the fewer number of samples collected during the 2014/2015 sampling program.

As during previous monitoring periods, TDS consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water in both the Fairford River and Lake St. Martin during 2014/2015 Operation (Figures 10 and 23). True colour did not exceed the MWQSOGs/Health Canada objective for drinking water in either the river or lake. Laboratory pH continued to frequently exceed the MWQSOGs/Heath Canada aesthetic objective for drinking water in both the Fairford River and Lake St. Martin.

4.1.4.2 Dissolved Oxygen

Similar to 2011/2012 Closure, DO concentrations in the Fairford River and Lake St. Martin were somewhat lower compared to 2011/2012 Operation with concentrations ranging from 5.7-12.0 mg/L and 6.5-11.9 mg/L, respectively (Figures 12 and 25). DO in the Fairford River was below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) during the one sampling event when water temperatures were ≤ 5°C (Table 9). Additionally, DO in Lake St.

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Martin was occasionally below the objective/lowest acceptable concentration for cold-water mature-life/other-life stages (6.5 mg/L) when water temperature was > 5°C.

4.1.4.3 TSS

TSS concentrations in the Fairford River during 2014/2015 Operation ranged from 7 mg/L to 23 mg/L (Figure 7). With increasing discharge during the 2014 open-water season, there was a corresponding increase in TSS concentrations. TSS in Lake St. Martin at LSM2 was elevated at the onset of 2014/2015 Operation but quickly declined and remained at background levels for the remainder of the sampling period (Figure 20).

4.1.4.4 Nutrients

TN concentrations in the Fairford River during 2014/2015 Operation (0.94 mg/L) were, on average, similar to those measured during 2011/2012 Closure (0.97 mg/L) (Figure 13). TN concentrations in Lake St. Martin were, on average, higher than those measured during 2011/2012 Closure (Table 8).

4.1.4.5 Chlorophyll *a*

During 2014/2015 Operation, chlorophyll *a* concentrations in the Fairford River averaged 5.90 mg/L and ranged from 3.62-7.22 mg/L (Figure 17). In Lake St. Martin, chlorophyll *a* averaged 6.31 mg/L and ranged between 5.89 mg/L and 6.72 mg/L (Figure 29). Although fewer samples were collected during 2014/2015 Operation, chlorophyll *a* concentrations still showed an increase through the open-water season in both waterbodies.

4.1.4.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

In contrast to previous monitoring periods, aluminum was within the MWQSOGs/CCME guideline for PAL (0.1 mg/L) in the Fairford River during 2014/2015 Operation; previously aluminum was consistently within this objective in Lake St. Martin and remained so (Table 10). As for all previous monitoring periods, chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) during the 2014/2015 Operation period in both the river and the lake (Table 10). As during 2011/2012 Operation, fluoride consistently exceeded the CCME interim PAL (0.12 mg/L) in the Fairford River and Lake St. Martin during 2014/2015 Operation (Table 10). All other metals and major ions were within guidelines for PAL (Table 10) and drinking water (Table 11) in the Fairford River and Lake St. Martin during 2014/2015 Operation.

4.1.4.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in Lake St. Martin at the onset of 2014/2015 Operation in July 2014 or during the Expanded Opening in November 2014 (Figure 30). Analytical detection limits for hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12). Petroleum hydrocarbons were not monitored at the Fairford River.

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4.1.5 2014/2015 Closure

Water quality data for the Upstream Areas during the 2014/2015 Closure period are limited to the north basin of Lake St. Martin (LSM1). Measurement parameters included DO, TSS, and nutrients. During 2014/2015 Closure, water quality conditions in Lake St. Martin remained generally consistent with those observed during from 2011-2014 (Table 8). The following sections highlight any qualitative changes observed.

4.1.5.1 Dissolved Oxygen

At the onset of 2014/2015 Closure, DO concentrations in Lake St. Martin were somewhat lower compared to 2014/2015 Operation though concentrations returned to pre-Project levels by 14 September (Figure 25). DO was below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water mature-life/other-life stages (6.5 mg/L) during the one sampling event (August 13) when water temperatures were > 5°C (Table 9).

4.1.5.2 TSS

TSS concentrations in Lake St. Martin during 2014/2015 Closure were similar to those during 2014/2015 Operation and pre-Project phases (Figure 20). TSS in the lake ranged from 6.8 mg/L to 7.4 mg/L (Table 8).

4.1.5.3 Nutrients

TP concentrations in Lake St. Martin during 2014/2015 Closure ranged from 0.017 to 0.023 mg/L and were similar to those measured during 2014/2015 Operation and the pre-Project phases (Figure 27; Table 8). In contrast, mean, minimum, and maximum TN concentrations (1.02, 0.85, and 1.22 mg/L, respectively) were similar to those measured during 2014/2015 Operation but were slightly lower than those measured during the 2011 Flood (Figure 26; Table 8).

All nutrients that were analysed during 2014/2015 Closure were within MWQSOGs and CCME guidelines for PAL, including ammonia (varies with pH and temperature); nitrate (2.93 mg/L); and, nitrite (0.06 mg/L).

4.1.6 Summary

Sites located in Lake St. Martin upstream of the Project exhibited natural variability in water quality parameters over the course of the monitoring program. Although conditions fluctuated seasonally and between years, there was no linkage between operation of Reach 1 and water quality in Lake St. Martin, with the following exception:

- During dredging in October 2011, total suspended solids (TSS) in the vicinity of the Reach 1 inlet exceeded the 30 day Manitoba water quality objectives / CCME long-term guideline for PAL (average of 5 mg/L above background), and periodically exceeded the 1-day Manitoba PAL objective/CCME short-term PAL guideline (25 mg/L above background).

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Table 8. Summary statistics for key water quality parameters measured in the Fairford River and Lake St. Martin, 2011-2015.

		Ammonia (mg N/L)							Nitrate/Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.143	0.106	0.005	0.710	0.0263	32	100	0.062	<0.010	<0.0060	1.56	0.0484	32	47
	2011 Flood	0.033	0.019	<0.010	0.206	0.0126	16	81	<0.05	<0.05	<0.0051	<0.05	0.0014	16	0
	2011/2012 Operation	<0.050	<0.050	<0.050	0.087	0.0060	15	100	<0.05	<0.05	<0.0051	0.073	-	14	14
	2011/2012 Closure	0.098	0.087	<0.010	0.209	0.0211	17	76	<0.05	<0.05	<0.0051	0.121	0.0096	15	60
	2014/2015 Operation	0.010	<0.010	<0.010	0.033	0.0035	8	25	<0.0051	<0.0051	<0.0051	<0.0051	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.050	<0.050	<0.050	0.052	-	4	25	<0.071	<0.071	<0.071	<0.071	-	4	25
	2011/2012 Operation	0.070	0.067	0.013	0.211	0.0130	19	100	<0.071	<0.071	<0.0051	<0.071	-	19	5
	2011/2012 Closure	0.068	<0.010	<0.010	0.247	0.0404	7	43	0.015	<0.0051	<0.0051	0.055	0.0082	7	29
	2014/2015 Operation	0.029	0.012	<0.010	0.108	0.0199	5	60	<0.071	0.019	<0.0051	0.089	0.0160	5	40
	2014/2015 Closure	<0.010	<0.010	<0.010	<0.010	-	3	0	<0.070	<0.070	<0.070	<0.070	-	3	0
LSM2	2011 Flood	0.044	0.044	0.044	0.044	-	1	100	0.009	0.009	0.009	0.009	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.028	0.010	<0.010	0.070	0.0209	3	67	<0.071	<0.071	<0.071	<0.071	-	3	0
	2014/2015 Operation	0.016	<0.010	<0.010	0.062	0.0075	9	22	<0.071	<0.071	<0.071	<0.071	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Nitrate (mg N/L)							Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011 Flood	-	-	-	-	-	1	0	-	-	-	-	-	1	0
	2011/2012 Operation	<0.0050	<0.0050	<0.0050	0.007	-	4	25	0.001	0.001	0.001	0.002	-	4	25
	2011/2012 Closure	0.023	<0.0050	<0.0050	0.086	0.0119	7	43	0.001	<0.0010	<0.0010	0.004	0.0006	7	29
	2014/2015 Operation	<0.0050	<0.0050	<0.0050	<0.0050	-	3	0	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	4	25	<0.050	<0.050	<0.050	<0.050	-	4	25
	2011/2012 Operation	<0.050	<0.050	<0.0050	<0.050	-	19	5	<0.050	<0.050	<0.0010	<0.050	0.0023	19	11
	2011/2012 Closure	0.014	<0.0050	<0.0050	0.052	0.0078	7	29	0.001	<0.0010	<0.0010	0.003	0.0003	7	29
	2014/2015 Operation	0.024	0.010	<0.0050	0.088	0.0161	5	40	<0.0010	<0.0010	<0.0010	<0.0010	-	5	0
	2014/2015 Closure	<0.020	<0.020	<0.020	<0.020	-	3	0	<0.010	<0.010	<0.010	<0.010	-	3	0
LSM2	2011 Flood	0.009	0.009	0.009	0.009	-	1	100	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.050	<0.050	<0.050	<0.050	-	3	0	<0.0050	<0.0050	<0.0050	<0.0050	-	3	0
	2014/2015 Operation	<0.050	<0.050	<0.050	0.065	0.0052	9	22	<0.050	<0.050	<0.050	<0.050	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Dissolved Inorganic Nitrogen (mg/L)							Total Kjeldahl Nitrogen (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.205	0.125	0.011	1.68	0.055	32	100	1.43	1.40	0.68	2.30	0.085	32	100
	2011 Flood	<0.050	<0.050	<0.050	0.231	0.014	16	25	1.12	1.12	0.82	1.50	0.045	16	100
	2011/2012 Operation	0.051	<0.050	<0.050	0.112	0.009	14	71	1.03	1.02	0.85	1.36	0.038	15	100
	2011/2012 Closure	0.129	0.117	<0.010	0.298	0.028	16	75	0.93	0.96	0.61	1.12	0.029	17	100
	2014/2015 Operation	0.015	0.010	<0.010	0.038	0.005	8	63	0.89	0.90	0.77	0.99	0.031	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.070	<0.070	<0.070	<0.070	-	4	25	1.39	1.12	1.02	2.29	0.302	4	100
	2011/2012 Operation	0.095	0.103	<0.070	0.246	0.015	19	79	1.03	1.04	0.36	1.74	0.056	19	100
	2011/2012 Closure	0.082	<0.010	<0.010	0.284	0.049	7	43	0.84	0.86	0.61	1.04	0.058	7	100
	2014/2015 Operation	<0.071	<0.010	<0.010	<0.071	-	4	25	0.96	0.93	0.90	1.06	0.030	5	100
	2014/2015 Closure	<0.010	<0.010	<0.010	<0.010	-	3	0	1.02	1.00	0.85	1.22	0.107	3	100
LSM2	2011 Flood	0.053	0.053	0.053	0.053	-	1	100	1.11	1.11	1.11	1.11	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.070	<0.070	<0.070	0.106	-	3	33	0.80	0.85	0.68	0.86	0.058	3	100
	2014/2015 Operation	<0.070	<0.070	<0.070	0.098	-	9	33	0.90	0.90	0.81	0.98	0.019	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Total Nitrogen (mg/L)							Dissolved Phosphorus (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	1.49	1.47	0.68	2.96	0.098	32	100	0.008	0.008	<0.0010	0.017	0.0007	32	97
	2011 Flood	1.15	1.15	0.85	1.53	0.045	16	100	0.012	0.013	<0.010	0.017	0.0010	16	88
	2011/2012 Operation	1.05	1.03	0.85	1.39	0.043	14	100	0.010	0.011	<0.010	0.022	0.0016	15	93
	2011/2012 Closure	0.97	1.02	0.64	1.21	0.040	15	100	0.006	0.005	0.002	0.015	0.0008	17	100
	2014/2015 Operation	0.94	0.96	0.87	0.98	0.034	3	100	0.005	0.006	0.005	0.006	0.0001	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	1.42	1.14	1.06	2.33	0.303	4	100	<0.010	<0.010	<0.0020	0.015	0.0032	4	50
	2011/2012 Operation	1.06	1.08	0.40	1.77	0.057	19	100	<0.010	<0.010	<0.010	0.014	0.0009	18	61
	2011/2012 Closure	0.85	0.87	0.61	1.08	0.063	7	100	0.007	0.007	0.003	0.011	0.0011	7	100
	2014/2015 Operation	0.98	1.00	0.91	1.06	0.029	5	100	<0.010	<0.010	<0.010	<0.010	0.0003	5	60
	2014/2015 Closure	1.02	1.00	0.85	1.22	0.107	3	100	<0.010	<0.010	<0.010	0.012	-	3	33
LSM2	2011 Flood	1.12	1.12	1.12	1.12	-	1	100	<0.010	<0.010	<0.010	<0.010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.83	0.89	0.72	0.90	0.058	3	100	<0.010	0.010	<0.010	0.013	0.0023	3	67
	2014/2015 Operation	0.94	0.94	0.85	1.01	0.018	9	100	<0.010	<0.010	<0.010	0.011	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Total Particulate Phosphorus (mg/L)							Total Phosphorus (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.013	0.010	<0.0010	0.037	0.0017	32	97	0.020	0.019	0.002	0.045	0.0017	32	100
	2011 Flood	0.012	<0.010	<0.010	0.026	0.0021	16	50	0.025	0.024	0.015	0.038	0.0013	16	100
	2011/2012 Operation	<0.010	<0.010	<0.010	0.023	0.0016	15	47	0.020	0.019	0.012	0.029	0.0016	15	100
	2011/2012 Closure	<0.010	<0.010	<0.0010	0.017	0.0011	17	88	0.015	0.013	0.008	0.021	0.0011	17	100
	2014/2015 Operation	0.014	0.015	0.012	0.017	0.0006	8	100	0.020	0.020	0.018	0.022	0.0005	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.010	<0.010	<0.010	0.016	0.0027	4	50	0.020	0.021	0.013	0.024	0.0024	4	100
	2011/2012 Operation	0.010	0.011	<0.010	0.018	0.0012	18	56	0.019	0.019	0.011	0.027	0.0011	19	100
	2011/2012 Closure	<0.010	<0.010	<0.010	0.015	0.0020	7	86	0.014	0.013	0.010	0.021	0.0016	7	100
	2014/2015 Operation	0.011	0.012	0.006	0.014	0.0014	5	100	0.017	0.017	0.012	0.020	0.0014	5	100
	2014/2015 Closure	0.012	0.012	0.011	0.013	0.0006	3	100	0.019	0.018	0.017	0.023	0.0019	3	100
LSM2	2011 Flood	0.011	0.011	0.011	0.011	-	1	100	0.016	0.016	0.016	0.016	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.029	0.033	0.012	0.041	0.0086	3	100	0.038	0.043	0.017	0.054	0.0110	3	100
	2014/2015 Operation	0.012	0.013	<0.010	0.020	0.0016	9	78	0.018	0.018	0.011	0.025	0.0012	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Dissolved Fraction, Phosphorus (%)							TN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	43	43	5	98	3.9	32	100	214	162	62	1002	32.0	32	100
	2011 Flood	49	52	13	74	5.1	16	100	103	98	70	144	5.4	16	100
	2011/2012 Operation	54	63	13	83	6.5	15	100	127	127	95	176	7.8	14	100
	2011/2012 Closure	43	38	17	98	5.2	17	100	151	120	0	302	19.9	16	100
	2014/2015 Operation	28	27	24	34	1.3	8	100	41	0	0	113	20.1	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	38	40	8	63	13.2	4	100	161	158	111	215	26.3	4	100
	2011/2012 Operation	47	43	17	100	5.7	18	100	132	125	52	196	8.6	19	100
	2011/2012 Closure	51	60	17	84	9.2	7	100	146	117	71	238	23.2	7	100
	2014/2015 Operation	39	36	30	49	3.6	5	100	134	116	107	191	15.8	5	100
	2014/2015 Closure	63	42	38	109	23.0	3	100	117	117	104	130	7.4	3	100
LSM2	2011 Flood	31	31	31	31	-	1	100	155	155	155	155	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	26	24	23	29	1.9	3	100	63	37	37	115	26.2	3	100
	2014/2015 Operation	32	28	20	55	3.7	9	100	117	113	87	178	8.9	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		DIN:DP Molar Ratio							DIN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	115	45	2	819	35.8	32	100	36	17	1	310	11.9	32	100
	2011 Flood	9	5	3	34	2.2	16	100	4	2	1	24	1.5	16	100
	2011/2012 Operation	17	9	3	58	5.1	14	100	7	5	2	21	1.5	14	100
	2011/2012 Closure	63	21	1	239	18.0	16	100	25	15	1	72	6.1	16	100
	2014/2015 Operation	6	4	2	14	1.8	8	100	2	1	1	5	0.6	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	43	11	5	146	34.3	4	100	5	4	3	11	1.9	4	100
	2011/2012 Operation	29	18	5	109	5.8	18	100	12	10	2	33	2.2	19	100
	2011/2012 Closure	35	4	1	174	24.6	7	100	17	1	1	63	10.4	7	100
	2014/2015 Operation	21	15	2	68	12.1	5	100	9	4	1	33	6.2	5	100
	2014/2015 Closure	2	2	1	2	0.4	3	100	1	1	0	1	0.1	3	100
LSM2	2011 Flood	23	23	23	23	-	1	100	7	7	7	7	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	15	16	6	23	5.0	3	100	4	5	1	5	1.2	3	100
	2014/2015 Operation	17	16	6	37	2.8	9	100	5	5	2	11	1.0	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Total Inorganic Carbon (mg/L)							Total Organic Carbon (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	44.2	44.0	38.0	52.0	0.77	28	100	15.6	15.4	8.1	23.0	0.62	28	100
	2011 Flood	44.5	43.9	42.7	49.1	0.43	16	100	13.7	13.9	11.8	15.3	0.23	16	100
	2011/2012 Operation	46.5	45.9	40.9	56.7	1.17	15	100	13.5	13.6	11.4	14.8	0.23	15	100
	2011/2012 Closure	47.2	47.8	37.3	58.8	1.71	17	100	13.9	14.3	11.3	16.2	0.40	17	100
	2014/2015 Operation	39.1	40.1	32.3	41.0	0.99	8	100	12.9	13.5	9.1	14.5	0.63	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	45.0	45.0	45.0	45.0	-	1	100	13.5	13.5	13.5	13.5	-	1	100
	2011/2012 Operation	45.9	45.2	42.0	51.1	2.04	4	100	14.1	14.2	12.7	15.4	0.56	4	100
	2011/2012 Closure	42.6	40.6	33.8	54.2	2.92	7	100	12.8	12.7	9.1	15.2	0.86	7	100
	2014/2015 Operation	43.3	42.0	36.4	51.4	4.38	3	100	12.3	12.4	9.8	14.7	1.40	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	30.2	30.2	30.2	30.2	-	1	100	14.8	14.8	14.8	14.8	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Dissolved Organic Carbon (mg/L)							TOC:ON Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	17	14	6	31	1.4	28	100
	2011 Flood	13.4	13.4	13.4	13.4	-	1	100	15	14	11	20	0.7	16	100
	2011/2012 Operation	12.1	12.1	11.5	12.5	0.27	4	100	16	16	13	20	0.6	15	100
	2011/2012 Closure	13.0	12.8	11.3	16.3	0.75	7	100	20	20	15	23	0.6	17	100
	2014/2015 Operation	12.0	13.2	8.5	14.3	1.78	3	100	17	18	12	21	0.9	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	12.0	12.0	12.0	12.0	-	1	100	14	14	14	14	-	1	100
	2011/2012 Operation	12.5	12.2	11.7	14.1	0.55	4	100	18	18	16	19	0.7	4	100
	2011/2012 Closure	12.5	12.7	9.0	15.4	0.85	7	100	19	20	16	23	1.0	7	100
	2014/2015 Operation	12.2	12.5	9.4	14.8	1.56	3	100	16	18	11	19	2.3	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	13.7	13.7	13.7	13.7	-	1	100	16	16	16	16	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		TOC:TN Molar Ratio							Laboratory pH						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	14	14	5	25	1.1	28	100	8.27	8.36	7.59	8.67	0.045	31	100
	2011 Flood	14	14	10	19	0.6	16	100	8.52	8.57	8.19	8.63	0.028	16	100
	2011/2012 Operation	15	15	12	18	0.5	14	100	8.51	8.51	8.43	8.63	0.015	15	100
	2011/2012 Closure	17	17	15	21	0.4	15	100	8.30	8.28	7.86	8.61	0.058	17	100
	2014/2015 Operation	15	16	12	17	1.6	3	100	8.51	8.50	8.39	8.61	0.024	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	14	14	14	14	-	1	100	8.47	8.47	8.47	8.47	-	1	100
	2011/2012 Operation	17	17	16	18	0.5	4	100	8.50	8.53	8.36	8.57	0.048	4	100
	2011/2012 Closure	18	17	15	20	0.7	7	100	8.41	8.51	8.03	8.62	0.081	7	100
	2014/2015 Operation	15	14	11	19	2.1	3	100	8.58	8.58	8.47	8.68	0.061	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	15	15	15	15	-	1	100	8.46	8.46	8.46	8.46	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Laboratory Conductivity (µmhos/cm)							Total Dissolved Solids (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	1557	1530	1280	2000	29.8	32	100	906	896	742	1480	26.6	29	100
	2011 Flood	1092	1060	964	1440	29.4	16	100	687	673	626	860	14.4	16	100
	2011/2012 Operation	1096	1090	1010	1240	15.7	15	100	672	661	604	802	13.6	15	100
	2011/2012 Closure	1157	1150	931	1390	36.9	17	100	656	615	546	810	27.4	13	100
	2014/2015 Operation	921	920	898	948	6.5	8	100	529	526	508	548	5.1	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	1080	1080	1080	1080	-	1	100	652	652	652	652	-	1	100
	2011/2012 Operation	1082	1095	1027	1110	18.8	4	100	681	680	622	744	25.1	4	100
	2011/2012 Closure	1063	1030	857	1310	60.3	7	100	622	598	488	772	38.6	7	100
	2014/2015 Operation	1008	953	920	1150	71.9	3	100	574	554	512	655	42.4	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	1060	1060	1060	1060	-	1	100	704	704	704	704	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Total Suspended Solids (mg/L)							Laboratory Turbidity (NTU)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	10	7	<5.0	32	1.6	31	90	6.6	5.4	1.0	18.3	1.09	27	100
	2011 Flood	18	15	<5.0	44	3.0	16	94	12.3	8.7	0.2	35.0	2.42	16	100
	2011/2012 Operation	13	12	<5.0	28	2.5	15	67	9.6	6.7	1.1	33.0	2.51	15	100
	2011/2012 Closure	6	5	<2.0	16	1.1	17	65	3.9	2.0	0.7	11.5	0.97	13	100
	2014/2015 Operation	15	15	7	23	1.7	8	100	9.4	9.1	5.6	14.7	1.44	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	7	6	4	10	1.3	4	100	3.8	3.8	3.8	3.8	-	1	100
	2011/2012 Operation	8	7	<2.0	19	1.1	19	84	6.1	3.7	1.2	33.6	2.23	14	100
	2011/2012 Closure	6	6	<2.0	10	1.3	7	86	2.5	3.0	0.6	4.3	0.58	7	100
	2014/2015 Operation	6	5	<2.0	13	1.7	6	83	3.8	2.9	1.5	8.5	1.00	6	100
	2014/2015 Closure	7	7	7	7	0.2	3	100	5.8	6.0	5.5	6.0	0.19	3	100
LSM2	2011 Flood	5.8	5.8	5.8	5.8	-	1	100	3.3	3.3	3.3	3.3	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	20	10	4	47	13.6	3	100	12.3	5.0	1.8	30.0	8.91	3	100
	2014/2015 Operation	8	6	5	16	0.9	12	100	4.1	3.4	2.5	7.9	0.46	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	True Colour (CU)							Chlorophyll *a* (µg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	6.0	<5.0	<5.0	20.0	0.94	26	46	5.84	4.49	<0.50	19.5	1.13	16	94
	2011 Flood	10.4	8.9	5.7	30.5	1.47	16	100	8.61	8.02	1.53	14.5	0.823	16	100
	2011/2012 Operation	7.4	7.5	<5.0	10.4	0.54	15	93	7.22	6.42	1.07	15.3	1.16	15	100
	2011/2012 Closure	7.7	7.9	<5.0	20.8	1.33	13	77	3.41	2.67	0.90	8.29	0.510	17	100
	2014/2015 Operation	9.0	8.6	6.3	13.3	0.86	7	100	5.90	6.20	3.62	7.22	0.413	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	6.9	6.9	6.9	6.9	-	1	100	6.85	6.85	6.85	6.85	-	1	100
	2011/2012 Operation	6.2	6.2	<5.0	9.9	1.51	4	75	4.86	4.41	3.48	7.14	0.792	4	100
	2011/2012 Closure	6.5	5.7	<5.0	10.7	0.98	7	86	4.10	4.67	0.50	6.86	0.956	7	100
	2014/2015 Operation	8.8	9.0	7.9	9.5	0.49	3	100	4.46	5.89	0.76	6.72	1.864	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	8.4	8.4	8.4	8.4	-	1	100	6.98	6.98	6.98	6.98	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Phaeophytin a (µg/L)							*In Situ* Dissolved Oxygen (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.73	<0.60	<0.50	4.30	0.268	16	25	10.0	9.7	7.3	13.2	0.33	26	100
	2011 Flood	1.57	1.49	<0.60	3.53	0.248	16	81	9.4	9.6	7.4	11.5	0.33	16	100
	2011/2012 Operation	1.35	0.94	<0.60	3.19	0.244	15	87	11.1	11.5	7.6	14.8	0.55	14	100
	2011/2012 Closure	0.61	0.51	<0.60	1.44	0.089	17	59	9.6	10.0	4.4	12.5	0.65	13	100
	2014/2015 Operation	0.95	1.01	<0.60	1.36	0.129	8	88	9.3	9.7	5.7	12.0	0.85	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	1.83	1.83	1.83	1.83	-	1	100	11.3	12.0	9.9	12.5	0.56	5	100
	2011/2012 Operation	1.10	0.92	0.64	1.94	0.286	4	100	11.7	11.6	8.2	14.4	0.48	15	93
	2011/2012 Closure	0.81	0.69	0.56	1.30	0.106	7	100	9.9	9.5	8.9	11.5	0.38	7	100
	2014/2015 Operation	0.97	1.08	0.44	1.39	0.278	3	100	9.9	9.8	7.6	11.9	0.63	6	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.7	6.7	6.1	10.3	1.32	3	100
LSM2	2011 Flood	1.92	1.92	1.92	1.92	-	1	100	13.1	13.1	13.1	13.1	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	8.6	8.9	6.9	9.9	0.89	3	100
	2014/2015 Operation	-	-	-	-	-	0	-	9.1	9.1	6.5	11.7	0.57	10	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Chloride, Dissolved (mg/L)							Fluoride, Dissolved (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	312	307	243	383	8.1	27	100	-	-	-	-	-	0	-
	2011 Flood	215	203	195	305	7.3	16	100	0.154	0.154	0.154	0.154	-	1	100
	2011/2012 Operation	193	197	174	210	3.3	15	100	0.148	0.149	0.130	0.165	0.0075	4	100
	2011/2012 Closure	199	186	137	264	10.2	13	100	0.135	0.130	0.111	0.163	0.0074	7	100
	2014/2015 Operation	142	142	133	151	2.2	7	100	0.131	0.129	0.128	0.135	0.0022	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	205	205	205	205	-	1	100	0.159	0.159	0.159	0.159	-	1	100
	2011/2012 Operation	193	188	178	220	9.8	4	100	0.151	0.150	0.133	0.170	0.0078	4	100
	2011/2012 Closure	187	183	139	242	14.3	7	100	0.135	0.134	0.110	0.160	0.0081	7	100
	2014/2015 Operation	155	151	145	169	7.1	3	100	0.142	0.133	0.127	0.165	0.0117	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	209	209	209	209	-	1	100	0.160	0.160	0.160	0.160	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Sulphate, Dissolved (mg/L)							Hardness, as CaCO3 (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	98.4	97.8	71.8	134	3.4	25	100	278	276	236	321	4.7	25	100
	2011 Flood	89.8	90.0	77.6	111	1.9	16	100	282	275	239	335	7.0	16	100
	2011/2012 Operation	98.5	94.5	84.5	133	3.5	15	100	299	287	251	348	10.4	11	100
	2011/2012 Closure	80.0	79.6	67.1	96.9	3.3	13	100	255	245	203	333	12.6	10	100
	2014/2015 Operation	73.2	72.6	64.1	82.4	2.2	7	100	237	236	220	261	5.2	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	93.9	93.9	93.9	93.9	-	1	100	341	341	341	341	-	1	100
	2011/2012 Operation	95.3	97.6	83.1	103	4.6	4	100	287	293	268	296	6.5	4	100
	2011/2012 Closure	77.2	72.9	63.4	92.5	4.1	7	100	256	254	224	292	10.4	7	100
	2014/2015 Operation	84.3	76.5	74.3	102.0	8.9	3	100	258	239	237	298	20.0	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	91.9	91.9	91.9	91.9	-	1	100	328	328	328	328	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Aluminum, Dissolved (mg/L)							Aluminum, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.0074	0.003	<0.0010	0.033	0.00171	25	84	0.054	0.0480	0.009	0.250	0.00891	27	100
	2011 Flood	0.0035	0.0016	<0.0020	0.0217	0.00128	16	50	0.064	0.052	0.011	0.148	0.0105	16	100
	2011/2012 Operation	0.0037	<0.0020	<0.0020	0.0218	0.00139	15	47	0.0570	0.0279	0.0094	0.223	0.0159	15	100
	2011/2012 Closure	0.0024	<0.0020	<0.0020	0.0131	0.00101	13	15	0.0312	0.0217	0.0065	0.102	0.00700	13	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	0.0020	-	7	14	0.0623	0.0628	0.0407	0.0886	0.00661	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.039	0.039	0.039	0.039	-	1	100
	2011/2012 Operation	0.0055	0.0029	<0.0020	0.0153	0.00338	4	50	0.0335	0.0229	0.0120	0.0763	0.0145	4	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	0.0035	-	7	14	0.0199	0.0202	0.0066	0.0311	0.00369	7	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	0.0276	0.0249	0.0165	0.0414	0.00731	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.0041	0.0041	0.0041	0.0041	-	1	100	0.0346	0.0346	0.0346	0.0346	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Antimony, Dissolved (mg/L)							Antimony, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.00042	0.0005	<0.0002	0.0006	0.000037	27	78
	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	16	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	4	25	<0.0002	<0.0002	<0.0002	0.00021	0.000008	15	13
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	<0.0002	-	13	0
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	0.00021	-	3	33	<0.0002	0.00022	<0.0002	0.00030	0.000032	7	57
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	0.00026	0.000040	4	25	<0.0002	<0.0002	<0.0002	<0.0002	-	4	0
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	<0.0002	-	7	0
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	3	0	<0.0002	<0.0002	<0.0002	0.00022	-	3	67
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Arsenic, Dissolved (mg/L)							Arsenic, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.00224	0.00210	0.00140	0.00406	0.000115	27	100
	2011 Flood	0.00283	0.00283	0.00283	0.00283	-	1	100	0.00289	0.00284	0.00236	0.00355	0.000071	16	100
	2011/2012 Operation	0.00215	0.00222	0.00166	0.00251	0.000207	4	100	0.00251	0.00249	0.00169	0.00326	0.000114	15	100
	2011/2012 Closure	0.00187	0.00186	0.00157	0.00233	0.000108	7	100	0.00197	0.00201	0.00158	0.00225	0.000062	13	100
	2014/2015 Operation	0.00174	0.00178	0.00167	0.00178	0.000037	3	100	0.00184	0.00187	0.00153	0.00214	0.000071	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.00296	0.00296	0.00296	0.00296	-	1	100	0.00275	0.00275	0.00275	0.00275	-	1	100
	2011/2012 Operation	0.00257	0.00260	0.00227	0.00281	0.000142	4	100	0.00239	0.00234	0.00214	0.00275	0.000145	4	100
	2011/2012 Closure	0.00185	0.00192	0.00138	0.00219	0.000117	7	100	0.00184	0.00198	0.00145	0.00216	0.000108	7	100
	2014/2015 Operation	0.00193	0.00177	0.00167	0.00234	0.000208	3	100	0.00194	0.00180	0.00170	0.00233	0.000195	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.00269	0.00269	0.00269	0.00269	-	1	100	0.00260	0.00260	0.00260	0.00260	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Barium, Dissolved (mg/L)							Barium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.0525	0.0525	0.0440	0.0650	0.00106	27	100
	2011 Flood	0.0491	0.0491	0.0491	0.0491	-	1	100	0.0506	0.0502	0.0422	0.0592	0.00105	16	100
	2011/2012 Operation	0.0469	0.0464	0.0435	0.0515	0.00200	4	100	0.0519	0.0503	0.0460	0.0659	0.00135	15	100
	2011/2012 Closure	0.0428	0.0394	0.0375	0.0542	0.00241	7	100	0.0461	0.0446	0.0361	0.0567	0.00167	13	100
	2014/2015 Operation	0.0409	0.0401	0.0395	0.0432	0.00115	3	100	0.0436	0.0422	0.0395	0.0539	0.00188	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.0498	0.0498	0.0498	0.0498	-	1	100	0.0535	0.0535	0.0535	0.0535	-	1	100
	2011/2012 Operation	0.0472	0.0475	0.0446	0.0492	0.00108	4	100	0.0513	0.0516	0.0460	0.0560	0.00211	4	100
	2011/2012 Closure	0.0416	0.0412	0.0344	0.0495	0.00197	7	100	0.0440	0.0424	0.0342	0.0528	0.00254	7	100
	2014/2015 Operation	0.0449	0.0412	0.0402	0.0532	0.00418	3	100	0.0455	0.0405	0.0402	0.0557	0.00511	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.0482	0.0482	0.0482	0.0482	-	1	100	0.0508	0.0508	0.0508	0.0508	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Boron, Dissolved (mg/L)							Boron, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.129	0.130	0.100	0.190	0.0036	27	100
	2011 Flood	0.115	0.115	0.115	0.115	-	1	100	0.101	0.103	0.084	0.115	0.0021	16	100
	2011/2012 Operation	0.089	0.091	0.067	0.108	0.0088	4	100	0.107	0.102	0.086	0.155	0.0049	15	100
	2011/2012 Closure	0.097	0.094	0.084	0.124	0.0051	7	100	0.094	0.091	0.074	0.111	0.0036	13	100
	2014/2015 Operation	0.093	0.098	0.082	0.100	0.0057	3	100	0.089	0.091	0.075	0.101	0.0032	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.119	0.119	0.119	0.119	-	1	100	0.106	0.106	0.106	0.106	-	1	100
	2011/2012 Operation	0.102	0.101	0.088	0.119	0.0073	4	100	0.104	0.099	0.081	0.135	0.0115	4	100
	2011/2012 Closure	0.090	0.087	0.071	0.113	0.0048	7	100	0.091	0.094	0.068	0.110	0.0056	7	100
	2014/2015 Operation	0.096	0.097	0.093	0.098	0.0015	3	100	0.100	0.098	0.093	0.108	0.0044	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.089	0.089	0.089	0.089	-	1	100	0.096	0.096	0.096	0.096	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Cadmium, Dissolved (mg/L)							Cadmium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.000040	<0.000040	<0.000010	0.000040	-	27	4
	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	0.000020	0.0000010	16	25
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	0.000023	-	4	25	0.000014	0.000010	<0.000010	0.000089	0.0000055	15	60
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	0.000026	-	7	14	<0.000010	<0.000010	<0.000010	0.000017	-	13	8
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	0.000049	0.000049	0.000049	0.000049	-	1	100
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	0.000017	-	4	25	<0.000010	<0.000010	<0.000010	0.000011	0.0000016	4	50
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.000016	0.000016	0.000016	0.000016	-	1	100	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Calcium, Dissolved (mg/L)							Calcium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	44.0	43.6	36.3	54.3	0.88	27	100
	2011 Flood	44.2	44.2	44.2	44.2	-	1	100	49.4	48.2	42.4	72.4	1.77	16	100
	2011/2012 Operation	43.7	43.7	38.1	49.4	3.05	4	100	49.3	48.5	42.8	55.6	0.94	15	100
	2011/2012 Closure	45.7	42.8	39.0	54.4	2.56	7	100	47.4	45.3	38.3	62.5	1.81	13	100
	2014/2015 Operation	41.0	41.9	38.8	42.2	1.09	3	100	43.1	42.6	40.1	45.9	0.75	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	44.7	44.7	44.7	44.7	-	1	100	54.8	54.8	54.8	54.8	-	1	100
	2011/2012 Operation	46.7	47.2	40.8	51.8	2.35	4	100	49.8	49.5	47.8	52.5	1.11	4	100
	2011/2012 Closure	43.4	43.2	33.7	52.5	2.28	7	100	46.4	45.6	40.7	53.6	1.94	7	100
	2014/2015 Operation	46.4	42.5	41.8	54.8	4.22	3	100	47.0	45.4	42.5	53.1	3.16	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	46.0	46.0	46.0	46.0	-	1	100	53.7	53.7	53.7	53.7	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Chromium, Dissolved (mg/L)							Chromium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.0010	<0.0010	<0.0002	<0.0010	0.00003	27	63
	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	16	0
	2011/2012 Operation	0.0010	<0.0020	<0.0020	0.0011	-	4	25	<0.0010	<0.0010	<0.0010	<0.0010	-	15	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0	<0.0010	<0.0010	<0.0010	<0.0010	-	13	0
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	0.0022	-	4	25	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Copper, Dissolved (mg/L)							Copper, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.00102	<0.0010	<0.0010	0.00390	0.000130	27	81
	2011 Flood	0.00063	0.00063	0.00063	0.00063	-	1	100	0.00074	0.00073	0.00057	0.00091	0.000024	16	100
	2011/2012 Operation	0.00060	0.00058	0.00037	0.00087	0.000119	4	100	0.00072	0.00065	0.00058	0.00101	0.000037	15	100
	2011/2012 Closure	0.00052	0.00048	<0.00020	0.00114	0.000118	7	86	0.00076	0.00064	0.00046	0.00127	0.000073	13	100
	2014/2015 Operation	0.00045	0.00042	0.00039	0.00055	0.000049	3	100	0.00089	0.00057	0.00038	0.00313	0.000375	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.00055	0.00055	0.00055	0.00055	-	1	100	0.00050	0.00050	0.00050	0.00050	-	1	100
	2011/2012 Operation	0.00047	0.00046	0.00036	0.00061	0.000052	4	100	0.00073	0.00073	0.00054	0.00093	0.000086	4	100
	2011/2012 Closure	0.00043	0.00044	<0.00020	0.00063	0.000070	7	86	0.00080	0.00061	0.00041	0.00202	0.000213	7	100
	2014/2015 Operation	0.00039	0.00034	0.00027	0.00057	0.000091	3	100	0.00056	0.00042	0.00042	0.00083	0.000137	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.00048	0.00048	0.00048	0.00048	-	1	100	0.00051	0.00051	0.00051	0.00051	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Iron, Dissolved (mg/L)							Iron, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	0.031	0.031	0.031	0.031	-	1	100	<0.10	<0.10	<0.010	0.260	0.0106	27	89
	2011 Flood	0.042	0.038	<0.010	0.092	0.0083	11	91	<0.10	<0.10	<0.10	0.220	0.0154	16	38
	2011/2012 Operation	0.033	0.018	<0.010	0.148	0.0119	12	75	0.086	<0.010	<0.010	0.220	0.0181	14	50
	2011/2012 Closure	0.017	<0.010	<0.010	0.080	0.0069	12	42	0.026	0.025	<0.010	0.041	0.0046	8	88
	2014/2015 Operation	0.010	<0.010	<0.010	0.020	-	3	33	0.053	0.045	0.036	0.092	0.0074	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	1	0	0.040	0.040	0.040	0.040	-	1	100
	2011/2012 Operation	<0.010	<0.010	<0.010	<0.010	-	4	0	0.027	0.021	0.010	0.056	0.0100	4	100
	2011/2012 Closure	<0.010	<0.010	<0.010	<0.010	-	7	0	0.019	0.023	<0.010	0.029	0.0038	7	71
	2014/2015 Operation	<0.010	<0.010	<0.010	<0.010	-	3	0	0.024	0.023	0.020	0.028	0.0023	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	1	0	<0.010	<0.010	<0.010	<0.010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Lead, Dissolved (mg/L)							Lead, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.000203	<0.00020	<0.00020	0.00160	0.0000567	27	44
	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	0.000209	0.000200	0.000090	0.000500	0.0000271	16	100
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	4	0	0.000166	0.000170	<0.000090	0.000330	0.0000268	15	73
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	7	0	<0.000090	<0.000090	<0.000090	0.000170	0.0000136	13	46
	2014/2015 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	3	0	0.000141	0.000150	<0.000090	0.000182	0.0000175	7	86
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	0.000288	0.000288	0.000288	0.000288	-	1	100
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	0.000104	-	4	25	<0.000090	<0.000090	<0.000090	0.000148	0.0000251	4	50
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	7	0	<0.000090	<0.000090	<0.000090	0.000155	-	7	14
	2014/2015 Operation	<0.000090	<0.000090	<0.000090	0.000091	-	3	33	<0.000090	<0.000090	<0.000090	0.000102	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	0.000095	0.000095	0.000095	0.000095	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Magnesium, Dissolved (mg/L)							Magnesium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	41.1	42.0	33.1	52.1	1.01	27	100
	2011 Flood	37.7	37.7	37.7	37.7	-	1	100	38.7	37.2	32.3	49.3	1.16	16	100
	2011/2012 Operation	36.4	35.7	34.4	39.7	1.27	4	100	40.4	38.8	31.3	51.7	1.77	15	100
	2011/2012 Closure	33.9	35.5	26.6	38.2	1.81	7	100	34.0	34.0	26.2	42.9	1.32	13	100
	2014/2015 Operation	30.5	30.5	29.4	31.5	0.61	3	100	31.6	31.4	29.1	35.6	0.82	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	41.7	41.7	41.7	41.7	-	1	100	49.5	49.5	49.5	49.5	-	1	100
	2011/2012 Operation	37.8	38.1	34.6	40.6	1.53	4	100	37.9	37.9	35.9	39.8	1.06	4	100
	2011/2012 Closure	32.1	33.9	25.9	36.3	1.55	7	100	33.9	34.0	29.5	38.5	1.34	7	100
	2014/2015 Operation	33.8	31.9	30.4	39.2	2.73	3	100	34.6	31.8	30.6	41.4	3.42	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	40.2	40.2	40.2	40.2	-	1	100	47.1	47.1	47.1	47.1	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Manganese, Dissolved (mg/L)							Manganese, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.0061	0.0058	0.0022	0.0124	0.00051	27	100
	2011 Flood	0.00019	0.00019	0.00019	0.00019	-	1	100	0.0092	0.0084	0.0039	0.0202	0.00107	16	100
	2011/2012 Operation	0.00028	0.00029	<0.000090	0.00049	0.000091	4	75	0.0066	0.0045	0.0020	0.0155	0.00118	15	100
	2011/2012 Closure	0.00088	0.00019	<0.00010	0.00520	0.000721	7	71	0.0054	0.0048	0.0026	0.0143	0.00088	13	100
	2014/2015 Operation	0.00020	0.00022	0.00014	0.00025	0.000033	3	100	0.0091	0.0062	0.0055	0.0231	0.00240	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.00018	0.00018	0.00018	0.00018	-	1	100	0.0049	0.0049	0.0049	0.0049	-	1	100
	2011/2012 Operation	0.00059	0.00026	<0.00010	0.00180	0.000408	4	75	0.0055	0.0054	0.0039	0.0072	0.00074	4	100
	2011/2012 Closure	0.00037	0.00018	0.00013	0.00106	0.000134	7	100	0.0045	0.0040	0.0029	0.0065	0.00053	7	100
	2014/2015 Operation	0.00040	0.00017	0.00015	0.00087	0.000236	3	100	0.0046	0.0037	0.0035	0.0066	0.00100	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.00036	0.00036	0.00036	0.00036	-	1	100	0.0054	0.0054	0.0054	0.0054	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Mercury, Dissolved (ng/L)							Mercury, Total (ng/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011 Flood	<1.0	<1.0	<1.0	<1.0	-	1	0	<1.0	<1.0	<1.0	<1.0	-	1	0
	2011/2012 Operation	<1.0	<1.0	<1.0	1.2	-	4	25	<1.0	<1.0	<1.0	1.5	0.27	4	50
	2011/2012 Closure	<5	<5	<1.0	<5	0.35	7	43	1.8	<5	<1.0	<5	0.36	7	71
	2014/2015 Operation	1.2	1.3	<1.0	1.9	0.41	3	67	1.9	2.1	1.5	2.1	0.20	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<1.0	<1.0	<1.0	<1.0	-	1	0	<1.0	<1.0	<1.0	<1.0	-	1	0
	2011/2012 Operation	<1.0	<1.0	<1.0	<1.0	-	4	0	<1.0	<1.0	<1.0	1.43	0.19	5	20
	2011/2012 Closure	<5	<5	<1.0	<5	0.32	7	29	<5	<5	<1.0	<5	0.42	7	57
	2014/2015 Operation	<1.0	1.02	<1.0	1.03	0.17	3	67	1.02	<1.0	<1.0	2.07	0.52	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<1.0	<1.0	<1.0	<1.0	-	1	0	1.5	1.5	1.5	1.5	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<1.0	<1.0	<1.0	<1.0	-	1	0	3.3	3.3	3.3	3.3	-	1	100
	2014/2015 Operation	2.0	1.7	1.3	3.0	0.51	3	100	1.2	1.2	1.2	1.3	0.03	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Methyl Mercury, Dissolved (ng/L)							Methyl Mercury, Total (ng/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	4	0	<0.050	<0.050	<0.050	0.087	-	4	25
	2011/2012 Closure	<0.050	<0.050	<0.050	0.061	-	7	14	<0.050	<0.050	<0.050	0.083	-	6	17
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	-	3	0	<0.050	<0.050	<0.050	0.052	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	5	0	<0.050	<0.050	<0.050	0.077	-	5	20
	2011/2012 Closure	<0.050	<0.050	<0.050	<0.050	-	7	0	<0.050	<0.050	<0.050	<0.050	-	7	0
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	-	3	0	<0.050	<0.050	<0.050	0.065	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	0.080	0.080	0.080	0.080	-	1	100
	2014/2015 Operation	0.075	<0.050	<0.050	0.175	-	3	33	<0.050	<0.050	<0.050	<0.050	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Molybdenum, Dissolved (mg/L)							Molybdenum, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.00247	0.00245	0.00190	0.00300	0.000046	27	100
	2011 Flood	0.00216	0.00216	0.00216	0.00216	-	1	100	0.00218	0.00214	0.00195	0.00282	0.000052	16	100
	2011/2012 Operation	0.00211	0.00206	0.00187	0.00243	0.000122	4	100	0.00226	0.00219	0.00191	0.00302	0.000077	15	100
	2011/2012 Closure	0.00187	0.00169	0.00146	0.00257	0.000146	7	100	0.00207	0.00189	0.00157	0.00278	0.000120	13	100
	2014/2015 Operation	0.00177	0.00178	0.00176	0.00178	0.000007	3	100	0.00183	0.00173	0.00165	0.00210	0.000062	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.00226	0.00226	0.00226	0.00226	-	1	100	0.00242	0.00242	0.00242	0.00242	-	1	100
	2011/2012 Operation	0.00228	0.00238	0.00190	0.00248	0.000130	4	100	0.00217	0.00213	0.00206	0.00234	0.000062	4	100
	2011/2012 Closure	0.00185	0.00182	0.00147	0.00243	0.000124	7	100	0.00195	0.00176	0.00156	0.00249	0.000139	7	100
	2014/2015 Operation	0.00188	0.00173	0.00169	0.00221	0.000167	3	100	0.00196	0.00178	0.00168	0.00241	0.000228	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.00219	0.00219	0.00219	0.00219	-	1	100	0.00229	0.00229	0.00229	0.00229	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Nickel, Dissolved (mg/L)							Nickel, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.0020	<0.0020	0.0006	0.0043	0.00014	27	74
	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	0.0020	-	16	6
	2011/2012 Operation	0.0015	0.0013	0.0005	0.0028	0.00058	4	50	<0.0020	<0.0020	<0.0020	<0.0020	0.00004	15	7
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0	<0.0020	<0.0020	<0.0020	<0.0020	-	13	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Potassium, Dissolved (mg/L)							Potassium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	12.1	12.0	9.82	15.4	0.290	27	100
	2011 Flood	10.2	10.2	10.2	10.2	-	1	100	10.7	10.8	9.08	12.1	0.188	16	100
	2011/2012 Operation	10.5	10.4	9.55	11.4	0.49	4	100	10.7	10.9	8.51	13.8	0.400	15	100
	2011/2012 Closure	9.02	8.58	7.13	11.3	0.54	7	100	9.48	9.18	7.79	11.5	0.348	13	100
	2014/2015 Operation	8.37	8.65	7.70	8.76	0.34	3	100	8.43	8.30	7.55	10.2	0.345	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	10.2	10.2	10.2	10.2	-	1	100	10.8	10.8	10.8	10.8	-	1	100
	2011/2012 Operation	10.1	10.2	9.55	10.7	0.24	4	100	11.0	11.0	10.1	11.8	0.348	4	100
	2011/2012 Closure	8.50	8.37	6.34	10.6	0.50	7	100	9.14	9.53	7.50	10.9	0.508	7	100
	2014/2015 Operation	9.43	8.57	8.31	11.40	0.99	3	100	9.33	8.35	7.95	11.70	1.189	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	10.4	10.4	10.4	10.4	-	1	100	10.5	10.5	10.5	10.5	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Selenium, Dissolved (mg/L)							Selenium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.0010	<0.0010	<0.00040	0.0013	0.00007	27	19
	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	0.0012	0.00006	16	19
	2011/2012 Operation	0.0013	<0.0010	<0.0010	0.0038	-	4	25	<0.0010	<0.0010	<0.0010	0.0021	-	15	13
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0	<0.0010	<0.0010	<0.0010	<0.0010	-	13	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0	<0.0010	<0.0010	<0.0010	<0.0010	-	7	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0	<0.0010	<0.0010	<0.0010	<0.0010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Silver, Dissolved (mg/L)							Silver, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.00010	<0.00010	<0.000005	0.00012	0.000006	27	11
	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	16	0
	2011/2012 Operation	<0.00010	<0.00010	<0.000040	<0.00010	-	4	0	<0.00010	<0.00010	<0.000040	<0.00010	-	15	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0	<0.00010	<0.00010	<0.00010	<0.00010	-	13	0
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0	<0.00010	<0.00010	<0.00010	<0.00010	-	7	14
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Sodium, Dissolved (mg/L)							Sodium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	194	188	160	254	4.1	27	100
	2011 Flood	121	121	121	121	-	1	100	148	143	119	231	6.5	16	100
	2011/2012 Operation	130	131	114	145	6.4	4	100	132	129	118	150	2.8	15	100
	2011/2012 Closure	131	114	98	182	12.3	7	100	135	131	100	182	6.6	13	100
	2014/2015 Operation	99	101	94	102	2.5	3	100	97	96	90	108	2.2	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	132	132	132	132	-	1	100	132	132	132	132	-	1	100
	2011/2012 Operation	122	118	110	142	7.5	4	100	130	129	118	144	5.8	4	100
	2011/2012 Closure	126	118	95	173	10.8	7	100	127	121	98	171	10.2	7	100
	2014/2015 Operation	103	103	94	111	4.9	3	100	107	101	94	126	9.7	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	138	138	138	138	-	1	100	131	131	131	131	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

		Thallium, Dissolved (mg/L)							Thallium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.00010	<0.00010	<0.000020	0.00035	0.000016	27	11
	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	16	0
	2011/2012 Operation	<0.00010	<0.00010	<0.000020	<0.00010	-	4	0	<0.00010	<0.00010	<0.000020	0.00025	-	15	7
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0	<0.00010	<0.00010	<0.00010	<0.00010	-	13	0
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0	<0.00010	<0.00010	<0.00010	<0.00010	-	7	0
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0	<0.00010	<0.00010	<0.00010	<0.00010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Uranium, Dissolved (mg/L)							Uranium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	0.00181	0.00188	0.00120	0.00230	0.000056	27	100
	2011 Flood	0.00164	0.00164	0.00164	0.00164	-	1	100	0.00164	0.00165	0.00148	0.00201	0.000035	16	100
	2011/2012 Operation	0.00170	0.00173	0.00154	0.00178	0.000057	4	100	0.00172	0.00167	0.00146	0.00221	0.000055	15	100
	2011/2012 Closure	0.00145	0.00136	0.00117	0.00180	0.000089	7	100	0.00154	0.00145	0.00126	0.00199	0.000072	13	100
	2014/2015 Operation	0.00132	0.00135	0.00122	0.00138	0.000049	3	100	0.00144	0.00140	0.00126	0.00158	0.000046	7	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	0.00169	0.00169	0.00169	0.00169	-	1	100	0.00177	0.00177	0.00177	0.00177	-	1	100
	2011/2012 Operation	0.00175	0.00173	0.00159	0.00196	0.000096	4	100	0.00178	0.00185	0.00144	0.00198	0.000123	4	100
	2011/2012 Closure	0.00141	0.00139	0.00118	0.00171	0.000079	7	100	0.00146	0.00141	0.00122	0.00177	0.000087	7	100
	2014/2015 Operation	0.00151	0.00138	0.00125	0.00190	0.000199	3	100	0.00164	0.00151	0.00141	0.00200	0.000182	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	0.00157	0.00157	0.00157	0.00157	-	1	100	0.00166	0.00166	0.00166	0.00166	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 8. Continued.

Site ID	Period	Zinc, Dissolved (mg/L)							Zinc, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
FR1	Historic[1]	-	-	-	-	-	0	-	<0.0050	<0.0050	<0.0010	0.0070	0.00033	27	41
	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	0.0053	-	16	6
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	0.0023	0.00032	4	25	<0.0050	<0.0050	<0.0020	<0.0050	0.00019	15	7
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	0.0025	-	7	14	<0.0020	<0.0020	<0.0020	0.0025	0.00016	13	23
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	<0.0050	<0.0050	<0.0020	<0.0050	-	7	14
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM1	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	<0.0050	<0.0050	<0.0020	<0.0050	-	4	25
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	0.0021	-	3	33	<0.0020	<0.0020	<0.0020	0.0044	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
LSM2	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

1 - Data for the Historic period were only available for FR1.

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Table 9. Frequency of dissolved oxygen values in the Fairford River and Lake St. Martin below the MWQSOGs and CCME lowest acceptable concentrations for PAL, 2004-2015.

Site ID	Period	Objectives Applicable when Water Temperature is > 5°C						Objectives Applicable when Water Temperature is ≤ 5°C					
		MWQSOGs PAL for Cool Water Early life, and CCME PAL for Early Life Stages of Warm Water Biota; 6.0 mg/L			MWQSOGs PAL for Cold Water Mature Life and CCME PAL for Other Life Stages of Cold Water Biota; 6.5 mg/L			MWQSOGs PAL for Cold Water Early Life, and CCME PAL for Early Life Stages of Cold Water Biota; 9.5 mg/L			MWQSOGs PAL for Cool Water Mature Life, and CCME PAL for Other Life Stages of Warm Water Biota; 5.5 mg/L		
		n	# below	% below	n	# below	% below	n	# below	% below	n	# below	% below
FR1	Historic [1]	12	0	0	12	0	0	14	2	14	14	0	0
	2011 Flood	15	0	0	15	0	0	1	0	0	1	0	0
	2011/2012 Operation	7	0	0	7	0	0	7	0	0	7	0	0
	2011/2012 Closure	7	0	0	7	0	0	6	2	33	6	1	17
	2014/2015 Operation	6	0	0	6	0	0	1	1	100	1	0	0
	2014/2015 Closure	0	-	-	0	-	-	0	-	-	0	-	-
LSM1	2011 Flood	5	0	0	5	0	0	0	-	-	0	-	-
	2011/2012 Operation	6	0	0	6	0	0	9	1	11	9	0	0
	2011/2012 Closure	5	0	0	5	0	0	2	1	50	2	0	0
	2014/2015 Operation	5	0	0	5	0	0	1	0	0	1	0	0
	2014/2015 Closure	3	0	0	3	1	33	0	-	-	0	-	-
LSM2	2011 Flood	0	-	-	0	-	-	1	0	0	1	0	0
	2011/2012 Operation	0	-	-	0	-	-	0	-	-	0	-	-
	2011/2012 Closure	3	0	0	3	0	0	0	-	-	0	-	-
	2014/2015 Operation	8	0	0	8	1	13	2	0	0	2	0	0
	2014/2015 Closure	0	-	-	0	-	-	0	-	-	0	-	-

1 - Data from the Historic period were only available for the Fairford River (FR1).

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Table 10. Frequency of exceedance of MWQSOGs and CCME guidelines for PAL for metals and major ions in the Fairford River and Lake St. Martin, 2004-2015. Only metals and major ions for which exceedances occurred within the Study Area are listed.[1] Percent exceedance values greater than zero are indicated in bold. Note: this table does not include 2014/2015 Closure data, because metals were not analysed during this period.

			Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
Site ID	Period		MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
FR1	Historic [7]	n	27	27	-	27	-	0	27	27
		# Exceeded	1	1	-	27	-	-	0	0
		% Exceedance	**4**	**4**	-	**100**	-	-	0	0
	2011 Flood	n	16	16	-	16	-	1	16	16
		# Exceeded	3	3	-	16	-	1	0	0
		% Exceedance	**19**	**19**	-	**100**	-	**100**	0	0
	2011/2012 Operation	n	15	15	-	15	-	4	15	15
		# Exceeded	3	3	-	15	-	4	0	0
		% Exceedance	**20**	**20**	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	13	13	-	13	-	7	13	13
		# Exceeded	1	1	-	13	-	6	0	0
		% Exceedance	**8**	**8**	-	**100**	-	**86**	0	0
	2014/2015 Operation	n	7	7	-	7	-	3	7	7
		# Exceeded	0	0	-	7	-	3	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
LSM1	2011 Flood	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
	2011/2012 Operation	n	4	4	-	4	-	4	4	4
		# Exceeded	0	0	-	4	-	4	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0

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Table 10. Continued.

Site ID	Period		Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
			MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
LSM1	2011/2012 Closure	n	7	7	-	7	-	7	7	7
		# Exceeded	0	0	-	7	-	4	0	0
		% Exceedance	0	0	-	**100**	-	**57**	0	0
	2014/2015 Operation	n	3	3	-	3	-	3	3	3
		# Exceeded	0	0	-	3	-	3	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
LSM2	2011 Flood	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-

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Table 10. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
FR1	Historic[10]	n	27	27	27	27	27	27
		# Exceeded	0	0	3	3	2	2
		% Exceedance	0	0	**11**	**11**	**7**	**7**
	2011 Flood	n	16	16	16	16	16	16
		# Exceeded	0	0	3	3	0	0
		% Exceedance	0	0	**19**	**19**	0	0
	2011/2012 Operation	n	14	14	15	15	15	15
		# Exceeded	0	0	2	2	0	0
		% Exceedance	0	0	**13**	**13**	0	0
	2011/2012 Closure	n	8	8	13	13	13	13
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2014/2015 Operation	n	7	7	7	7	7	7
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
LSM1	2011 Flood	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2011/2012 Operation	n	4	4	4	4	4	4
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0

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Table 10. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
LSM1	2011/2012 Closure	n	7	7	7	7	7	7
		# Exceeded	0	0	0	0	1	1
		% Exceedance	0	0	0	0	**14**	**14**
	2014/2015 Operation	n	3	3	3	3	3	3
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
LSM2	2011 Flood	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2011/2012 Closure	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-

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1 - The following metals where consistently within both the applicable MWQSOGs and CCME PAL guidelines at all sites and times: arsenic; boron; cadmium; dissolved chromium; copper; lead; mercury, methyl mercury; molybdenum; nickel; thallium; uranium; and, zinc.
2 - Long-term guideline. All concentrations were within the short-term guideline at all sites and times.
3 - Interim guideline.
4 - MWQSOGs 4-day objective. All concentrations were within the 1-hour objective.
5 - Based on sample specific hardness.
6 - Analytical detection limit is equal to the PAL guideline.
7 - Data from the Historic period were only available for the Fairford River (FR1).

Table 11. Frequency of exceedance of MWQSOGs/Health Canada aesthetic objectives for drinking water for metals and major ions measured in the Fairford River and Lake St. Martin, 2004-2015. All parameters with maximum acceptable concentrations were within these guidelines at all sites and times, including: antimony; arsenic; barium; boron; lead; mercury; selenium; and, uranium. Percent exceedance values greater than zero are indicated in bold. Note: this table does not include 2014/2015 Closure data, because metal were not analysed during this period.

Site ID	Period		Chloride, Dissolved	Iron, Total	Manganese, Total	Sodium, Total	Sulphate, Dissolved
MWQSOGs/Health Canada Aesthetic Objective (mg/L)			≤250	≤0.3	≤0.050	≤200	≤500
FR1	Historic [1]	n	27	27	27	27	25
		# Exceeded	25	0	0	9	0
		% Exceedance	**93**	0	0	**33**	0
	2011 Flood	n	16	16	16	16	16
		# Exceeded	2	0	0	1	0
		% Exceedance	**13**	0	0	**6**	0
	2011/2012 Operation	n	15	14	15	15	15
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	13	8	13	13	13
		# Exceeded	1	0	0	0	0
		% Exceedance	**8**	0	0	0	0
	2014/2015 Operation	n	7	7	7	7	7
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
LSM1	2011 Flood	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Operation	n	4	4	4	4	4
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	7	7	7	7	7
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2014/2015 Operation	n	3	3	3	3	3
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0

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Table 11. Continued.

Site ID	Period		Chloride, Dissolved	Iron, Total	Manganese, Total	Sodium, Total	Sulphate, Dissolved
MWQSOGs/Health Canada Aesthetic Objective (mg/L)			≤250	≤0.3	≤0.050	≤200	≤500
LSM2	2011 Flood	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
	2011/2012 Closure	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-

1 - Data from the Historic period were only available for the Fairford River (FR1).

Table 12. Laboratory analytical detection limits and water quality guidelines for PAL and drinking water for petroleum hydrocarbon parameters measured in the Study Area, 2011-2014.

		Protection of Aquatic Life (PAL)		Drinking Water [1]	
Parameter	Analytical Detection Limit	MWQSOGs [1]	CCME [2] Interim	Maximum Acceptable Concentration	Aesthetic Objective
Benzene	0.0005	0.370 mg/L	0.370 mg/L	0.005 mg/L	-
Toluene	0.001	0.0020 mg/L	0.0020 mg/L	0.06 mg/L [3]	0.024 mg/L
Ethyl benzene	0.0005	0.090 mg/L	0.090 mg/L	0.14 mg/L [3]	0.0016 mg/L [3]
Xylenes (-o,-m)	0.0005	-	-	-	-
Xylenes (-p)	0.0005	-	-	-	-
Xylene (Total)	0.0015	-	-	0.09 mg/L [3]	0.02 mg/L [3]
F1 (C6 - C10)	0.1	-	-	-	-
F2 (C10 - C16)	0.25	-	-	-	-
F3 (C16 - C34)	0.25	-	-	-	-
F4 (C34 - C50)	0.25	-	-	-	-
Total Hydrocarbons (C6 - C50)	0.44	-	-	-	-

1 - Manitoba Water Quality Standards, Objectives, and Guidelines (MWS 2011).

2 - Canadian Council of Ministers of the Environment guidelines for the protection of freshwater aquatic life (CCME 1999, updated to 2015).

3 - As updated by Health Canada in 2014. Since the intent of the MWQSOGs is to use the Health Canada guidelines, the updated guideline/objective has been applied.

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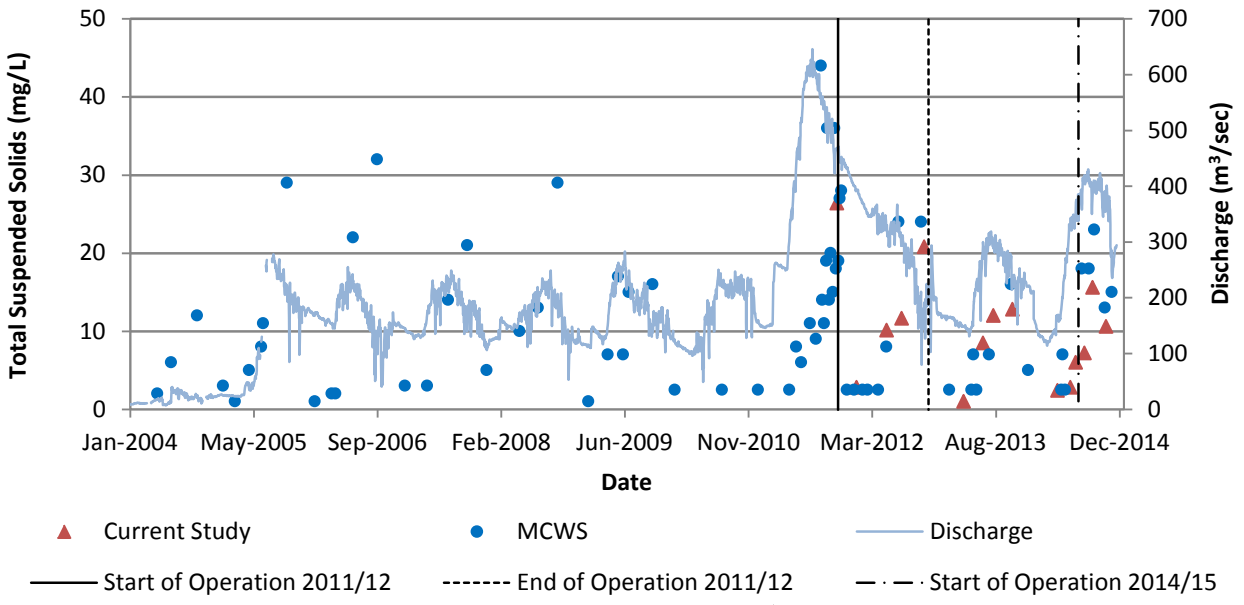


Figure 7. Total suspended solids in the Fairford River, 2004-2014.

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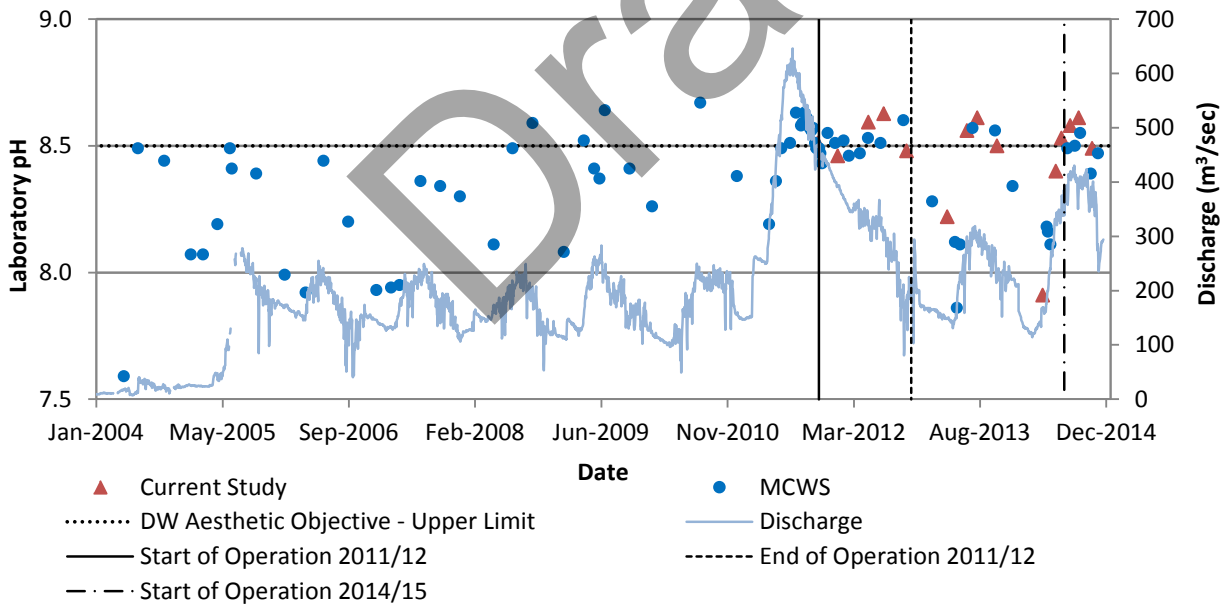


Figure 8. Laboratory measured pH in the Fairford River, 2004-2014.

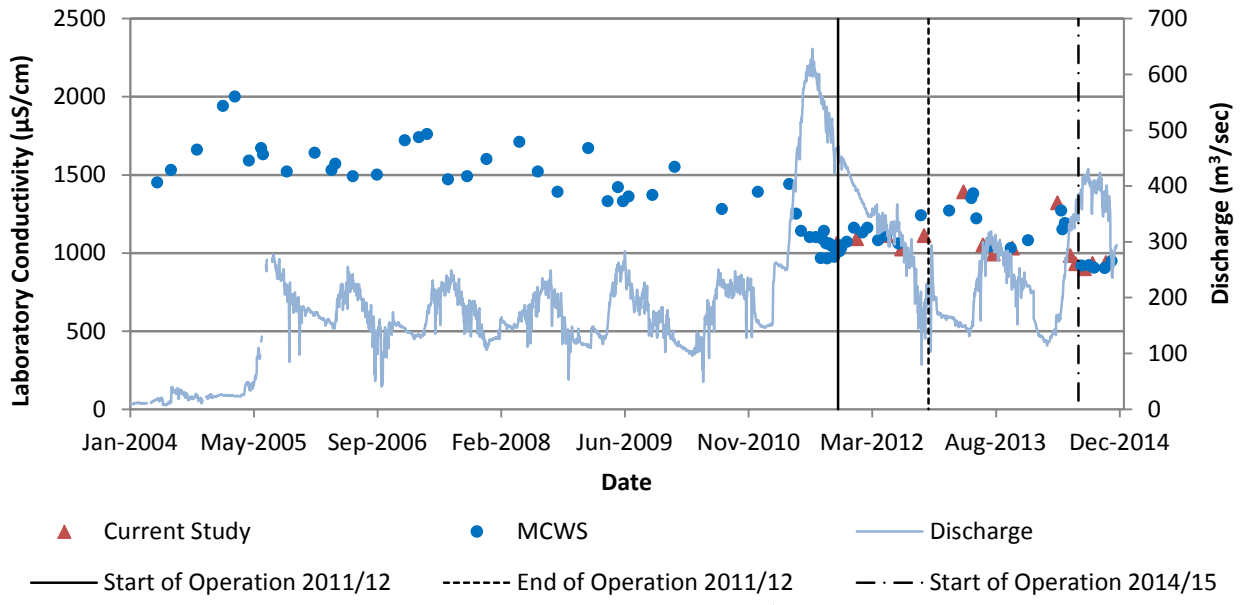


Figure 9. Conductivity in the Fairford River, 2004-2014.

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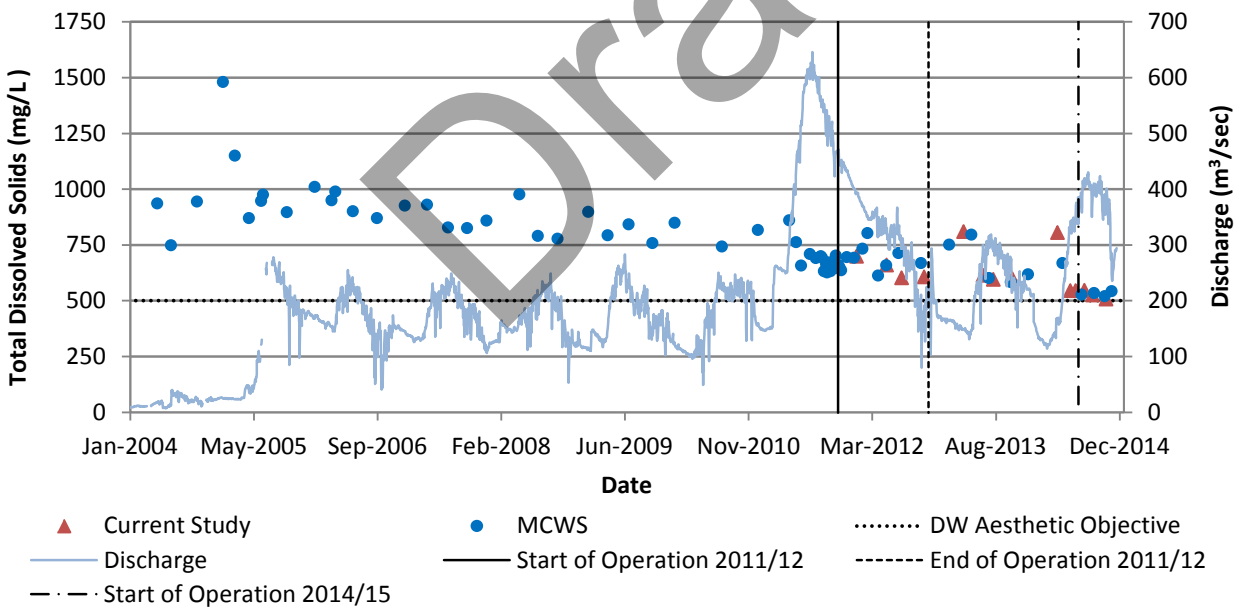


Figure 10. Total dissolved solids in the Fairford River, 2004-2014.

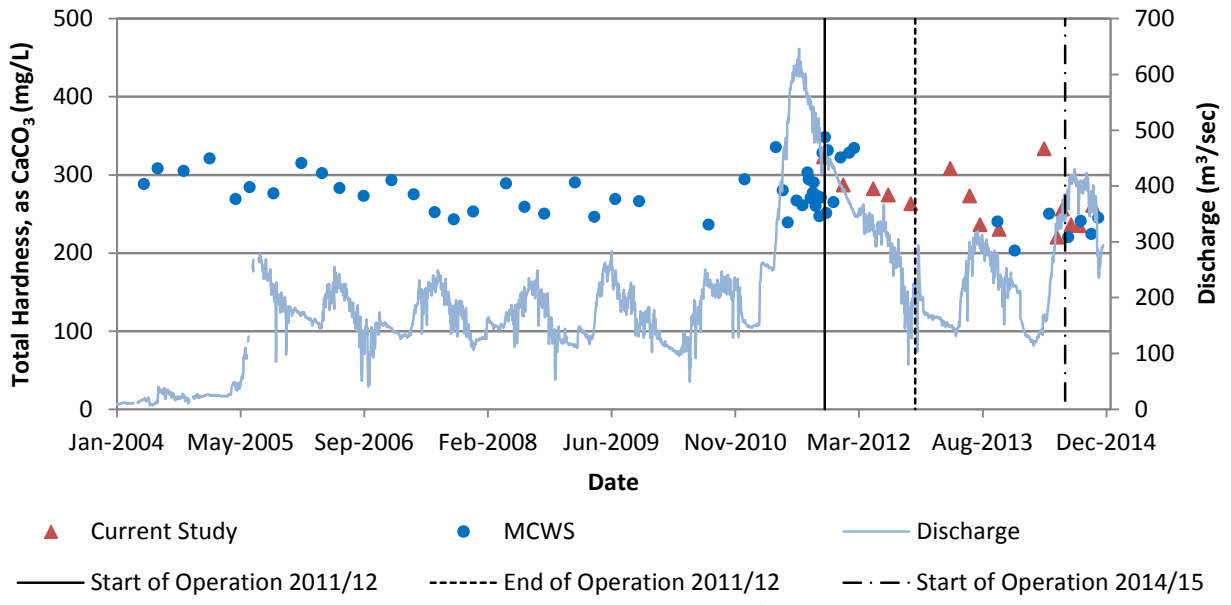


Figure 11. Total hardness in the Fairford River, 2004-2014.

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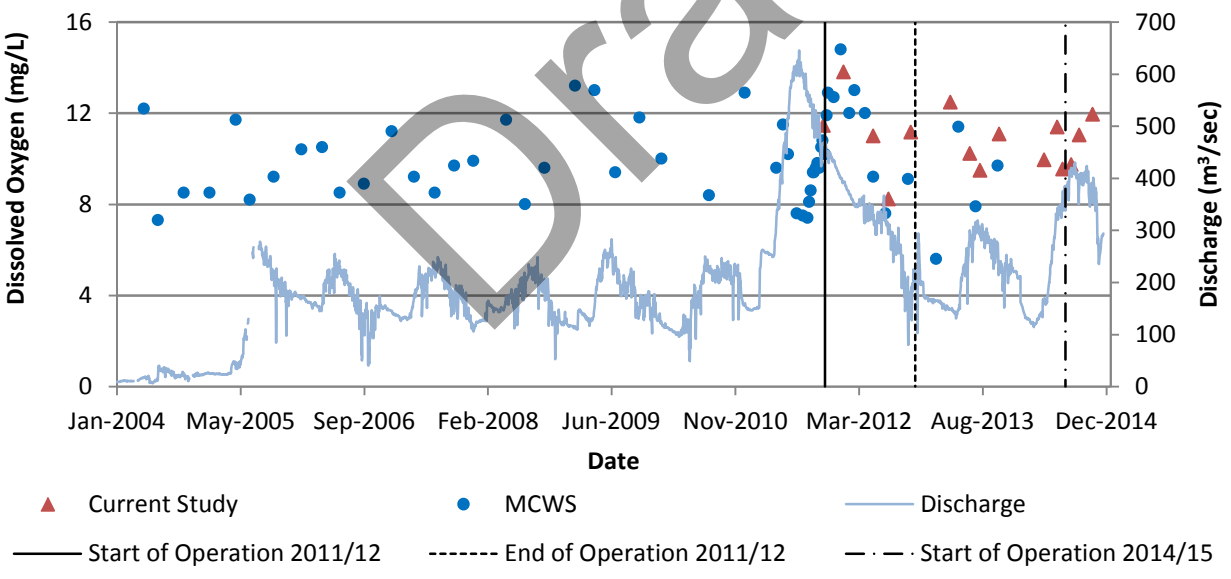


Figure 12. Dissolved oxygen concentrations in the Fairford River, 2004-2014.

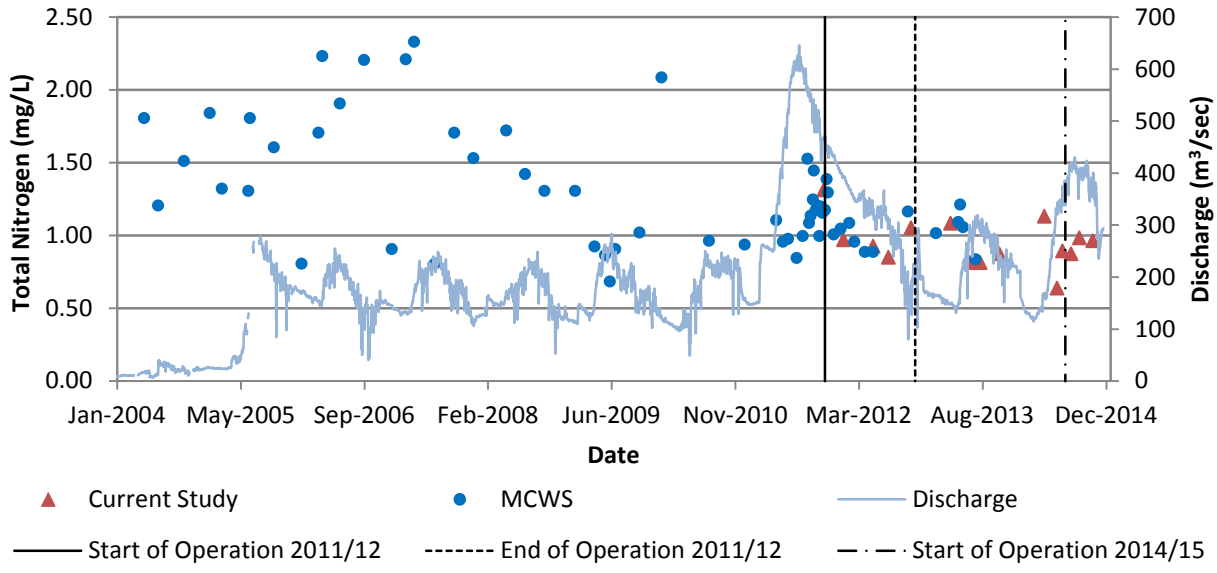


Figure 13. Total nitrogen concentrations in the Fairford River, 2004-2014.

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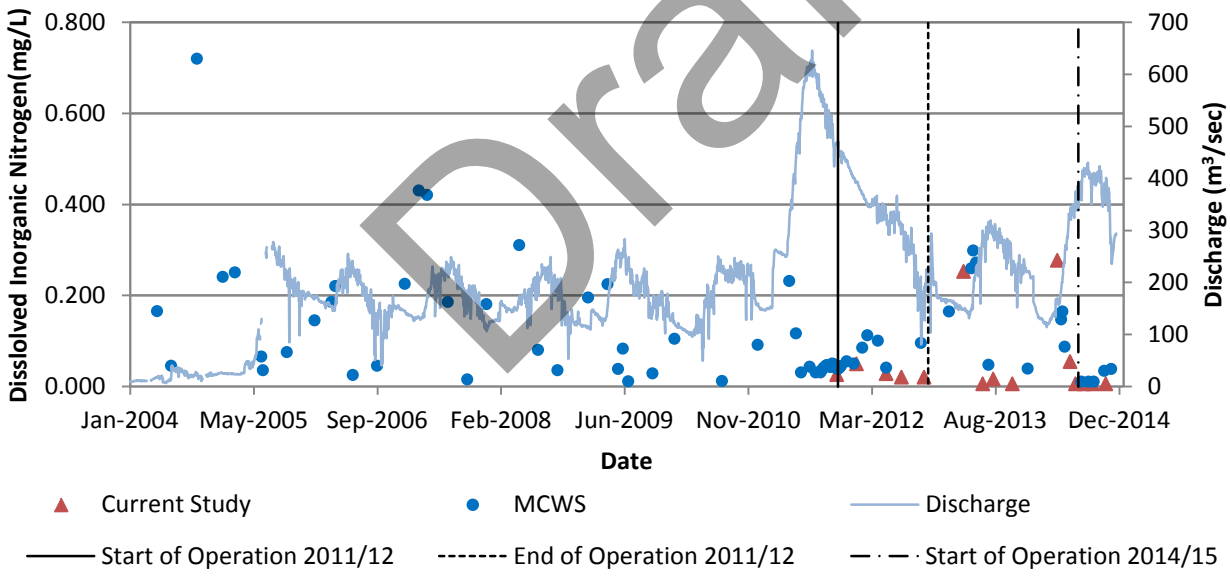


Figure 14. Dissolved inorganic nitrogen concentrations in the Fairford River, 2004-2014.

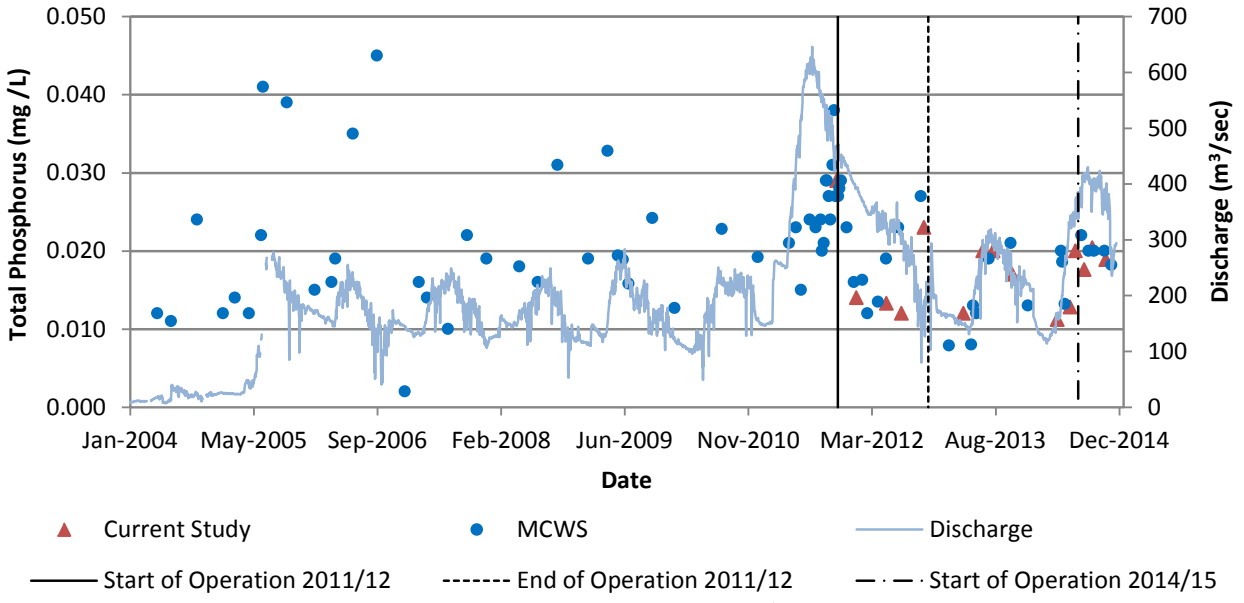


Figure 15. Total phosphorus concentrations in the Fairford River, 2004-2014. The maximum value of the y-axis is set at the MWQSOGs narrative guideline for streams.

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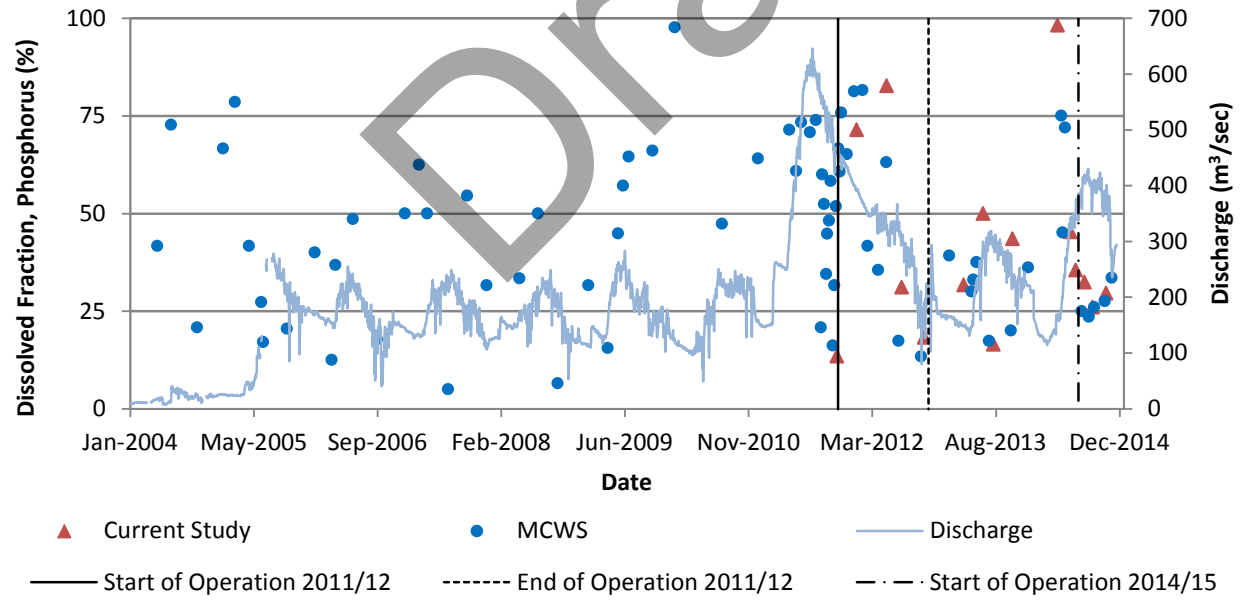


Figure 16. Phosphorus composition in the Fairford River, 2004-2014.

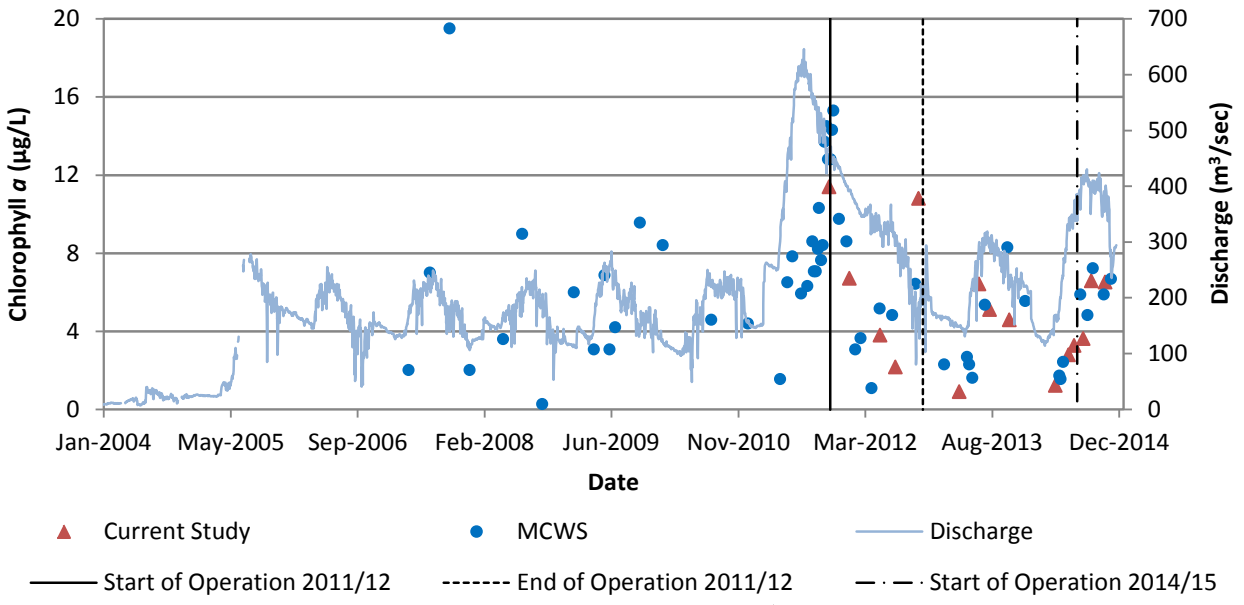


Figure 17. Chlorophyll *a* concentrations in the Fairford River, 2004-2014.

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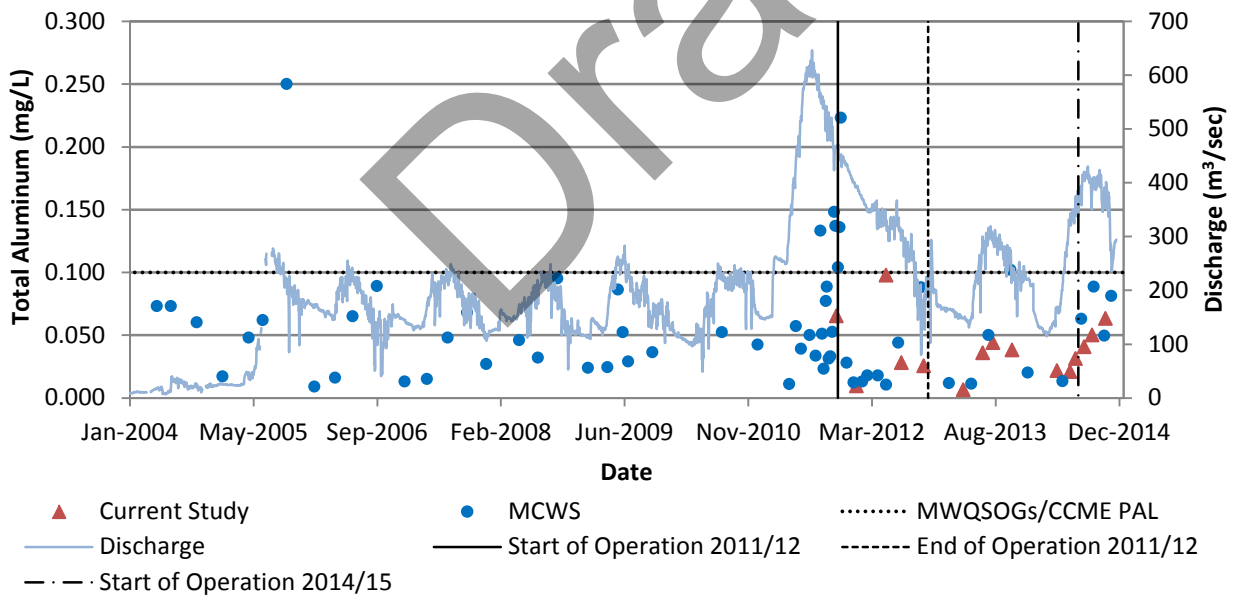


Figure 18. Total aluminum concentrations in the Fairford River, 2004-2014.

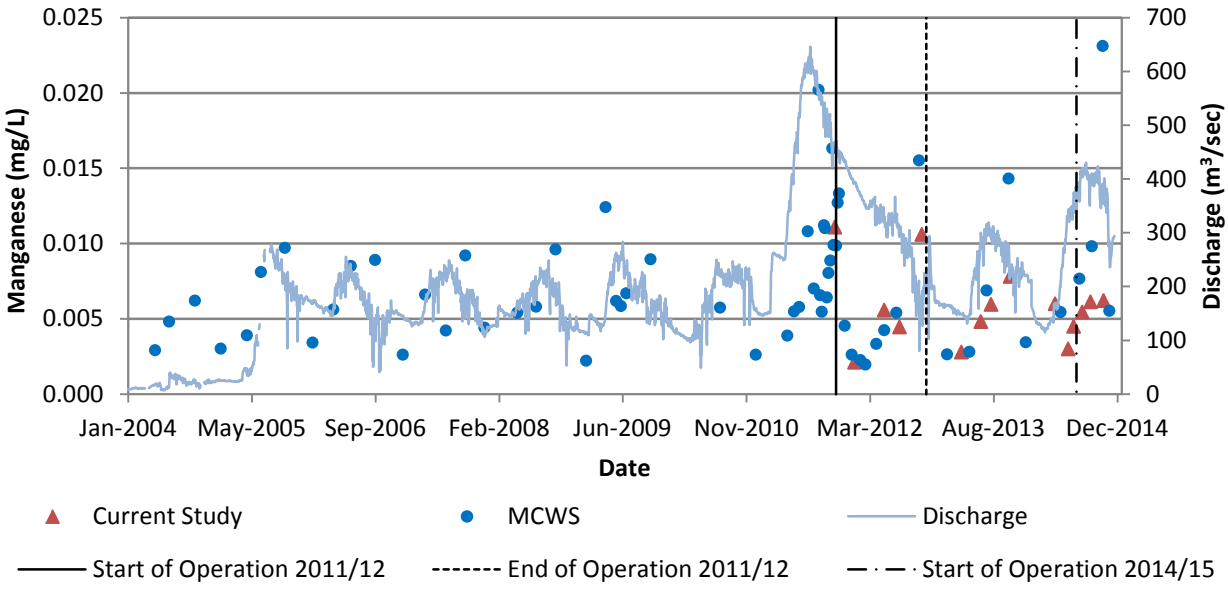


Figure 19. Total manganese concentrations in the Fairford River, 2004-2014.

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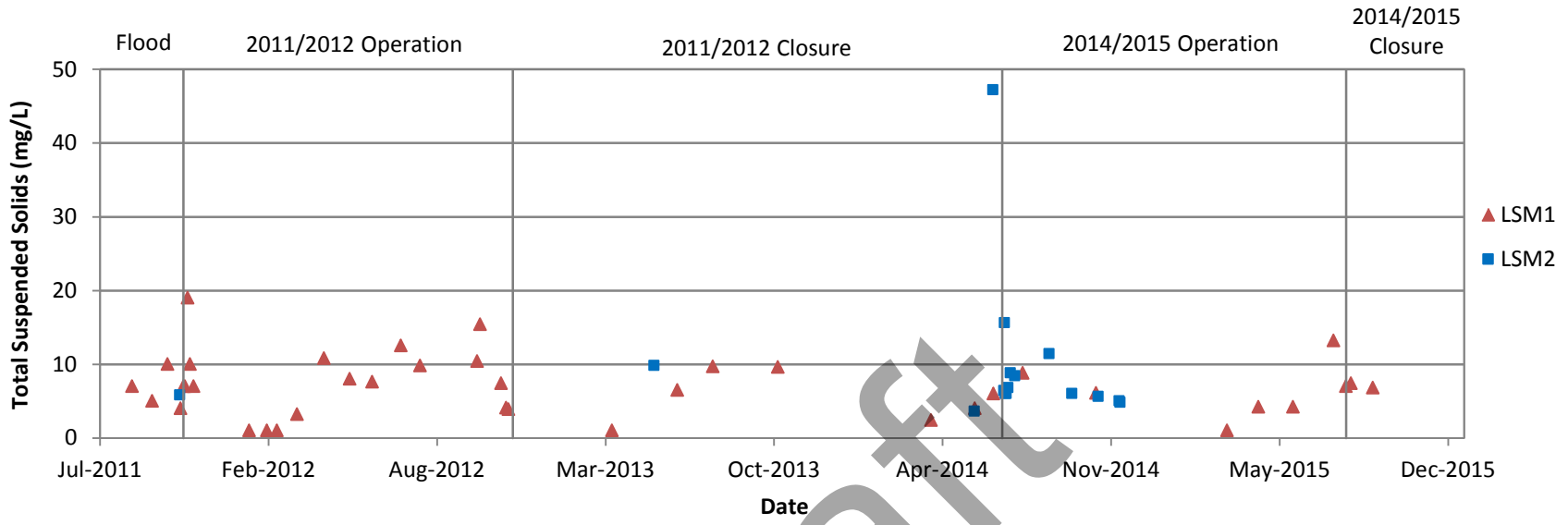


Figure 20. Total suspended solids in Lake St. Martin, 2011-2015.

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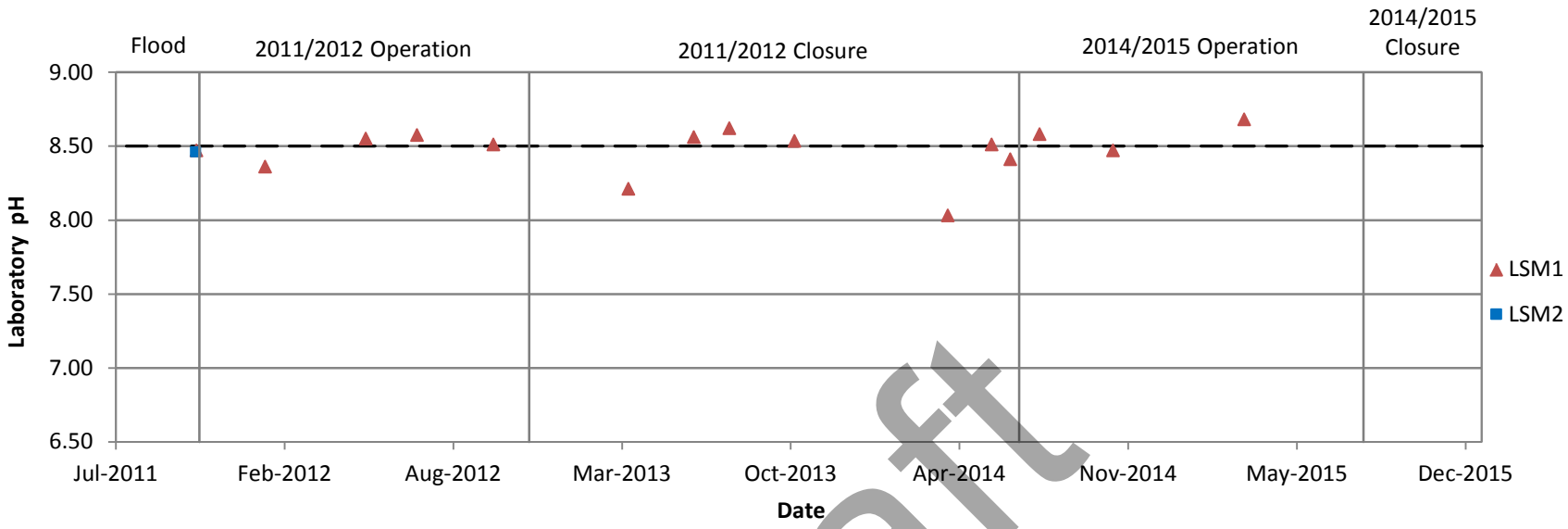


Figure 21. Laboratory measured pH in Lake St. Martin, 2011-2015. Dashed line represents the upper limit of the MWQSOGs/ Health Canada aesthetic objective for drinking water.

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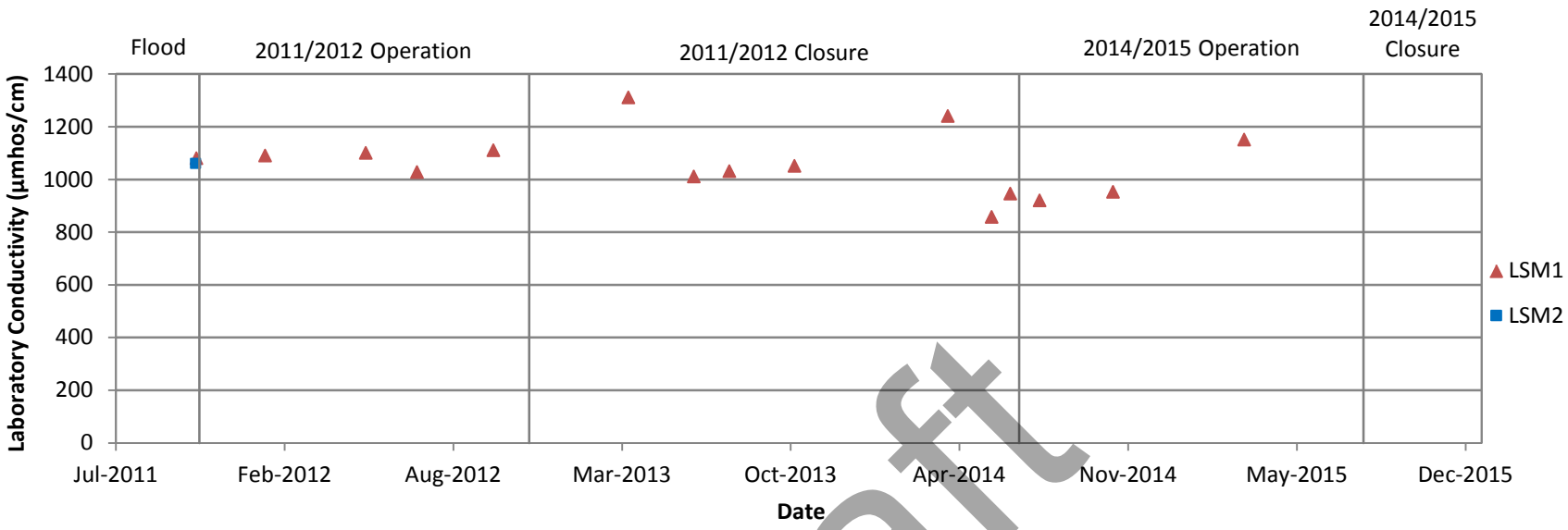


Figure 22. Conductivity in Lake St. Martin, 2011-2015.

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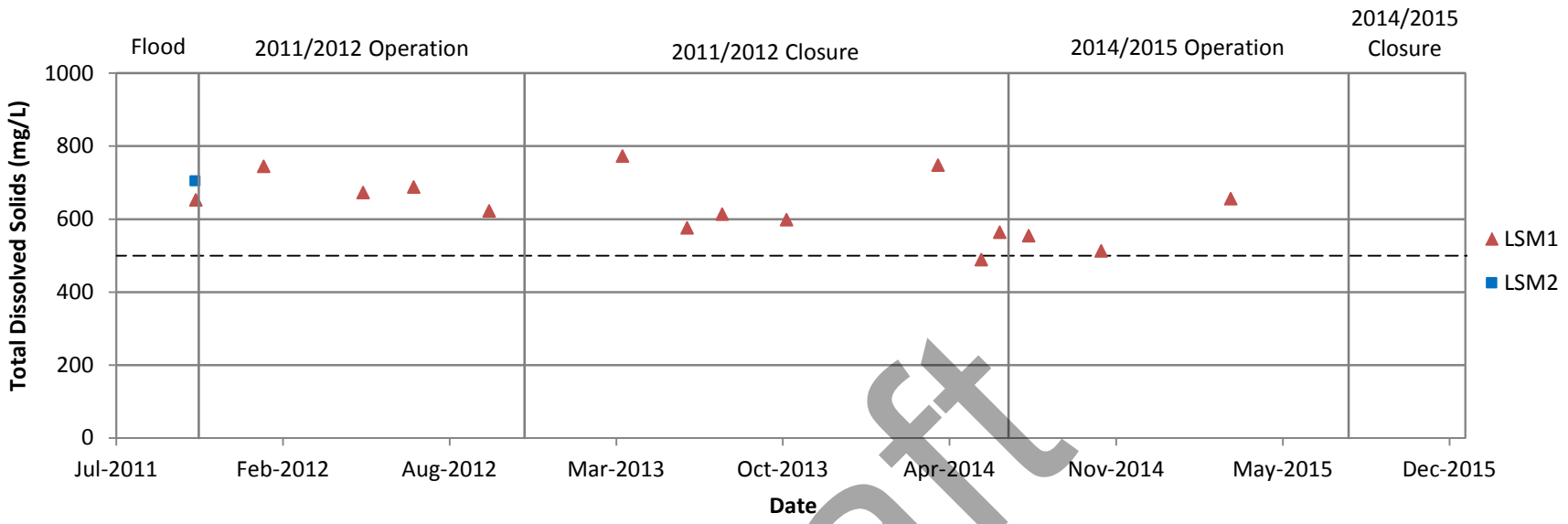


Figure 23. Total dissolved solids in Lake St. Martin, 2011-2015. Dashed line represents the MWQSOGs/Health Canada aesthetic objective for drinking water.

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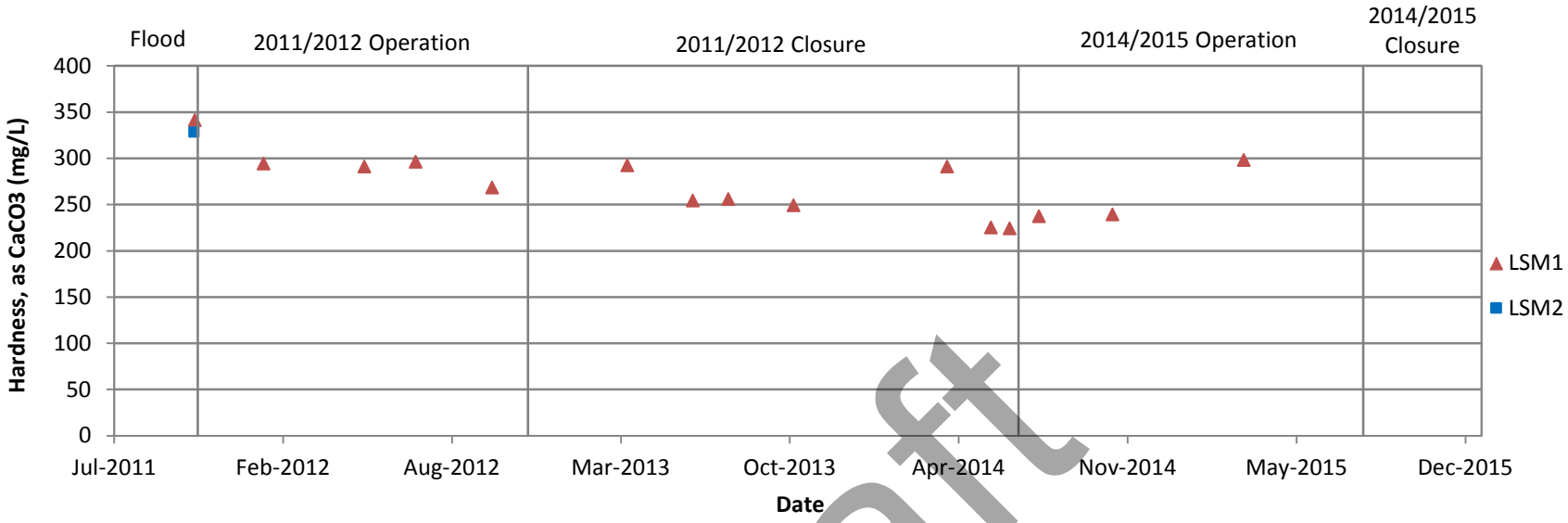
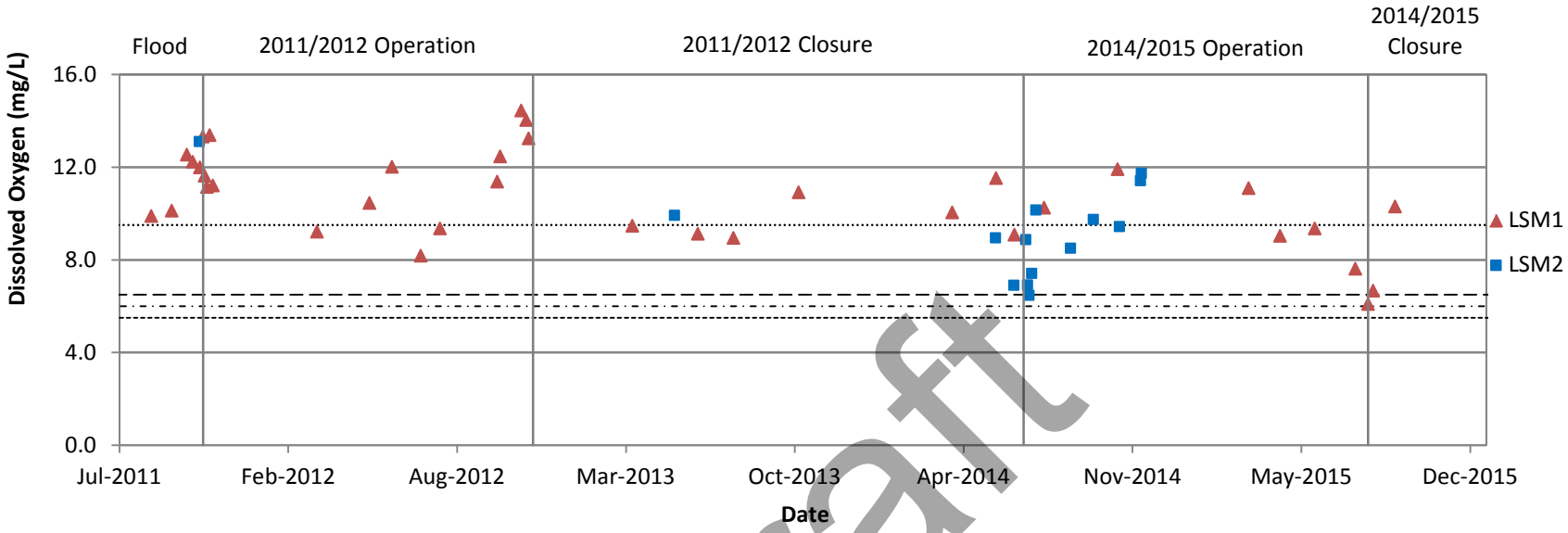


Figure 24. Total hardness in Lake St. Martin, 2011-2015.

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Figure 25. Dissolved oxygen concentrations in Lake St. Martin, 2011-2015.

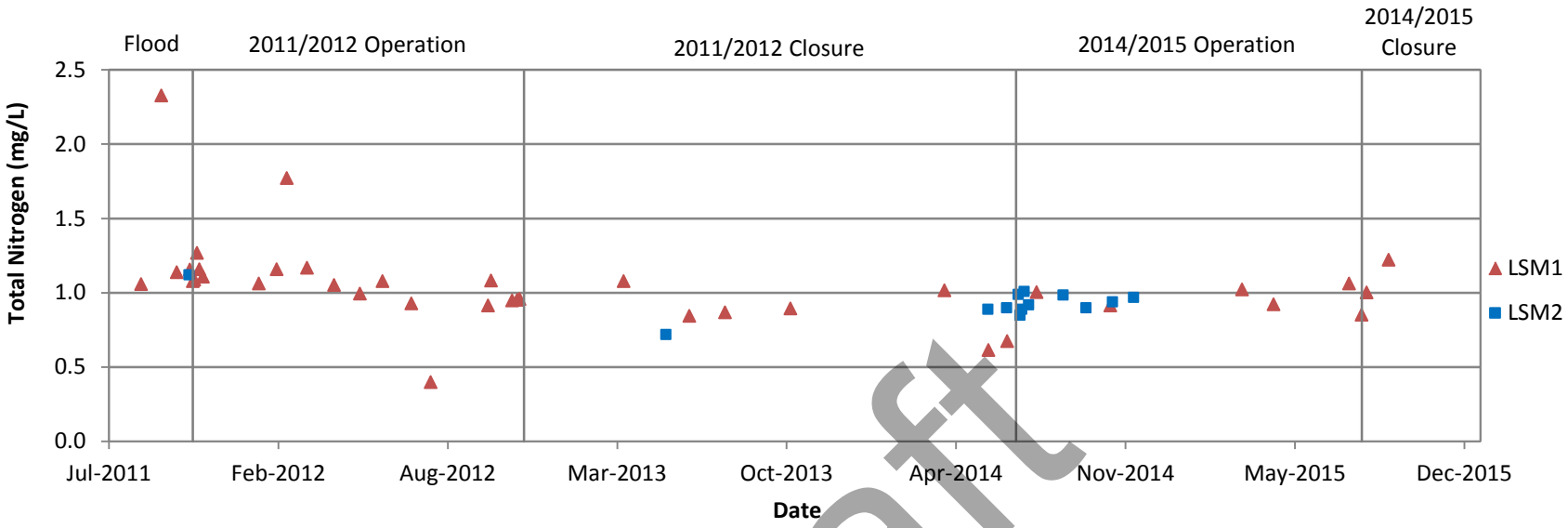


Figure 26. Total nitrogen in Lake St. Martin, 2011-2015.

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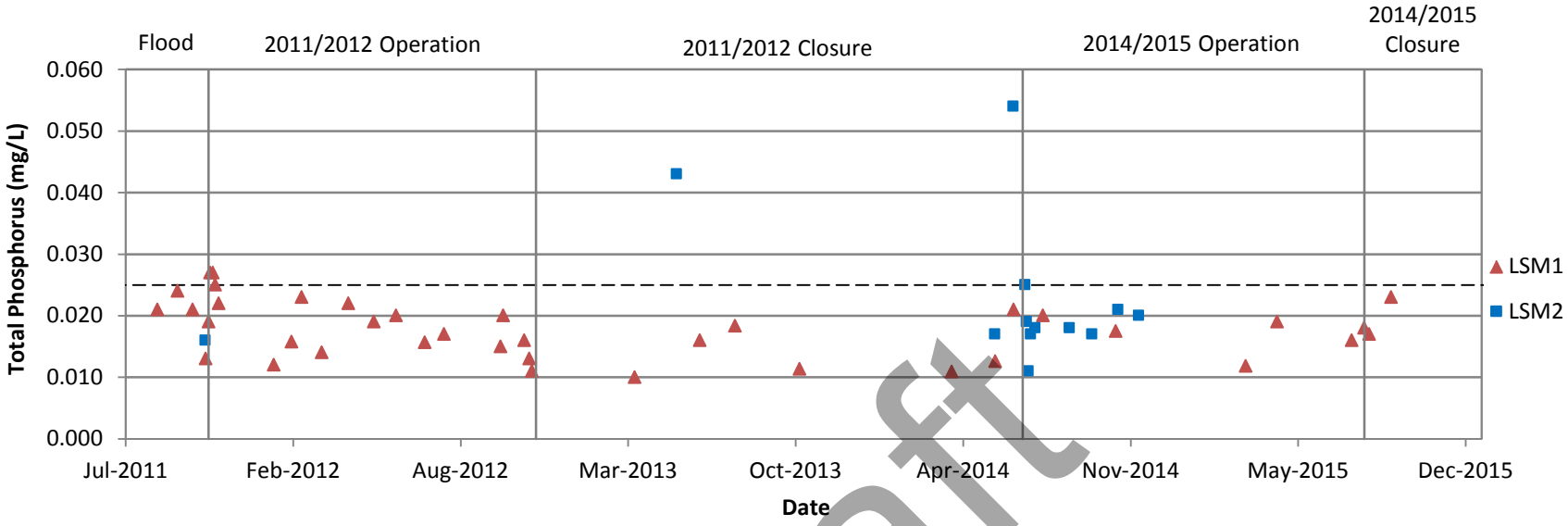


Figure 27. Total phosphorus in Lake St. Martin, 2011-2015. Dashed line represents the MWQSOGs narrative guideline for lakes and river mouths.

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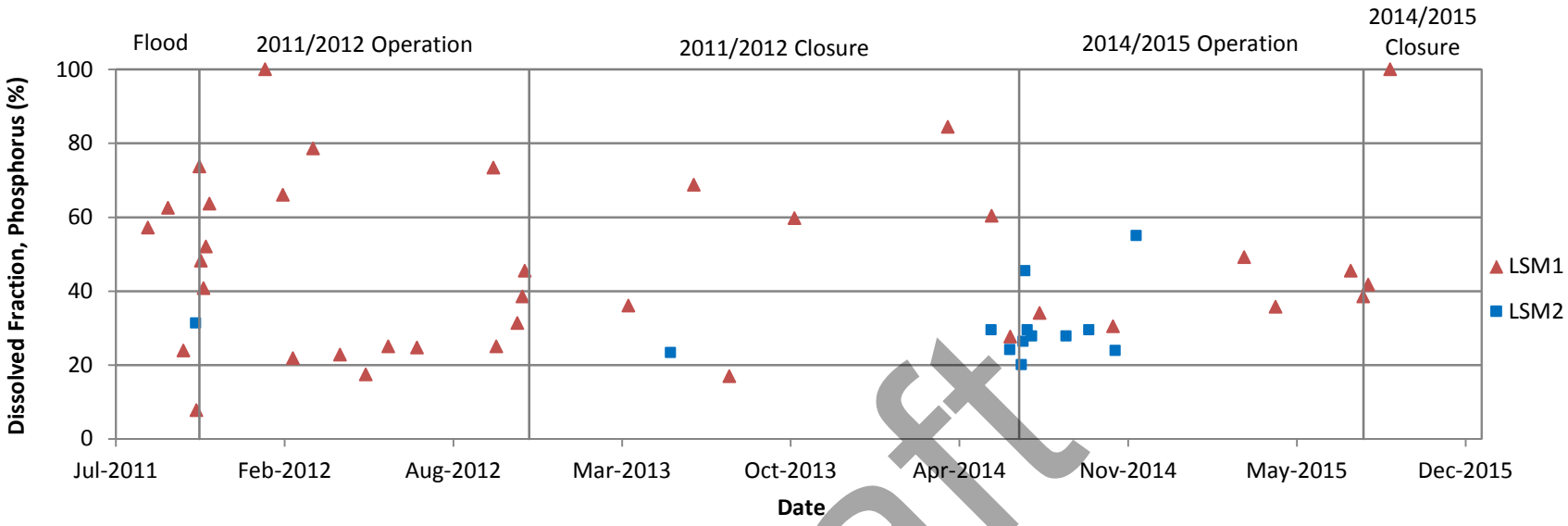


Figure 28. Phosphorus composition in Lake St. Martin, 2011-2015. Percent dissolved phosphorus values greater than 100% are plotted at 100% for the purposes of this figure.

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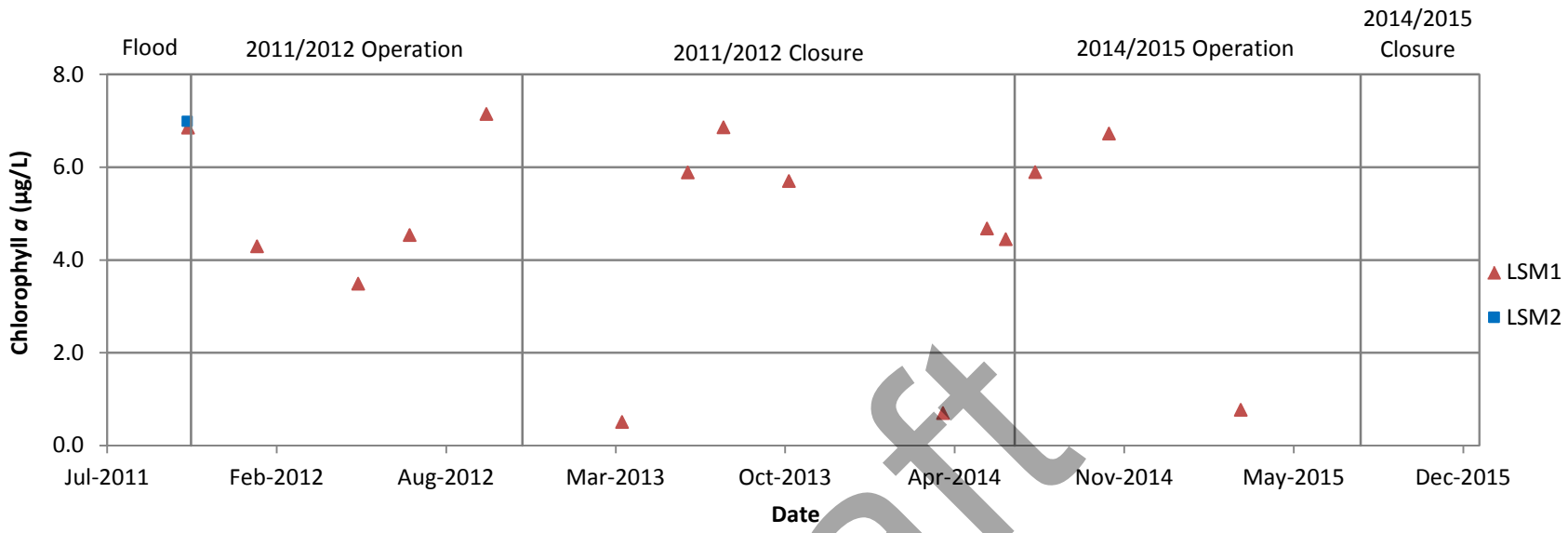


Figure 29. Chlorophyll *a* concentrations in Lake St. Martin, 2011-2015.

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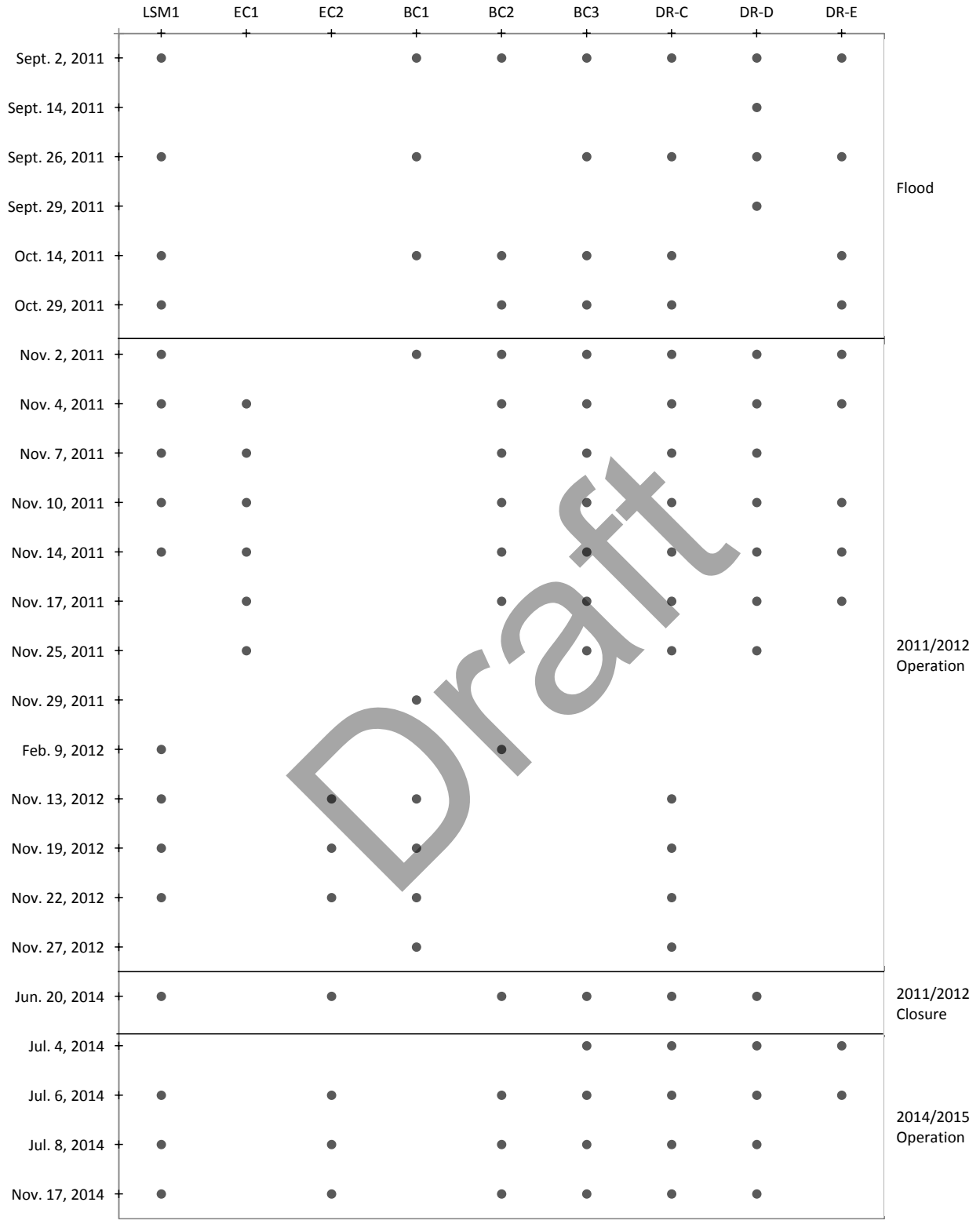


Figure 30. Petroleum hydrocarbon samples collected in the Study Area, 2011-2014. All concentrations were below the analytical detection limits.

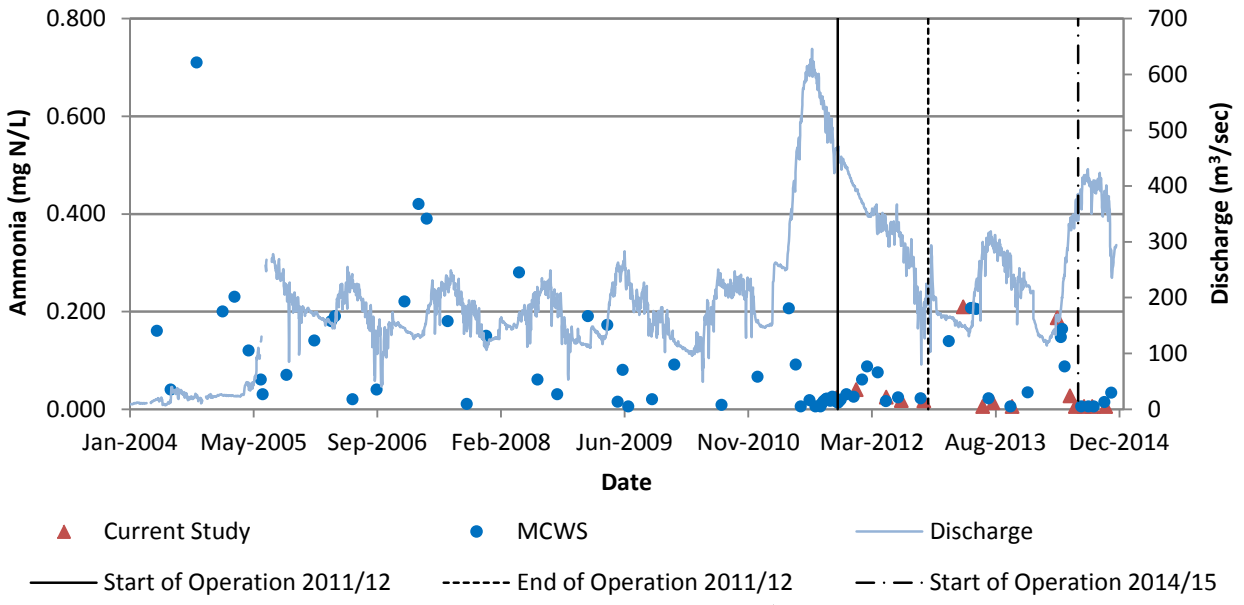


Figure 31. Ammonia concentrations in the Fairford River, 2004-2014.

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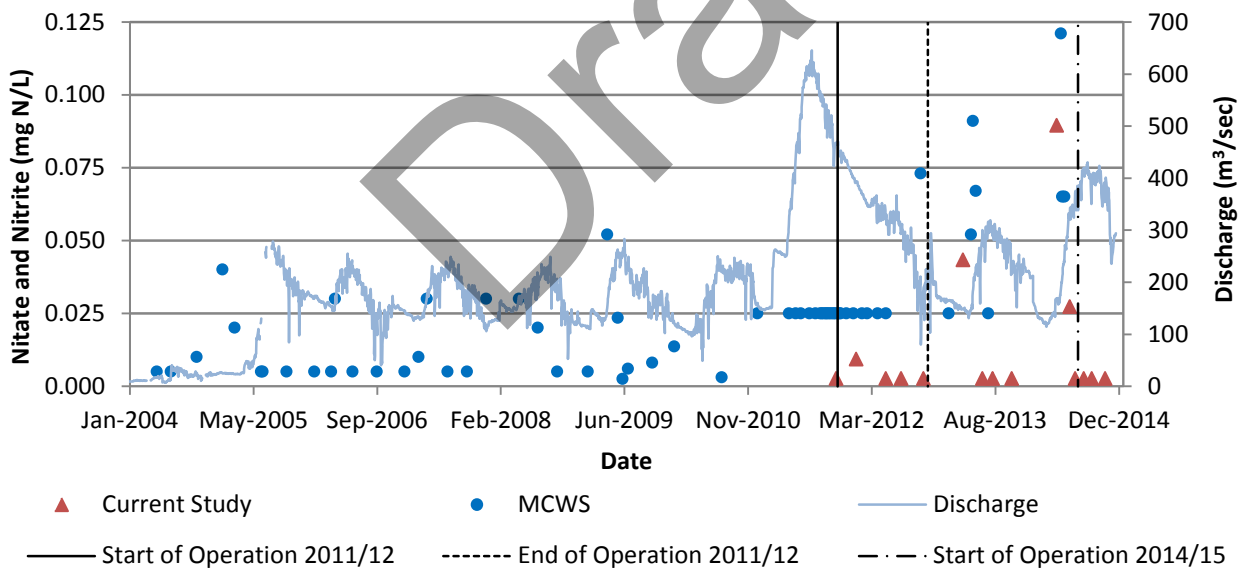


Figure 32. Nitrate/nitrite nitrogen concentrations in the Fairford River, 2004-2014.

4.2 BUFFALO CREEK WATERSHED MONITORING RESULTS

This section presents the assessment of change/lack of change to water quality within the Buffalo Creek watershed from 2011 through 2015. Summary statistics for key water quality parameters for each time period are presented in Table 13. Figures 33 to 52 show trends in water quality from 2011 through 2015 within the watershed. Water quality data for Big Buffalo Lake are not available prior to 2013.

4.2.1 Pre-Operation

Water quality data for the Buffalo Creek watershed prior to the initiation of the Project are limited to those collected in Buffalo Creek in fall 2011 during the 2011 Flood period. No historical data are available and no data are available for Big Buffalo Lake. Based on these data, the water quality of Buffalo Creek could be generally described as nutrient moderate, clear, slightly alkaline, highly coloured, hard, and generally well-oxygenated (Table 13). TSS concentrations were similar throughout the creek and ranged from < 2.0 to 6.0 mg/L (Figure 33). Laboratory data for pH are limited, but values ranged from 8.12 to 8.19. True colour ranged from 51.5 to 53.2 CU. Conductivity and TDS in the creek were relatively low for the Study Area and ranged from 217-237 µmhos/cm and 164-177 mg/L, respectively (Figures 34 and 35). Hardness ranged from 155 to 166 mg/L. DO concentrations ranged from 6.4 to 12.2 mg/L (Figure 36). TN ranged from 0.76 to 1.15 mg/L and was mostly composed of organic forms (Figures 37 and 38). TP concentrations in the creek ranged from < 0.010 to 0.026 mg/L and were predominately composed of dissolved forms (Figures 39 and 40). Carbon concentrations were composed of similar amounts of organic and inorganic forms; and, organic carbon was primarily dissolved (Table 13). On the basis of TN:TP molar ratios, Buffalo Creek was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002). TOC:ON molar ratios indicate that the organic matter in Buffalo Creek watershed was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983). Chlorophyll *a* concentrations indicate that primary productivity in the creek was low; concentrations ranged from 0.37 to 0.52 µg/L (Figure 41).

One of five DO measurements from the upstream end of the creek (BC1) was below the MWQSOGs PAL for cold water mature life/CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L; Figure 36). All other DO measurements were within the MWQSOGs and CCME PALs (Table 14). All other routine parameters were within MWQSOGs and CCME guidelines for PAL, including ammonia, TP, nitrate, nitrite, and pH. Turbidity and true colour exceeded the MWQSOGs/Health Canada aesthetic objectives for drinking water (1.0 NTU and ≤ 15 CU, respectively) throughout the creek. All other routine parameters were within drinking water guidelines, including pH, nitrate/nitrite, nitrate, nitrite, and TDS.

Antimony, total boron, cadmium, chromium, lead, molybdenum, nickel, selenium, silver, thallium, uranium, and zinc were not detected in Buffalo Creek during 2011 Flood. Total aluminum, arsenic, barium, calcium, chloride, fluoride, magnesium, manganese, mercury, total methyl mercury, potassium, sodium, and sulphate were consistently detected; and, dissolved boron, copper, iron, and dissolved methyl mercury were detected in some samples. Aluminum exceeded the MWQSOGs and CCME PAL

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(0.1 mg/L) at the downstream end of Buffalo Creek (Figure 42). All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 15) and drinking water (Table 16).

Petroleum hydrocarbons were not detected in Buffalo Creek during the 2011 Flood period.

4.2.2 2011/2012 Operation

Water quality data for the Buffalo Creek watershed during 2011/2012 Operation are limited to Reach 1 and Buffalo Creek. Due to safety concerns, sampling at the upstream end of Reach 1 (EC1) and the most upstream site on Buffalo Creek (BC1) was not conducted at the onset of operation; therefore data for these sites are not available until January 2012. No data are available for Big Buffalo Lake during 2011/2012 Operation.

4.2.2.1 Routine

During 2011/2012 Operation, the water quality of Buffalo Creek changed as water from Lake St. Martin was introduced to the watershed (Table 13). Conductivity, TDS, and hardness increased substantially to range from 1020-1170 µmhos/cm, 618-732 mg/L, and 254-309 mg/L, respectively (Figures 34 and 35). Laboratory pH also increased, though to a smaller degree, to range from 8.24 to 8.39. Conversely, true colour decreased and ranged from 9.0 to 15.2 CU.

TDS consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) throughout the watershed. Additionally, true colour occasionally exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 15 CU) at the downstream end of Buffalo Creek (BC3). Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0) and the MWQSOGs/Health Canada aesthetic objective for drinking water (6.5-8.5). There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

4.2.2.2 Dissolved Oxygen

During 2011/2012 Operation, Reach 1 was well oxygenated with concentrations ranging from 8.3 to 14.9 mg/L (Figure 36). DO concentrations in Reach 1 were consistently above MWQSOGs objectives and CCME guidelines for PAL.

DO concentrations in Buffalo Creek were generally lower than in Reach 1, ranging from 2.9 to 12.5 mg/L; and, with a few exceptions, remained above PAL objectives (Table 14). Exceptions occurred in March, August and November 2012, as follows:

- On 16 March, DO was below the MWQSOGs objective for cold water early life/CCME lowest acceptable concentration for early life stages of cold water biota (9.5 mg/L) at the first site at the upstream end of the creek (BC1) and at the downstream end of the creek (BC3);
- On 09 August, DO throughout Buffalo Creek (BC1, BC2, and BC3) was below the MWQSOGs PAL for cold water mature life/the CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L). DO was also below the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for early life stages of warm water biota (6.0 mg/L) at one of the sites in the upstream reaches in the creek (BC2); and,

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- On 27 November, a few days after the Reach 1 was closed, DO concentrations at the upstream end of Buffalo Creek (BC1 and BC2) were below both the MWQSOGs PAL for cold water early life/CCME lowest acceptable concentration for early life stages of cold water biota (9.5 mg/L); and, the MWQSOGs PAL for cool water mature life/CCME lowest acceptable concentration for other life stages of warm water biota (5.5 mg/L).

4.2.2.3 TSS and Turbidity

In November 2011, at the onset of 2011/2012 Operation, TSS concentrations in the Buffalo Creek watershed increased. Beginning 04 November, TSS ranged from 17 to 130 mg/L in Reach 1, from 10 to 30 mg/L at the upstream end of Buffalo Creek (BC2), and from 17 to 60 mg/L at the downstream end of the creek (BC3; Figure 33). TSS was consistently higher at the downstream end of the creek indicating that there was erosion and suspension of sediment occurring as the water progressed downstream. TSS remained elevated in the watershed on 25 November when sampling was stopped due to safety concerns.

TSS concentrations exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure objective of 25 mg/L above background as follows: 04, 07, and 17 November in Reach 1 (EC1); 04 November at the upstream end of Buffalo Creek (BC2); and, 04, 07, and 25 November at the downstream end of the creek (BC3). TSS concentrations consistently exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure objective of 5 mg/L above background throughout the Buffalo Creek watershed (EC1, BC2, and BC3) from 04-25 November.

TSS concentrations in the Buffalo Creek watershed had decreased when sampling resumed in January, 2012 (Figure 33); TSS concentrations in the watershed ranged from 2.8 to 6.8 mg/L in January and February 2012. TSS remained at background levels in the watershed until March 2012, when TSS increased above 20 mg/L at the downstream ends of Reach 1 (EC2) and Buffalo Creek (BC3). This change is thought to be associated with the spring melt.

Following the spring freshet, TSS concentrations returned to background in Reach 1 (EC1 and EC2) and at the upstream end of Buffalo Creek (BC1 and BC2). At the downstream end of Buffalo Creek (BC3), TSS initially returned to background levels similar to other areas, and then began to increase such that concentrations were typically above background from May to October. This trend of increasing concentration occurred throughout the creek but was most obvious at the downstream end where TSS was consistently higher.

On 12 September 2012, heavy wind and wave conditions on Lake St. Martin resulted in a plume of sediment that was visible from Lake St. Martin through Reach 1 and into Buffalo Creek (Figures 20 and 33). Additionally, on 19 November 2012, there was a notable spike in TSS in Buffalo Creek (14.7 and 18.1 mg/L, at BC2 and BC3 respectively). This spike corresponded with the closure activities on Reach 1, and although an increase in TSS was not detected upstream in Reach 1, the increased TSS in Buffalo Creek could be a result of in-stream work that occurred earlier in the week when sampling did not occur. Another possible reason for the spike could be the development of border ice, or changes in water levels and flows, that resulted in increased erosion along the banks of the creek.

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It is important to note that when TSS concentrations in Reach 1 were elevated (e.g., spring freshest and 12 September), TSS remained within background at the upstream end of Buffalo Creek (BC1). This indicates that Big Buffalo Lake and the bog complex surrounding the lake acted as a settling area for suspended sediment coming from Reach 1.

TSS concentrations exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure guideline of 25 mg/L above background at the upstream end of Reach 1 (EC1) on 12 September 2012 (Figure 33). Additionally, TSS exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure guideline of 5 mg/L above background as follows: On 16 March, 17 April, 12 September and 22 November 2012 at the downstream end of Reach 1(EC2); on 16 March, 12 September and 19 November 2012 at the second sampling site at the upstream end of Buffalo Creek (BC2); and, on 8 of 12 sampling dates between 16 March and 22 November 2012 at the downstream end of Buffalo Creek (BC3).

In 2012, trends in laboratory turbidity were similar to those for TSS (Figure 43). Laboratory turbidity was not measured during 2011/2012 Operation in 2011. Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Buffalo Creek watershed during 2011/2012 Operation.

4.2.2.4 Nutrients

At the onset of 2011/2012 Operation, there was a small increase in nitrogen at the downstream end of Buffalo Creek (BC3; Figure 37) that can be attributed to an increase in ammonia concentrations (Figure 44). In addition, although TN showed little change at the upstream end of the creek (BC2), there was a small increase in ammonia at the upstream end of the creek. Ammonia concentrations remained elevated throughout the winter, but by spring 2012, nitrogen concentrations in Buffalo Creek were within the range measured during the 2011 Flood period. An increase in DIN, due to increases in both ammonia and nitrate/nitrite, occurred again in fall 2012. During 2011/2012 Operation, TN in Buffalo Creek ranged from 0.39 to 1.43 mg/L and was mostly composed of organic forms (Table 13).

On 04 November 2011, there was a spike in TP in Reach 1 and Buffalo Creek (Figure 39); this spike was composed primarily of particulate forms and was short lived (Figure 40). TP throughout the watershed returned to levels measured in Buffalo Creek during 2011 Flood within a week and remained there throughout the remainder of 2011/2012 Operation. During 2011/2012 Operation, TP in Buffalo Creek ranged from < 0.010 to 0.061 mg/L and, unlike the 2011 Flood period, was composed of a mix of dissolved and particulate forms. On the basis of TN:TP molar ratios, Buffalo Creek was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002) similar to the 2011 Flood period.

During 2011/2012 Operation, organic carbon (total and dissolved) concentrations decreased and inorganic carbon concentrations increased in Buffalo Creek (Table 13). Similar to the 2011 Flood period, TOC:ON molar ratios indicate that the organic matter in Buffalo Creek watershed was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983).

Ammonia rarely exceeded (1 of 16 samples) the CCME PAL guideline at the upstream end of Reach 1. Ammonia was within MWQSOGs and CCME PAL in the Buffalo Creek watershed at all other times during

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2011/2012 Operation. TP exceeded the MWQSOGs narrative guideline for streams (0.050 mg/L) at the upstream end of Reach 1 (EC1) and at the downstream end of Buffalo Creek (BC3) on 04 November 2011. TP was within the MWQSOGs narrative guidelines in Reach 1 and Buffalo Creek at all other times during 2011/2012 Operation. Nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.2.2.5 Chlorophyll *a*

Chlorophyll *a* concentrations in Buffalo Creek during 2011/2012 Operation were higher than those measured in October 2011, ranging from 1.54 to 3.89 µg/L (Figure 41). Chlorophyll *a* was not measured in Reach 1. There are no MWQSOGs or CCME guidelines for chlorophyll *a*.

4.2.2.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Chromium, dissolved lead, silver, dissolved thallium, and dissolved zinc were not detected in the Buffalo Creek watershed during 2011/2012 Operation. Total aluminum, arsenic, barium, boron, calcium, chloride, copper, fluoride, total iron, magnesium, manganese, molybdenum, potassium, sodium, sulphate, and uranium were consistently detected. Dissolved aluminum, total antimony, cadmium, dissolved iron, total lead, mercury, methyl mercury, nickel, selenium, and total zinc were detected in some samples.

Concentrations of several metals and major ions increased in Buffalo Creek during 2011/2012 Operation, including: Arsenic; barium; boron; calcium; chloride; copper; fluoride; magnesium; molybdenum; potassium; sodium; sulphate; and, uranium. Additionally, several metals that were not detected in Buffalo Creek prior to the Project were detected in the creek during 2011/2012 Operation, including: Antimony; boron; cadmium; lead; molybdenum; selenium; thallium; uranium; and, zinc. However, caution should be used when drawing any conclusions from these results. Due to an exception with laboratory methods, analytical DLs for several metals were lowered for some samples collected in May and July 2012. As a result, some metals that were previously not detected in Buffalo Creek may have been detected only because the analytical DL was lower.

Similar to the 2011 Flood period, aluminum frequently exceeded the MWQSOGs and CCME PAL (0.1 mg/L) at the downstream end of Buffalo Creek (2 of 4 samples collected; Figure 42). Unlike the 2011 Flood period, Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) throughout the watershed during 2011/2012 Operation (Figure 45). Similarly, fluoride consistently exceeded the CCME interim PAL (0.12 mg/L), and selenium was frequently above the MWQSOGs and CCME PAL (0.001 mg/L) in the watershed during 2011/2012 Operation (Figure 46). All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 15) and drinking water (Table 16) in the Buffalo Creek watershed during 2011/2012 Operation.

4.2.2.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in Buffalo Creek or Reach 1 at the onset of 2011/2012 Operation, or during closure activities in November 2012 (Figure 30). Analytical detection limits for

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hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

4.2.3 2011/2012 Closure

Water quality data for the Buffalo Creek watershed during 2011/2012 Closure are available for Reach 1, Big Buffalo Lake and Buffalo Creek.

4.2.3.1 Routine

During 2011/2012 Closure, the water quality of Buffalo Creek changed as water from Lake St. Martin was no longer entering the watershed (Table 13). Conductivity, TDS, pH, and hardness decreased, and colour increased in Buffalo Creek. Although conductivity and TDS decreased, they remained higher than were measured during the 2011 Flood period and ranged from 273-479 µmhos/cm and 206-392 mg/L, respectively (Figures 34 and 35). Conversely, laboratory pH, hardness, and colour returned to pre-operation conditions during 2011/2012 Closure; pH ranged from 8.15-8.29, hardness ranged from 124-231 mg/L, and colour ranged from 39.8-65.8 CU.

In Big Buffalo Lake, water quality varied between the open-water and ice-covered seasons; such that, conductivity, TDS and hardness were higher and pH was lower under-ice than during the open-water season during 2011/2012 Closure. Conductivity, TDS and hardness ranged from 203-1170 µmhos/cm, 250-761 mg/L, and 153-484 mg/L, respectively. Similar to Buffalo Creek, colour was high in the lake and ranged from 39.3 to 53.7 CU. No pre-Project data are available for comparison.

TDS frequently (2 of 4 samples) exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) and laboratory pH was occasionally (1 of 4 samples) above the upper limit of the MWQGOGs/Health Canada aesthetic objective (6.5-8.5) in Big Buffalo Lake. TDS and pH were consistently within these objectives in Reach 1 and Buffalo Creek. Colour consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤15 CU) throughout the watershed. Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0). There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

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4.2.3.2 Dissolved Oxygen

In March 2013 following closure of the Reach 1, anoxic conditions existed in Reach 1 and Big Buffalo Lake. At this time, DO concentrations in Buffalo Creek were also low (Figure 36). In spring 2013, DO concentrations were higher in Reach 1 (EC1 and EC2) and at the downstream end of Buffalo Creek (BC3), but remained low in Big Buffalo Lake and the upstream end of Buffalo Creek (BC1 and BC2). In fall 2013, the entire watershed was well oxygenated. Under ice in April 2014, Big Buffalo Lake was again anoxic; Buffalo Creek and Reach 1 were not sampled in winter 2013/2014. During the open-water season of 2014, the Buffalo Creek watershed was generally well oxygenated prior to 2014/2015 Operation.

During 2011/2012 Closure, when water temperatures were less than or equal to 5°C, DO concentrations in the Buffalo Creek watershed were below the MWQSOGs/CCME PALs as follows (Table 14):

- In Reach 1, DO was frequently below the MWQSOGs objective for cold water early life/CCME lowest acceptable concentration for early life stages of cold water biota (9.5 mg/L) and occasionally below the MWQSOGs PAL for cool water mature life/CCME lowest acceptable concentration for other life stages of warm water biota (5.5 mg/L);
- In Big Buffalo Lake, DO was consistently below the MWQSOGs objective for cold water early life/CCME lowest acceptable concentration for early life stages of cold water biota (9.5 mg/L) and frequently below the MWQSOGs PAL for cool water mature life/CCME lowest acceptable concentration for other life stages of warm water biota (5.5 mg/L); and,
- In Buffalo Creek, DO was frequently below the MWQSOGs objective for cold water early life/CCME lowest acceptable concentration for early life stages of cold water biota (9.5 mg/L) and occasionally below the MWQSOGs PAL for cool water mature life/CCME lowest acceptable concentration for other life stages of warm water biota (5.5 mg/L);

During 2011/2012 Closure, when water temperatures were greater than 5°C DO concentrations in the Buffalo Creek watershed were below the MWQSOGs/CCME PAL objectives as follows (Table 14):

- In Big Buffalo Lake, DO was occasionally below the MWQSOGs PAL for cold water mature life/CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L), and the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for other life stages of warm water biota (6.0 mg/L); and,
- In Buffalo Creek, DO was occasionally below the MWQSOGs PAL for cold water mature life/CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L), and rarely below the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for other life stages of warm water biota (6.0 mg/L).

In Reach 1, DO was consistently above the MWQSOGs/CCME PAL objectives when water temperatures were greater than 5°C.

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4.2.3.3 TSS and Turbidity

In spring 2013, TSS concentrations throughout Buffalo Creek were higher than were measured after Reach 1 was closed in November 2012 (Figure 33). Following the freshet, TSS decreased to background levels at the upstream end of Buffalo Creek, but remained consistently higher than in 2011 at the downstream end of the creek. In spring 2014, a similar pattern was observed, however, at the upstream end of the creek the spike in TSS was less pronounced than was observed in 2013. TSS concentrations ranged from < 2.0 to 24 mg/L in Buffalo Creek during 2011/2012 Closure; and, with the exception of the spring freshet in 2013, TSS continued to be higher at the downstream end than at the upstream end of the creek.

TSS concentrations in Reach 1 and Big Buffalo Lake also spiked during the spring freshet of 2013 (Figure 33). TSS concentrations decreased following freshet and then remained fairly stable throughout the remainder of 2011/2012 Closure.

TSS concentrations exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure objective of 5 mg/L above background from May to July in 2013 and in May 2014 at the upstream end of Buffalo Creek (BC1 and BC2); and, consistently exceeded these objectives at the downstream end of Buffalo Creek (BC3) throughout 2011/2012 Closure. TSS concentrations never exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure objective of 25 mg/L above background in Buffalo Creek during 2011/2012 Closure. An assessment of the MWQSOGs/CCME PAL objectives for TSS could not be conducted for Big Buffalo Lake due to a lack of background data. Assessment of TSS objectives was not possible for Reach 1 as it was no longer operational.

Trends in laboratory turbidity were similar to those for TSS (Figure 43). Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Buffalo Creek watershed during 2011/2012 Closure.

4.2.3.4 Nutrients

Following the closure of Reach 1 in 2012, nitrogen increased in Big Buffalo Lake and Buffalo Creek; TN and DIN were higher than both 2011/2012 Operation and the 2011 Flood period in winter and spring 2013 (Figures 37 and 47). After the spring freshet, nitrogen concentrations decreased in the lake and creek. High nitrogen concentrations were again present in Big Buffalo Lake under the ice in April 2014 and a small spike in ammonia occurred in the watershed during the spring freshet. In Reach 1, TN was lower during 2011/2012 Closure than it was during 2011/2012 Operation. During 2011/2012 Closure, TN ranged from 0.53 to 2.83 mg/L in Buffalo Creek and from 0.81 to 3.29 mg/L in Big Buffalo Lake (Table 13). Nitrogen was nearly an equal mix of organic and inorganic forms in winter and in spring 2013, but was mostly in organic form in the Buffalo Creek watershed during the remainder of 2011/2012 Closure (Figure 38).

Similar to nitrogen, in the winter and spring following the closure of Reach 1 in 2012, phosphorus increased throughout the Buffalo Creek watershed. TP concentrations were particularly high during the spring freshet; this was due to increases in both dissolved and particulate forms of phosphorus (Figures 39 and 48). Phosphorus concentrations decreased in Reach 1 (EC1 and EC2), Big Buffalo Lake, and the upstream reaches of Buffalo Creek (BC1 and BC2) after the freshet, but remained elevated at the downstream end of Buffalo Creek (BC3) throughout the open-water season of 2013. In 2014, TP increased again in the spring but had returned to pre-Project levels throughout the watershed prior to 2014/2015 Operation. During 2011/2012 Closure, TP ranged from 0.011 to 0.054 mg/L in Buffalo Creek and, unlike the 2011 Flood period, was composed of a mix of dissolved and particulate forms. TP ranged from < 0.010 to 0.044 mg/L in Big Buffalo Lake and was also composed of a mix of dissolved and particulate forms; no pre-Project data are available for comparison. On the basis of TN:TP molar ratios, the Buffalo Creek watershed remained phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002).

During 2011/2012 Closure, organic carbon (total and dissolved) concentrations in Buffalo Creek increased such that they returned to levels similar to what they were in fall 2011. Conversely, inorganic carbon concentrations in the creek did not change and remained higher than they were before 2011/2012 Operation (Table 13). Carbon (organic and inorganic) concentrations in Big Buffalo Lake were higher than in Buffalo Creek; no pre-Project data are available for comparison. Similar to the 2011

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Flood period, TOC:ON molar ratios indicate that the organic matter in Buffalo Creek watershed was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983).

Ammonia occasionally (2 of 12 samples) exceeded the CCME PAL guideline in Big Buffalo Lake; ammonia was within MWQSOGs and CCME PAL in the Buffalo Creek watershed at all other times during 2011/2012 Closure. TP was above the MWQSOGs narrative guideline for streams (0.050 mg/L) in Reach 1 (EC1) in March 2013; and, in the upstream reaches of Buffalo Creek (BC2) in May 2013. TP was within the MWQSOGs narrative guidelines in Reach 1 and Buffalo Creek at all other times during 2011/2012 Closure. However, TP frequently exceeded the MWQSOGs narrative guideline for lakes (0.025 mg/L) in Big Buffalo Lake. Nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.2.3.5 Chlorophyll *a*

Chlorophyll *a* concentrations in Buffalo Creek during 2011/2012 Closure remained higher than October 2011. Concentrations at the downstream end of the creek (BC3) ranged from 1.98 to 5.64 µg/L (Figure 41). Chlorophyll *a* in Big Buffalo Lake ranged from 1.34 to 7.96 µg/L; there are no pre-Project data for Buffalo Lake for comparison. Chlorophyll *a* was not measured in Reach 1. There are no MWQSOGs or CCME guidelines for chlorophyll *a*.

4.2.3.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Antimony, dissolved chromium, dissolved lead, nickel, selenium, silver, thallium, and dissolved zinc were not detected in the Buffalo Creek watershed during 2011/2012 Closure. Total aluminum, arsenic, barium, boron, calcium, chloride, total copper, magnesium, manganese, total mercury, methyl mercury, molybdenum, potassium, sodium, sulphate, and uranium were consistently detected. Dissolved aluminum, cadmium, dissolved copper, fluoride, iron, total lead, dissolved mercury, and total zinc were detected in some samples.

Most metals and major ions that had increased in Buffalo Creek during 2011/2012 Operation showed a decreasing trend in concentration during 2011/2012 Closure but remained above pre-operation levels, including: Arsenic; barium; boron; chloride; fluoride; molybdenum; and, uranium. Calcium, magnesium, potassium, sodium, and sulphate also decreased in concentration but had returned to pre-operation levels by the end the 2011/2012 Closure period. Conversely, total copper continued to increase in concentration in Buffalo Creek and, concentrations of total forms of aluminum, iron, lead, and manganese were higher in Buffalo Creek during 2011/2012 Closure than were previously measured.

Several metals with MWQSOGs or CCME guidelines for PAL and/or drinking water that were not detected in Buffalo Creek prior to the Project were still detected in the creek after Reach 1 was closed, including: boron; cadmium; lead; molybdenum; uranium; and, zinc (Table 13).

Aluminum continued to frequently exceed the MWQSOGs and CCME PAL (0.1 mg/L) in Buffalo Creek (Figure 42) as it did during 2011/2012 Operation and prior to the Project. Chloride exceeded the CCME long-term exposure guideline in 1 of 4 samples collected from Big Buffalo Lake; this guideline was no

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longer exceeded elsewhere in the watershed (Figure 45). Fluoride exceeded the CCME interim PAL (0.12 mg/L) in the samples that were collected in Reach 1 and in 1 of 4 samples collected from Big Buffalo Lake; this guideline was no longer exceeded in Buffalo Creek (Figure 46). Additionally, iron frequently (in 3 of 6 samples) exceeded the MWQSOGs/CCME PAL (0.3 mg/L) and the MWQSOGs/Health Canada aesthetic objective for drinking water (0.3 mg/L; Figure 49) and chromium occasionally (1 of 6 samples) exceeded the CCME PAL at the downstream end of Buffalo Creek (BC3; Table 15). Exceedance of the latter two guidelines had not previously occurred. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 15) and drinking water (Table 16) in the Buffalo Creek watershed during 2011/2012 Closure.

4.2.3.7 Petroleum Hydrocarbons

During 2011/2012 Closure, petroleum hydrocarbons were only sampled prior to the onset of 2014/2015 Operation; they were not detected in Reach 1 or Buffalo Creek at this time (Figure 30). Analytical detection limits for hydrocarbon parameters sampled were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12). Petroleum hydrocarbons were not sampled in Big Buffalo Lake.

4.2.4 2014/2015 Operation

Water quality data for the Buffalo Creek watershed during 2014/2015 Operation are available for Reach 1, Big Buffalo Lake and Buffalo Creek.

4.2.4.1 Routine

Similar to 2011/2012 Operation, at the onset of 2014/2015 Operation, the water quality of Buffalo Creek changed as water from Lake St. Martin was introduced to the watershed (Table 13). Conductivity, TDS and hardness increased to range from 846-938 µmhos/cm, 488-537 mg/L, and 211-239 mg/L, respectively. In addition, there was a small increase in laboratory pH; pH ranged from 8.24 to 8.39 during operation in 2014. Conversely, true colour decreased and ranged from 10.3 to 20.7 CU.

TDS and true colour frequently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L and ≤ 15 CU, respectively) in Buffalo Creek. Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0) and the MWQSOGs/Health Canada aesthetic objective for drinking water (6.5-8.5). There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

There are no data for these parameters for Reach 1 or Big Buffalo Lake during this period.

4.2.4.2 Dissolved Oxygen

At the onset of 2014/2015 Operation, DO concentrations dropped in Buffalo Creek (Figure 36); there was little effect on DO concentrations in Reach 1 and Big Buffalo Lake. DO concentrations recovered quickly at the downstream end of Buffalo Creek (BC3), but remained low until at least the middle of July at the upstream end of the creek (BC1 and BC2). From August to November 2014 DO steadily increased throughout the watershed then declined from May to July 2015.

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DO concentrations in 2014 were below the MWQSOGs PAL for cold water mature life and CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L) at water temperatures > 5°C in Reach 1 on 06 July (EC2) and 08 July (EC1 and EC2), Big Buffalo Lake on 06 July, the upstream end of Buffalo Creek (BC1) from 04 July to 26 August, BC2 from 06-16 July, and at the downstream end of the creek on 03, 05, and 11 July. In 2015, DO concentrations were below this objective at water temperatures > 5°C on 11 June at the downstream end of Buffalo Creek (BC3) and on 30 July at the upstream and downstream ends (BC1 and BC3) of Buffalo Creek.

DO in 2014 was below the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for early life stages of warm water biota (6.0 mg/L) at water temperatures > 5°C at the downstream end of Reach 1 on 06 and 08 July (EC2), the upstream end of Buffalo Creek at BC1 from 04-16 July and at BC2 from 06-16 July, and at the downstream end of the creek on 03, 05 and 11 July. In 2015, DO concentrations were below this objective at water temperatures > 5°C on 11 June at the downstream end of Buffalo Creek (BC3) and on 30 July at the upstream and downstream ends (BC1 and BC3) of Buffalo Creek.

In March 2015, DO was below the MWQSOGs PAL for cold water early life/CCME lowest acceptable-concentration for early life stages of cold water biota (9.5 mg/L) at the downstream end of Buffalo Creek (BC3).

4.2.4.3 TSS and Turbidity

At the onset of 2014/2015 Operation, TSS concentrations increased throughout the Buffalo Creek watershed (Figure 33) with the magnitude of change the greatest at the downstream ends of both Reach 1 and Buffalo Creek. TSS concentrations increased as the water entered Reach 1 from Lake St. Martin and flowed downstream towards Big Buffalo Lake. At Big Buffalo Lake, TSS concentrations were lower than in Reach 1 indicating that settling occurred when the water reached the wetland. TSS concentrations then continued to increase from upstream to downstream in Buffalo Creek. At the downstream end of Buffalo Creek, the spike in TSS concentrations that occurred was approximately three times greater than that which occurred at the onset of 2011/2012 Operation and concentrations were approximately thirty times higher than those measured during the flood in October 2011. In July 2014, TSS concentrations ranged from 12 to 174 mg/L in Reach 1, from 6.4 to 23.6 mg/L in Big Buffalo Lake and from 3.2 to 180 mg/L in Buffalo Creek.

Following the initial onset of 2014/2015 Operation, with one exception, TSS concentrations in the watershed gradually decreased throughout 2014. The exception occurred on 17 November when TSS concentrations spiked in Reach 1 coincident with excavation work during the Expanded Opening. TSS concentrations in Reach 1 had decreased again by 18 November.

TSS exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure objective of 25 mg/L above background as follows (Figure 33): 04 July at the upstream end of Reach 1 (EC1); 03-06 July at the downstream end of Reach 1 (EC2); 04 July at the most upstream site in Buffalo Creek (BC1); 04 and 06 July at the second sampling site at the upstream end of the creek (BC2); and, from 05-11 July at the downstream end of the creek (BC3). TSS concentrations exceeded the MWQSOGs 30-day averaging

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objective/CCME long-term exposure objective of 5 mg/L above background throughout Reach 1 (EC1 and EC2) from 03-16 July and on 17 November, in Big Buffalo Lake from 03 July to 23 October, at the upstream end of Buffalo Creek (BC1 and/or BC2) from 04-11 July, and at the downstream end of the creek (BC3) from 03 July to 23 October, 2014 and 27 March to 30 July, 2015.

Trends in laboratory turbidity were similar to those for TSS (Figure 43). Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Buffalo Creek watershed during 2014/2015 Operation.

4.2.4.4 Nutrients

During 2014/2015 Operation, nitrogen concentrations in the Buffalo Creek were similar to those measured in fall 2011, and concentrations in Big Buffalo Lake were similar to those measured in 2014 prior to the onset of operation (Figure 37). TN ranged from 0.64 to 1.44 mg/L in Buffalo Creek and from 0.73 to 1.06 mg/L in Big Buffalo Lake. Nitrogen in the Buffalo Creek watershed was mostly composed of organic forms (Figure 38).

At the onset of 2014/2015 Operation, there was an increase in phosphorus concentrations in the Buffalo Creek watershed (Figure 39). A similar spike in phosphorus was observed at the onset of 2011/2012 Operation; again, this spike was composed primarily of particulate forms (Figure 40). In about one week, TP throughout the watershed returned to levels measured in Buffalo Creek during 2011 Flood where they persisted throughout the remainder of 2014 and 2015. During 2014/2015 Operation, TP ranged from 0.011 to 0.089 mg/L in Buffalo Creek and from 0.014 to 0.030 mg/L in Big Buffalo Lake; TP was composed of a mix of dissolved and particulate forms. On the basis of TN:TP molar ratios, Buffalo Creek was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002).

During 2014/2015 Operation, organic carbon (total and dissolved) concentrations decreased and inorganic carbon concentrations increased in Buffalo Creek (Table 13). Similar to the 2011 Flood period, TOC:ON molar ratios indicate that the organic matter in Buffalo Creek watershed was composed of a mix of autochthonous and allochthonous sources; however, TOC:ON molar ratios were approaching the autochthonous boundary (Wetzel 1983).

At the onset of 2014/2015 Operation, TP exceeded the MWQSOGs narrative guideline for streams (0.050 mg/L) at the upstream end of Reach 1 (EC1) and at the downstream end of Buffalo Creek (BC3) and the MWQSOGs narrative guideline for lakes (0.25 mg/L) in Big Buffalo Lake. TP was consistently within the MWQSOGs narrative guidelines in the Buffalo Creek watershed after 11 July in 2014. Ammonia, nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.2.4.5 Chlorophyll *a*

Chlorophyll *a* concentrations in Buffalo Creek changed very little at the onset of 2014/2015 Operation and remained within the ranges that have been measured since 2011/2012 Operation. Chlorophyll *a* ranged from 1.46 to 2.80 µg/L at the downstream end of the creek (BC3) during 2014/2015 Operation in

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2014 (Figure 41). Chlorophyll *a* was not measured in Reach 1 or Big Buffalo Lake. There are no MWQSOGs or CCME guidelines for chlorophyll *a*.

4.2.4.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Cadmium, chromium, dissolved iron, dissolved lead, nickel, selenium, silver, thallium, and dissolved zinc were not detected in the Buffalo Creek watershed during 2014/2015 Operation. Total aluminum, arsenic, barium, boron, calcium, chloride, total copper, fluoride, total iron, total lead, magnesium, manganese, molybdenum, potassium, sodium, sulphate, and uranium were consistently detected. Dissolved aluminum, antimony, dissolved copper, mercury, methyl mercury, and total zinc were detected in some samples.

Similar to 2011/2012 Operation, several metals and major ions increased in Buffalo Creek during 2014/2015 Operation, including: arsenic; barium; boron; calcium; chloride; fluoride; magnesium; molybdenum; potassium; sodium; sulphate; and, uranium. Additionally, at the onset of 2014/2015 Operation there was a slight increase in mercury and methyl mercury concentrations in Buffalo Creek, but concentrations had returned to pre-Project levels by October 2014 (Figures 50 and 51). Conversely, unlike in 2011/2012 Operation, copper concentrations decreased in Buffalo Creek following the opening of Reach 1 in 2014 (Figure 52).

- Iron exceeded the MWQSOGs/CCME PAL (0.3 mg/L) at the downstream end of Buffalo Creek (BC3) in May 2015.

Similar to the 2011 Flood period, aluminum consistently exceeded the MWQSOGs and CCME PAL (0.1 mg/L) at the downstream end of Buffalo Creek during 2014/2015 Operation (Figure 42). And similar to 2011/2012 Operation, chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) and fluoride consistently exceeded the CCME interim PAL (0.12 mg/L; Figures 45 and 46). Iron also exceeded the MWQSOGs/CCME PAL (0.3 mg/L) at the downstream end of Buffalo Creek (BC3) in May 2015. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 15) and drinking water (Table 16) in the Buffalo Creek watershed during 2014/2015 Operation.

4.2.4.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in Buffalo Creek or Reach 1 at the onset of 2014/2015 Operation in July 2014 or during the Expanded Opening in November 2014 (Figure 30). Analytical detection limits for sampled hydrocarbon parameters were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

4.2.5 2014/2015 Closure

Water quality data for the Buffalo Creek watershed during 2014/2015 Closure are available for Reach 1, Big Buffalo Lake and Buffalo Creek. Measurement parameters included DO, TSS, and nutrients.

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4.2.5.1 Dissolved Oxygen

There was little effect of the Project on DO concentrations in Reach 1, Big Buffalo Lake, or Buffalo Creek during 2014/2015 Closure. At the onset, DO concentrations were low and similar to those measured at the end of the 2014/2015 Operation; however, all concentrations increased to pre-Project levels by 14 September (Figure 36).

On 13 and 19 August, DO concentrations were below the MWQSOGs PAL for cold water mature life and CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L) in Reach 1 (EC2), Big Buffalo Lake, and the upstream and downstream ends of Buffalo Creek (BC1 and BC3).

DO was also below the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for early life stages of warm water biota (6.0 mg/L) in Big Buffalo Lake, and the upstream end of Buffalo Creek (BC1) on 13 and 19 August and the downstream end of Buffalo Creek (BC3) on 13 August.

4.2.5.2 TSS and Turbidity

TSS concentrations at the upstream and downstream ends of Buffalo Creek (BC1 and BC3, respectively) increased immediately following 2014/2015 Closure though concentrations were lower at the downstream end, indicating that settling occurred with progression through the creek (Figure 33). Concentrations in the creek during the 2014/2015 Closure were up to three times higher than those measured during the 2011 Flood but remained relatively low (ranging from 5 to 19 mg/L) and similar to those measured during 2011/2012 Closure (1.0 to 25.4 mg/L; Figure 33).

TSS exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure objective of 5 mg/L above background at the upstream end of Buffalo Creek (BC1) on 14 September, and at the downstream end of the creek (BC3) on 19 August (Figure 33).

Trends in laboratory turbidity were similar to those for TSS (Figure 43). Similar to other periods, turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Buffalo Creek watershed during 2014/2015 Closure.

4.2.5.3 Nutrients

Similar to the 2011/2012 Closure, nutrients in Big Buffalo Lake and Buffalo Creek increased following the 2014/2015 Closure, and concentrations remained elevated at the conclusion of the monitoring program. On 19 August and 14 September, ammonia, TN, and TP increased in Big Buffalo Lake, the upstream end of Buffalo Creek (BC-1) and, to a lesser degree, the downstream end of Buffalo Creek (BC-3; Figures 37, 39, and 44). During 2014/2015 Closure, nitrogen and phosphorous concentrations in the Buffalo Creek watershed remained lower than the spike observed during 2011/2012 Closure, however. TN ranged from 0.82 to 1.70 mg/L in Buffalo Creek and from 0.91 to 1.84 mg/L in Big Buffalo Lake and was mostly composed of inorganic forms (Figure 38). TP ranged from 0.019 to 0.040 mg/L in Buffalo Creek and from 0.018 to 0.030 mg/L in Big Buffalo Lake; TP was composed of a mix of dissolved and particulate forms. On the basis of TN:TP molar ratios, Buffalo Creek was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002).

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Total Phosphorus exceeded the MWQSOGs narrative guideline for lakes (0.025 mg/L) in Big Buffalo Lake on 14 September. Ammonia also exceeded the CCME guideline (varies with water temperature and pH) in Big Buffalo Lake on 14 September. All other nutrients (nitrate/nitrite, nitrate, and nitrite) were within guidelines.

4.2.6 Summary

The water quality of the Buffalo Creek watershed changed during each Project phase, reflecting the influence of the chemistry of water from Lake St. Martin as well as Project activities, as follows:

- Routine water quality parameters (conductivity, TDS, pH, hardness, and colour) varied in part as a result of the input of water from Lake St. Martin:
    - During the two periods when Reach 1 was operational (November 2011-November 2012, July 2014-August 2015), conductivity, TDS, pH, and hardness increased (relative to conditions measured during flood conditions in 2011), and colour decreased.
    - While Reach 1 was closed from November 2012 to July 2014, conductivity, TDS, hardness, and pH declined, though conductivity and TDS levels remained above those measured during the 2011 Flood. These parameters were not measured after closure in August 2015.

- DO generally met the Manitoba objectives for the protection of cool and cold-water aquatic life, though it declined below the objectives at various points during the monitoring program:
    - At the onset of 2014/2015 Operation, DO temporarily (for 1-10 days depending upon location) decreased below the Manitoba/CCME PALs throughout the watershed (this was not observed at the onset of 2011/2012 Operation).
    - Concentrations measured in August 2015 at the onset of closure also temporarily decreased below the PALs.
    - DO concentrations below the Manitoba guidelines and CCME objectives were also observed prior to Reach 1 operation. However, baseline data are too limited to determine whether declines observed during the Project were as a result of the Project or natural conditions.

- TSS concentrations were affected at the onset of both Project operation and closure periods:
    - At the onset of the 2011/2012 and 2014/2015 Operation periods, TSS concentrations in the Buffalo Creek watershed increased 5 to 30 times compared to the 2011 flood. TSS increases at the downstream end of Buffalo Creek were three times greater in 2014 than in 2011.
    - During closure after November 2012, spring TSS was approximately four times higher than pre-Project levels; concentrations subsequently declined but remained higher than baseline at the downstream end of Buffalo Creek. A similar increase in TSS was observed following closure activities in August 2015, and levels remained elevated at the end of the monitoring program in September 2015.

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  - The increases in TSS described above resulted in exceedances of both the short and long term MSWQSOGs

- Nutrients and chlorophyll *a* fluctuated during the Project, but the limited baseline data do not allow Project effects to be distinguished from natural variation:
  - At the onset of operation in 2011 and 2014, TP in Buffalo Creek increased above the MWQSOGs narrative guideline for streams (0.050 mg/L), but returned to pre-Project concentrations within a week in both years.
  - In winter and spring 2012 following the closure of Reach 1, TP and TN increased beyond the concentrations measured during 2011/2012 Operation and pre-Project phases. Following the freshet, both nutrients returned to baseline in most of the watershed, but TP remained high at the downstream end of Buffalo Creek throughout 2013. In spring 2014, there was another spike in TP, and TP increased again immediately following closure in August 2015.
  - TP occasionally exceeded the narrative guideline for streams during closures from November 2012-July 2014 and after August 2015.
  - During closure, ammonia occasionally exceeded the CCME PAL guideline in Big Buffalo Lake.
  - Chlorophyll *a* concentrations in Buffalo Creek were consistently higher than baseline from spring 2012 to August 2015, though baseline data are limited. There are no MWQSOGs or CCME guidelines for chlorophyll *a*.

- Concentrations of several metals and ions were affected by Project operation/closure, likely due to the influence of water from Lake St. Martin. However, due to limited baseline data, the extent of exceedance of guidelines under natural conditions is not known:
  - Several metals and major ions increased relative to baseline conditions in Buffalo Creek during operation in 2011/2012 and 2014/2015, including: arsenic, barium, boron, calcium, chloride, fluoride, magnesium, molybdenum, potassium, sodium, sulphate, and uranium. These metals all decreased during closure from November 2012-July 2014 to concentrations near pre-Project levels.
  - Copper increased during 2011/2012 Operation, but decreased during 2014/2015 Operation.
  - At the onset of 2014/2015 Operation there was a small increase in mercury and methylmercury in Buffalo Creek, but both returned to baseline by October 2014. Comparable data were not collected during the 2011/2012 Operation.
  - During operation in 2011/2012 and 2013/2014, chloride and fluoride exceeded the CCME PAL guidelines (120 and 0.12 mg/L, respectively) in the Buffalo Creek watershed. These guidelines were occasionally exceeded in Big Buffalo Lake during the closure from November 2012-July 2014, but not in Buffalo Creek.
  - During 2011/2012 Operation, selenium was frequently above the MWQSOGs/CCME PAL (0.001 mg/L) in the Buffalo Creek watershed.

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- During closure from November 2012-July 2014, iron frequently exceeded the PAL (0.3 mg/L), and chromium occasionally exceeded the CCME PAL (0.0089 mg/L) at the downstream end of Buffalo Creek.

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Table 13. Summary statistics for key water quality parameters measured in the Buffalo Creek watershed, 2011-2015.

		Ammonia (mg N/L)							Nitrate/Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.059	0.067	<0.010	0.149	0.0092	16	94	<0.071	<0.071	<0.071	<0.071	-	16	6
	2011/2012 Closure	0.041	0.020	<0.010	0.212	0.0220	9	67	<0.071	<0.071	<0.071	0.103	-	9	11
	2014/2015 Operation	<0.010	<0.010	<0.010	0.039	-	9	11	<0.071	<0.071	<0.071	<0.071	-	9	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.053	0.035	<0.010	0.145	0.0126	11	91	<0.071	<0.071	<0.071	<0.071	-	11	9
	2011/2012 Closure	0.102	0.024	<0.010	0.414	0.0486	9	78	<0.071	<0.071	<0.071	<0.071	-	9	0
	2014/2015 Operation	0.011	<0.010	<0.010	0.033	0.0033	11	27	<0.071	<0.071	<0.0051	<0.071	-	11	9
	2014/2015 Closure	<0.010	<0.010	<0.010	<0.010	-	3	0	<0.070	<0.070	<0.070	<0.070	-	3	0
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.562	0.172	0.024	1.91	0.204	12	100	<0.071	<0.071	<0.0051	<0.071	-	12	8
	2014/2015 Operation	0.011	<0.010	<0.010	0.038	0.0032	11	36	<0.071	<0.071	<0.071	<0.071	0.0035	11	18
	2014/2015 Closure	0.181	0.131	0.010	0.402	0.1159	3	100	<0.070	<0.070	<0.070	<0.070	-	3	0
BC1	2011 Flood	<0.050	<0.050	<0.010	<0.050	-	4	0	<0.071	<0.071	<0.071	<0.071	-	4	25
	2011/2012 Operation	0.085	<0.050	<0.050	0.371	0.0307	11	91	<0.071	<0.071	<0.071	0.114	0.0078	11	18
	2011/2012 Closure	0.361	0.105	<0.010	1.44	0.175	10	80	<0.071	<0.071	<0.071	0.087	0.0062	10	20
	2014/2015 Operation	0.012	<0.010	<0.010	0.042	0.0034	11	45	<0.071	<0.071	<0.071	<0.071	0.0026	11	18
	2014/2015 Closure	0.141	0.139	0.015	0.268	0.0730	3	100	<0.070	<0.070	<0.070	0.106	-	3	33
BC2	2011 Flood	<0.050	<0.050	<0.010	<0.050	-	4	0	<0.071	<0.071	<0.071	<0.071	-	4	25
	2011/2012 Operation	0.070	<0.050	<0.010	0.364	0.0185	19	68	<0.071	<0.071	<0.071	0.075	0.0022	19	11
	2011/2012 Closure	0.377	0.076	<0.010	1.55	0.195	10	80	<0.071	<0.071	<0.071	0.102	-	10	10
	2014/2015 Operation	0.010	<0.010	<0.010	0.040	0.0038	9	22	<0.071	<0.071	<0.071	<0.071	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.050	<0.050	<0.010	<0.050	-	4	0	<0.071	<0.071	<0.0051	<0.071	-	4	0
	2011/2012 Operation	<0.050	<0.050	<0.050	0.125	0.0071	20	75	<0.071	<0.071	<0.071	0.076	0.0040	20	25
	2011/2012 Closure	0.063	0.029	<0.010	0.355	0.0289	13	62	<0.071	<0.071	<0.071	0.105	0.0085	13	54
	2014/2015 Operation	0.017	<0.010	<0.010	0.099	0.0064	15	47	<0.071	<0.071	<0.071	0.088	0.0052	14	36
	2014/2015 Closure	0.063	0.044	0.035	0.109	0.0233	3	100	<0.070	<0.070	<0.070	0.193	0.0546	3	67

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Table 13. Continued.

		Nitrate (mg N/L)							Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	16	6	<0.050	<0.050	<0.050	<0.050	-	16	6
	2011/2012 Closure	<0.050	<0.050	<0.050	0.103	-	9	22	<0.050	<0.050	<0.050	<0.050	-	9	0
	2014/2015 Operation	<0.050	<0.050	<0.0051	<0.050	-	9	0	<0.050	<0.050	<0.0010	<0.050	-	9	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	11	9	<0.050	<0.050	<0.0010	<0.050	-	11	0
	2011/2012 Closure	<0.050	<0.050	<0.050	0.068	-	9	11	<0.050	<0.050	<0.050	<0.050	-	9	0
	2014/2015 Operation	<0.050	<0.050	<0.0050	<0.050	-	11	9	<0.050	<0.050	<0.0010	<0.050	-	11	0
	2014/2015 Closure	<0.020	<0.020	<0.020	<0.020	-	3	0	<0.010	<0.010	<0.010	<0.010	-	3	0
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.050	<0.050	<0.0050	0.064	0.0047	12	17	<0.050	<0.050	<0.0010	<0.050	-	12	8
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	0.0025	11	18	<0.050	<0.050	<0.0010	<0.050	-	11	0
	2014/2015 Closure	<0.020	<0.020	<0.020	0.026	-	3	33	<0.010	<0.010	<0.010	<0.010	-	3	0
BC1	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	4	25	<0.050	<0.050	<0.0010	<0.050	-	4	0
	2011/2012 Operation	<0.050	<0.050	<0.050	0.114	0.0090	11	18	<0.050	<0.050	<0.050	<0.050	-	11	0
	2011/2012 Closure	<0.050	<0.050	<0.050	0.087	0.0080	10	30	<0.050	<0.050	<0.050	<0.050	-	10	0
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	0.0019	11	18	<0.050	<0.050	<0.0010	<0.050	-	11	0
	2014/2015 Closure	0.038	0.024	<0.020	0.079	0.0211	3	67	<0.010	<0.010	<0.010	0.027	-	3	33
BC2	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	4	25	<0.050	<0.050	<0.0010	<0.050	-	4	0
	2011/2012 Operation	<0.050	<0.050	<0.050	0.075	0.0034	19	16	<0.050	<0.050	<0.050	<0.050	-	19	5
	2011/2012 Closure	<0.050	<0.050	<0.050	0.102	0.0083	10	30	<0.050	<0.050	<0.050	<0.050	-	10	0
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	-	9	11	<0.050	<0.050	<0.0010	<0.050	-	9	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.050	<0.050	<0.0050	<0.050	-	4	0	<0.050	<0.050	<0.0010	<0.050	-	4	0
	2011/2012 Operation	<0.050	<0.050	<0.0050	0.076	0.0043	20	25	<0.050	<0.050	<0.0010	<0.050	-	20	5
	2011/2012 Closure	<0.050	<0.050	<0.0050	0.099	0.0087	13	54	<0.050	<0.050	<0.0010	<0.050	0.0032	13	15
	2014/2015 Operation	<0.050	<0.050	<0.050	0.083	0.0049	14	43	<0.050	<0.050	<0.0010	<0.050	-	14	7
	2014/2015 Closure	0.068	0.030	0.024	0.151	0.0413	3	100	0.017	<0.010	<0.010	0.042	-	3	33

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Table 13. Continued.

		Dissolved Inorganic Nitrogen (mg/L)							Total Kjeldahl Nitrogen (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.088	0.101	<0.070	0.185	0.011	16	69	1.06	1.06	0.28	1.75	0.073	16	100
	2011/2012 Closure	0.072	<0.070	<0.070	0.315	0.031	9	22	0.29	0.10	0.10	1.32	0.134	9	33
	2014/2015 Operation	<0.070	<0.070	<0.070	0.075	-	9	11	0.87	0.88	0.69	1.02	0.033	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.074	<0.070	<0.070	0.181	0.015	11	45	1.00	1.00	0.39	1.77	0.096	11	100
	2011/2012 Closure	0.129	<0.070	<0.070	0.450	0.051	9	44	0.47	0.39	0.22	1.36	0.118	9	100
	2014/2015 Operation	<0.071	<0.071	<0.010	<0.071	0.0034	11	18	0.87	0.88	0.70	1.10	0.033	11	100
	2014/2015 Closure	<0.070	<0.070	<0.070	<0.070	-	3	0	0.94	0.98	0.85	1.00	0.049	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.584	0.208	<0.070	1.91	0.203	12	83	1.52	1.00	0.77	3.29	0.262	12	100
	2014/2015 Operation	<0.071	<0.071	<0.010	0.074	0.004	11	36	0.88	0.90	0.69	1.02	0.036	11	100
	2014/2015 Closure	0.216	0.166	<0.070	0.437	0.116	3	67	1.32	1.21	0.91	1.84	0.274	3	100
BC1	2011 Flood	<0.070	<0.070	<0.070	<0.070	-	4	25	0.94	0.93	0.81	1.11	0.068	4	100
	2011/2012 Operation	0.123	0.111	<0.070	0.407	0.033	11	64	0.83	0.79	0.38	1.19	0.058	11	100
	2011/2012 Closure	0.403	0.147	<0.070	1.48	0.174	10	70	1.18	0.85	0.52	2.72	0.238	10	100
	2014/2015 Operation	<0.071	<0.071	<0.071	0.078	0.005	11	27	0.82	0.84	0.63	1.06	0.035	11	100
	2014/2015 Closure	0.199	0.174	<0.070	0.374	0.094	3	67	1.21	1.15	0.88	1.59	0.207	3	100
BC2	2011 Flood	<0.070	<0.070	<0.070	<0.070	-	4	25	0.91	0.88	0.80	1.06	0.055	4	100
	2011/2012 Operation	0.094	<0.070	<0.070	0.400	0.020	19	47	0.91	0.95	0.35	1.24	0.040	19	100
	2011/2012 Closure	0.416	0.124	<0.070	1.59	0.195	10	70	1.21	1.01	0.53	2.79	0.220	10	100
	2014/2015 Operation	<0.070	<0.070	<0.070	0.075	-	9	22	0.80	0.82	0.71	0.92	0.024	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.070	<0.070	<0.010	<0.070	-	4	0	0.95	1.02	0.76	1.03	0.067	4	100
	2011/2012 Operation	0.076	<0.070	<0.070	0.181	0.011	20	60	0.93	0.91	0.35	1.39	0.049	20	100
	2011/2012 Closure	0.105	<0.070	<0.010	0.391	0.032	13	69	0.84	0.79	0.52	1.43	0.074	13	100
	2014/2015 Operation	<0.071	<0.071	<0.071	0.079	0.004	13	54	0.86	0.87	0.60	1.44	0.048	15	100
	2014/2015 Closure	0.147	0.144	0.059	0.237	0.051	3	100	0.99	1.06	0.79	1.11	0.099	3	100

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Table 13. Continued.

		Total Nitrogen (mg/L)							Dissolved Phosphorus (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	1.10	1.09	0.32	1.79	0.073	16	100	<0.010	0.011	<0.010	0.015	0.0010	15	60
	2011/2012 Closure	0.31	<0.20	<0.20	1.42	0.146	9	33	<0.010	<0.010	<0.010	0.016	0.0012	9	11
	2014/2015 Operation	0.91	0.92	0.73	1.02	0.031	9	100	<0.010	<0.010	<0.010	0.011	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	1.03	1.03	0.43	1.81	0.096	11	100	<0.010	<0.010	<0.010	0.035	0.0030	10	30
	2011/2012 Closure	0.51	0.43	0.26	1.40	0.118	9	100	0.010	<0.010	<0.010	0.029	0.0027	9	56
	2014/2015 Operation	0.90	0.91	0.74	1.10	0.031	11	100	<0.010	<0.010	<0.010	0.010	-	11	9
	2014/2015 Closure	0.94	0.98	0.85	1.00	0.049	3	100	<0.010	<0.010	<0.010	0.013	-	3	33
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	1.54	1.04	0.81	3.29	0.259	12	100	0.011	<0.010	<0.010	0.033	0.0023	12	67
	2014/2015 Operation	0.90	0.91	0.73	1.06	0.036	11	100	<0.010	<0.010	<0.010	0.011	-	11	9
	2014/2015 Closure	1.32	1.21	0.91	1.84	0.274	3	100	<0.010	0.010	<0.010	0.013	0.0023	3	67
BC1	2011 Flood	0.98	0.96	0.84	1.15	0.068	4	100	0.016	0.018	<0.010	0.021	0.0037	4	75
	2011/2012 Operation	0.87	0.87	0.42	1.22	0.059	11	100	<0.010	<0.010	<0.010	0.020	0.0015	10	20
	2011/2012 Closure	1.23	0.91	0.56	2.76	0.237	10	100	0.010	<0.010	<0.010	0.023	0.0020	10	50
	2014/2015 Operation	0.85	0.84	0.67	1.10	0.035	11	100	<0.010	<0.010	<0.010	<0.010	-	11	0
	2014/2015 Closure	1.24	1.15	0.88	1.70	0.241	3	100	<0.010	0.011	<0.010	0.013	0.0024	3	67
BC2	2011 Flood	0.93	0.92	0.81	1.10	0.060	4	100	0.016	0.018	<0.010	0.022	0.0037	4	75
	2011/2012 Operation	0.94	0.99	0.39	1.28	0.040	19	100	<0.010	<0.010	<0.0010	0.018	0.0013	17	41
	2011/2012 Closure	1.25	1.04	0.57	2.83	0.220	10	100	0.010	<0.010	<0.010	0.023	0.0020	10	50
	2014/2015 Operation	0.83	0.86	0.72	0.95	0.026	9	100	<0.010	<0.010	<0.010	0.012	-	9	11
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.98	1.05	0.76	1.07	0.075	4	100	0.014	0.017	<0.010	0.018	0.0030	4	75
	2011/2012 Operation	0.97	0.96	0.39	1.43	0.049	20	100	<0.010	<0.010	<0.010	0.018	0.0010	19	58
	2011/2012 Closure	0.89	0.83	0.53	1.52	0.078	13	100	<0.010	<0.010	<0.010	0.018	0.0013	13	69
	2014/2015 Operation	0.89	0.87	0.64	1.44	0.046	15	100	<0.010	<0.010	<0.010	0.011	0.0006	14	43
	2014/2015 Closure	1.06	1.06	0.82	1.30	0.139	3	100	<0.010	0.010	<0.010	0.012	0.0021	3	67

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Table 13. Continued.

		Total Particulate Phosphorus (mg/L)							Total Phosphorus (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.027	0.017	<0.010	0.140	0.0088	15	73	0.035	0.027	0.013	0.145	0.0081	16	100
	2011/2012 Closure	0.022	<0.010	<0.010	0.110	0.0117	9	33	0.027	0.012	<0.010	0.115	0.0122	9	67
	2014/2015 Operation	0.019	0.015	0.010	0.051	0.0042	9	100	0.024	0.020	0.015	0.056	0.0042	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.010	<0.010	<0.010	0.023	0.0023	10	40	0.019	0.017	0.013	0.031	0.0020	11	100
	2011/2012 Closure	0.017	0.014	<0.010	0.056	0.0056	9	56	0.029	0.018	0.012	0.070	0.0066	9	100
	2014/2015 Operation	0.018	0.014	<0.010	0.038	0.0030	11	91	0.023	0.020	0.013	0.043	0.0028	11	100
	2014/2015 Closure	0.016	0.015	0.012	0.020	0.0024	3	100	0.023	0.025	0.020	0.025	0.0018	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.013	<0.010	<0.010	0.036	0.0034	12	50	0.025	0.021	<0.010	0.044	0.0040	12	92
	2014/2015 Operation	0.013	0.012	<0.010	0.025	0.0017	11	91	0.019	0.017	0.014	0.030	0.0015	11	100
	2014/2015 Closure	0.015	0.015	0.013	0.017	0.0012	3	100	0.024	0.025	0.018	0.030	0.0035	3	100
BC1	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	4	0	0.018	0.021	<0.010	0.024	0.0044	4	75
	2011/2012 Operation	<0.010	<0.010	<0.010	0.013	0.0011	10	40	0.015	0.015	<0.010	0.023	0.0014	11	91
	2011/2012 Closure	0.014	<0.010	<0.010	0.045	0.0043	10	40	0.024	0.024	0.011	0.050	0.0041	10	100
	2014/2015 Operation	0.013	0.011	<0.010	0.029	0.0020	11	82	0.018	0.016	0.011	0.034	0.0019	11	100
	2014/2015 Closure	0.019	0.016	0.014	0.027	0.0040	3	100	0.029	0.027	0.019	0.040	0.0061	3	100
BC2	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	4	0	0.019	0.019	0.011	0.025	0.0029	4	100
	2011/2012 Operation	<0.010	0.010	<0.010	0.026	0.0013	17	59	0.018	0.016	0.010	0.042	0.0016	19	100
	2011/2012 Closure	0.019	0.015	<0.010	0.044	0.0041	10	80	0.029	0.027	0.013	0.054	0.0045	10	100
	2014/2015 Operation	0.015	0.011	<0.010	0.033	0.0035	9	78	0.021	0.016	0.013	0.038	0.0032	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.010	<0.010	<0.010	0.010	-	4	25	0.018	0.018	0.011	0.026	0.0032	4	100
	2011/2012 Operation	0.013	0.011	<0.010	0.047	0.0023	19	68	0.021	0.018	0.011	0.061	0.0026	20	100
	2011/2012 Closure	0.020	0.020	<0.010	0.030	0.0022	13	92	0.028	0.028	0.015	0.041	0.0024	13	100
	2014/2015 Operation	0.024	0.017	<0.010	0.084	0.0053	14	93	0.031	0.026	0.017	0.089	0.0048	15	100
	2014/2015 Closure	0.016	0.018	0.010	0.019	0.0028	3	100	0.025	0.023	0.022	0.029	0.0022	3	100

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Table 13. Continued.

		Dissolved Fraction, Phosphorus (%)							TN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	40	36	3	100	6.9	15	100	96	88	19	179	11.5	16	100
	2011/2012 Closure	54	42	4	100	12.3	9	100	30	27	17	44	4.0	9	100
	2014/2015 Operation	26	28	9	38	2.7	9	100	96	109	38	131	10.7	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	48	36	18	113	10.6	10	100	126	129	52	178	11.9	11	100
	2011/2012 Closure	37	39	15	62	5.7	9	100	44	44	20	68	5.5	9	100
	2014/2015 Operation	27	26	12	50	3.3	11	100	96	102	38	141	9.0	11	100
	2014/2015 Closure	56	34	25	108	26.3	3	100	90	88	87	96	2.8	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	52	49	12	100	7.3	12	100	158	148	82	370	23.2	12	100
	2014/2015 Operation	32	30	17	52	3.3	11	100	112	116	56	167	9.4	11	100
	2014/2015 Closure	61	67	38	76	11.4	3	100	118	112	107	136	8.8	3	100
BC1	2011 Flood	90	88	83	100	3.9	4	100	176	115	78	397	74.1	4	100
	2011/2012 Operation	48	37	28	100	8.4	10	100	152	128	54	451	32.0	11	100
	2011/2012 Closure	47	44	10	92	8.2	10	100	120	119	64	197	15.4	10	100
	2014/2015 Operation	32	31	15	50	3.0	11	100	109	114	67	156	8.3	11	100
	2014/2015 Closure	51	48	36	69	9.6	3	100	97	94	94	102	2.8	3	100
BC2	2011 Flood	80	87	45	100	11.8	4	100	123	118	71	184	24.2	4	100
	2011/2012 Operation	46	38	5	95	5.6	17	100	128	122	45	217	11.2	19	100
	2011/2012 Closure	39	35	10	86	7.2	10	100	100	103	48	145	10.0	10	100
	2014/2015 Operation	32	31	13	77	6.4	9	100	99	113	47	136	11.3	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	84	78	33	145	23.7	4	100	129	135	91	153	15.0	4	100
	2011/2012 Operation	44	33	23	97	5.5	19	100	117	125	43	193	10.0	20	100
	2011/2012 Closure	31	29	11	58	4.1	13	100	70	72	46	96	4.0	13	100
	2014/2015 Operation	26	24	6	65	3.9	14	100	76	75	20	127	7.8	15	100
	2014/2015 Closure	67	53	28	120	27.5	3	100	97	81	79	131	17.0	3	100

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Table 13. Continued.

		DIN:DP Molar Ratio							DIN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	26	18	7	82	5.2	15	100	8	7	1	18	1.3	16	100
	2011/2012 Closure	31	16	5	140	13.9	9	100	10	6	1	17	2.0	9	100
	2014/2015 Operation	14	16	2	16	1.5	9	100	4	4	1	6	0.6	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	30	16	2	80	8.0	10	100	10	6	3	20	2.2	11	100
	2011/2012 Closure	45	16	6	221	23.1	9	100	10	6	2	42	4.1	9	100
	2014/2015 Operation	16	16	2	30	2.2	11	100	4	4	1	6	0.5	11	100
	2014/2015 Closure	2	2	1	2	0.5	3	100	0	0	0	1	0.0	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	129	48	14	511	52.4	12	100	38	29	6	100	9.7	12	100
	2014/2015 Operation	15	16	5	25	1.4	11	100	4	5	2	8	0.5	11	100
	2014/2015 Closure	44	37	20	74	16.1	3	100	17	15	6	32	7.8	3	100
BC1	2011 Flood	7	4	4	16	2.8	4	100	7	4	3	16	3.0	4	100
	2011/2012 Operation	54	49	4	180	16.6	10	100	23	16	3	78	7.5	11	100
	2011/2012 Closure	105	42	6	605	57.2	10	100	28	17	6	105	10.0	10	100
	2014/2015 Operation	17	16	6	34	2.2	11	100	5	5	2	11	0.7	11	100
	2014/2015 Closure	40	35	22	64	12.3	3	100	14	14	6	21	4.3	3	100
BC2	2011 Flood	6	4	1	16	3.1	4	100	4	4	1	7	1.2	4	100
	2011/2012 Operation	43	18	4	177	12.4	17	100	14	8	2	68	3.5	19	100
	2011/2012 Closure	109	32	6	684	65.5	10	100	22	10	4	70	7.9	10	100
	2014/2015 Operation	14	16	5	16	1.1	9	100	4	5	2	11	0.9	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	6	4	1	16	3.2	4	100	3	3	1	5	0.9	4	100
	2011/2012 Operation	29	16	4	80	6.3	19	100	10	5	1	33	1.9	20	100
	2011/2012 Closure	28	16	2	132	9.8	13	100	7	6	1	21	1.8	13	100
	2014/2015 Operation	17	16	4	56	3.3	14	100	4	3	0	12	0.8	15	100
	2014/2015 Closure	34	32	26	44	5.2	3	100	13	11	6	24	5.4	3	100

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Table 13. Continued.

		Total Inorganic Carbon (mg/L)							Total Organic Carbon (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	50.7	50.7	50.7	50.7	-	1	100	14.6	14.6	14.6	14.6	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	3.6	3.6	3.6	3.6	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	50.3	50.3	50.3	50.3	-	1	100	15.1	15.1	15.1	15.1	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	10.5	10.5	10.5	10.5	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	84.3	91.8	37.0	124	25.4	3	100	23.0	22.1	18.6	29.1	2.62	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	22.3	22.3	22.3	22.3	-	1	100	20.7	20.7	20.7	20.7	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	16.7	16.7	16.7	16.7	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	23.5	23.5	23.5	23.5	-	1	100	19.1	19.1	19.1	19.1	-	1	100
	2011/2012 Operation	51.1	51.1	51.1	51.1	-	1	100	14.6	14.6	14.6	14.6	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	21.3	21.3	21.3	21.3	-	1	100	19.6	19.6	19.6	19.6	-	1	100
	2011/2012 Operation	47.3	46.5	44.3	52.0	1.76	4	100	13.7	13.5	13.1	14.7	0.36	4	100
	2011/2012 Closure	34.8	34.3	27.4	45.0	3.12	5	100	18.4	18.3	16.3	22.3	0.87	6	100
	2014/2015 Operation	41.9	41.4	36.0	49.0	2.07	5	100	12.1	12.0	9.7	14.5	0.80	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Dissolved Organic Carbon (mg/L)							TOC:ON Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	13.0	13.0	13.0	13.0	-	1	100	18	18	18	18	-	1	100
	2011/2012 Closure	3.3	3.3	3.3	3.3	-	1	100	16	16	16	16	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	13.0	13.0	13.0	13.0	-	1	100	19	19	19	19	-	1	100
	2011/2012 Closure	10.2	10.2	10.2	10.2	-	1	100	25	25	25	25	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	22.7	22.1	18.4	28.3	2.49	4	100	24	24	23	25	0.3	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	20.8	20.8	20.8	20.8	-	1	100	30	30	30	30	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	16.9	16.9	16.9	16.9	-	1	100	28	28	28	28	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	16.9	16.9	16.9	16.9	-	1	100	28	28	28	28	-	1	100
	2011/2012 Operation	14.1	14.1	14.1	14.1	-	1	100	19	19	19	19	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	17.3	17.3	17.3	17.3	-	1	100	30	30	30	30	-	1	100
	2011/2012 Operation	12.6	12.4	11.7	13.9	0.51	4	100	18	18	16	21	1.0	4	100
	2011/2012 Closure	17.9	17.8	15.3	21.6	0.87	6	100	31	31	24	37	1.7	6	100
	2014/2015 Operation	11.9	11.7	9.4	14.4	0.83	5	100	17	17	13	21	1.5	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		TOC:TN Molar Ratio							Laboratory pH						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	16	16	16	16	-	1	100	8.39	8.39	8.39	8.39	-	1	100
	2011/2012 Closure	13	13	13	13	-	1	100	8.37	8.37	8.37	8.37	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	17	17	17	17	-	1	100	8.41	8.41	8.41	8.41	-	1	100
	2011/2012 Closure	21	21	21	21	-	1	100	8.43	8.43	8.43	8.43	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	16	16	10	23	3.4	4	100	7.92	7.91	7.31	8.54	0.303	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	29	29	29	29	-	1	100	8.12	8.12	8.12	8.12	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	24	24	24	24	-	1	100	8.00	8.00	8.00	8.00	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	28	28	28	28	-	1	100	8.19	8.19	8.19	8.19	-	1	100
	2011/2012 Operation	17	17	17	17	-	1	100	8.26	8.26	8.26	8.26	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	30	30	30	30	-	1	100	8.19	8.19	8.19	8.19	-	1	100
	2011/2012 Operation	17	17	16	18	0.5	4	100	8.30	8.32	8.24	8.35	0.023	4	100
	2011/2012 Closure	29	27	24	37	1.9	6	100	8.23	8.24	8.15	8.29	0.021	6	100
	2014/2015 Operation	16	15	13	21	1.5	5	100	8.29	8.29	8.04	8.44	0.073	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Laboratory Conductivity (µmhos/cm)							Total Dissolved Solids (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	1150	1150	1150	1150	-	1	100	740	740	740	740	-	1	100
	2011/2012 Closure	571	571	571	571	-	1	100	344	344	344	344	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	1150	1150	1150	1150	-	1	100	704	704	704	704	-	1	100
	2011/2012 Closure	498	498	498	498	-	1	100	292	292	292	292	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	779	792	362	1170	203	4	100	490	474	250	761	125	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	217	217	217	217	-	1	100	164	164	164	164	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	401	401	401	401	-	1	100	241	241	241	241	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	217	217	217	217	-	1	100	166	166	166	166	-	1	100
	2011/2012 Operation	1160	1160	1160	1160	-	1	100	758	758	758	758	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	237	237	237	237	-	1	100	177	177	177	177	-	1	100
	2011/2012 Operation	1093	1090	1020	1170	30.7	4	100	664	653	618	732	25.2	4	100
	2011/2012 Closure	356	355	273	479	30.3	6	100	256	236	208	392	28.1	6	100
	2014/2015 Operation	917	869	846	1080	44.1	5	100	524	525	474	597	21.6	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Total Suspended Solids (mg/L)							Laboratory Turbidity (NTU)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	29	13	2	137	9.7	18	100	11.1	3.9	1.1	89.3	7.13	12	100
	2011/2012 Closure	7	7	2	14	1.2	9	100	6.1	5.8	2.9	10.7	0.78	9	100
	2014/2015 Operation	26	14	6	136	12.4	10	100	17.6	8.0	3.1	97.0	9.00	10	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-							
	2011/2012 Operation	18	10	3	93	6.7	13	100	10.4	5.2	1.7	74.6	5.40	13	100
	2011/2012 Closure	7	7	<2.0	15	1.6	9	89	6.4	6.5	1.8	12.9	1.19	9	100
	2014/2015 Operation	32	17	5	174	11.3	15	100	25.3	11.3	3.0	121	1.17	15	100
	2014/2015 Closure	13	13	11	15	1.2	3	100	15.6	17.3	8.4	21.0	3.76	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	5	3	<2.0	26	2.0	12	58	4.3	1.7	0.7	25.4	2.00	12	100
	2014/2015 Operation	10	7	3	24	1.9	12	100	8.1	6.0	1.8	25.0	0.63	12	100
	2014/2015 Closure	7	7	7	8	0.6	3	100	5.4	5.5	4.9	5.8	0.26	3	100
BC1	2011 Flood	<5.0	<5.0	<2.0	6	1.1	4	50	0.7	0.7	0.7	0.7	-	1	100
	2011/2012 Operation	<5.0	<5.0	<2.0	6	0.5	14	71	2.3	1.9	1.2	6.7	0.41	13	100
	2011/2012 Closure	8	4	<2.0	24	2.4	10	90	3.8	2.0	1.0	14.2	1.27	10	100
	2014/2015 Operation	8	4	<2.0	43	3.0	14	93	5.0	2.7	1.2	24.0	0.29	14	100
	2014/2015 Closure	10	7	5	19	4.5	3	100	6.5	4.5	2.9	12.2	2.87	3	100
BC2	2011 Flood	<5.0	<5.0	<2.0	6	1.1	4	25	0.9	0.9	0.9	0.9	-	1	100
	2011/2012 Operation	9	7	<5.0	30	1.7	19	95	2.9	3.2	1.4	4.5	0.34	13	100
	2011/2012 Closure	8	6	<2.0	20	1.8	10	90	6.1	4.5	1.6	25.4	2.19	10	100
	2014/2015 Operation	18	7	4	65	6.7	10	100	10.7	4.6	1.9	34.0	3.88	10	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<5.0	<5.0	<5.0	6	0.8	4	50	4.8	4.8	4.8	4.8	-	1	100
	2011/2012 Operation	15	8	<5.0	60	3.0	22	95	4.4	4.1	2.2	7.0	0.34	15	100
	2011/2012 Closure	15	15	11	24	1.2	13	100	11.6	11.1	4.9	19.2	1.42	13	100
	2014/2015 Operation	31	12	4	180	9.7	20	100	21.5	7.4	3.9	132	0.27	20	100
	2014/2015 Closure	10	11	7	12	1.6	3	100	7.2	6.2	5.7	9.8	1.29	3	100

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Table 13. Continued.

		True Colour (CU)							Chlorophyll *a* (µg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	10.8	10.8	10.8	10.8	-	1	100	6.23	6.23	6.23	6.23	-	1	100
	2011/2012 Closure	<5.0	<5.0	<5.0	<5.0	-	1	0	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	11.5	11.5	11.5	11.5	-	1	100	6.16	6.16	6.16	6.16	-	1	100
	2011/2012 Closure	20.0	20.0	20.0	20.0	-	1	100	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	47.3	48.2	39.3	53.7	3.65	4	100	3.94	2.51	1.34	7.96	2.04	3	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	52.3	52.3	52.3	52.3	-	1	100	0.51	0.51	0.51	0.51	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	39.8	39.8	39.8	39.8	-	1	100	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	51.5	51.5	51.5	51.5	-	1	100	0.37	0.37	0.37	0.37	-	1	100
	2011/2012 Operation	9.0	9.0	9.0	9.0	-	1	100	3.89	3.89	3.89	3.89	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	53.2	53.2	53.2	53.2	-	1	100	0.52	0.52	0.52	0.52	-	1	100
	2011/2012 Operation	11.6	11.0	9.1	15.2	1.32	4	100	2.33	2.30	1.54	3.20	0.369	4	100
	2011/2012 Closure	57.2	59.3	43.9	65.8	3.53	6	100	3.21	2.79	1.98	5.64	0.650	5	100
	2014/2015 Operation	13.6	11.4	7.4	20.7	2.50	5	100	2.23	2.56	0.61	3.72	0.542	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Phaeophytin *a* (µg/L)							*In Situ* Dissolved Oxygen (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	2.30	2.30	2.30	2.30	-	1	100	11.2	11.0	8.3	14.9	0.54	15	100
	2011/2012 Closure	-	-	-	-	-	0	-	9.7	8.5	7.5	12.3	0.67	9	100
	2014/2015 Operation	-	-	-	-	-	0	-	9.0	8.7	6.5	12.0	0.59	10	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	2.34	2.34	2.34	2.34	-	1	100	11.0	10.0	8.4	14.9	0.77	10	100
	2011/2012 Closure	-	-	-	-	-	0	-	7.9	8.0	0.2	12.1	1.09	9	100
	2014/2015 Operation	-	-	-	-	-	0	-	8.5	7.7	5.0	12.0	0.56	13	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.5	6.4	6.0	10.0	1.24	3	100
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.49	0.30	<0.10	1.13	0.326	3	67	6.3	6.9	0.0	12.3	1.10	12	100
	2014/2015 Operation	-	-	-	-	-	0	-	8.3	8.0	6.2	11.7	0.47	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.5	5.8	5.8	10.8	1.65	3	100
BC1	2011 Flood	0.57	0.57	0.57	0.57	-	1	100	9.7	10.4	6.4	12.0	0.96	6	83
	2011/2012 Operation	-	-	-	-	-	0	-	8.8	9.8	2.9	11.7	0.77	11	73
	2011/2012 Closure	-	-	-	-	-	0	-	7.3	6.8	2.1	11.8	0.90	10	100
	2014/2015 Operation	-	-	-	-	-	0	-	6.6	6.2	4.5	10.4	0.56	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	6.9	5.9	5.3	9.5	1.31	3	100
BC2	2011 Flood	0.61	0.61	0.61	0.61	-	1	100	9.7	9.1	7.8	11.9	0.66	6	100
	2011/2012 Operation	1.96	1.96	1.96	1.96	-	1	100	9.2	10.0	4.2	11.8	0.58	15	87
	2011/2012 Closure	-	-	-	-	-	0	-	7.8	7.2	5.1	11.9	0.60	10	100
	2014/2015 Operation	-	-	-	-	-	0	-	6.7	6.8	3.5	10.2	0.73	10	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.77	0.77	0.77	0.77	-	1	100	10.3	10.3	8.1	12.2	0.79	6	100
	2011/2012 Operation	1.06	0.95	0.62	1.73	0.242	4	100	9.8	10.0	6.3	12.5	0.45	18	89
	2011/2012 Closure	2.62	2.26	1.29	5.23	0.676	5	100	9.0	9.1	6.4	10.7	0.39	13	100
	2014/2015 Operation	1.03	1.09	0.41	1.42	0.173	5	100	7.8	8.0	2.9	11.4	0.53	19	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.4	6.4	5.9	10.0	1.29	3	100

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Table 13. Continued.

		Chloride, Dissolved (mg/L)							Fluoride, Dissolved (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	219	219	219	219	-	1	100	0.177	0.177	0.177	0.177	-	1	100
	2011/2012 Closure	32	32	32	32	-	1	100	0.180	0.180	0.180	0.180	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	220	220	220	220	-	1	100	0.171	0.171	0.171	0.171	-	1	100
	2011/2012 Closure	33	33	33	33	-	1	100	0.150	0.150	0.150	0.150	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	74	67	18	144	27.0	4	100	0.122	0.102	0.085	0.200	0.0264	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	4	4	4	4	-	1	100	0.060	0.060	0.060	0.060	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	29	29	29	29	-	1	100	0.050	0.050	0.050	0.050	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	4	4	4	4	-	1	100	0.061	0.061	0.061	0.061	-	1	100
	2011/2012 Operation	222	222	222	222	-	1	100	0.172	0.172	0.172	0.172	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	6	6	6	6	-	1	100	0.069	0.069	0.069	0.069	-	1	100
	2011/2012 Operation	190	182	174	222	11.2	4	100	0.149	0.150	0.122	0.173	0.0105	4	100
	2011/2012 Closure	20	23	9	30	3.6	6	100	<0.10	<0.10	<0.10	0.109	0.0102	6	83
	2014/2015 Operation	142	141	125	170	7.7	5	100	0.134	0.134	0.126	0.148	0.0038	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Sulphate, Dissolved (mg/L)							Hardness, as CaCO3 (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	106.0	106.0	106.0	106.0	-	1.0	100	295	295	295	295	-	1	100
	2011/2012 Closure	90.2	90.2	90.2	90.2	-	1	100	220	220	220	220	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	106	106	106	106	-	1	100	299	299	299	299	-	1	100
	2011/2012 Closure	53.5	53.5	53.5	53.5	-	1	100	202	202	202	202	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	38.0	16.5	11.2	108	23.4	4	100	289	260	153	484	76.5	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	1.4	1.4	1.4	1.4	-	1	100	166	166	166	166	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	8.9	8.9	8.9	8.9	-	1	100	167	167	167	167	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	1.4	1.4	1.4	1.4	-	1	100	166	166	166	166	-	1	100
	2011/2012 Operation	107	107	107	107	-	1	100	309	309	309	309	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	5.0	5.0	5.0	5.0	-	1	100	159	159	159	159	-	1	100
	2011/2012 Operation	93.1	92.5	80.3	107	5.7	4	100	286	292	254	308	12.9	4	100
	2011/2012 Closure	9.9	9.3	5.1	18.9	2.0	6	100	168	162	124	231	14.5	6	100
	2014/2015 Operation	75.0	73.5	62.1	95.3	5.7	5	100	243	239	211	286	12.1	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Aluminum, Dissolved (mg/L)							Aluminum, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0251	0.0251	0.0251	0.0251	-	1	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0479	0.0479	0.0479	0.0479	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0220	0.0220	0.0220	0.0220	-	1	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0648	0.0648	0.0648	0.0648	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	0.0255	0.0260	0.0065	0.0435	0.00885	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.0052	0.0052	0.0052	0.0052	-	1	100	0.0307	0.0307	0.0307	0.0307	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.0029	0.0029	0.0029	0.0029	-	1	100	0.166	0.166	0.166	0.166	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	0.0043	0.0043	0.0043	0.0043	-	1	100	0.0550	0.0550	0.0550	0.0550	-	1	100
	2011/2012 Operation	<0.002	<0.002	<0.002	<0.002	-	1	0	0.0207	0.0207	0.0207	0.0207	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.0103	0.0103	0.0103	0.0103	-	1	100	0.219	0.219	0.219	0.219	-	1	100
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	0.0023	-	4	25	0.135	0.0904	0.0431	0.318	0.0630	4	100
	2011/2012 Closure	0.0183	0.0110	0.0079	0.0568	0.00777	6	100	0.402	0.382	0.0987	0.736	0.0933	6	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	0.0025	0.00030	5	20	0.237	0.283	0.122	0.314	0.0417	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Antimony, Dissolved (mg/L)							Antimony, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	0.00022	-	4	25	<0.0002	<0.0002	<0.0002	0.00020	-	4	25
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	4	0	<0.0002	<0.0002	<0.0002	<0.0002	-	4	25
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	6	0	<0.0002	<0.0002	<0.0002	<0.0002	-	6	0
	2014/2015 Operation	0.00024	<0.00020	<0.00020	0.00052	-	5	20	<0.0002	<0.0002	<0.0002	0.00028	-	5	20
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Arsenic, Dissolved (mg/L)							Arsenic, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00386	0.00386	0.00386	0.00386	-	1	100	0.00357	0.00357	0.00357	0.00357	-	1	100
	2011/2012 Closure	0.00080	0.00080	0.00080	0.00080	-	1	100	0.00086	0.00086	0.00086	0.00086	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00373	0.00373	0.00373	0.00373	-	1	100	0.00347	0.00347	0.00347	0.00347	-	1	100
	2011/2012 Closure	0.00091	0.00091	0.00091	0.00091	-	1	100	0.00097	0.00097	0.00097	0.00097	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00116	0.00124	<0.00020	0.00207	0.000405	4	75	0.00132	0.00119	0.00098	0.00191	0.000206	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.00048	0.00048	0.00048	0.00048	-	1	100	0.00045	0.00045	0.00045	0.00045	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00127	0.00127	0.00127	0.00127	-	1	100	0.00126	0.00126	0.00126	0.00126	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	0.00050	0.00050	0.00050	0.00050	-	1	100	0.00048	0.00048	0.00048	0.00048	-	1	100
	2011/2012 Operation	0.00379	0.00379	0.00379	0.00379	-	1	100	0.00348	0.00348	0.00348	0.00348	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.00059	0.00059	0.00059	0.00059	-	1	100	0.00055	0.00055	0.00055	0.00055	-	1	100
	2011/2012 Operation	0.00255	0.00227	0.00193	0.00372	0.000410	4	100	0.00240	0.00229	0.00192	0.00312	0.000274	4	100
	2011/2012 Closure	0.00110	0.00103	0.00094	0.00138	0.000075	6	100	0.00130	0.00121	0.00094	0.00208	0.000169	6	100
	2014/2015 Operation	0.00170	0.00162	0.00148	0.00203	0.000095	5	100	0.00176	0.00173	0.00154	0.00207	0.000089	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Barium, Dissolved (mg/L)							Barium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0520	0.0520	0.0520	0.0520	-	1	100	0.0591	0.0591	0.0591	0.0591	-	1	100
	2011/2012 Closure	0.0170	0.0170	0.0170	0.0170	-	1	100	0.0174	0.0174	0.0174	0.0174	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0517	0.0517	0.0517	0.0517	-	1	100	0.0583	0.0583	0.0583	0.0583	-	1	100
	2011/2012 Closure	0.0197	0.0197	0.0197	0.0197	-	1	100	0.0209	0.0209	0.0209	0.0209	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.0397	0.0386	0.0246	0.0569	0.00753	4	100	0.0414	0.0402	0.0236	0.0617	0.00831	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.0073	0.0073	0.0073	0.0073	-	1	100	0.0078	0.0078	0.0078	0.0078	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.0253	0.0253	0.0253	0.0253	-	1	100	0.0274	0.0274	0.0274	0.0274	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	0.0075	0.0075	0.0075	0.0075	-	1	100	0.0080	0.0080	0.0080	0.0080	-	1	100
	2011/2012 Operation	0.0486	0.0486	0.0486	0.0486	-	1	100	0.0535	0.0535	0.0535	0.0535	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.0092	0.0092	0.0092	0.0092	-	1	100	0.0103	0.0103	0.0103	0.0103	-	1	100
	2011/2012 Operation	0.0464	0.0462	0.0450	0.0482	0.00072	4	100	0.0478	0.0484	0.0438	0.0504	0.00156	4	100
	2011/2012 Closure	0.0198	0.0205	0.0145	0.0237	0.00133	6	100	0.0267	0.0244	0.0178	0.0427	0.00361	6	100
	2014/2015 Operation	0.0403	0.0406	0.0349	0.0463	0.00202	5	100	0.0419	0.0412	0.0364	0.0491	0.00207	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Boron, Dissolved (mg/L)							Boron, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.107	0.107	0.107	0.107	-	1	100	0.113	0.113	0.113	0.113	-	1	100
	2011/2012 Closure	0.065	0.065	0.065	0.065	-	1	100	0.069	0.069	0.069	0.069	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.100	0.100	0.100	0.100	-	1	100	0.107	0.107	0.107	0.107	-	1	100
	2011/2012 Closure	0.054	0.054	0.054	0.054	-	1	100	0.059	0.059	0.059	0.059	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.051	0.051	0.042	0.059	0.0049	4	100	0.048	0.046	0.040	0.061	0.0045	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	1	0	<0.010	<0.010	<0.010	<0.010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.047	0.047	0.047	0.047	-	1	100	0.050	0.050	0.050	0.050	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.010	<0.010	<0.010	<0.010	-	1	0	<0.010	<0.010	<0.010	<0.010	-	1	0
	2011/2012 Operation	0.094	0.094	0.094	0.094	-	1	100	0.106	0.106	0.106	0.106	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.014	0.014	0.014	0.014	-	1	100	<0.010	<0.010	<0.010	<0.010	-	1	0
	2011/2012 Operation	0.104	0.102	0.087	0.125	0.0091	4	100	0.111	0.110	0.092	0.131	0.0104	4	100
	2011/2012 Closure	0.046	0.044	0.040	0.055	0.0025	6	100	0.049	0.043	0.033	0.074	0.0063	6	100
	2014/2015 Operation	0.084	0.086	0.072	0.088	0.0029	5	100	0.084	0.086	0.073	0.091	0.0030	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Cadmium, Dissolved (mg/L)							Cadmium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.000039	0.000039	0.000039	0.000039	-	1	100	0.000020	0.000020	0.000020	0.000020	-	1	100
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.000014	0.000014	0.000014	0.000014	-	1	100	0.000011	0.000011	0.000011	0.000011	-	1	100
	2011/2012 Closure	0.000010	0.000010	0.000010	0.000010	-	1	100	0.000012	0.000012	0.000012	0.000012	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	0.000013	-	4	25	<0.000010	<0.000010	<0.000010	0.000016	-	4	25
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	0.000011	0.000011	0.000011	0.000011	-	1	100	0.000011	0.000011	0.000011	0.000011	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	0.000013	-	4	25	<0.000010	<0.000010	<0.000010	0.000011	-	4	25
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	6	0	<0.000010	<0.000010	<0.000010	0.000013	0.0000014	6	33
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	5	0	<0.000010	<0.000010	<0.000010	<0.000010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Calcium, Dissolved (mg/L)							Calcium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	45.8	45.8	45.8	45.8	-	1	100	50.6	50.6	50.6	50.6	-	1	100
	2011/2012 Closure	32.2	32.2	32.2	32.2	-	1	100	34.1	34.1	34.1	34.1	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	46.8	46.8	46.8	46.8	-	1	100	49.5	49.5	49.5	49.5	-	1	100
	2011/2012 Closure	30.3	30.3	30.3	30.3	-	1	100	32.9	32.9	32.9	32.9	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	49.2	45.5	32.7	73.2	9.84	4	100	51.5	46.9	29.2	82.9	12.3	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	22.9	22.9	22.9	22.9	-	1	100	27.2	27.2	27.2	27.2	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	30.2	30.2	30.2	30.2	-	1	100	32.9	32.9	32.9	32.9	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	23.3	23.3	23.3	23.3	-	1	100	27.1	27.1	27.1	27.1	-	1	100
	2011/2012 Operation	49.9	49.9	49.9	49.9	-	1	100	51.5	51.5	51.5	51.5	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	25.9	25.9	25.9	25.9	-	1	100	28.8	28.8	28.8	28.8	-	1	100
	2011/2012 Operation	47.7	48.6	39.5	54.2	3.04	4	100	46.6	46.4	44.7	48.9	0.88	4	100
	2011/2012 Closure	30.8	30.3	26.7	36.9	1.58	6	100	33.7	33.0	26.0	43.3	2.36	6	100
	2014/2015 Operation	43.3	42.2	36.5	52.9	2.66	5	100	44.1	42.5	39.7	52.3	2.20	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Chromium, Dissolved (mg/L)							Chromium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	6	0	<0.0010	<0.0010	<0.0010	0.0013	-	6	17
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	5	0	<0.0010	<0.0010	<0.0010	<0.0010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Copper, Dissolved (mg/L)							Copper, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00050	0.00050	0.00050	0.00050	-	1	100	0.00076	0.00076	0.00076	0.00076	-	1	100
	2011/2012 Closure	0.00049	0.00049	0.00049	0.00049	-	1	100	0.00053	0.00053	0.00053	0.00053	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00045	0.00045	0.00045	0.00045	-	1	100	0.00070	0.00070	0.00070	0.00070	-	1	100
	2011/2012 Closure	0.00038	0.00038	0.00038	0.00038	-	1	100	0.00056	0.00056	0.00056	0.00056	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	0.00031	-	4	25	0.00031	0.00032	0.00022	0.00039	0.000035	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	0.00039	0.00039	0.00039	0.00039	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	0.00021	0.00021	0.00021	0.00021	-	1	100
	2011/2012 Operation	0.00041	0.00041	0.00041	0.00041	-	1	100	0.00057	0.00057	0.00057	0.00057	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.00028	0.00028	0.00028	0.00028	-	1	100	0.00037	0.00037	0.00037	0.00037	-	1	100
	2011/2012 Operation	0.00044	0.00043	0.00039	0.00050	0.000024	4	100	0.00071	0.00070	0.00054	0.00088	0.000077	4	100
	2011/2012 Closure	0.00035	0.00032	0.00021	0.00053	0.000047	6	100	0.00113	0.00116	0.00072	0.00174	0.000150	6	100
	2014/2015 Operation	0.00029	0.00034	<0.00020	0.00040	0.000055	5	80	0.00060	0.00057	0.00040	0.00080	0.000067	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Iron, Dissolved (mg/L)							Iron, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.010	<0.010	<0.010	<0.010	-	1	0	0.110	0.110	0.110	0.110	-	1	100
	2011/2012 Closure	<0.010	<0.010	<0.010	<0.010	-	1	0	<0.10	<0.10	<0.10	<0.10	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.010	<0.010	<0.010	<0.010	-	1	0	0.100	0.100	0.100	0.100	-	1	100
	2011/2012 Closure	<0.10	<0.10	<0.10	<0.10	-	1	0	<0.10	<0.10	<0.10	<0.10	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.10	<0.10	<0.010	0.105	0.0211	4	75	<0.10	<0.10	<0.10	0.160	0.0267	4	75
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.10	<0.10	<0.10	<0.10	-	1	0	<0.10	<0.10	<0.10	<0.10	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.10	<0.10	<0.10	<0.10	-	1	0	0.180	0.180	0.180	0.180	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.10	<0.10	<0.10	<0.10	-	1	0	<0.10	<0.10	<0.10	<0.10	-	1	0
	2011/2012 Operation	<0.010	<0.010	<0.010	<0.010	-	1	0	0.021	0.021	0.021	0.021	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.10	<0.10	<0.10	<0.10	-	1	0	0.150	0.150	0.150	0.150	-	1	100
	2011/2012 Operation	<0.10	<0.10	<0.10	0.014	-	4	25	0.089	0.081	0.046	0.150	0.0220	4	100
	2011/2012 Closure	0.028	0.024	<0.10	0.050	0.0047	6	83	0.355	0.350	0.110	0.630	0.0764	6	100
	2014/2015 Operation	<0.010	<0.010	<0.010	<0.010	-	5	0	0.230	0.280	0.120	0.320	0.0415	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Lead, Dissolved (mg/L)							Lead, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	0.000092	0.000092	0.000092	0.000092	-	1	100
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	4	0	<0.000090	<0.000090	<0.000090	0.000093	-	4	25
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	0.000123	0.000123	0.000123	0.000123	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0	<0.000090	<0.000090	<0.000090	<0.000090	-	1	0
	2011/2012 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	4	0	0.000107	0.000118	<0.000090	0.000150	0.0000222	4	75
	2011/2012 Closure	<0.000090	<0.000090	<0.000090	<0.000090	-	6	0	0.000278	0.000265	0.000157	0.000447	0.0000410	6	100
	2014/2015 Operation	<0.000090	<0.000090	<0.000090	<0.000090	-	5	0	0.000151	0.000165	0.000095	0.000175	0.0000146	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Magnesium, Dissolved (mg/L)							Magnesium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	43.8	43.8	43.8	43.8	-	1	100	46.7	46.7	46.7	46.7	-	1	100
	2011/2012 Closure	34.0	34.0	34.0	34.0	-	1	100	36.8	36.8	36.8	36.8	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	44.3	44.3	44.3	44.3	-	1	100	40.2	40.2	40.2	40.2	-	1	100
	2011/2012 Closure	28.0	28.0	28.0	28.0	-	1	100	29.0	29.0	29.0	29.0	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	36.5	33.5	17.7	61.4	10.3	4	100	39.0	34.7	19.5	67.2	11.1	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	16.6	16.6	16.6	16.6	-	1	100	23.9	23.9	23.9	23.9	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	20.0	20.0	20.0	20.0	-	1	100	20.6	20.6	20.6	20.6	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	17.3	17.3	17.3	17.3	-	1	100	23.9	23.9	23.9	23.9	-	1	100
	2011/2012 Operation	44.7	44.7	44.7	44.7	-	1	100	48.0	48.0	48.0	48.0	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	17.7	17.7	17.7	17.7	-	1	100	22.5	22.5	22.5	22.5	-	1	100
	2011/2012 Operation	39.0	38.7	33.8	44.7	2.58	4	100	39.1	37.6	33.8	47.3	2.93	4	100
	2011/2012 Closure	18.6	19.1	13.6	22.4	1.28	6	100	20.4	19.5	14.3	29.9	2.12	6	100
	2014/2015 Operation	31.8	31.1	27.8	36.4	1.45	5	100	32.5	32.9	27.2	37.7	1.68	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Manganese, Dissolved (mg/L)							Manganese, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00065	0.00065	0.00065	0.00065	-	1	100	0.0034	0.0034	0.0034	0.0034	-	1	100
	2011/2012 Closure	0.00033	0.00033	0.00033	0.00033	-	1	100	0.0072	0.0072	0.0072	0.0072	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00059	0.00059	0.00059	0.00059	-	1	100	0.0037	0.0037	0.0037	0.0037	-	1	100
	2011/2012 Closure	0.00041	0.00041	0.00041	0.00041	-	1	100	0.0175	0.0175	0.0175	0.0175	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.280	0.228	0.00055	0.666	0.166	4	100	0.276	0.236	0.0116	0.622	0.153	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.00432	0.00432	0.00432	0.00432	-	1	100	0.0057	0.0057	0.0057	0.0057	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.0196	0.0196	0.0196	0.0196	-	1	100	0.0639	0.0639	0.0639	0.0639	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	0.00318	0.00318	0.00318	0.00318	-	1	100	0.0049	0.0049	0.0049	0.0049	-	1	100
	2011/2012 Operation	0.0246	0.0246	0.0246	0.0246	-	1	100	0.0313	0.0313	0.0313	0.0313	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.00695	0.00695	0.00695	0.00695	-	1	100	0.0108	0.0108	0.0108	0.0108	-	1	100
	2011/2012 Operation	0.00605	0.00455	0.00020	0.0149	0.00316	4	100	0.0205	0.0168	0.0119	0.0363	0.00567	4	100
	2011/2012 Closure	0.00933	0.00810	0.00549	0.0137	0.00141	6	100	0.0425	0.0406	0.0105	0.0839	0.0105	6	100
	2014/2015 Operation	0.00398	0.00230	0.00161	0.01130	0.001835	5	100	0.0171	0.0161	0.0089	0.0260	0.00284	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Mercury, Dissolved (ng/L)							Mercury, Total (ng/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<1.0	<1.0	<1.0	<1.0	-	1	0	<1.0	<1.0	<1.0	<1.0	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<1.0	<1.0	<1.0	<1.0	-	1	0	<1.0	<1.0	<1.0	<1.0	-	1	0
	2011/2012 Closure	1.2	1.2	1.2	1.2	-	1	100	-	-	-	-	-	0	-
	2014/2015 Operation	1.2	1.2	<1.0	1.8	0.38	3	67	1.8	1.8	1.2	2.4	0.35	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<25	<25	<25	<25	3.1	3	67	4.7	5.4	2.1	6.5	1.3	3	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	1.6	1.6	1.6	1.6	-	1	100	1.9	1.9	1.9	1.	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	1.3	1.3	1.3	1.3	-	1	100	1.6	1.6	1.6	1.6	-	1	100
	2011/2012 Operation	<1.0	<1.0	<1.0	<1.0	-	1	0	<1.0	<1.0	<1.0	<1.0	-	1	0
	2011/2012 Closure	<1.0	<1.0	<1.0	<1.0	-	1	0	-	-	-	-	-	0	-
	2014/2015 Operation	2.0	1.7	1.6	2.6	0.33	3	100	2.0	1.9	1.3	2.9	0.47	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	1.7	1.7	1.7	1.7	-	1	100	2.1	2.1	2.1	2.1	-	1	100
	2011/2012 Operation	<1.0	<1.0	<1.0	2.3	0.45	4	25	1.6	0.8	<1.0	4.2	0.89	4	50
	2011/2012 Closure	1.3	1.2	<1.0	1.7	0.22	5	80	2.0	2.0	1.6	3.0	0.26	5	100
	2014/2015 Operation	1.5	1.5	<1.0	2.3	0.22	7	86	2.1	2.1	<1.0	3.7	0.38	7	86
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Methyl Mercury, Dissolved (ng/L)							Methyl Mercury, Total (ng/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	0.246	0.246	0.246	0.246	-	1	100
	2014/2015 Operation	<0.050	<0.050	<0.050	<0.050	-	3	0	0.054	0.058	<0.050	0.080	0.0160	3	67
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	1.08	1.08	0.140	2.01	0.540	3	100	1.57	1.43	0.175	3.11	0.850	3	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.050	0.050	0.050	0.050	-	1	100	0.057	0.057	0.057	0.057	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	1	0	0.056	0.056	0.056	0.056	-	1	100
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	1	0	<0.050	<0.050	<0.050	<0.050	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	0.164	0.164	0.164	0.164	-	1	100
	2014/2015 Operation	0.128	0.161	<0.050	0.199	0.0528	3	67	0.360	0.390	0.210	0.481	0.0796	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	0.052	0.052	0.052	0.052	-	1	100	0.067	0.067	0.067	0.067	-	1	100
	2011/2012 Operation	0.230	0.050	<0.050	0.793	0.188	4	50	0.340	0.117	<0.050	1.10	0.254	4	75
	2011/2012 Closure	0.253	0.292	0.120	0.376	0.0503	5	100	0.300	0.359	0.184	0.378	0.0439	5	100
	2014/2015 Operation	0.181	0.170	<0.050	0.452	0.0577	7	71	0.249	0.240	<0.050	0.476	0.0736	7	86
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Molybdenum, Dissolved (mg/L)							Molybdenum, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00251	0.00251	0.00251	0.00251	-	1	100	0.00251	0.00251	0.00251	0.00251	-	1	100
	2011/2012 Closure	0.00114	0.00114	0.00114	0.00114	-	1	100	0.00135	0.00135	0.00135	0.00135	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00236	0.00236	0.00236	0.00236	-	1	100	0.00247	0.00247	0.00247	0.00247	-	1	100
	2011/2012 Closure	0.00093	0.00093	0.00093	0.00093	-	1	100	0.00104	0.00104	0.00104	0.00104	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00052	0.00039	0.00019	0.00110	0.000209	4	100	0.00053	0.00039	0.00021	0.00113	0.000213	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00059	0.00059	0.00059	0.00059	-	1	100	0.00059	0.00059	0.00059	0.00059	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	0.00228	0.00228	0.00228	0.00228	-	1	100	0.00224	0.00224	0.00224	0.00224	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	0.00199	0.00205	0.00164	0.00222	0.000127	4	100	0.00203	0.00203	0.00185	0.00220	0.000084	4	100
	2011/2012 Closure	0.00039	0.00038	0.00027	0.00054	0.000045	6	100	0.00065	0.00049	0.00033	0.00173	0.000219	6	100
	2014/2015 Operation	0.00167	0.00159	0.00142	0.00200	0.000106	5	100	0.00171	0.00165	0.00144	0.00209	0.000122	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Nickel, Dissolved (mg/L)							Nickel, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0031	0.0031	0.0031	0.0031	-	1	100	0.0024	0.0024	0.0024	0.0024	-	1	100
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0031	0.0031	0.0031	0.0031	-	1	100	0.0023	0.0023	0.0023	0.0023	-	1	100
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Operation	0.0030	0.0030	0.0030	0.0030	-	1	100	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2011/2012 Operation	0.0011	<0.0010	<0.0010	0.0030	-	4	25	<0.0020	<0.0020	<0.0020	<0.0020	-	4	25
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	6	0	<0.0020	<0.0020	<0.0020	<0.0020	-	6	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	5	0	<0.0020	<0.0020	<0.0020	<0.0020	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Potassium, Dissolved (mg/L)							Potassium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	10.3	10.3	10.3	10.3	-	1	100	11.3	11.3	11.3	11.3	-	1	100
	2011/2012 Closure	3.30	3.30	3.30	3.30	-	1	100	3.37	3.37	3.37	3.37	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	10.6	10.6	10.6	10.6	-	1	100	11.0	11.0	11.0	11.0	-	1	100
	2011/2012 Closure	3.53	3.53	3.53	3.53	-	1	100	3.60	3.60	3.60	3.60	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	5.31	5.48	1.68	8.59	1.54	4	100	5.69	5.78	1.76	9.43	1.71	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	0.91	0.91	0.91	0.91	-	1	100	1.10	1.10	1.10	1.10	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	2.73	2.73	2.73	2.73	-	1	100	2.86	2.86	2.86	2.86	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	0.98	0.98	0.98	0.98	-	1	100	0.99	0.99	0.99	0.99	-	1	100
	2011/2012 Operation	11.1	11.1	11.1	11.1	-	1	100	10.9	10.9	10.9	10.9	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	1.18	1.18	1.18	1.18	-	1	100	1.37	1.37	1.37	1.37	-	1	100
	2011/2012 Operation	10.4	10.7	9.33	10.9	0.37	4	100	10.9	10.7	10.3	11.8	0.333	4	100
	2011/2012 Closure	1.99	2.26	0.95	2.55	0.27	6	100	3.20	2.53	1.14	8.85	1.16	6	100
	2014/2015 Operation	8.39	8.14	6.75	10.60	0.65	5	100	8.39	8.32	6.79	10.70	0.647	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Selenium, Dissolved (mg/L)							Selenium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0018	0.0018	0.0018	0.0018	-	1	100	0.0018	0.0018	0.0018	0.0018	-	1	100
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.0015	0.0015	0.0015	0.0015	-	1	100	0.0016	0.0016	0.0016	0.0016	-	1	100
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	0.0013	0.0013	0.0013	0.0013	-	1	100	0.0011	0.0011	0.0011	0.0011	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0	<0.0010	<0.0010	<0.0010	<0.0010	-	1	0
	2011/2012 Operation	<0.0010	<0.0010	<0.0010	0.0012	-	4	25	0.0014	0.0010	<0.0010	0.0032	0.00063	4	50
	2011/2012 Closure	<0.0010	<0.0010	<0.0010	<0.0010	-	6	0	<0.0010	<0.0010	<0.0010	<0.0010	-	6	0
	2014/2015 Operation	<0.0010	<0.0010	<0.0010	<0.0010	-	5	0	<0.0010	<0.0010	<0.0010	<0.0010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Silver, Dissolved (mg/L)							Silver, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.00004	<0.00010	-	4	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	6	0	<0.00010	<0.00010	<0.00010	<0.00010	-	6	0
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	5	0	<0.00010	<0.00010	<0.00010	<0.00010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Sodium, Dissolved (mg/L)							Sodium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	132	132	132	132	-	1	100	142	142	142	142	-	1	100
	2011/2012 Closure	30	30	30	30	-	1	100	34	34	34	34	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	134	134	134	134	-	1	100	141	141	141	141	-	1	100
	2011/2012 Closure	27	27	27	27	-	1	100	26	26	26	26	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	61	63	19	100	19.7	4	100	61	61	21	102	19.2	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	4	4	4	4	-	1	100	6	6	6	6	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	24	24	24	24	-	1	100	27	27	27	27	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	4	4	4	4	-	1	100	5	5	5	5	-	1	100
	2011/2012 Operation	140	140	140	140	-	1	100	140	140	140	140	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	6	6	6	6	-	1	100	8	8	8	8	-	1	100
	2011/2012 Operation	129	133	111	139	6.2	4	100	126	131	103	139	8.3	4	100
	2011/2012 Closure	19	21	10	28	2.8	6	100	19	23	11	25	3.1	5	100
	2014/2015 Operation	95	93	87	107	3.5	5	100	98	96	83	117	5.7	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Thallium, Dissolved (mg/L)							Thallium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	0.00026	0.00026	0.00026	0.00026	-	1	100
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	4	0	<0.00010	<0.00010	<0.000020	<0.00010	-	4	0
	2011/2012 Closure	<0.00010	<0.00010	<0.00010	<0.00010	-	6	0	<0.00010	<0.00010	<0.00010	<0.00010	-	6	0
	2014/2015 Operation	<0.00010	<0.00010	<0.00010	<0.00010	-	5	0	<0.00010	<0.00010	<0.00010	<0.00010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Uranium, Dissolved (mg/L)							Uranium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00194	0.00194	0.00194	0.00194	-	1	100	0.00194	0.00194	0.00194	0.00194	-	1	100
	2011/2012 Closure	0.00230	0.00230	0.00230	0.00230	-	1	100	0.00224	0.00224	0.00224	0.00224	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	0.00189	0.00189	0.00189	0.00189	-	1	100	0.00192	0.00192	0.00192	0.00192	-	1	100
	2011/2012 Closure	0.00166	0.00166	0.00166	0.00166	-	1	100	0.00167	0.00167	0.00167	0.00167	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00040	0.00037	0.00016	0.00070	0.000113	4	100	0.00042	0.00037	0.00023	0.00070	0.000101	4	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	0.00046	0.00046	0.00046	0.00046	-	1	100	0.00045	0.00045	0.00045	0.00045	-	1	100
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0
	2011/2012 Operation	0.00174	0.00174	0.00174	0.00174	-	1	100	0.00174	0.00174	0.00174	0.00174	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0	<0.00010	<0.00010	<0.00010	<0.00010	-	1	0
	2011/2012 Operation	0.00143	0.00148	0.00107	0.00167	0.000129	4	100	0.00143	0.00148	0.00112	0.00165	0.000117	4	100
	2011/2012 Closure	0.00028	0.00026	0.00014	0.00041	0.000043	6	100	0.00042	0.00027	0.00019	0.00115	0.000148	6	100
	2014/2015 Operation	0.00124	0.00131	0.00096	0.00154	0.000109	5	100	0.00127	0.00124	0.00107	0.00157	0.000094	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 13. Continued.

		Zinc, Dissolved (mg/L)							Zinc, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
EC1	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
EC2	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BBL	2011 Flood	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	<0.0020	<0.0020	<0.0020	0.0029	-	4	25
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC1	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC2	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
BC3	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	<0.0050	<0.0050	<0.0050	<0.0050	-	1	0
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	4	0	<0.0050	<0.0020	<0.0020	0.0054	-	4	25
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	6	0	0.0046	0.0028	<0.0020	0.0160	0.00233	6	67
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	5	0	0.0027	0.0023	<0.0020	0.0063	0.00097	5	60
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 14. Frequency of dissolved oxygen values in the Buffalo Creek watershed below the MWQSOGs and CCME lowest acceptable concentrations for PAL, 2011-2015.

Site ID	Period	Objectives Applicable when Water Temperature is > 5°C						Objectives Applicable when Water Temperature is ≤ 5°C					
		MWQSOGs PAL for Cool Water Early life, and CCME PAL for Early Life Stages of Warm Water Biota; 6.0 mg/L			MWQSOGs PAL for Cold Water Mature Life and CCME PAL for Other Life Stages of Cold Water Biota; 6.5 mg/L			MWQSOGs PAL for Cold Water Early Life, and CCME PAL for Early Life Stages of Cold Water Biota; 9.5 mg/L			MWQSOGs PAL for Cool Water Mature Life, and CCME PAL for Other Life Stages of Warm Water Biota; 5.5 mg/L		
		n	# below	% below	n	# below	% below	n	# below	% below	n	# below	% below
EC1	2011 Flood	0	-	-	0	-	-	0	-	-	0	-	-
	2011/2012 Operation	5	0	0	5	0	0	10	0	0	10	0	0
	2011/2012 Closure	7	0	0	7	0	0	2	1	50	2	0	0
	2014/2015 Operation	8	0	0	8	1	13	2	0	0	2	0	0
	2014/2015 Closure	0	-	-	0	-	-	0	-	-	0	-	-
EC2	2011 Flood	0	-	-	0	-	-	0	-	-	0	-	-
	2011/2012 Operation	5	0	0	5	0	0	5	0	0	5	0	0
	2011/2012 Closure	7	0	0	7	0	0	2	1	50	2	1	50
	2014/2015 Operation	11	1	9	11	2	18	2	0	0	2	0	0
	2014/2015 Closure	3	0	0	3	2	67	0	-	-	0	-	-
BBL	2011 Flood	0	-	-	0	-	-	0	-	-	0	-	-
	2011/2012 Operation	0	-	-	0	-	-	0	-	-	0	-	-
	2011/2012 Closure	8	1	13	8	2	25	4	4	100	4	3	75
	2014/2015 Operation	11	0	0	11	1	9	1	0	0	1	0	0
	2014/2015 Closure	3	2	67	3	2	67	0	-	-	0	-	-
BC1	2011 Flood	5	0	0	5	1	20	1	0	0	1	0	0
	2011/2012 Operation	4	0	0	4	1	25	7	2	29	7	1	14
	2011/2012 Closure	7	1	14	7	3	43	3	2	67	3	1	33
	2014/2015 Operation	11	6	55	11	7	64	1	0	0	1	0	0
	2014/2015 Closure	3	2	67	3	2	67	0	-	-	0	-	-

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Table 14. Continued.

Site ID	Period	Objectives Applicable when Water Temperature is > 5°C						Objectives Applicable when Water Temperature is ≤ 5°C					
		MWQSOGs PAL for Cool Water Early life, and CCME PAL for Early Life Stages of Warm Water Biota; 6.0 mg/L			MWQSOGs PAL for Cold Water Mature Life and CCME PAL for Other Life Stages of Cold Water Biota; 6.5 mg/L			MWQSOGs PAL for Cold Water Early Life, and CCME PAL for Early Life Stages of Cold Water Biota; 9.5 mg/L			MWQSOGs PAL for Cool Water Mature Life, and CCME PAL for Other Life Stages of Warm Water Biota; 5.5 mg/L		
		n	# below	% below	n	# below	% below	n	# below	% below	n	# below	% below
BC2	2011 Flood	5	0	0	5	0	0	1	0	0	1	0	0
	2011/2012 Operation	5	1	20	5	1	20	10	1	10	10	1	10
	2011/2012 Closure	7	0	0	7	0	0	3	3	100	3	1	33
	2014/2015 Operation	8	4	50	8	4	50	2	0	0	2	0	0
	2014/2015 Closure	0	-	-	0	-	-	0	-	-	0	-	-
BC3	2011 Flood	5	0	0	5	0	0	1	0	0	1	0	0
	2011/2012 Operation	7	0	0	7	1	14	11	1	9	11	0	0
	2011/2012 Closure	12	0	0	12	1	8	1	1	100	1	0	0
	2014/2015 Operation	16	5	31	16	5	31	3	1	33	3	0	0
	2014/2015 Closure	3	1	33	3	2	67	0	-	-	0	-	-

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Table 15. Frequency of exceedance of MWQSOGs and CCME guidelines for PAL for metals and major ions in the Buffalo Creek watershed, 2011-2015. Only metals and major ions for which exceedances occurred within the Study Area are listed.[1] Percent exceedance values greater than zero are indicated in bold. Note: this table does not include 2014/2015 Closure data, because metals were not analysed during this period.

			Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
Site ID	Period		MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
EC1	2011 Flood	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2011/2012 Operation	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	0	-	1	0	0
		% Exceedance	0	0	-	0	-	**100**	0	0
	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
EC2	2011 Flood	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2011/2012 Operation	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	0	-	1	0	0
		% Exceedance	0	0	-	0	-	**100**	0	0

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Table 15. Continued.

Site ID	Period		Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
			MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
EC2	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
BBL	2011 Flood	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2011/2012 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2011/2012 Closure	n	4	4	-	4	-	4	4	4
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**25**	-	**25**	0	0
	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
BC1	2011 Flood	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	0	-	0	0	0
		% Exceedance	0	0	-	0	-	0	0	0
	2011/2012 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-

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Table 15. Continued.

Site ID	Period		Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
			MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
BC1	2011/2012 Closure	n	1	1	-	1	-	1	1	1
		# Exceeded	1	1	-	0	-	0	0	0
		% Exceedance	**100**	**100**	-	0	-	0	0	0
	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
BC2	2011 Flood	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	0	-	0	0	0
		% Exceedance	0	0	-	0	-	0	0	0
	2011/2012 Operation	n	1	1	-	1	-	1	1	1
		# Exceeded	0	0	-	1	-	1	0	0
		% Exceedance	0	0	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
	2014/2015 Operation	n	0	0	-	0	-	0	0	0
		# Exceeded	-	-	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-	-	-
BC3	2011 Flood	n	1	1	-	1	-	1	1	1
		# Exceeded	1	1	-	0	-	0	0	0
		% Exceedance	**100**	**100**	-	0	-	0	0	0

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Table 15. Continued.

Site ID	Period		Aluminum, Total		Chloride, Dissolved		Fluoride, Dissolved		Chromium, Total	
			MWQSOGs	CCME	MWQSOGs	CCME [2]	MWQSOGs	CCME [3]	MWQSOGs [4,5]	CCME [2]
MWQSOGs/CCME PAL (mg/L)			0.1	0.1	-	120	-	0.12	0.103-0.316	0.001
BC3	2011/2012 Operation	n	4	4	-	4	-	4	4	4
		# Exceeded	2	2	-	4	-	4	0	0
		% Exceedance	**50**	**50**	-	**100**	-	**100**	0	0
	2011/2012 Closure	n	6	6	-	6	-	6	6	6
		# Exceeded	5	5	-	0	-	0	0	1
		% Exceedance	**83**	**83**	-	0	-	0	0	**17**
	2014/2015 Operation	n	5	5	-	5	-	5	5	5
		# Exceeded	5	5	-	5	-	5	0	0
		% Exceedance	**100**	**100**	-	**100**	-	**100**	0	0

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Table 15. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
EC1	2011 Flood	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2011/2012 Operation	n	1	1	1	1	1	1
		# Exceeded	0	0	1	1	0	0
		% Exceedance	0	0	**100**	**100**	0	0
	2011/2012 Closure	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
EC2	2011 Flood	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2011/2012 Operation	n	1	1	1	1	1	1
		# Exceeded	0	0	1	1	0	0
		% Exceedance	0	0	**100**	**100**	0	0
	2011/2012 Closure	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0

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Table 15. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
EC2	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
BBL	2011 Flood	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2011/2012 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2011/2012 Closure	n	4	4	4	4	4	4
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
BC1	2011 Flood	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2011/2012 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-

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Table 15. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
BC1	2011/2012 Closure	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
BC2	2011 Flood	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0
	2011/2012 Operation	n	1	1	1	1	1	1
		# Exceeded	0	0	1	1	0	0
		% Exceedance	0	0	**100**	**100**	0	0
	2011/2012 Closure	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
	2014/2015 Operation	n	0	0	0	0	0	0
		# Exceeded	-	-	-	-	-	-
		% Exceedance	-	-	-	-	-	-
BC3	2011 Flood	n	1	1	1	1	1	1
		# Exceeded	0	0	0	0	0	0
		% Exceedance	0	0	0	0	0	0

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Table 15. Continued.

Site ID	Period		Iron, Total		Selenium, Total		Silver, Total	
			MWQSOGs	CCME	MWQSOGs [6]	CCME [6]	MWQSOGs [6]	CCME [6]
MWQSOGs/CCME PAL (mg/L)			0.3	0.3	0.001	0.001	0.0001	0.0001
BC3	2011/2012 Operation	n	4	4	4	4	4	4
		# Exceeded	0	0	2	2	0	0
		% Exceedance	0	0	**50**	**50**	0	0
	2011/2012 Closure	n	6	6	6	6	6	6
		# Exceeded	3	3	0	0	0	0
		% Exceedance	**50**	**50**	0	0	0	0
	2014/2015 Operation	n	5	5	5	5	5	5
		# Exceeded	1	1	0	0	0	0
		% Exceedance	20	20	0	0	0	0

1 - The following metals where consistently within both the applicable MWQSOGs and CCME PAL guidelines at all sites and times: arsenic; boron; cadmium; dissolved chromium; copper; lead; mercury, methyl mercury; molybdenum; nickel; thallium; uranium; and, zinc.
2 - Long-term guideline. All concentrations were within the short-term guideline at all sites and times.
3 - Interim guideline.
4 - MWQSOGs 4-day objective. All concentrations were within the 1-hour objective.
5 - Based on sample specific hardness.
6 - Analytical detection limit is equal to the PAL guideline.

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Table 16. Frequencies of exceedances of MWQSOGs/Health Canada aesthetic objectives for drinking water for metals and major ions measured in the Buffalo Creek watershed, 2011-2015. All parameters with maximum acceptable concentrations were within these guidelines at all sites and times, including: antimony; arsenic; barium; boron; lead; mercury; selenium; and, uranium. Percent exceedance values greater than zero are indicated in bold. Note: this table does not include 2014/2015 Closure data, because metals were not analysed during this period.

Site ID	Period		Chloride, Dissolved	Iron, Total	Manganese, Total	Sodium, Total	Sulphate, Dissolved
MWQSOGs/Health Canada Aesthetic Objective (mg/L)			≤250	≤0.3	≤0.050	≤200	≤500
EC1	2011/2012 Operation	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
EC2	2011/2012 Operation	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
BBL	2011/2012 Closure	n	4	4	4	4	4
		# Exceeded	0	0	2	0	0
		% Exceedance	0	0	**50**	0	0
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
BC1	2011 Flood	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0

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Table 16. Continued.

Site ID	Period		Chloride, Dissolved	Iron, Total	Manganese, Total	Sodium, Total	Sulphate, Dissolved
MWQSOGs/Health Canada Aesthetic Objective (mg/L)			≤250	≤0.3	≤0.050	≤200	≤500
BC1	2011/2012 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
	2011/2012 Closure	n	1	1	1	1	1
		# Exceeded	0	0	1	0	0
		% Exceedance	0	0	**100**	0	0
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
BC2	2011 Flood	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Operation	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
	2014/2015 Operation	n	0	0	0	0	0
		# Exceeded	-	-	-	-	-
		% Exceedance	-	-	-	-	-
BC3	2011 Flood	n	1	1	1	1	1
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Operation	n	4	4	4	4	4
		# Exceeded	0	0	0	0	0
		% Exceedance	0	0	0	0	0
	2011/2012 Closure	n	6	6	6	5	6
		# Exceeded	0	3	2	0	0
		% Exceedance	0	**50**	**33**	0	0
	2014/2015 Operation	n	5	5	5	5	5
		# Exceeded	0	1	0	0	0
		% Exceedance	0	**20**	0	0	0

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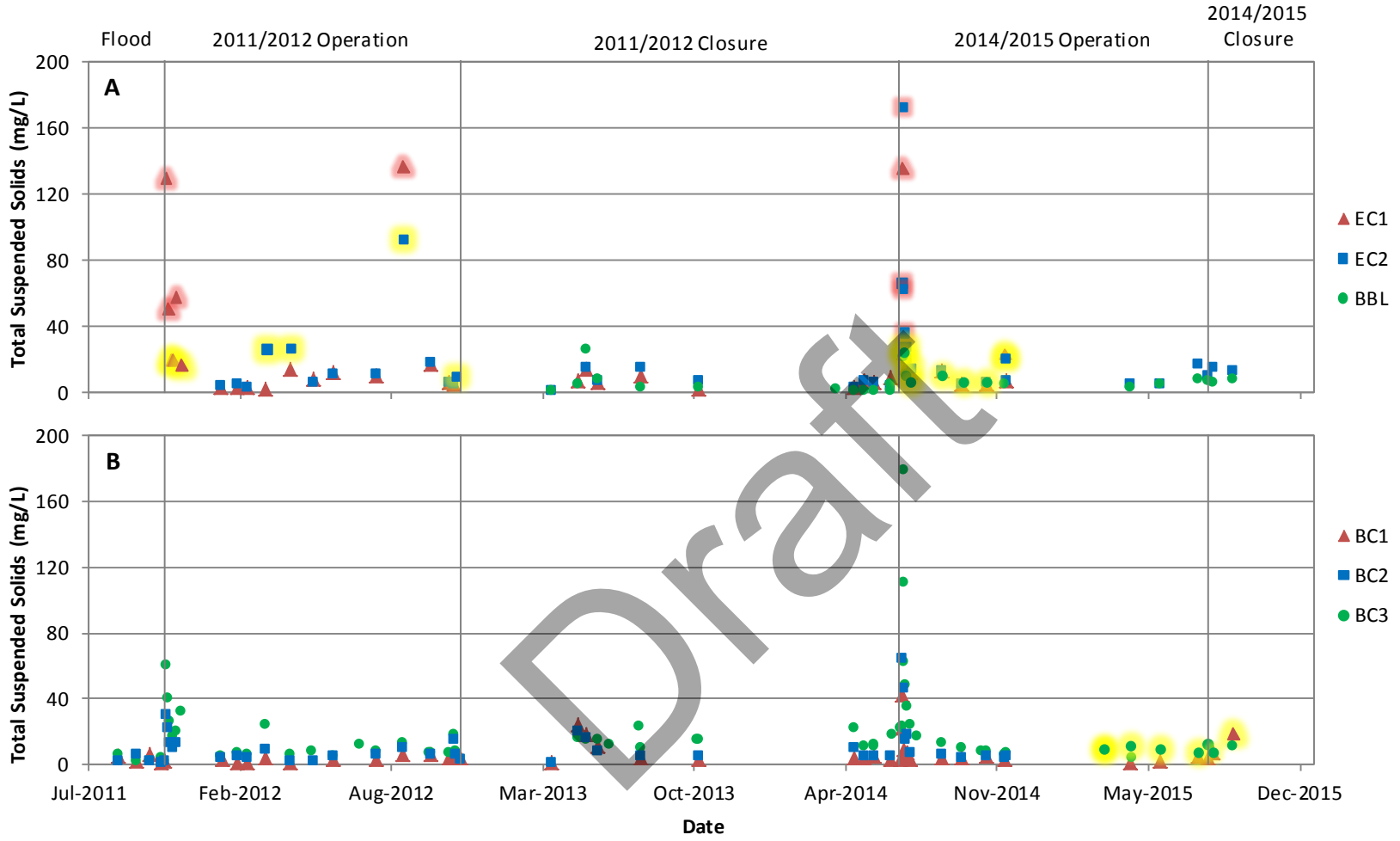
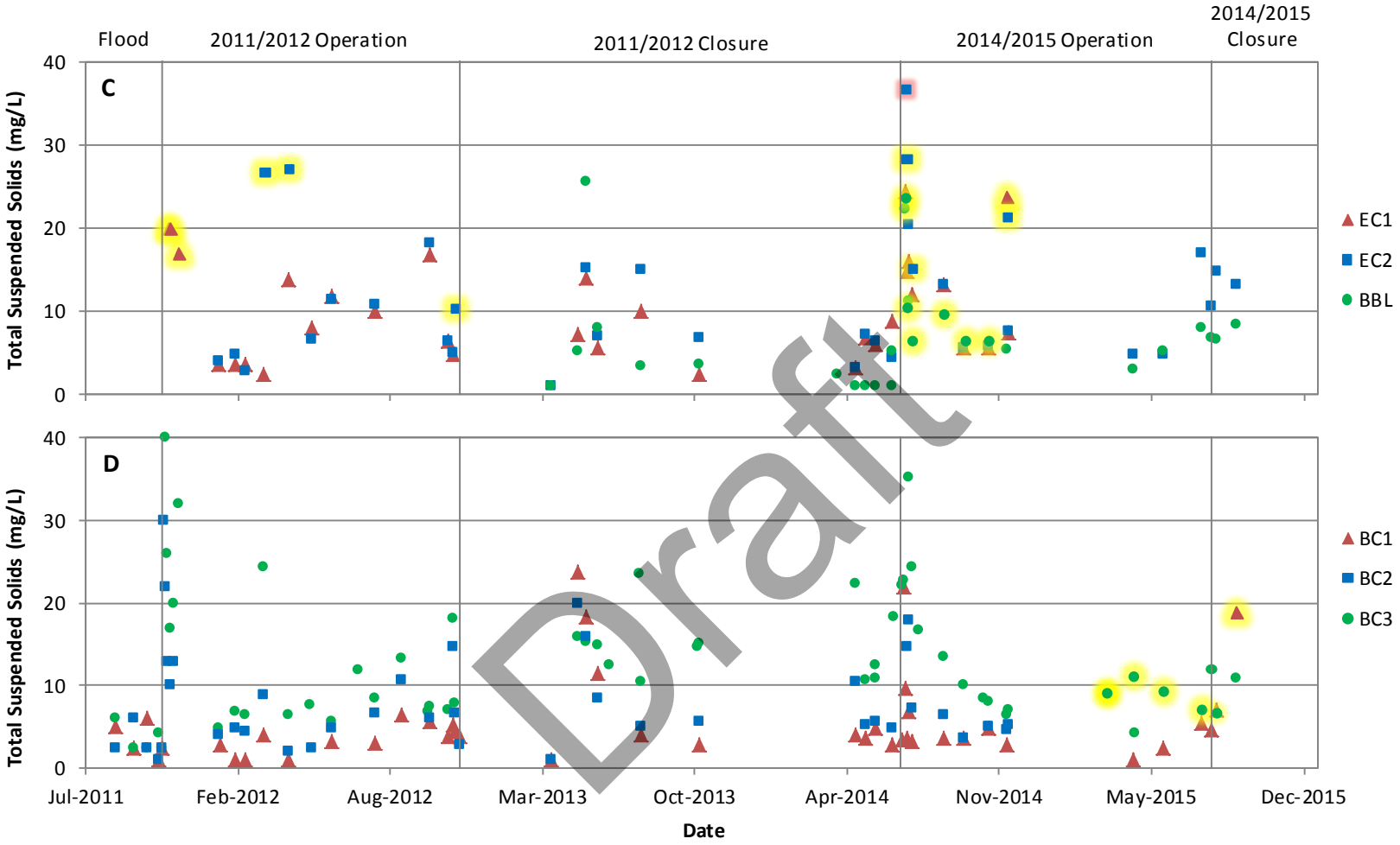
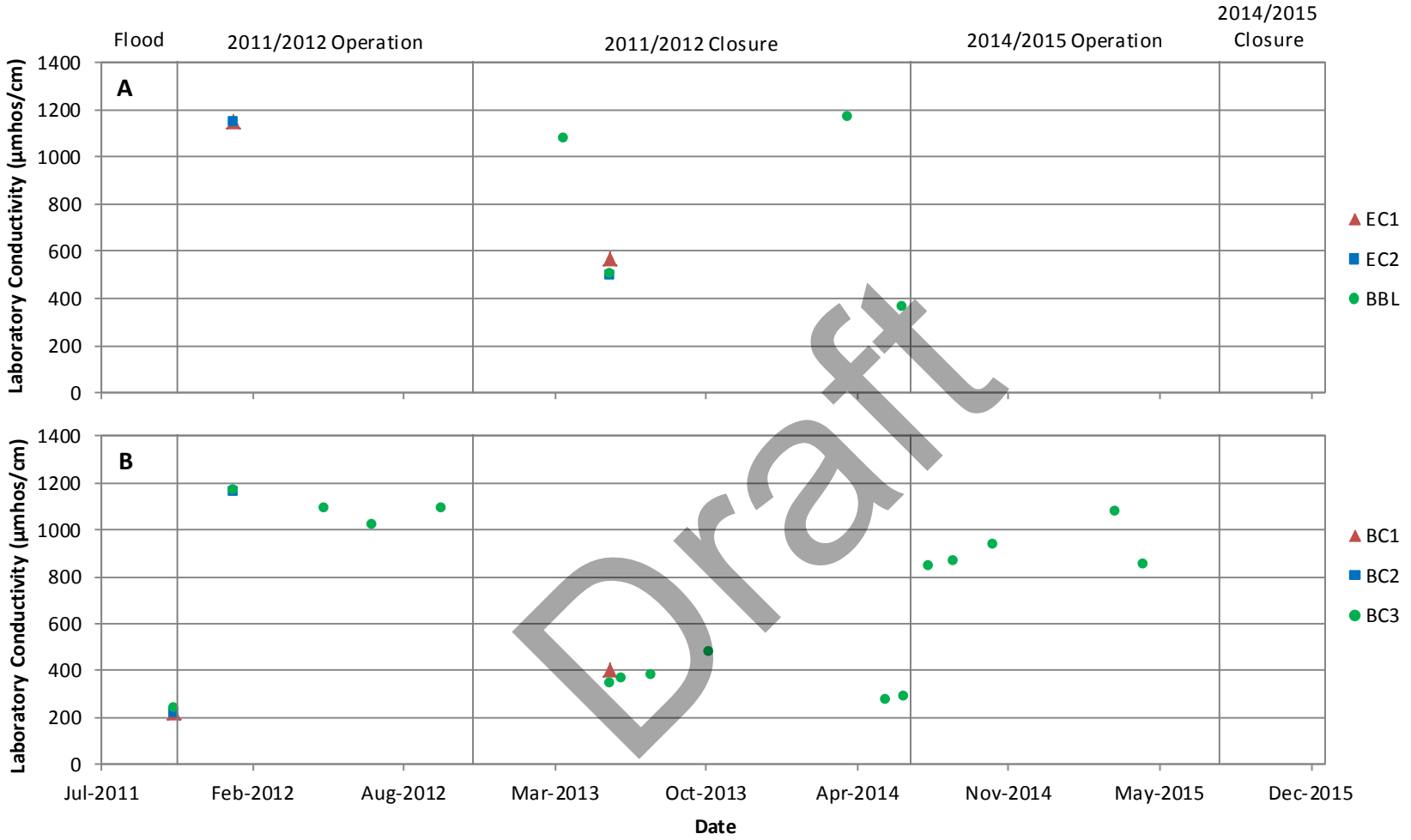


Figure 33. Total suspended solids concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Values highlighted in red were more than 25 mg/L above background. Values highlighted in yellow were more than 5 mg/L above background. Plots (C) and (D) show the same data as (A) and (B), respectively, but at a smaller scale such that only values less than or equal to 40 mg/L are shown.



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Figure 33. Continued.



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Figure 34. Laboratory conductivity in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.

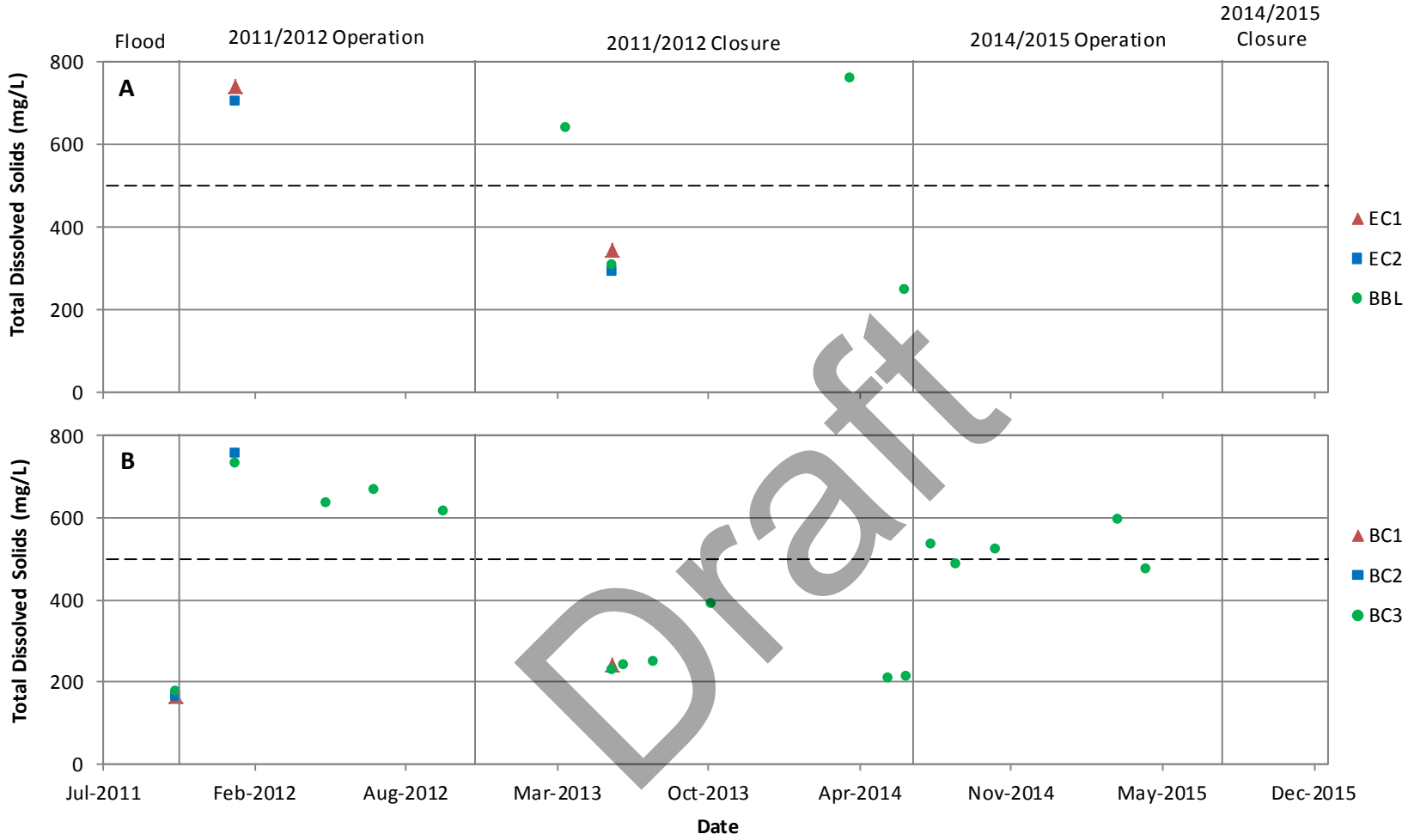
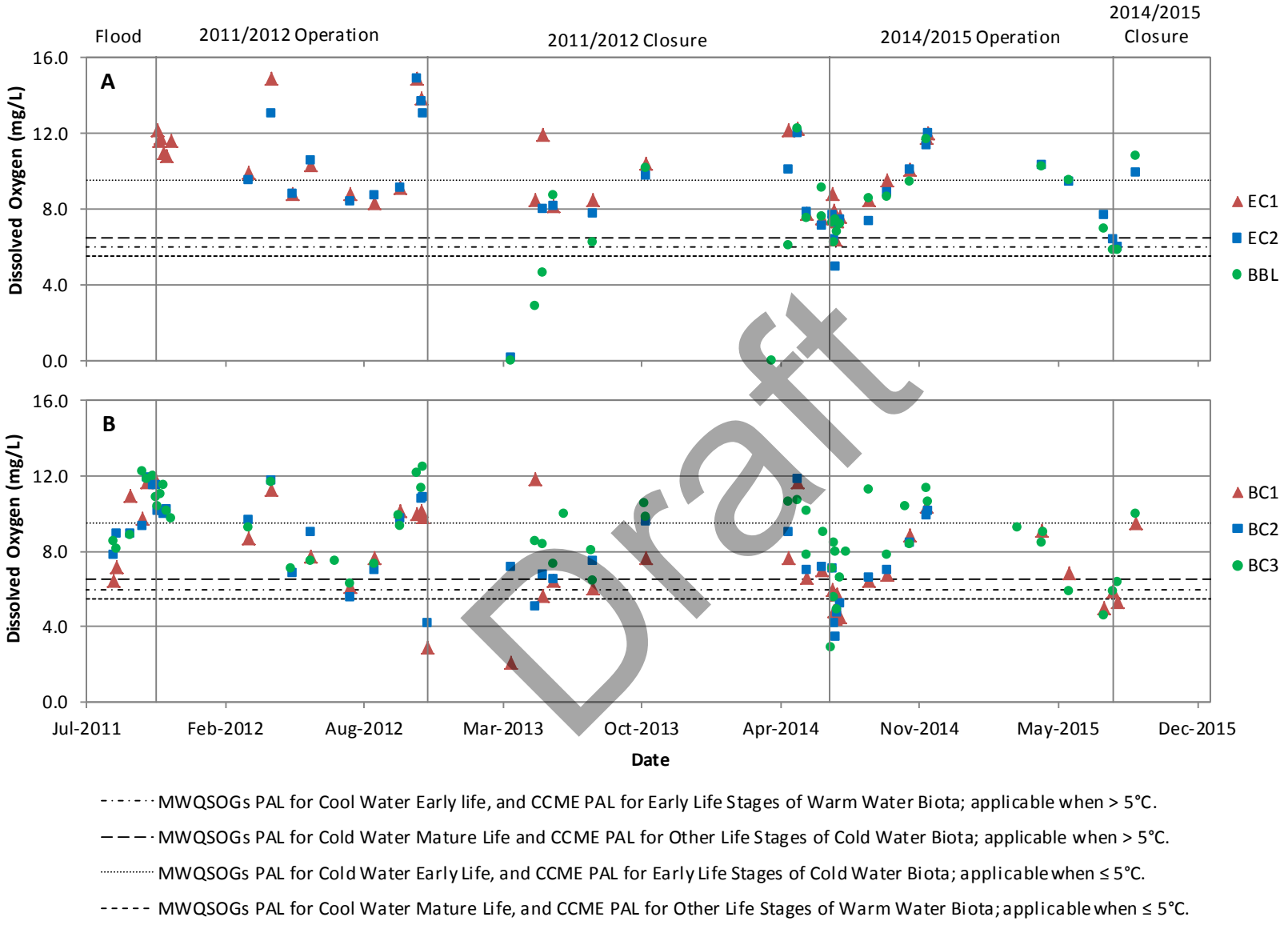


Figure 35. Total dissolved solids concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents the MWQSOGs and Health Canada aesthetic objective for drinking water.



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Figure 36. Dissolved oxygen concentrations measured in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.

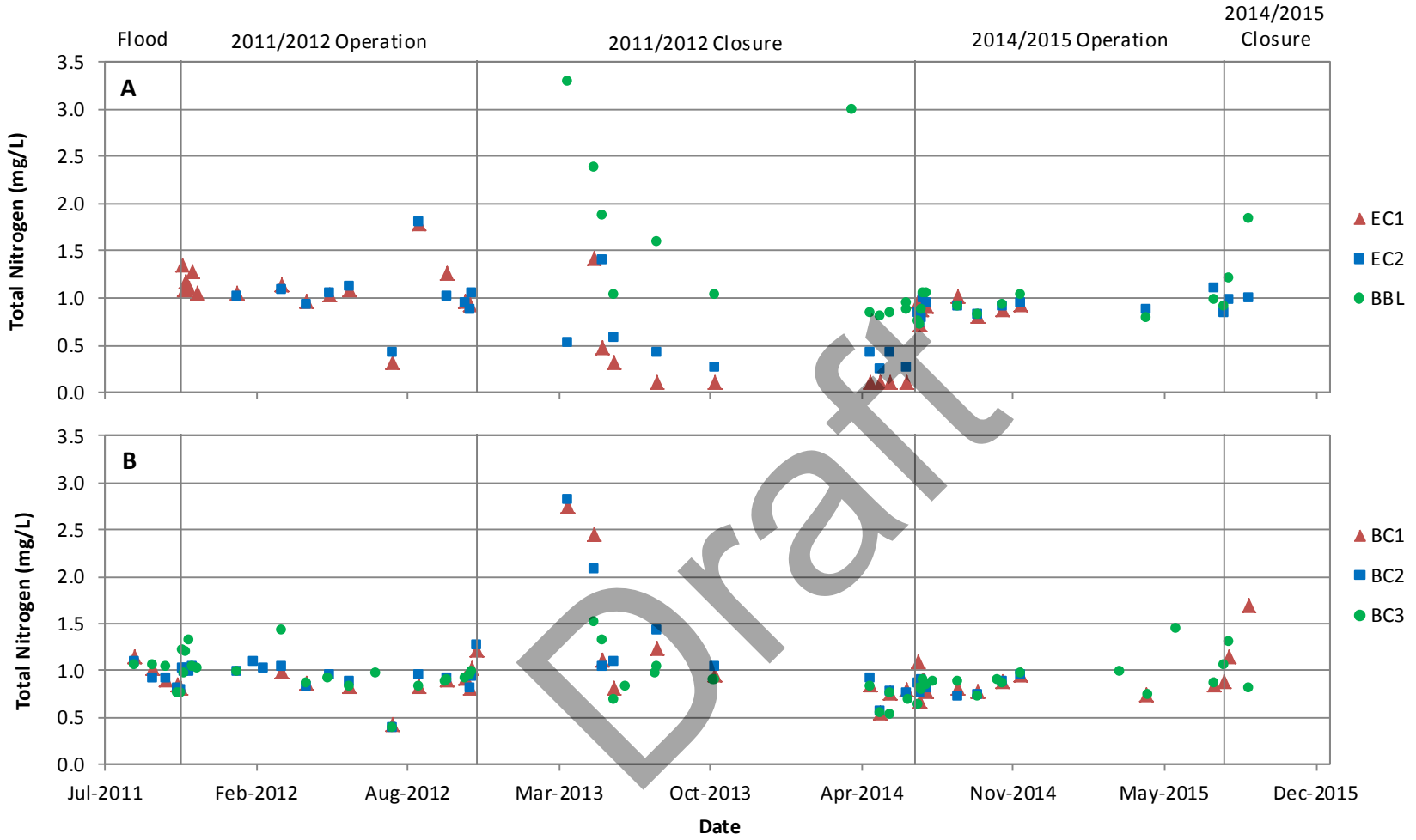
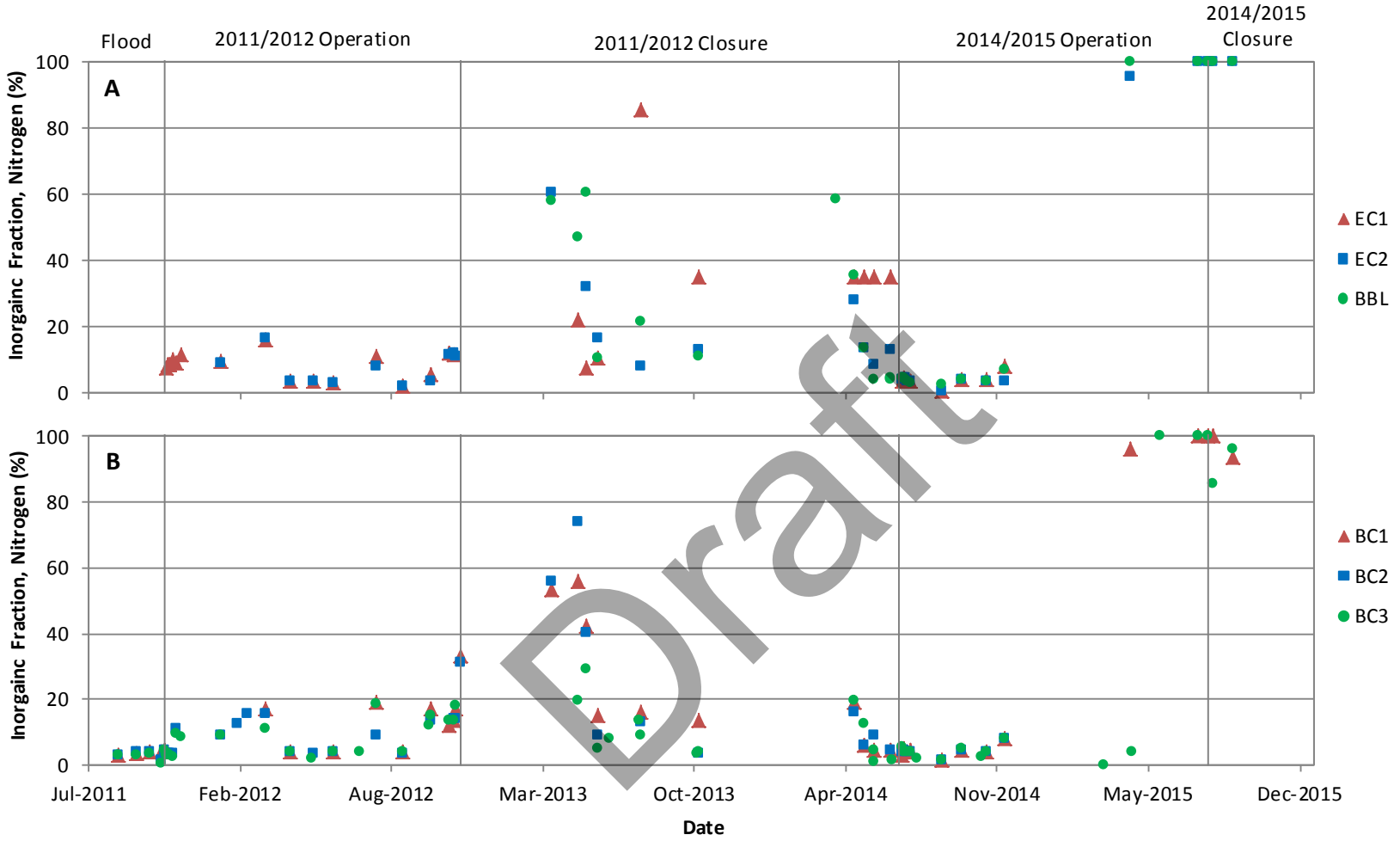


Figure 37. Total nitrogen concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.



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Figure 38. Nitrogen composition in (A) Reach 1, Big Buffalo Lake, and (B) Buffalo Creek, 2011-2015.

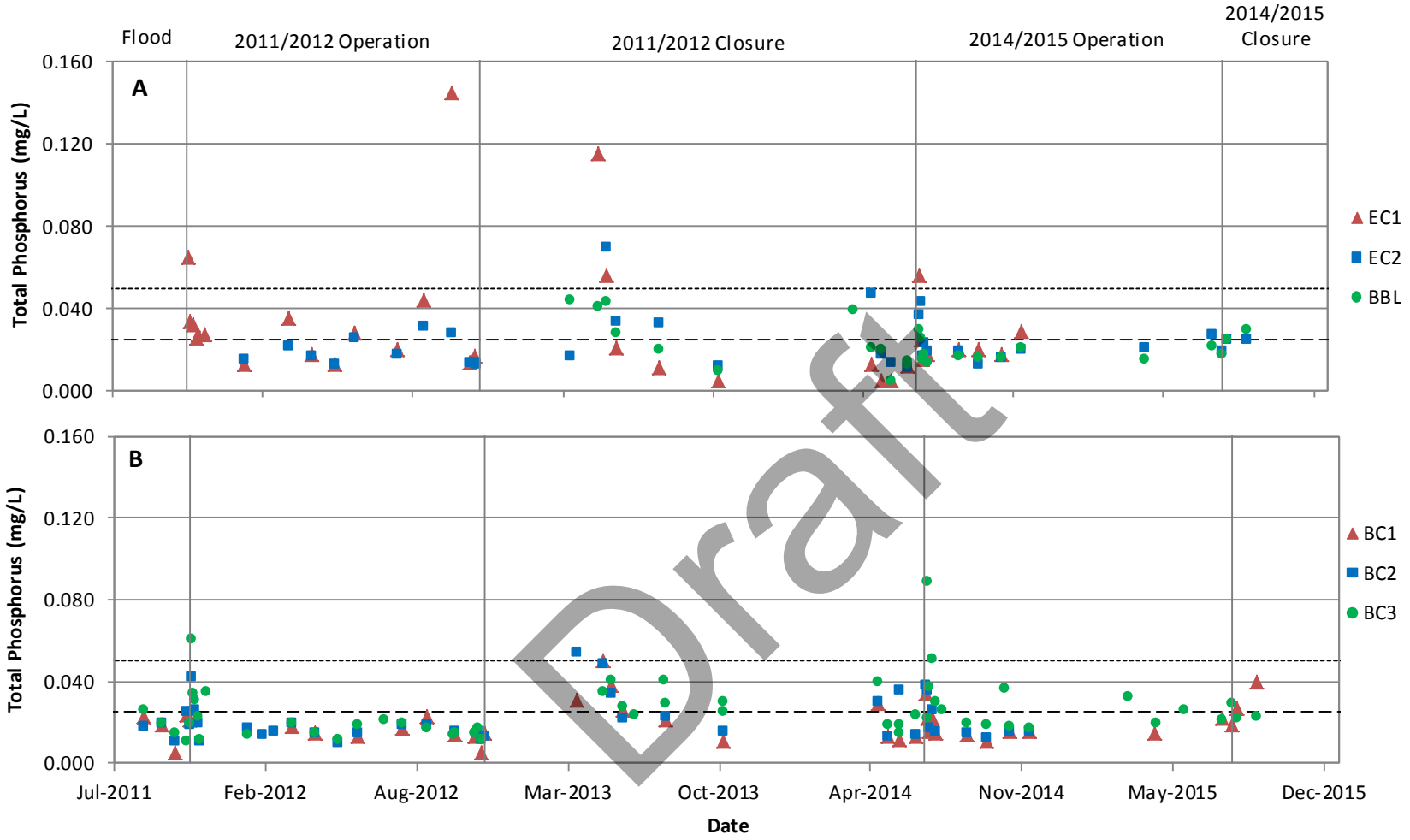
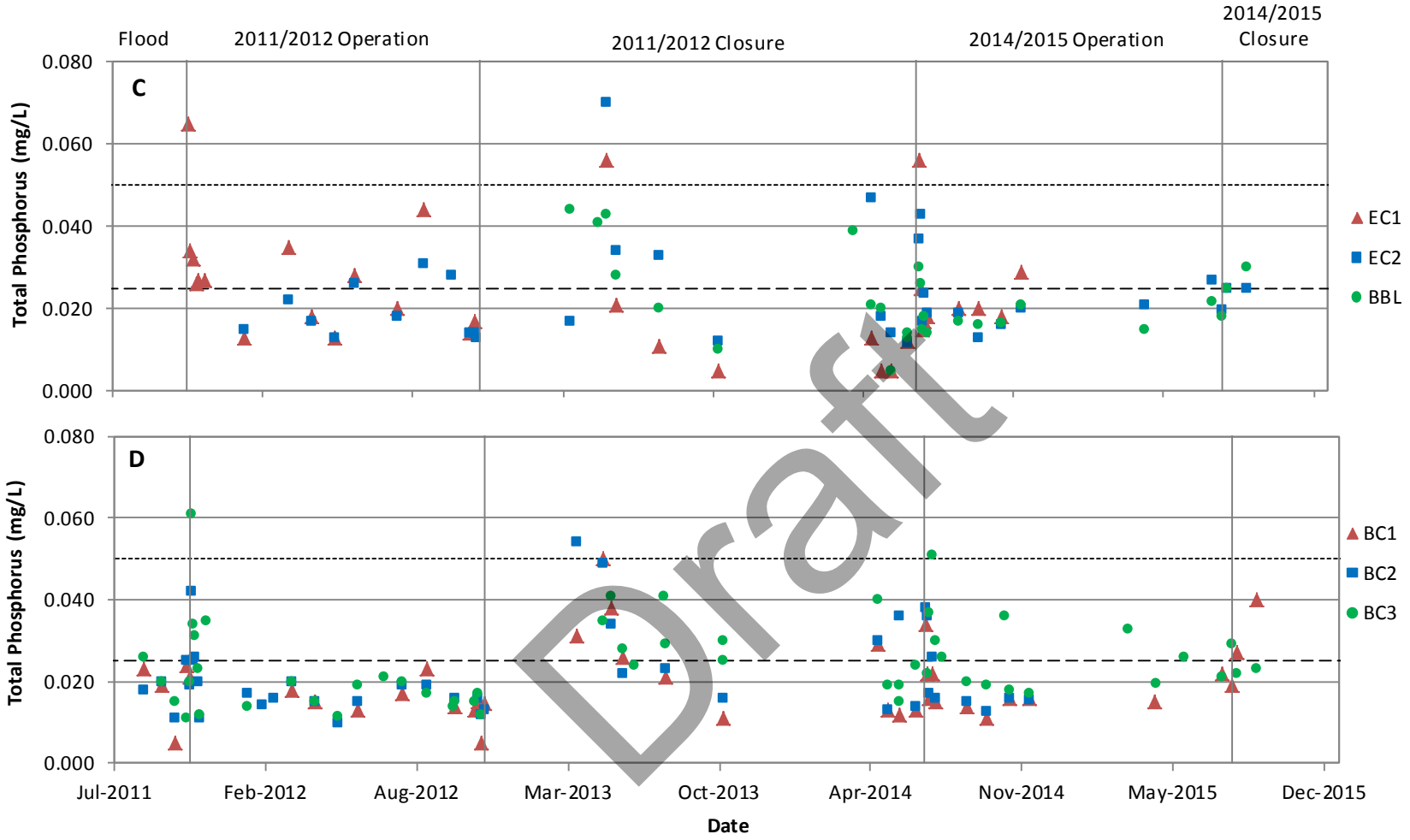
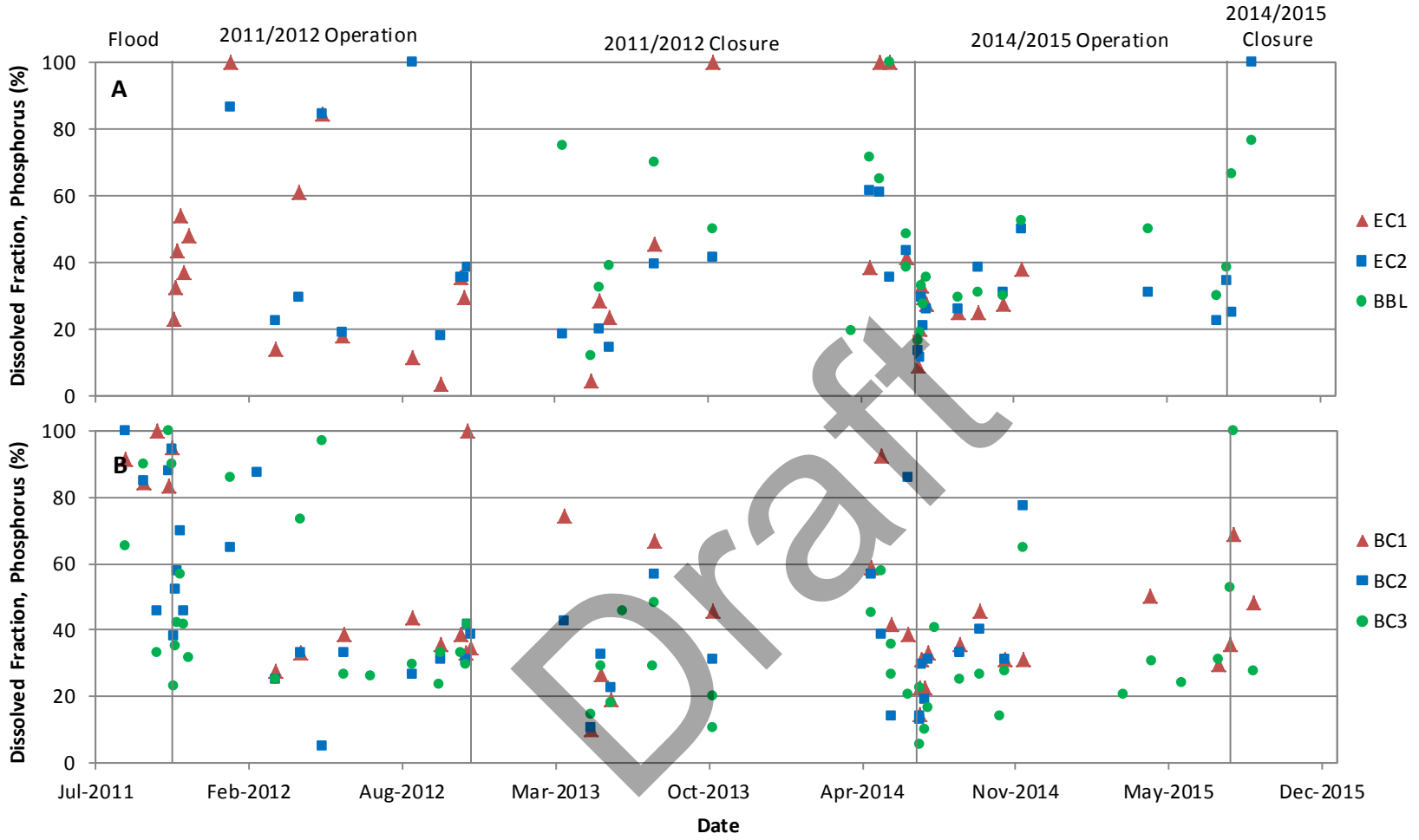


Figure 39. Total phosphorus concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents the MWQSOGs narrative guideline for lakes and the dotted line represents the MWQSOGs narrative guideline for streams. Plots (C) and (D) show the same data as (A) and (B), respectively, but at half scale such that only values less than or equal to 0.080 mg/L are shown.



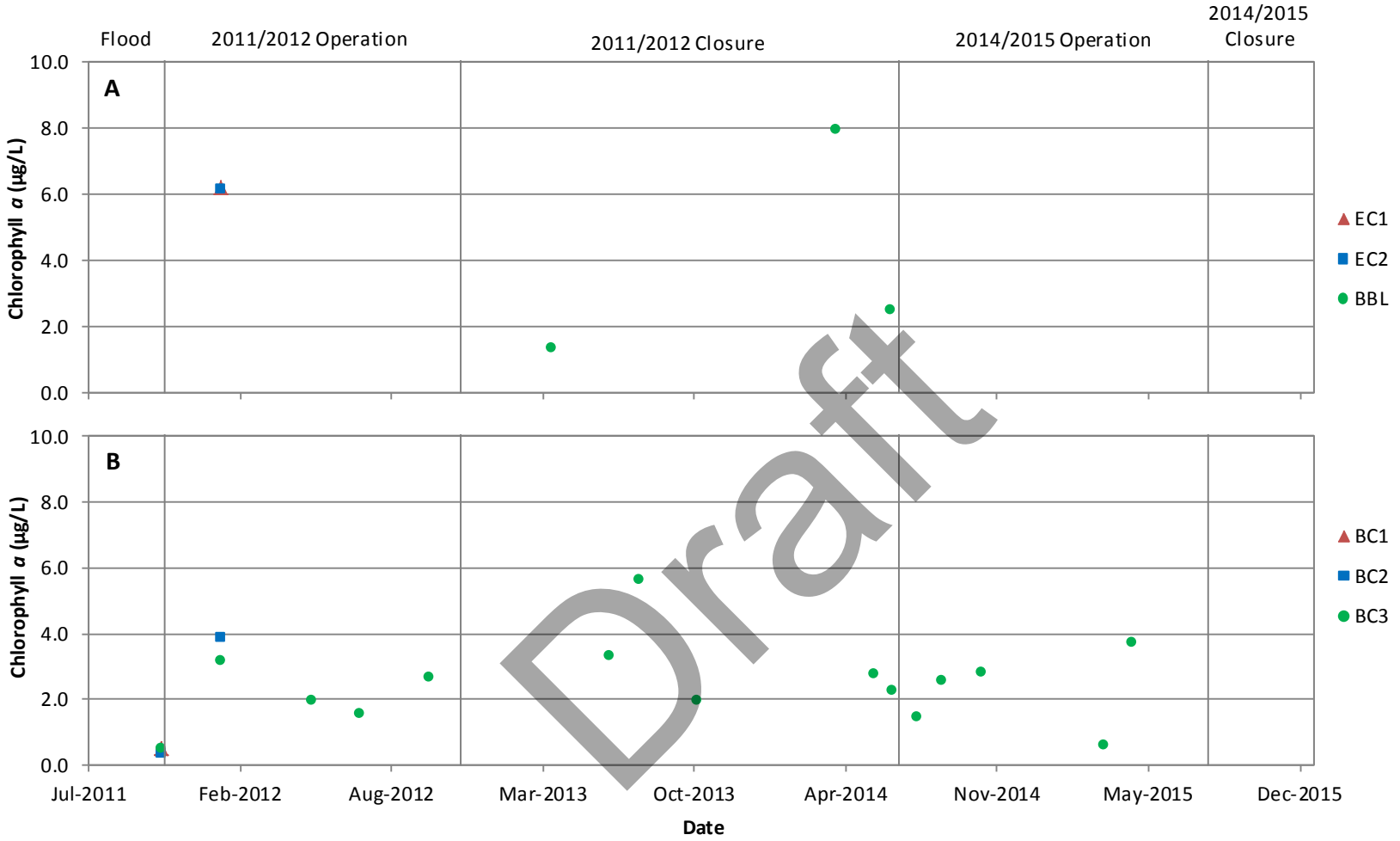
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Figure 39. Continued.



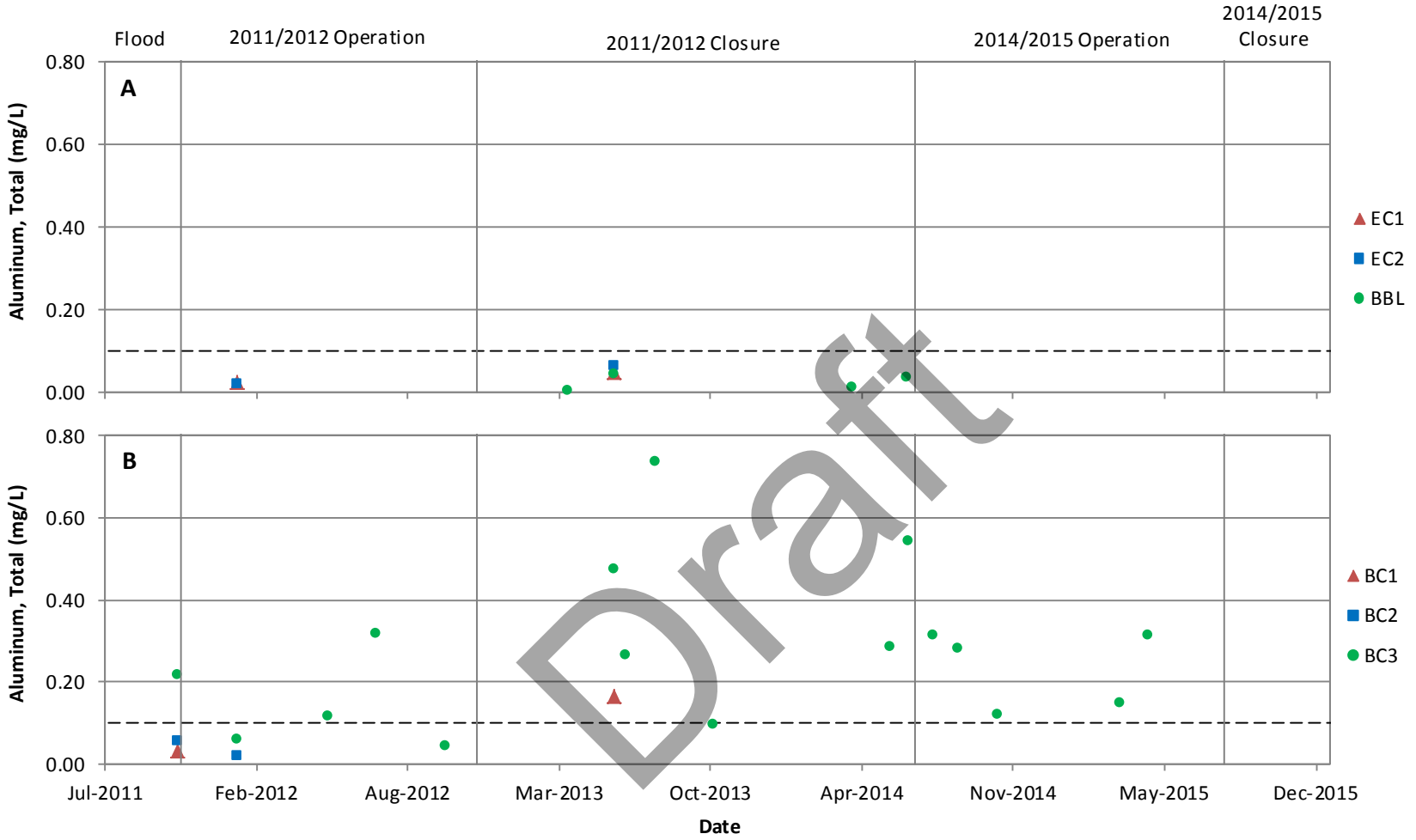
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Figure 40. Phosphorus composition in (A) Reach 1, Big Buffalo Lake, and (B) Buffalo Creek, 2011-2015. Percent dissolved phosphorus values greater than 100% are plotted at 100% for the purposes of this figure.



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Figure 41. Chlorophyll *a* concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.



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Figure 42. Aluminum concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents the MWQSOGs/CCME PAL.

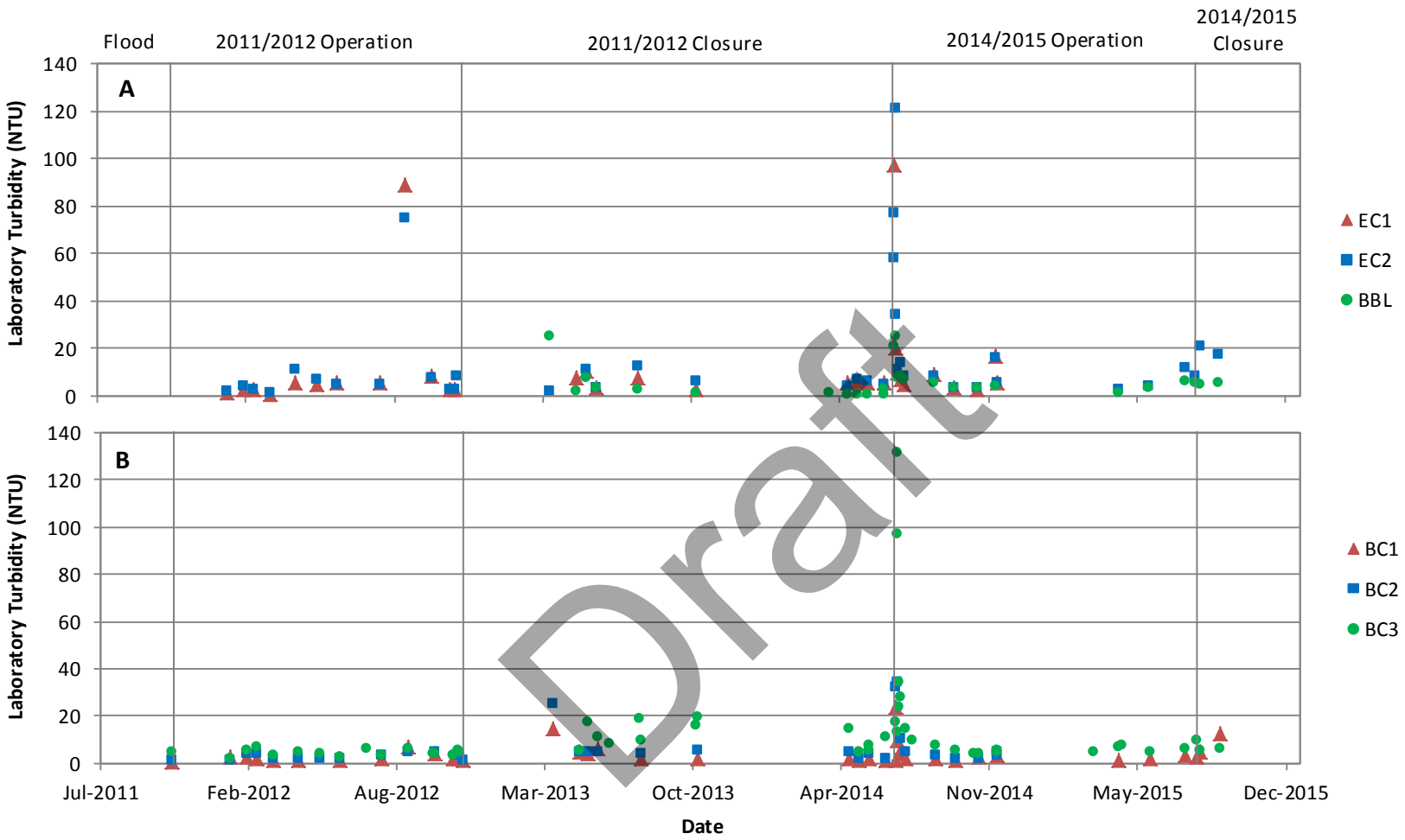
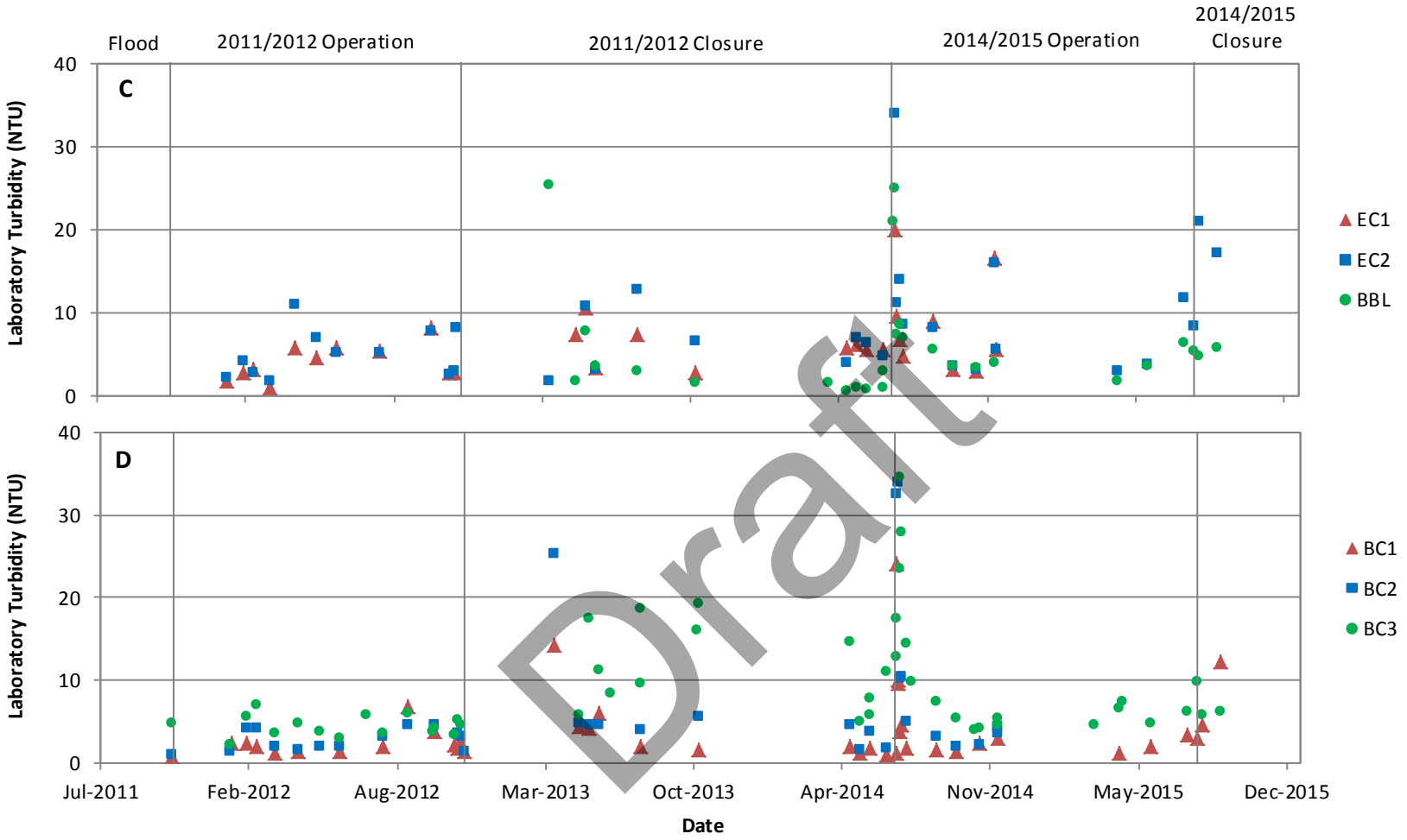
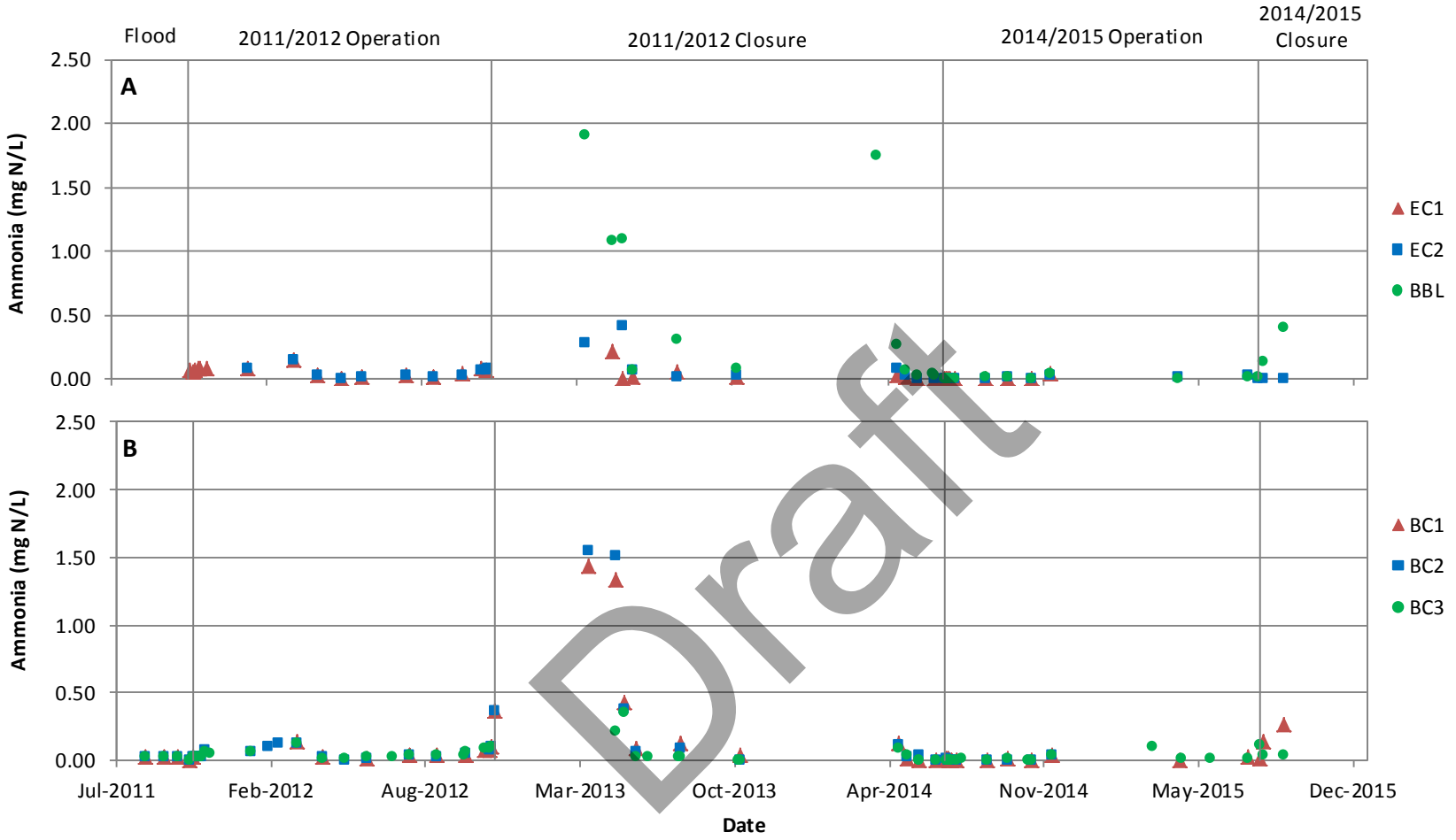


Figure 43. Laboratory turbidity in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Plots (C) and (D) show the same data as (A) and (B), respectively, but at a smaller scale such that only values less than or equal to 40 NTU are shown.



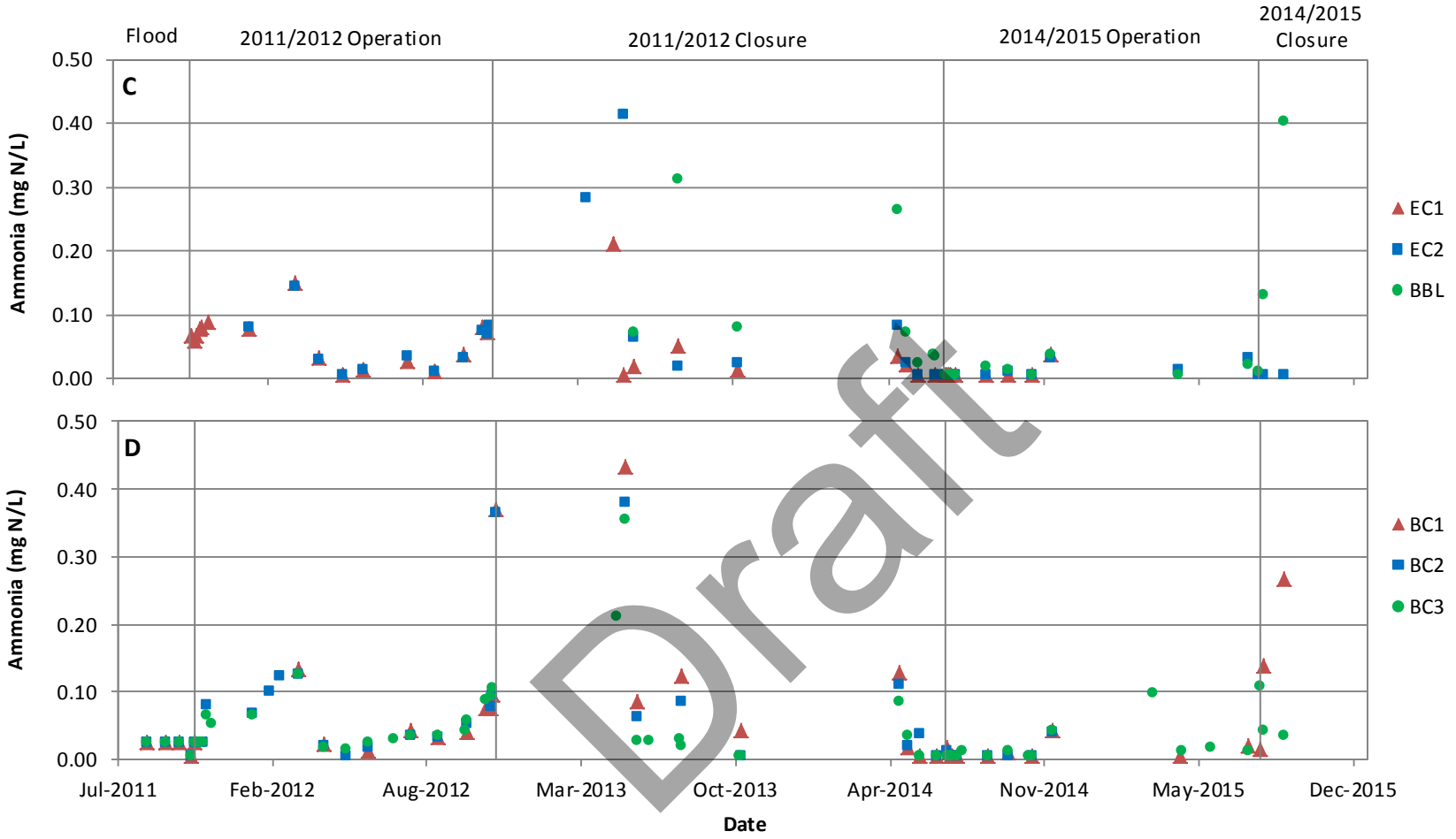
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Figure 43. Continued.



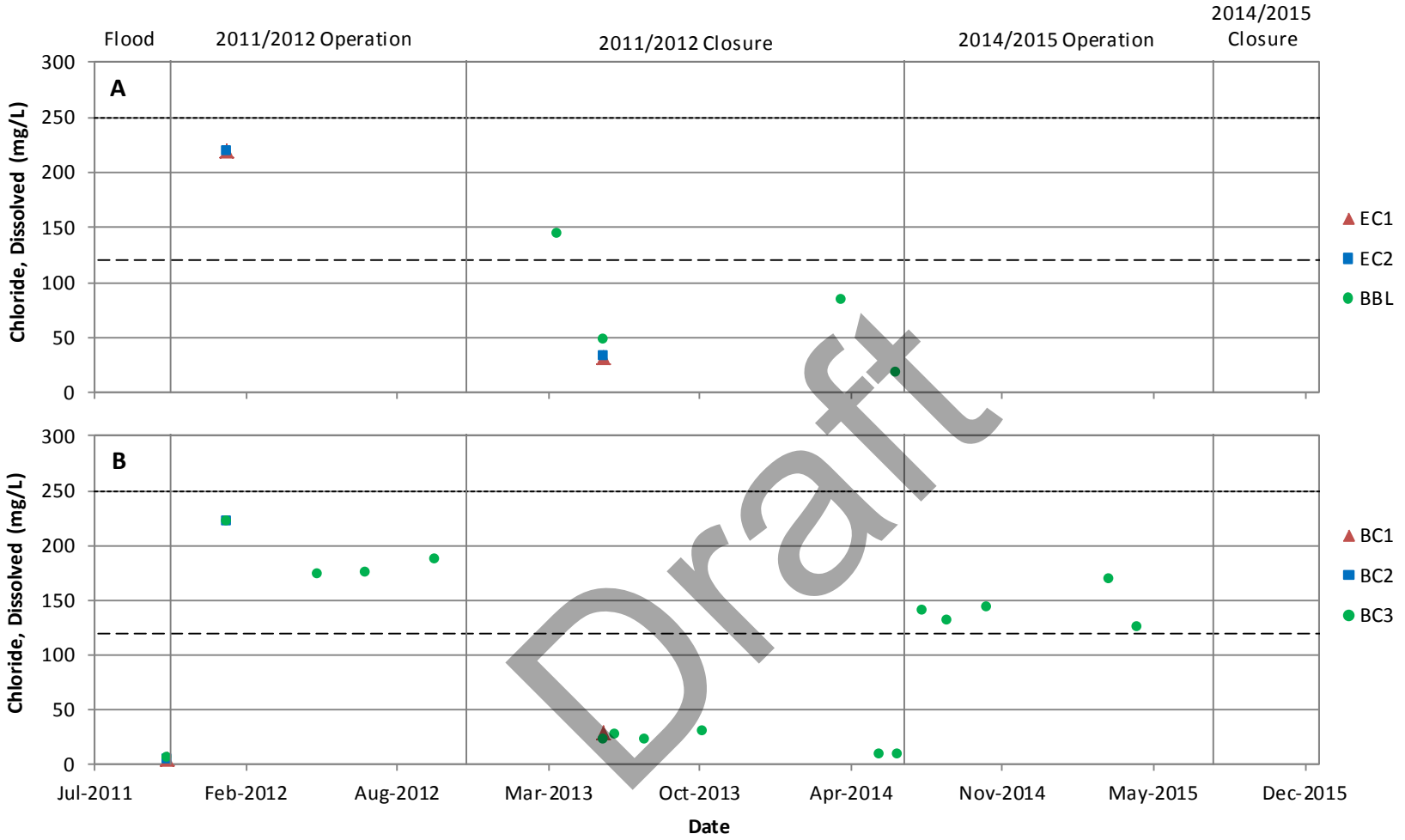
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Figure 44. Ammonia concentrations measured in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Plots (C) and (D) show the same data as (A) and (B), respectively, but at a smaller scale such that only values less than or equal to 0.50 mg/L are shown.



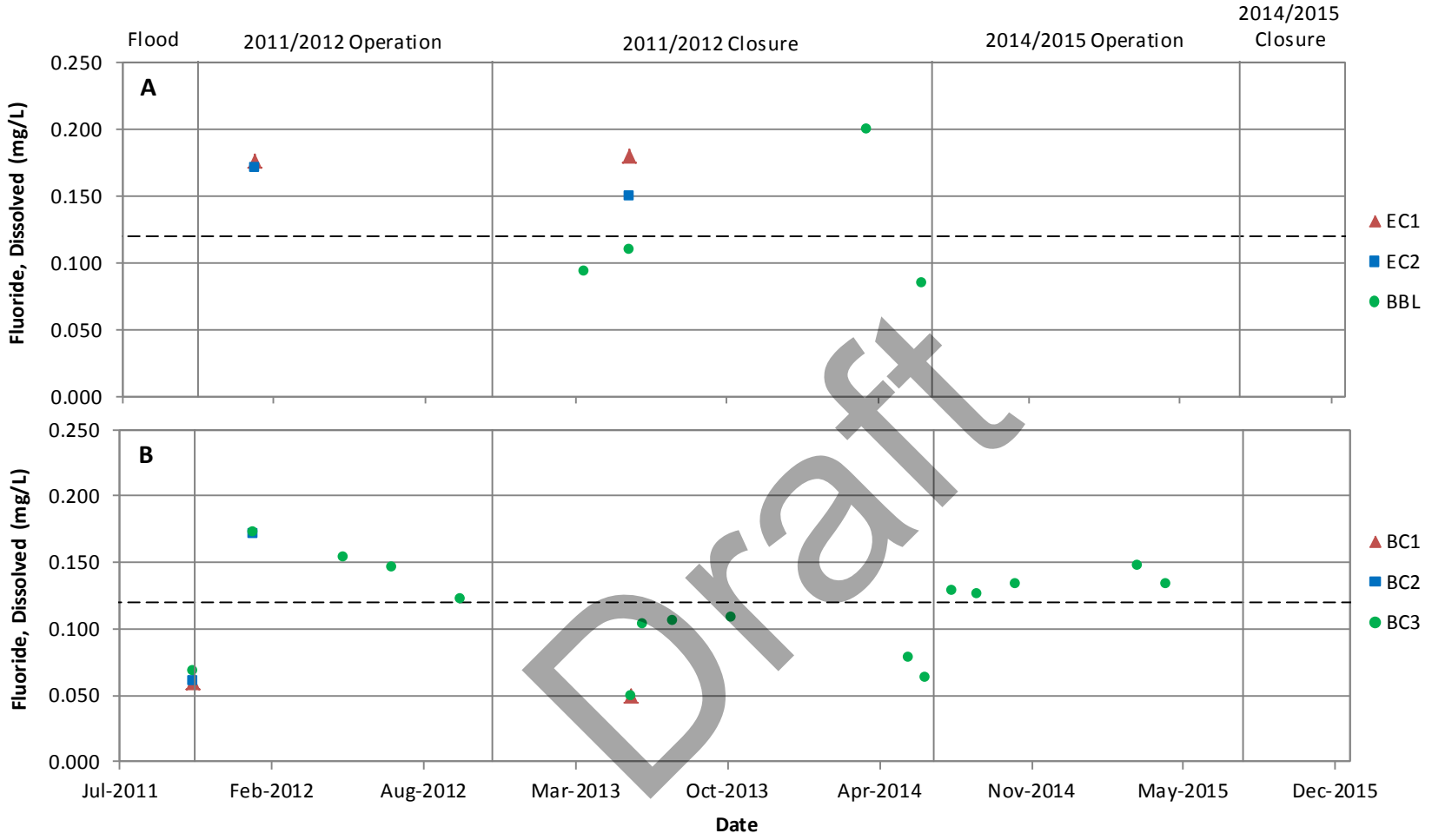
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Figure 44. Continued.



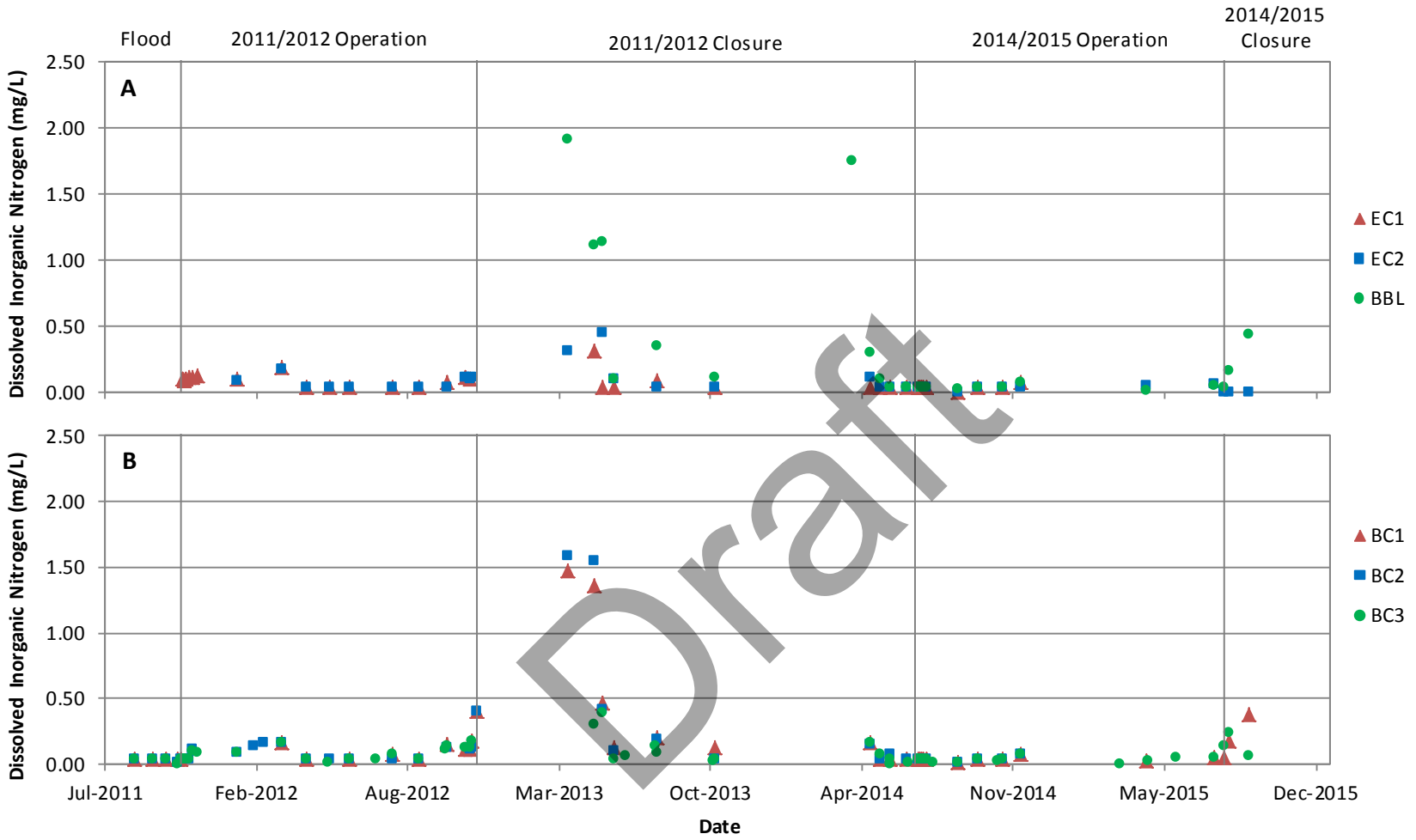
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Figure 45. Chloride concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents the CCME long-term exposure PAL and the dotted line represents the MWQSOGs/Health Canada aesthetic objective for drinking water.



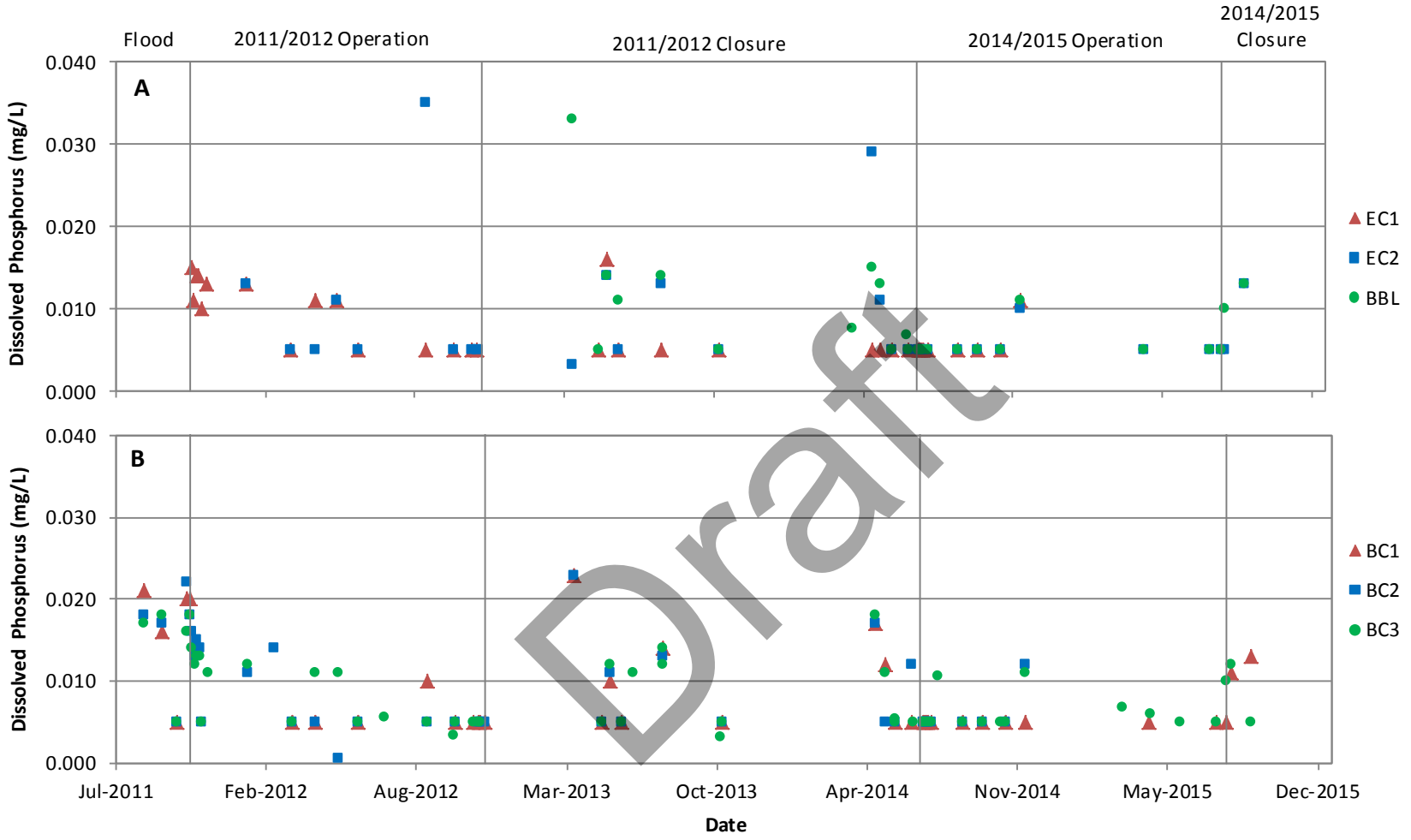
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Figure 46. Fluoride concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents the CCME interim PAL.



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Figure 47. Dissolved inorganic nitrogen concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.



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Figure 48. Dissolved phosphorus concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.

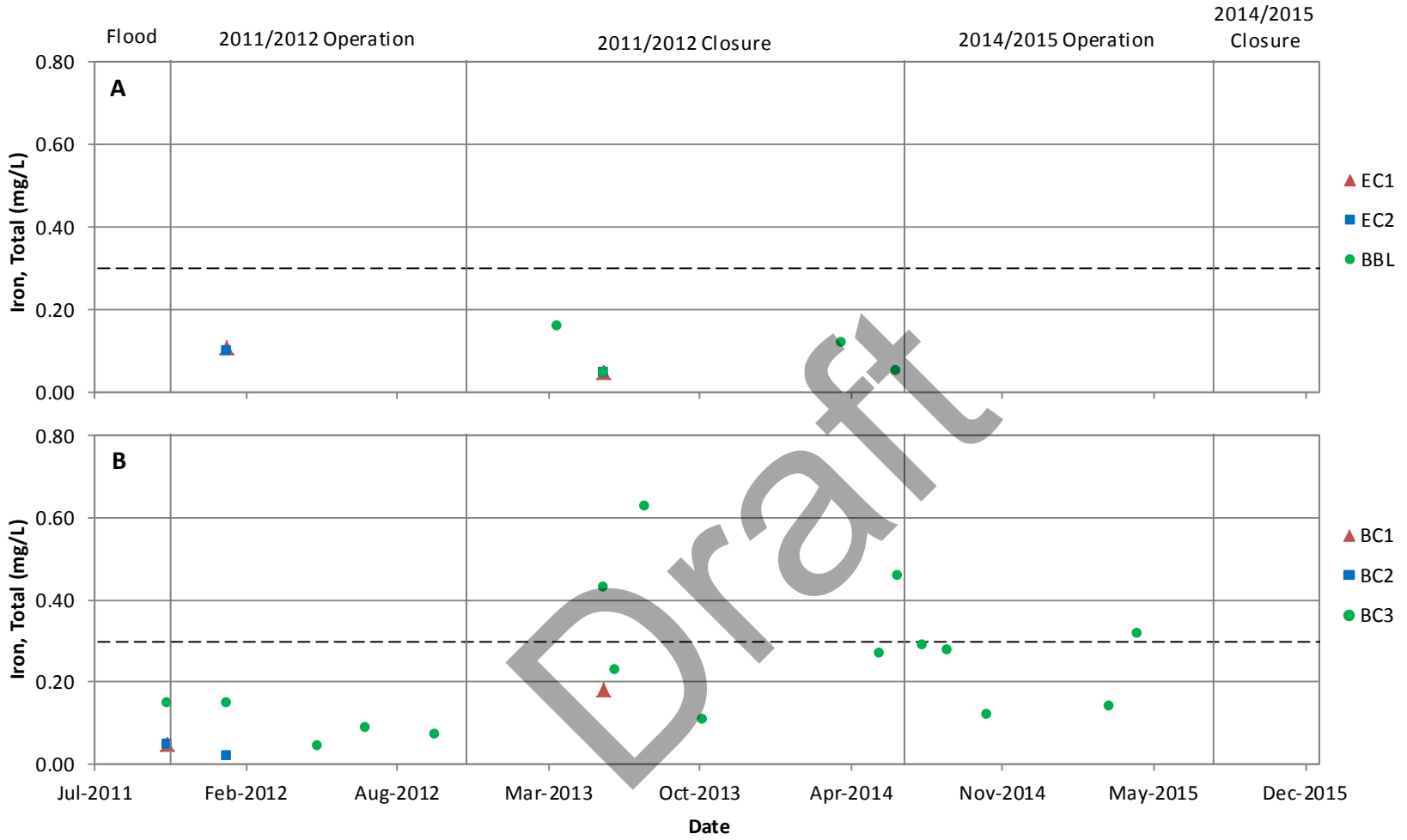
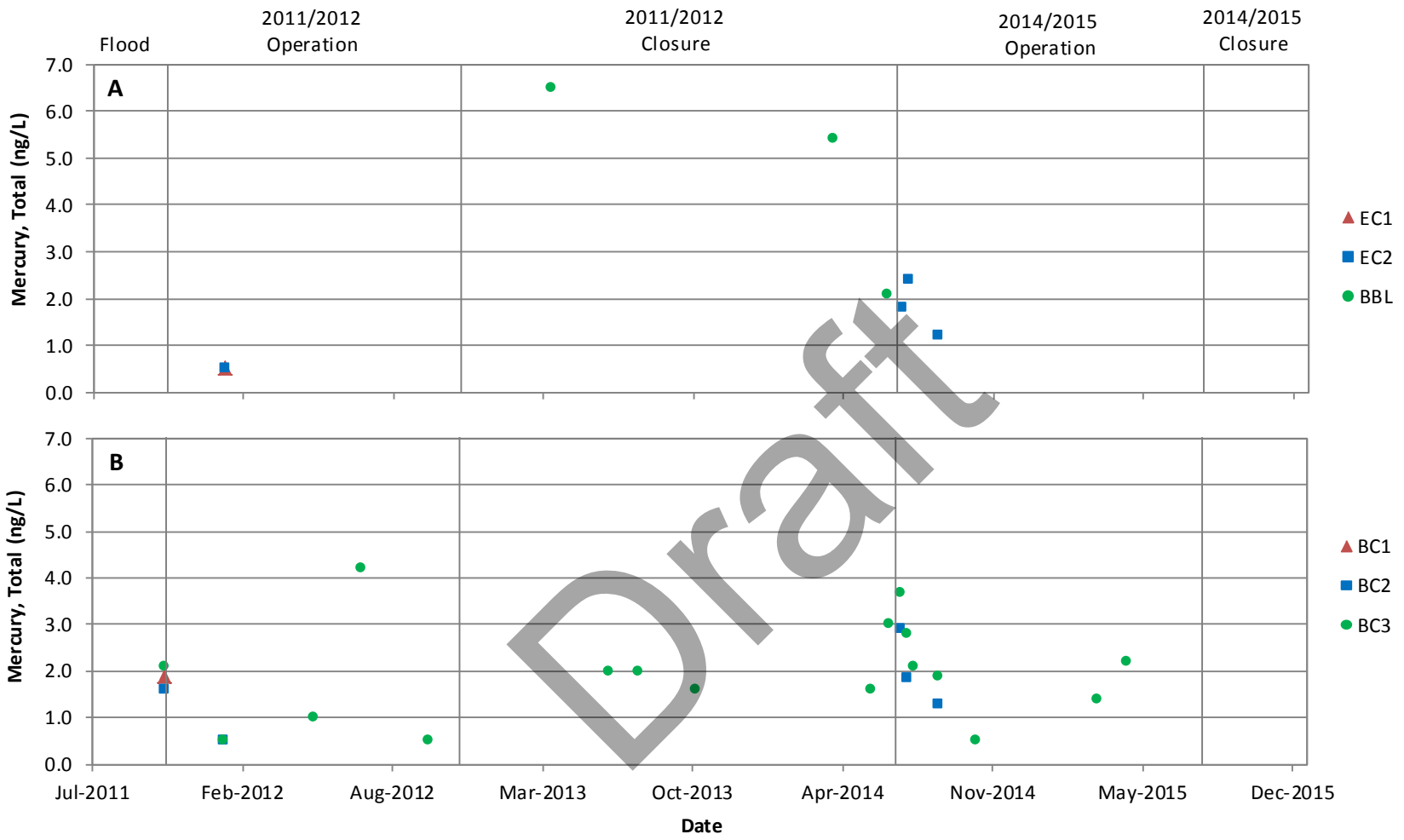
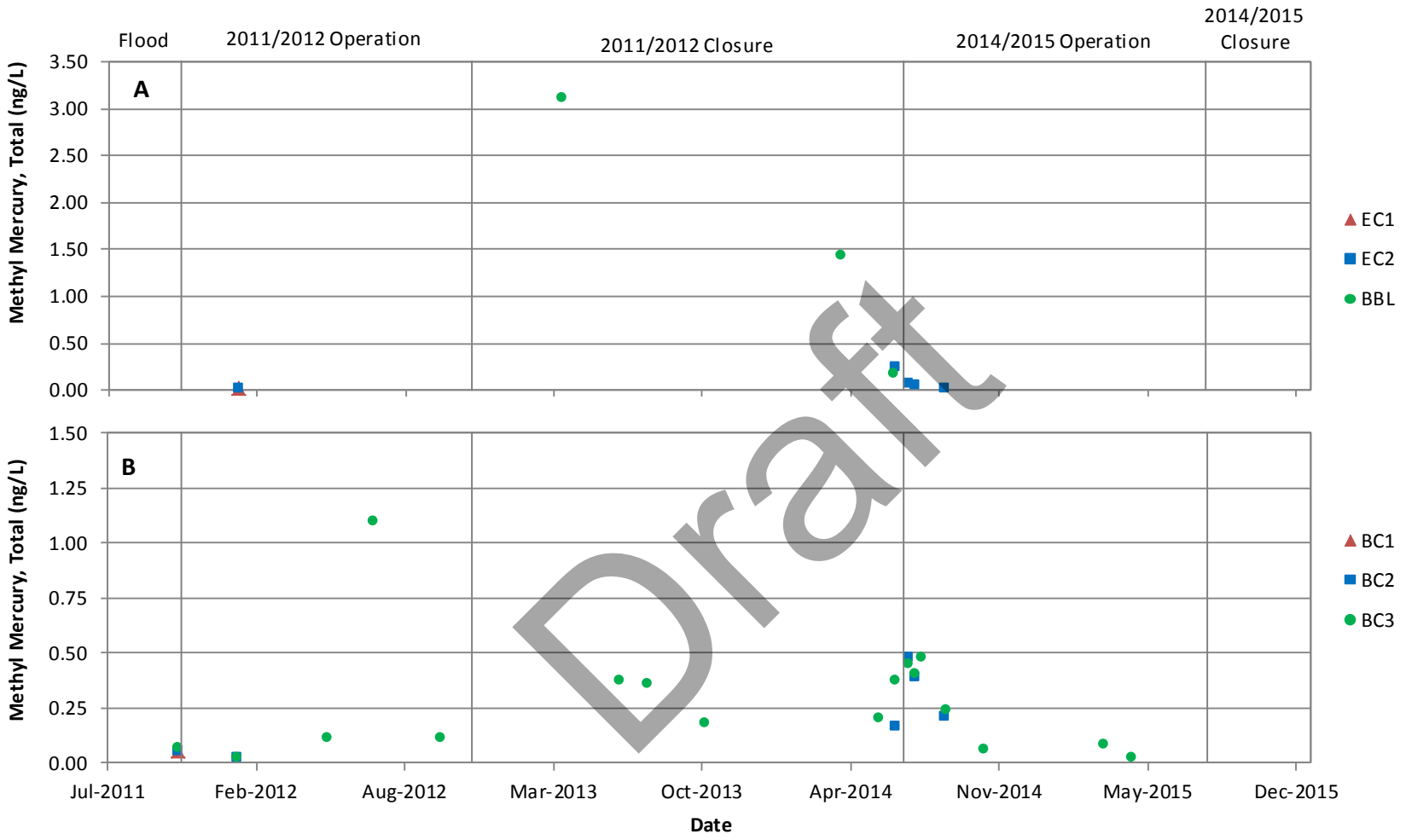


Figure 49. Iron concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Dashed line represents both the MWQSOGs/CCME PAL and the MWQSOGs/Health Canada aesthetic objective for drinking water.



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Figure 50. Mercury concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.



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Figure 51. Methyl mercury concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015. Note difference in scale between the two plots.

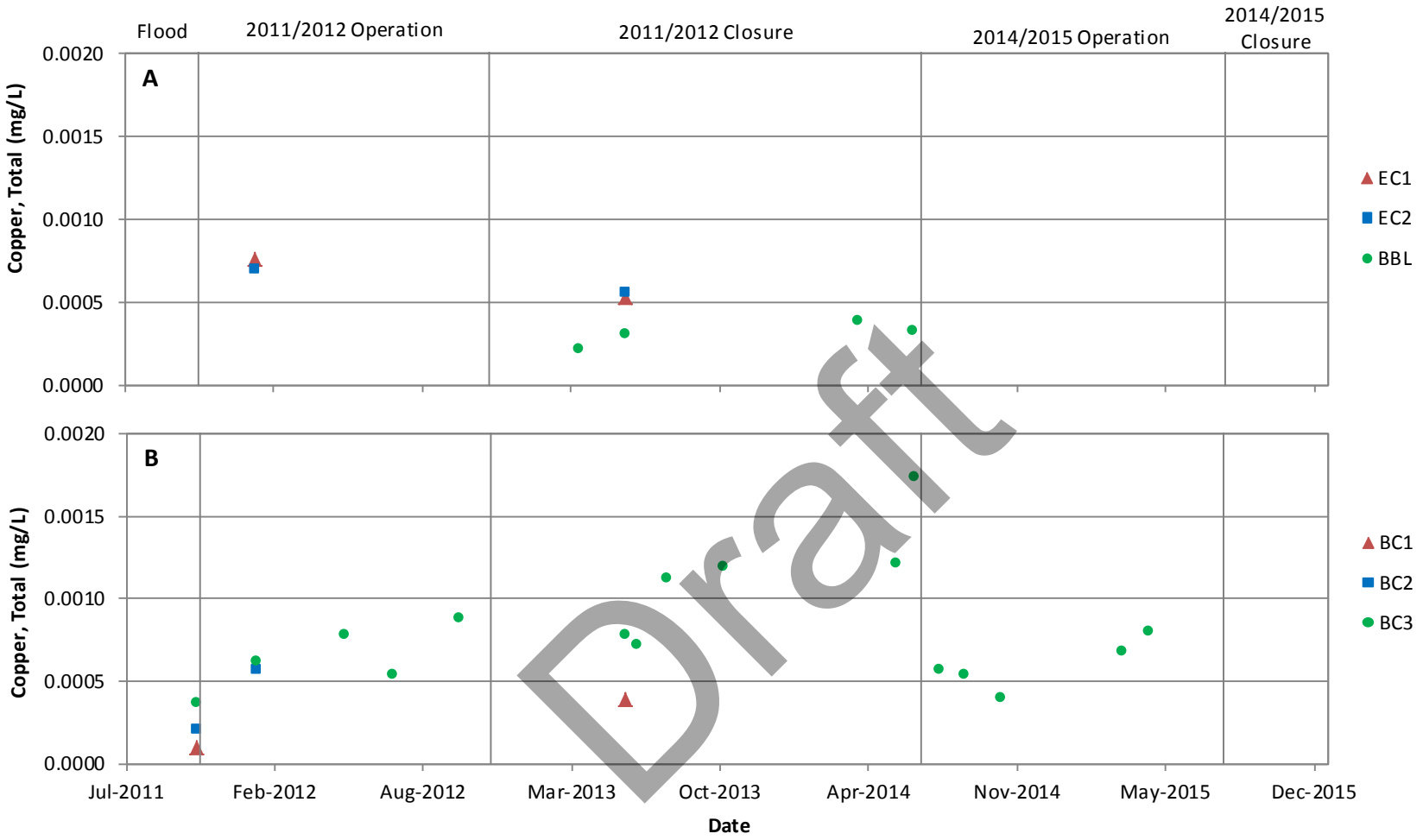


Figure 52. Copper concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015.

4.3 DAUPHIN RIVER MONITORING RESULTS

This section presents the assessment of change/lack of change to water quality of the Dauphin River from 2011 through 2015. Summary statistics for key water quality parameters for each time period are presented in Table 17. Figures 53to 63 show trends in water quality at the site upstream of the Big Bend (DR-B) from 2004-2014 and Figures 64 to 80 show trends in water quality from 2011 to 2015 throughout the Dauphin River.

4.3.1 Pre-Operation

Water quality data for the Dauphin River prior to the Project include Historic and 2011 Flood data collected by MCWS at a site upstream of the Big Bend (DR-B); as well as those collected at multiple sites along the river in fall 2011 during the 2011 Flood period. Based on these data, the water quality of the Dauphin River could be generally described as moderately nutrient rich, low to moderately turbid, slightly alkaline, very hard, and well-oxygenated (Table 17).

Historically, TSS concentrations ranged from < 5.0 to 16 mg/L (Figure 53) in the Dauphin River upstream of the Big Bend. Laboratory pH ranged from 7.48-8.66 (Figure 54) and true colour ranged from ≤ 5.0 to 17.0 CU (Table 17). Conductivity and TDS in the Dauphin River ranged from 1230-1760 µmhos/cm and 709-978 mg/L, respectively (Figures 55 and 56). Hardness ranged from 225 to 310 mg/L. The Dauphin River was well oxygenated; DO ranged from 7.4 to 11.9 mg/L (Figure 57). TN ranged from 0.95 to 2.51 mg/L and was mostly composed of organic forms, although, DIN tended to increase during the winter (Figures 58 and 59). TP concentrations in the Dauphin River averaged 0.022 mg/L, but ranged from 0.002 to 0.066 mg/L, and were typically composed of a mix of particulate and dissolved forms (Figures 60 and 61). Carbon concentrations were dominated by inorganic forms and organic carbon was primarily dissolved in form (Table 17). On the basis of TN:TP molar ratios, the Dauphin River was phosphorus limited (i.e., TN:TP ratio > 20; Kalff 2002). TOC:ON molar ratios indicate that the organic matter in the Dauphin River was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983). Chlorophyll *a* concentrations indicate that primary productivity was moderate; concentrations ranged from 1.15 to 9.00 µg/L (Figure 62).

During 2011 Flood, water quality of the Dauphin River was generally similar to what it was historically; however, conductivity, TDS, chloride and sodium were lower during 2011 Flood than they were during the Historic period, particularly in fall 2011 (Table 17 and Figures 55, 56, and 63). During 2011 Flood, conductivity and TDS ranged from 1090-1400 µmhos/cm and 656-826 mg/L, respectively. TN was also lower during 2011 Flood than it typically was during the Historic period, but TN had been lower in the Dauphin River since 2009 and did not change during 2011 Flood (Figures 58). During 2011 Flood, TN ranged from 1.02 to 1.56 mg/L. Water quality was generally similar throughout the Dauphin River in fall 2011 (Table 17).

DO was occasionally (2 of 9 measurements) below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) when water temperatures were ≤ 5°C in the Dauphin River during the Historic period (Table 18). DO was consistently within the

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MWQSOGs/CCME PALs at all other times sampled during the Historic period and during 2011 Flood. Ammonia rarely (1 of 21 samples) exceeded the CCME PAL guideline in the Dauphin River during the Historic period. Ammonia concentrations in the Dauphin River were consistently within MWQSOGs PAL during the Historic period and the MWQSOGs and CCME PALs during 2011 Flood. During the Historic period, TP rarely (1 of 22 samples) exceeded the MWQSOGs narrative guideline for streams (0.050 mg/L) in the Dauphin River upstream of the Big Bend (DR-B); TP was consistently below this guideline at all sites during 2011 Flood. TP occasionally (1 of 4 samples) exceeded the MWQSOGs narrative guideline for lakes and river mouths (0.025 mg/L) at the Dauphin River mouth (DR-E) during 2011 Flood. All other routine parameters were within MWQSOGs and CCME guidelines for PAL, including nitrate, nitrite, and pH.

TDS and turbidity consistently exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤500 mg/L and 1 NTU, respectively) in the Dauphin River during the Historic and 2011 Flood periods (Table 17 and Figure 56). True colour rarely (1 of 22 samples) exceeded the MWQSOGs/Health Canada aesthetic objectives for drinking water (≤ 15 CU) during the Historic period; true colour was consistently within this objective during 2011 Flood. Laboratory pH was occasionally (5 of 22 samples) above the MWQOSGs/Health Canada aesthetic objective (6.5-8.5) upper limit during the Historic period while pH was consistently within this objective during 2011 Flood (Figures 54). All other routine parameters were within drinking water guidelines, including nitrate/nitrite, nitrate, and nitrite.

Methyl mercury was the only metal or major ion that was not detected in the Dauphin River prior to the Project. Arsenic, barium, boron, calcium, chloride, fluoride, magnesium, manganese, molybdenum, potassium, sodium, and sulphate were consistently detected; and, aluminum, antimony, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, uranium and zinc were detected in some samples.

Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L) during the Historic and 2011 Flood periods (Figure 63). Additionally, chloride frequently exceeded the MWQSOGs/Health Canada aesthetic objective (≤ 250 mg/L) in the Dauphin River upstream of the Big Bend (DR-B). Fluoride consistently exceeded the CCME interim PAL (0.12 mg/L) in the Dauphin River during 2011 Flood (Figure 64); no historical data are available for fluoride. Selenium exceeded the MWQSOGs/CCME PAL (0.001 mg/L) in the Dauphin River downstream of Buffalo Creek during 2011 Flood; however, the selenium concentration was near the analytical detection limit and measurements that are at or near analytical detection limits are associated with relatively high uncertainty and there is low confidence that an actual exceedance of a PAL guideline has occurred. Sodium rarely exceeded the MWSOGs/Health Canada aesthetic objective (≤ 200 mg/L) in the Dauphin River during the Historic period and met this objective during 2011 Flood. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 19) and drinking water (Table 20).

Petroleum hydrocarbons were not detected in the Dauphin River during the 2011 Flood period.

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4.3.2 2011/2012 Operation

4.3.2.1 Routine

Conductivity, TDS, laboratory pH, true colour and hardness showed no change in the Dauphin River as a result of 2011/2012 Operation. Conductivity and TDS concentrations remained lower than they were historically and were similar to those during 2011 Flood; conductivity and TDS ranged from 1020-1210 µmhos/cm and 585-776 mg/L, respectively (Figures 65 and 66). Similarly, laboratory pH, true colour and hardness were within the historical values during 2011/2012 Operation, ranging from 8.26-8.46 pH units, 5.9-10.6 CU, and 251-350 mg/L, respectively (Table 17).

TDS continued to consistently exceed the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) in the Dauphin River both upstream and downstream of Buffalo Creek. Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0) and the MWQSOGs/Health Canada aesthetic objective for drinking water (6.5-8.5). Similarly, true colour was consistently within the MWQSOGs/Health Canada aesthetic objectives for drinking water (≤ 15 CU). There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

4.3.2.2 Dissolved Oxygen

In general, the Dauphin River was well oxygenated during 2011/2012 Operation; however, low DO conditions were present in winter 2012, both upstream (DR-B) and downstream (DR-D, DR-E) of Buffalo Creek (Figure 67). DO was frequently below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) upstream of the Big Bend and occasionally below this objective downstream of Buffalo Creek (DR-D and DR-E) in winter 2012 (Table 18). DO was also occasionally below the cold-water early-life objective in the Dauphin River during the Historic period.

4.3.2.3 TSS and Turbidity

At the onset of 2011/2012 Operation, TSS concentrations increased in the Dauphin River downstream of Buffalo Creek as far as Sturgeon Bay (DR-D and DR-E), such that there was a visible plume of sediment along the left-hand bank of the river as viewed facing upstream (i.e., the Buffalo Creek side). In 2011, starting on 04 November TSS ranged from 16 to 69 mg/L immediately downstream of the creek, and from 11 to 23 mg/L at the river mouth (Figure 68). Concurrently, TSS concentrations upstream of the creek ranged from < 5.0 to 12 mg/L. A direct comparison in TSS concentrations between the two sampling locations downstream of the creek would indicate that a significant amount of settling/mixing occurred in the river between Buffalo Creek and Sturgeon Bay; however, a direct comparison between these data may not be appropriate. The sampling location immediately downstream of the creek was located along the left-hand bank within the sediment plume; whereas, the sampling location near the river mouth was located on the right-hand bank (Figure 69). The sediment plume remained visible along the left-hand bank as far as the river mouth and, therefore, the actual TSS concentrations in the Dauphin River at Sturgeon Bay in November 2011 may be under represented by the data presented.

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TSS concentrations exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure guideline of 25 mg/L above background immediately downstream of Buffalo Creek (DR-D) from 04 to 07 November 2011. TSS concentrations consistently exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure guideline of 5 mg/L above background immediately downstream of Buffalo Creek (DR-D) from 04 to 25 November 2011, and in the river at Sturgeon Bay from 10 to 17 November 2011.

When sampling resumed in January 2012, TSS concentrations in the Dauphin River were similar upstream and downstream of Buffalo Creek and, with one exception, remained similar for remainder of 2011/2012 Operation (Figure 68). The exception occurred on 19 October 2012 when TSS immediately downstream of Buffalo Creek (DR-D) was more than 5 mg/L higher than was observed upstream of the creek (DR-C; i.e., TSS exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure guideline). It is unlikely that this elevated TSS concentration was related to the Project as TSS concentrations were not elevated in Buffalo Creek or Reach 1 at the time (Figure 33) and similar TSS concentrations had recently been observed upstream in the Dauphin River (Figure 68) and in the Fairford River (Figure 7).

Water quality was not monitored in the Dauphin River downstream of Buffalo Creek in November 2012 during closure activities; therefore, it is unknown if the increase in TSS that was observed in Buffalo Creek on 19 November (see Section 4.2.3) affected TSS concentrations in the river.

In 2012, trends in laboratory turbidity were similar to those for TSS (Figure 70). Laboratory turbidity was not measured during 2011/2012 Operation in 2011. Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Dauphin River during 2011/2012 Operation.

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4.3.2.4 Nutrients

Nitrogen concentrations in the Dauphin River did not change as a result of 2011/2012 Operation. TN and DIN were similar upstream and downstream of Buffalo Creek throughout the period (Figures 71 and 72); TN ranged from 0.34 mg/L to 1.55 mg/L. Similar to the Historic period, nitrogen was predominantly organic in form and DIN concentrations increased in winter.

At the onset of 2011/2012 Operation, phosphorus concentrations increased in the Dauphin River downstream of Buffalo Creek as far as the river mouth (DR-D and DR-E; Figure 73). Increases were observed for both dissolved and particulate forms of phosphorus. For the remainder of the 2011/2012 Operation, phosphorus concentrations downstream of Buffalo Creek were similar to those upstream of the creek and remained at or below those measured during 2011 Flood. During 2011/2012 Operation, TP ranged from 0.010 to 0.029 mg/L upstream of Buffalo Creek, and from 0.010 to 0.070 mg/L downstream of Buffalo Creek. Based on TN:TP molar ratios the Dauphin River was phosphorus limited throughout.

Like nitrogen, carbon concentrations in the Dauphin River were not affected by 2011/2012 Operation. Similar to pre-Project, carbon concentrations were dominated by inorganic forms; and, organic carbon

was primarily dissolved in form (Table 17). TOC:ON molar ratios indicate that the organic matter in the Dauphin River was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983).

At the onset of 2011/2012 Operation, TP exceeded the MWQSOGs narrative guideline for rivers (0.050 mg/L) in the Dauphin River immediately downstream of Buffalo Creek (DR-D) and TP exceeded the MWQSOGs narrative guideline for lakes and river mouths (0.025 mg/L) at the mouth of the Dauphin River (DR-E). Ammonia was consistently within the MWQSOGs and CCME PAL. Nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.3.2.5 Chlorophyll *a*

During 2011/2012 Operation, chlorophyll *a* concentrations were similar throughout the Dauphin River and were within range of those measured during the Historic and 2011 Flood periods (Figures 62 and 74). Chlorophyll *a* concentrations ranged from 1.91 to 8.55 µg/L.

4.3.2.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

Dissolved forms of antimony, lead, nickel, selenium and zinc, as well as total and dissolved forms of silver and thallium, were not detected in the Dauphin River during 2011/2012 Operation. Total aluminum, arsenic, barium, boron, calcium, total copper, magnesium, manganese, molybdenum, potassium, sodium, and uranium were consistently detected. Dissolved aluminum, total antimony, cadmium, chromium, dissolved copper, iron, total lead, mercury, methyl mercury, total nickel, total selenium, and total zinc were detected in some samples. In general, concentrations of metals and major ions were similar throughout the Dauphin River during 2011/2012 Operation (Table 17).

Aluminum occasionally exceeded the MWQSOGs/CCME PAL (0.1 mg/L) in the Dauphin River during 2011/2012 Operation; concentrations above the guideline were measured both upstream (DR-B and DR-C) and downstream (DR-E) of Buffalo Creek (Figure 75). Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L; Figure 76) and fluoride consistently exceeded the CCME interim PAL (0.12 mg/L; Figure 64) throughout the Dauphin River. Selenium occasionally exceeded the MWQSOGs/CCME PAL (0.001 mg/L) in the Dauphin River both upstream and downstream of Buffalo Creek. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 19) and drinking water (Table 20).

4.3.2.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in the Dauphin River at the onset of 2011/2012 Operation or during closure activities in November 2012 (Figure 30). Analytical detection limits for sampled hydrocarbon parameters were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

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4.3.3 2011/2012 Closure

4.3.3.1 Routine

During 2011/2012 Closure, conductivity and TDS changed seasonally in response to river discharge, such that they were higher in fall and winter when flows were lower, then decreased as flows increased in the spring (Figures 55 and 65). This pattern of change was observed both upstream and downstream of Buffalo Creek and similar trends have been observed historically. As would be expected, pH also showed a seasonal response such that it was higher during the open-water season than in winter (Figure 77). Laboratory-measured pH in the Dauphin River ranged from 7.90 to 8.59 during 2011/2012 Closure and was similar upstream and downstream of Buffalo Creek. True colour was generally similar throughout the river and was within the historical range during 2011/2012 Closure; true colour ranged from 5.0 CU to 17.3 CU (Table 17).

TDS typically exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) in the Dauphin River both upstream and downstream of Buffalo Creek. Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0), but was frequently above the upper limit of the MWQSOGs/Health Canada aesthetic objective for drinking water (6.5-8.5). True colour was consistently within the MWQSOGs/Health Canada aesthetic objectives for drinking water (≤ 15 CU). There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

4.3.3.2 Dissolved Oxygen

In general, the Dauphin River was well oxygenated during 2011/2012 Closure; however, low DO conditions were present in winter both upstream (DR-B) and downstream (DR-D, DR-E) of Buffalo Creek (Figure 67). When water temperatures were less than or equal to 5°C, DO was frequently below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) immediately upstream of Buffalo Creek (DR-C) and occasionally below the PALs upstream of the Big Bend (DR-B), and at the river mouth (DR-E; Table 18). This is similar to the Historic period when low DO concentrations were occasionally observed upstream of the Big Bend (DR-B). DO was consistently above the MWQSOGs/CCME PAL objectives when water temperatures were greater than 5°C.

4.3.3.3 TSS and Turbidity

In spring 2013, TSS concentrations in the Dauphin River downstream of Buffalo Creek were elevated along the left-hand bank of the river as viewed facing upstream (i.e., the Buffalo Creek side; Figure 69). At the right-hand bank of the river, TSS concentrations were similar to those measured upstream of Buffalo Creek. Following the freshet, TSS concentrations in the Dauphin River were comparable upstream and downstream of Buffalo Creek along both sides of the river. During 2011/2012 Closure, the average (across the river or at mid-channel) TSS concentration in the Dauphin River ranged from < 2 to 12 mg/L upstream of Buffalo Creek, and from 2 to 16 mg/L downstream of the Creek.

On 14 May 2013, TSS concentrations along the left-hand bank of the Dauphin River exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure guideline of 5 mg/L above background from Buffalo Creek to Sturgeon Bay (DR-D and DR-E; Figure 69); on this date the average TSS

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concentration across the river was below the PAL (Figure 68). In 2014, TSS concentrations exceeded the above guideline on 29 May at the right-hand bank near the river mouth (DR-E), and on 20 June at the left-hand bank immediately downstream of Buffalo Creek (DR-D); no other locations across the river channel were sampled on these dates.

During 2011/2012 Closure, trends in laboratory turbidity were similar to those for TSS (Figure 70). Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Dauphin River during 2011/2012 Closure.

4.3.3.4 Nutrients

During 2011/2012 Closure, TN and DIN were similar upstream and downstream of Buffalo Creek (Figures 71 and 72); TN ranged from 0.56 to 1.22 mg/L. Similar to the Historic period, nitrogen was predominantly organic in form and DIN concentrations increased in winter.

In spring 2013, phosphorus concentrations increased in the Dauphin River downstream of Buffalo Creek as far as the river mouth (DR-D and DR-E; Figure 73). Phosphorus was also higher downstream of the creek in spring of 2014, though to a lesser extent. Following the freshets, phosphorus concentrations in the Dauphin River downstream of Buffalo Creek were similar to those upstream of the creek. During 2011/2012 Closure, TP ranged from 0.008 to 0.025 mg/L upstream of Buffalo Creek, and from 0.008 to 0.036 mg/L downstream of Buffalo Creek. Based on TN:TP molar ratios, the Dauphin River was phosphorus limited throughout.

During 2011/2012 Closure, carbon concentrations showed similar patterns upstream and downstream of Buffalo Creek. Carbon concentrations were dominated by inorganic forms and organic carbon was primarily dissolved in form (Table 17). TOC:ON molar ratios indicate that the organic matter in the Dauphin River was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983).

Ammonia rarely (1 of 17 samples) exceeded the CCME PAL guideline just upstream of Buffalo Creek (DR-C) and was consistently within the MWQSOGs and CCME PAL at all other locations along the Dauphin River. TP was consistently within the MWQSOGs narrative guidelines in the Dauphin River during 2011/2012 Closure. Nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.3.3.5 Chlorophyll *a*

During 2011/2012 Closure, chlorophyll *a* concentrations were similar throughout the Dauphin River and were within range of those measured during the Historic and 2011 Flood periods (Figures 62 and 74). Chlorophyll *a* concentrations ranged from 0.47 to 7.12 µg/L.

4.3.3.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

During 2011/2012 Closure, the following metals and ions were not detected in the Dauphin River: dissolved forms of antimony, cadmium, and methyl mercury; total thallium; and, total and dissolved forms of chromium, nickel, selenium, and silver. Arsenic, barium, boron, calcium, total copper, magnesium, total manganese, molybdenum, potassium, sodium, and uranium were consistently

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detected. Total antimony, total cadmium, dissolved copper, iron, lead, dissolved manganese, mercury, total methyl mercury, and zinc were detected in some samples. In general, concentrations of metals and major ions were similar throughout the Dauphin during 2011/2012 Closure (Table 17).

Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L; Figure 76) and fluoride frequently exceeded the CCME interim PAL (0.12 mg/L; Figure 64) throughout the Dauphin River. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 19) and drinking water (Table 20).

4.3.3.7 Petroleum Hydrocarbons

During 2011/2012 Closure, petroleum hydrocarbons were only sampled prior to the onset of 2014/2015 Operation; they were not detected in the Dauphin River at this time (Figure 30). Analytical detection limits for sampled hydrocarbon parameters were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

4.3.4 2014/2015 Operation

4.3.4.1 Routine

Conductivity, TDS, laboratory pH, true colour and hardness showed no change in the Dauphin River downstream of Buffalo Creek as a result of 2014/2015 Operation. Conductivity and TDS concentrations remained lower than they were during the Historic period and were also lower than they were during 2011 Flood; conductivity and TDS ranged from 862-955 µmhos/cm and 504-559 mg/L, respectively (Figures 65 and 66). Laboratory pH, true colour and hardness were similar to the historical values during 2014/2015 Operation, ranging from 8.33-8.53 pH units, 6.8-23.1 CU, and 207-249 mg/L, respectively (Table 17).

TDS continued to exceed the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 500 mg/L) during most sampling events in the Dauphin River both upstream and downstream of Buffalo Creek. Laboratory pH was consistently within the MWQOSGs/CCME PAL (6.5-9.0). However, pH was occasionally above the upper limit of the MWQSOGs/Health Canada aesthetic objective for drinking water (6.5-8.5) both upstream and downstream of the creek. True colour exceeded the MWQSOGs/Health Canada aesthetic objective for drinking water (≤ 15 CU) in 1 of 7 samples collected upstream of the Big Bend (DR-B), but was below this objective at all other sites and times during 2014/2015 Operation. There are no MWQSOGs or CCME guidelines for PAL or drinking water for conductivity or hardness.

4.3.4.2 Dissolved Oxygen

The Dauphin River was generally well oxygenated and DO concentrations were similar upstream and downstream of Buffalo Creek during 2014/2015 Operation. However, when water temperatures were ≤ 5°C, DO was below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (9.5 mg/L) upstream of the Big Bend (DR-B; Table 18; Figure 67); DO was above the PALs at all other sites.

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In spring and summer 2015, when water temperatures were > 5°C, DO was below the MWQSOGs PAL for cold water mature life and CCME lowest acceptable concentration for other life stages of cold water biota (6.5 mg/L) on 11 June immediately downstream of the Buffalo Creek confluence (DR-D) and on 30 July upstream and downstream of the confluence (DR-C and DR-D). DO was also below the MWQSOGs PAL for cool water early life/CCME lowest acceptable concentration for early life stages of warm water biota (6.0 mg/L) downstream of the confluence (DR-D) on 30 July.

4.3.4.3 TSS and Turbidity

During 2014/2015 Operation, the average (i.e., across the river or at mid-channel) TSS concentration in the Dauphin River ranged from 5 to 18 mg/L upstream of Buffalo Creek and from 5 to 51 mg/L downstream of the creek (Figure 68; Table 17).

At the onset of 2014/2015 Operation, TSS concentrations in the Dauphin River increased downstream of Buffalo Creek (Figure 68). TSS in the lower Dauphin River returned to background after approximately two weeks; however, TSS increased again in March 2015. Similar to 2011/2012 Operation, there was a visible plume of sediment along the left-hand bank of the river as viewed facing upstream (i.e., the Buffalo Creek side). TSS concentrations along the left-hand bank were considerably higher than those along the right-hand bank, particularly at the site immediately downstream of the creek (DR-D; Figure 69). In the Dauphin River at Sturgeon Bay (DR-E), TSS concentrations at the left-hand bank remained higher than those at the right-hand bank; however, concentrations at mid-channel had also increased, indicating that some mixing had occurred.

TSS concentrations exceeded the MWQSOGs 1-day averaging objective/CCME short-term exposure objective of 25 mg/L above background, as follows:

- At the left-hand bank immediately downstream of Buffalo Creek (DR-D) from 06-11 July 2014 (this site was not sampled on 05 July);
- At the left-hand bank and at mid-channel in the Dauphin River at Sturgeon Bay (DR-E) on 05 and 06 July 2014;
- On average (i.e., across the river) immediately downstream of Buffalo Creek (DR-D) on 06 July 2014; and,
- On average (i.e., across the river) in the Dauphin River at Sturgeon Bay (DR-E) on 05 and 06 July 2014.

TSS concentrations exceeded the MWQSOGs 30-day averaging objective/CCME long-term exposure objective of 5 mg/L above background, as follows:

- At the left-hand bank immediately downstream of Buffalo Creek (DR-D) from 06-16 July 2014 (this site was not sampled on 05 July), May 1, 2015, and June 11, 2015);
- At mid-channel immediately downstream of Buffalo Creek (DR-D) on 08 and 16 July 2014;
- At the left-hand bank in the Dauphin River at Sturgeon Bay (DR-E) from 05-16 July 2014;
- At the mid-channel in the Dauphin River at Sturgeon Bay (DR-E) from 05-11 July 2014;
- At the right-hand bank in the Dauphin River at Sturgeon Bay (DR-E) on 05 July;

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- On average (i.e., across the river) immediately downstream of Buffalo Creek (DR-D) from 06-16 July 2014;
- On average (i.e., across the river) in the river at Sturgeon Bay (DR-E) from 05-16 July, and,
- At the left-hand bank in the Dauphin River at Sturgeon Bay (DR-E) on March 27, 2015.

TSS concentrations were consistently within the MWQSOGs/CCME PAL guidelines at the right-hand bank immediately downstream of Buffalo Creek (DR-D) during 2014/2015 Operation. The site immediately downstream of Buffalo Creek (DR-D) was not sampled on 05 July 2014.

By 24 July 2014, TSS concentrations in the Dauphin River downstream of Buffalo Creek were similar to those measured upstream and, with one exception, remained below the MWQSOGs/CCME PAL guidelines for the remainder of 2014 and 2015. The exception occurred on 22 September when the TSS concentration in the Dauphin River at Sturgeon Bay (DR-E) was 5.2 mg/L higher than was observed upstream of Buffalo Creek (DR-C) and therefore above the MWQSOGs 30-day averaging objective/CCME long-term exposure guideline of 5 mg/L above background.

During 2014/2015 Operation, trends in laboratory turbidity were similar to those for TSS (Figure 70). Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Dauphin River.

4.3.4.4 Nutrients

Similar to 2011/2012 Operation, at the onset of 2014/2015 Operation, phosphorus increased in the Dauphin River downstream of Buffalo Creek, but nitrogen and carbon concentrations showed no change.

Throughout 2014/2015 Operation, TN and DIN were similar upstream and downstream of Buffalo Creek (Figures 71 and 72); TN ranged from 0.70 to 1.01 mg/L (Table 17). Similar to the Historic period, nitrogen was predominantly organic in form.

At the onset of operation in 2014, phosphorus concentrations increased in the Dauphin River downstream of Buffalo Creek as far as the river mouth (DR-D and DR-E; Figure 73). Immediately downstream of the creek, the increase in phosphorus was due primarily to an increase in particulate forms of phosphorus, but dissolved forms accounted for most of the phosphorus at the river mouth (Figure 78). By 24 July 2014, phosphorus concentrations in the Dauphin River downstream of Buffalo Creek were similar to those upstream of the creek. During 2014/2015 Operation, TP ranged from 0.014 to 0.021 mg/L upstream of Buffalo Creek and from 0.016 to 0.044 mg/L downstream of Buffalo Creek. Based on TN:TP molar ratios, the Dauphin River was phosphorus limited throughout.

During 2014/2015 Operation, carbon concentrations were similar upstream and downstream of Buffalo Creek. Carbon concentrations were dominated by inorganic forms and organic carbon was primarily dissolved in form (Table 17). TOC:ON molar ratios indicate that the organic matter in the Dauphin River was composed of a mix of autochthonous and allochthonous sources (Wetzel 1983).

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At the onset of 2014/2015 Operation, TP exceeded the MWQSOGs narrative guideline for lakes and river mouths (0.025 mg/L) at the mouth of the Dauphin River (DR-E). Ammonia was consistently within the MWQSOGs and CCME PAL. Nitrate/nitrite, nitrite and nitrate were consistently within the MWQSOGs/CCME guidelines for PAL and drinking water. There are no MWQSOGs or CCME guidelines for carbon.

4.3.4.5 Chlorophyll *a*

During 2014/2015 Operation, chlorophyll *a* concentrations were similar throughout the Dauphin River and were within range of those measured during the Historic period (Figures 62 and 74). Chlorophyll *a* concentrations and ranged from 4.22 to 6.38 µg/L.

4.3.4.6 Metals and Major Ions with MWQSOGs and/or CCME Guidelines

- Chloride exceeded the CCME long-term PAL (120 mg/L) in the Dauphin Rivers, in March and where sampled in May, 2015.
- Fluoride consistently exceeded the CCME long-term PAL (0.12 mg/L) at all sites sampled in March and May, 2015.

During 2014/2015 Operation the following metals and ions were not detected in the Dauphin River: dissolved forms of antimony and lead; and, total and dissolved forms of chromium, nickel, selenium, silver, and thallium. Arsenic, barium, boron, calcium, total copper, magnesium, manganese, molybdenum, potassium, sodium, and uranium were consistently detected. Total antimony, cadmium, dissolved copper, iron, lead, mercury, methyl mercury, and zinc were detected in some samples.

During 2014/2015 Operation, concentrations of metals and major ions were generally similar throughout the Dauphin River (Table 17). However, at the onset of operation in 2014, mercury and methyl mercury concentrations increased downstream of Buffalo Creek (DR-D and DR-E; Figures 79 and 80). Mercury and methyl mercury also increased in Buffalo Creek at this time (Figure 50 and 4.2-19), indicating that the creek was likely the source of the increased mercury concentrations in the river. Both mercury and methyl mercury concentrations remained well below the MWQSOGs/CCME PAL (29 and 4 ng/L, respectively) in the Dauphin River and Buffalo Creek.

Chloride consistently exceeded the CCME long-term exposure guideline for PAL (120 mg/L; Figure 76) and fluoride consistently exceeded the CCME interim PAL (0.12 mg/L; Figure 64) throughout the Dauphin River. All other metals and major ions were within MWQSOGs and CCME guidelines for PAL (Table 19) and drinking water (Table 20).

4.3.4.7 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in the Dauphin River at the onset of 2014/2015 Operation in July 2014 or during the Expanded Opening in November 2014 (Figure 30). Analytical detection limits for sampled hydrocarbon parameters were well below the MWQSOGs/CCME guidelines for PAL and drinking water, as applicable (Table 12).

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4.3.5 2014/2015 Closure

Water quality data for the Dauphin River during 2014/2015 Closure are limited to measurements of DO, TSS, and nutrients at sites immediately upstream and downstream of the confluence with Buffalo Creek.

4.3.5.1 Dissolved Oxygen

Low DO conditions were present at the end of 2014/2015 Operation and persisted through August in the upstream (DR-B) and downstream (DR-D) reaches of the Dauphin River; however, the sites were well oxygenated by 14 September and concentrations were similar to those measured during the 2011 Flood (Figure 67; Table 17). DO was below the MWQSOGs long-term objective/CCME lowest acceptable concentration for cold-water early-life (6.5 mg/L) on 13 August downstream (DR-D) of the Buffalo Creek confluence and on 19 August upstream of confluence (DR-C; Table 18; Figure 67). DO was also below the MWQSOGs PAL for cool water early life, and CCME PAL for early life stages of warm water biota (6.0 mg/L) immediately following closure downstream of the confluence.

4.3.5.2 TSS and Turbidity

Compared to concentrations measured during 2014/2015 Operation, there was little effect of 2014/2015 Closure on TSS concentrations in the Dauphin River (Figure 68). Specifically, no spike in concentrations was observed as a result of Project activities and average (i.e., across the river or at mid-channel) TSS concentrations in the Dauphin River remained similar upstream and downstream of the confluence (with ranges of 9 to 11 mg/L and 8.1 to 10.4 mg/L, respectively; Figure 68; Table 17). Further, no difference in TSS was observed between the left- and right-hand banks of the river (Figure 69). Average and maximum TSS concentrations in the river were 2 to 4 mg/L higher than those measured during the pre-Project phase, however.

TSS concentrations remained within the MWQSOGs and CCME short- and long-term exposure guidelines (25 mg/L and 5 mg/L above background, respectively) throughout the 2014/2015 Closure.

During 2014/2015 Operation, trends in laboratory turbidity were similar to those for TSS (Figure 70). Turbidity was consistently above the MWQSOGs/Health Canada aesthetic objective for drinking water (1 NTU) in the Dauphin River.

4.3.5.3 Nutrients

At the onset of 2014/2015 Closure, there was little effect of the project on nutrient concentrations in the Dauphin River. Specifically, TN and TP concentrations were similar upstream and downstream of the confluence with Buffalo Creek and were similar, or slightly lower than, concentrations measured during the pre-Project period (Figures 71 and 73). During 2014/2015 Closure, TN ranged from 0.73 to 1.13 mg/L and TP ranged from 0.017 to 0.023 mg/L (Table 17). Similar to previous periods, nitrogen was predominantly organic in form and the river was phosphorus limited on the basis of TN:TP molar ratios.

There was a single exceedance of the MWQSOGs and CCME guidelines for PAL for ammonia (varies with pH and temperature) immediately upstream of the Buffalo Creek confluence (DR-C) immediately

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following closure on 13 August. All other routine variables were within MWQSOGs and CCME guidelines for PAL, including: pH (6.5-9.0); nitrate (2.93 mg/L); and, nitrite (0.06 mg/L).

4.3.6 Summary

Temporary changes in some water chemistry parameters in the lower Dauphin River were observed during Project operation and closure periods:

- No changes to routine water quality of the Dauphin River were observed that were attributable to the Project:
    - Conductivity, TDS, laboratory pH, true colour and hardness were similar in the Dauphin River upstream and downstream of Buffalo Creek during baseline, operation, and closure.
    - Although conductivity and TDS in the Dauphin River did not vary as a result of operation, conditions measured during each operation and closure period were lower than those recorded in October 2011.
- The Dauphin River was generally well-oxygenated and DO generally met the Manitoba objectives and CCME guidelines for the protection of cool and cold-water aquatic life, though it declined below the PALs at various points during the monitoring program:
    - A small decrease (<2 mg/L) in DO was observed downstream of Buffalo Creek during operation in 2015.
    - DO concentrations below the MWQSOGs objectives/CCME PAL guidelines were periodically observed both upstream and downstream of Buffalo Creek during both the open-water and ice cover seasons. Reductions below the guidelines were also observed historically in the river during the ice-cover period.

- TSS concentrations increased at various times during both operation and closure:
    - At the onset of operation in 2011 and 2014, TSS increased and a sediment plume was visible along the left shoreline. After approximately one month of operation in 2011 and two weeks of operation in 2014, TSS returned to background (i.e., similar to conditions observed concurrently upstream of Buffalo Creek).
    - During March of the 2014/2015 Operation, TSS was again elevated downstream of Buffalo Creek.
    - TSS increased along the Dauphin River left-hand bank downstream of Buffalo Creek in spring 2013 during closure.
    - At the onset of operation in both 2011 and 2014, TSS concentrations exceeded the MWQSOGs /CCME short-term PAL as far downstream as Sturgeon Bay.
    - TSS was also consistently above the MWQSOGs 30 day/CCME long-term PAL from 04-25 November 2011, 05-16 July 2014, 27 March 2015; and, along the left shoreline downstream of Buffalo Creek 01 May 2015 and 11 June 2015.

- Phosphorous concentrations increased at various points during monitoring but no other changes to nutrient or chlorophyll *a* concentrations can be attributed to Project-related activities:

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  - Phosphorus concentrations between the confluence and Sturgeon Bay increased at the onset of operation in 2011 and 2014, in the spring of 2013, and in March of 2015.
  - At the onset of each operation period, TP exceeded the MWQSOGs narrative guidelines.

- There were no observed changes to most metals or major ions, with the exception of mercury and methylmercury, that can be attributed to the Project:
  - Mercury and methylmercury increased downstream of Buffalo Creek at the onset of 2014/2015 Operation. Comparable data were not collected during the 2011/2012 Operation.
  - Both mercury compounds remained well below the MWQSOGs/CCME PAL guidelines (26 and 4 ng/L, respectively) during 2014/2015 Operation.

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Table 17. Summary statistics for key water quality parameters measured in the Dauphin River, 2004-2015.

		Ammonia (mg N/L)							Nitrate/Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.060	0.060	0.060	0.060	-	1	100	0.027	0.027	0.027	0.027	-	1	100
	2011/2012 Operation	0.018	0.021	0.012	0.022	0.0032	3	100	<0.0051	<0.0051	<0.0051	<0.0051	-	3	0
	2011/2012 Closure	0.071	0.012	<0.010	0.239	0.0395	7	57	0.014	<0.0051	<0.0051	0.053	0.0078	7	29
	2014/2015 Operation	0.059	0.029	<0.010	0.143	0.0426	3	67	0.0293	<0.0051	<0.0051	0.0828	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	0.131	0.050	<0.010	0.590	0.0327	21	95	0.014	<0.010	<0.0060	0.060	0.0037	22	32
	2011 Flood	0.128	0.128	0.069	0.187	0.0590	2	100	<0.05	<0.05	<0.05	<0.05	-	2	50
	2011/2012 Operation	0.076	0.039	<0.010	0.182	0.0204	12	92	<0.05	<0.05	<0.0051	<0.05	-	10	10
	2011/2012 Closure	0.109	0.084	<0.010	0.246	0.0240	17	82	<0.05	<0.05	<0.0051	0.071	0.0073	14	50
	2014/2015 Operation	0.028	<0.010	<0.010	0.175	0.0187	9	33	0.0212	<0.0051	<0.0051	0.0768	-	4	25
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	<0.050	0.057	<0.050	0.069	0.0100	5	60	<0.071	<0.071	<0.071	<0.071	0.0044	5	40
	2011/2012 Operation	0.076	0.076	<0.010	0.216	0.0111	22	95	<0.071	<0.071	<0.0051	<0.071	-	22	5
	2011/2012 Closure	0.111	<0.010	<0.010	0.830	0.0503	17	47	<0.071	<0.071	<0.0051	<0.071	0.0041	17	18
	2014/2015 Operation	0.021	<0.010	<0.010	0.184	0.0119	15	47	<0.071	<0.071	<0.071	0.078	-	15	1
	2014/2015 Closure	0.200	<0.010	<0.010	0.590	0.1950	3	33	<0.070	<0.070	<0.070	<0.070	-	3	0
DR-D	2011 Flood	<0.050	<0.050	<0.050	0.068	0.0111	4	50	<0.071	<0.071	<0.071	<0.071	-	4	25
	2011/2012 Operation	<0.050	<0.050	<0.010	0.164	0.0093	16	63	<0.071	<0.071	<0.071	0.075	-	16	6
	2011/2012 Closure	0.065	<0.010	<0.010	0.240	0.0297	9	44	<0.071	<0.071	<0.071	<0.071	-	9	0
	2014/2015 Operation	0.010	<0.010	<0.010	0.040	0.0033	11	27	<0.071	<0.071	<0.071	<0.071	-	11	9
	2014/2015 Closure	0.017	0.018	<0.010	0.028	0.0037	5	80	<0.070	<0.070	<0.070	<0.070	-	5	0
DR-E	2011 Flood	<0.050	<0.050	<0.050	0.067	0.0107	4	50	<0.071	<0.071	<0.071	<0.071	-	4	25
	2011/2012 Operation	0.052	<0.050	<0.050	0.180	0.0133	15	80	<0.071	<0.071	<0.0051	<0.071	-	15	7
	2011/2012 Closure	0.067	0.015	<0.010	0.255	0.0231	15	53	<0.071	<0.071	<0.0051	<0.071	0.0044	15	13
	2014/2015 Operation	0.018	<0.010	<0.010	0.119	0.0094	12	33	<0.071	<0.071	<0.0051	<0.071	-	12	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Nitrate (mg N/L)							Nitrite (mg N/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.025	0.025	0.025	0.025	-	1	100	0.002	0.002	0.002	0.002	-	1	100
	2011/2012 Operation	<0.0050	<0.0050	<0.0050	<0.0050	-	3	0	0.001	<0.0010	<0.0010	0.002	-	3	33
	2011/2012 Closure	0.014	<0.0050	<0.0050	0.051	0.0076	7	29	0.001	<0.0010	<0.0010	0.002	0.0002	7	29
	2014/2015 Operation	0.0285	<0.0050	<0.0050	0.0805	-	3	33	0.0011	<0.0010	<0.0010	0.0023	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011 Flood	0.013	0.013	0.013	0.013	-	1	100	0.002	0.002	0.002	0.002	-	1	100
	2011/2012 Operation	<0.050	<0.050	<0.0050	<0.050	-	5	20	<0.050	<0.050	<0.0010	<0.050	-	5	40
	2011/2012 Closure	<0.0050	<0.0050	<0.0050	0.048	0.0077	7	29	<0.0010	<0.0010	<0.0010	0.003	0.0003	7	29
	2014/2015 Operation	<0.0050	<0.0050	<0.0050	<0.0050	-	4	0	<0.0010	<0.0010	<0.0010	<0.0010	-	4	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	5	40	<0.050	<0.050	<0.050	<0.050	0.0055	5	40
	2011/2012 Operation	<0.050	<0.050	<0.0050	<0.050	-	22	5	<0.050	<0.050	<0.0010	<0.050	-	22	5
	2011/2012 Closure	<0.050	<0.050	<0.0050	0.057	0.0041	17	24	<0.050	<0.050	<0.0010	<0.050	0.0030	17	18
	2014/2015 Operation	<0.050	<0.050	<0.0050	0.0763	-	15	1	<0.050	<0.050	<0.0010	<0.050	-	15	0
	2014/2015 Closure	<0.020	<0.020	<0.020	<0.020	-	3	0	<0.010	<0.010	<0.010	<0.010	-	3	0
DR-D	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	4	25	<0.050	<0.050	<0.050	<0.050	-	4	25
	2011/2012 Operation	<0.050	<0.050	<0.050	<0.050	-	16	6	<0.050	<0.050	<0.050	<0.050	-	16	0
	2011/2012 Closure	<0.050	<0.050	<0.050	0.056	0.0045	9	22	<0.050	<0.050	<0.050	<0.050	-	9	0
	2014/2015 Operation	<0.050	<0.050	<0.0050	<0.050	0.0022	11	18	<0.050	<0.050	<0.0010	<0.050	-	11	0
	2014/2015 Closure	<0.020	<0.020	<0.020	<0.020	-	5	0	<0.010	<0.010	<0.010	<0.010	-	5	0
DR-E	2011 Flood	<0.050	<0.050	<0.050	<0.050	-	4	25	<0.050	<0.050	<0.050	<0.050	-	4	25
	2011/2012 Operation	<0.050	<0.050	<0.0050	0.062	0.0034	15	13	<0.050	<0.050	<0.0010	<0.050	0.0026	15	0
	2011/2012 Closure	<0.050	<0.050	<0.0050	0.059	0.0051	15	27	<0.050	<0.050	<0.0010	<0.050	-	15	0
	2014/2015 Operation	<0.050	<0.050	<0.0050	<0.050	-	12	0	<0.050	<0.050	<0.0010	<0.050	-	12	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Dissolved Inorganic Nitrogen (mg/L)							Total Kjeldahl Nitrogen (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.087	0.087	0.087	0.087	-	1	100	1.06	1.06	1.06	1.06	-	1	100
	2011/2012 Operation	0.021	0.024	0.015	0.025	0.003	3	100	1.00	0.98	0.96	1.05	0.027	3	100
	2011/2012 Closure	0.085	0.015	<0.010	0.274	0.047	7	57	0.85	0.82	0.66	1.09	0.066	7	100
	2014/2015 Operation	0.018	0.018	<0.010	0.032	-	2	50	0.98	0.97	0.96	1.01	0.015	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	0.145	0.055	<0.010	0.595	0.035	21	95	1.51	1.50	0.91	2.50	0.099	22	100
	2011 Flood	0.148	0.148	0.084	0.212	0.064	2	100	1.08	1.08	1.05	1.10	0.025	2	100
	2011/2012 Operation	0.106	0.101	<0.050	0.215	0.026	10	90	1.05	1.05	0.95	1.18	0.026	12	100
	2011/2012 Closure	0.138	0.147	<0.010	0.302	0.029	16	75	0.94	0.98	0.56	1.13	0.035	17	100
	2014/2015 Operation	0.013	0.010	<0.010	0.037	0.004	8	75	0.90	0.91	0.75	1.05	0.031	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	<0.070	0.086	<0.070	0.093	0.013	5	60	1.19	1.09	0.98	1.52	0.094	5	100
	2011/2012 Operation	0.106	0.112	<0.070	0.252	0.013	22	91	1.00	1.01	0.33	1.51	0.042	22	100
	2011/2012 Closure	0.136	<0.070	<0.010	0.866	0.052	17	41	0.90	0.89	0.63	1.16	0.037	17	100
	2014/2015 Operation	<0.070	<0.070	<0.010	0.076	0.0052	14	21	0.89	0.94	0.71	1.01	0.024	15	100
	2014/2015 Closure	0.212	<0.070	<0.070	0.625	-	3	33	0.98	1.02	0.78	1.13	0.103	3	100
DR-D	2011 Flood	<0.070	<0.070	<0.070	0.093	0.016	4	50	1.14	1.14	1.08	1.22	0.032	4	100
	2011/2012 Operation	<0.070	<0.070	<0.070	0.200	0.012	16	38	0.93	0.98	0.32	1.12	0.049	16	100
	2011/2012 Closure	0.097	<0.070	<0.070	0.275	0.030	9	44	0.91	0.87	0.67	1.14	0.063	9	100
	2014/2015 Operation	<0.071	<0.071	<0.010	0.076	0.0051	11	27	0.82	0.80	0.66	0.97	0.030	11	100
	2014/2015 Closure	<0.070	<0.070	<0.070	<0.070	-	5	0	0.97	1.00	0.73	1.07	0.063	5	100
DR-E	2011 Flood	<0.070	<0.070	<0.070	0.091	0.015	4	50	1.08	1.10	0.99	1.14	0.032	4	100
	2011/2012 Operation	0.070	<0.070	<0.070	0.216	0.016	15	53	0.91	0.99	0.30	1.07	0.049	15	100
	2011/2012 Closure	0.090	<0.070	<0.010	0.281	0.026	15	47	0.90	0.92	0.58	1.18	0.045	15	100
	2014/2015 Operation	<0.070	<0.070	<0.010	<0.070	0.0043	11	18	0.88	0.91	0.72	1.01	0.027	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Total Nitrogen (mg/L)							Dissolved Phosphorus (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	1.09	1.09	1.09	1.09	-	1	100	0.003	0.003	0.003	0.003	-	1	100
	2011/2012 Operation	1.00	0.98	0.96	1.05	0.027	3	100	0.006	0.004	0.003	0.011	0.0025	3	100
	2011/2012 Closure	0.87	0.82	0.66	1.13	0.073	7	100	0.007	0.007	0.003	0.010	0.0008	7	100
	2014/2015 Operation	1.01	0.97	0.96	1.09	0.042	3	100	0.007	0.006	0.005	0.008	0.0010	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	1.53	1.51	0.95	2.51	0.098	22	100	0.007	0.007	<0.0010	0.016	0.0008	22	95
	2011 Flood	1.10	1.10	1.08	1.12	0.020	2	100	0.008	0.008	<0.0020	0.014	-	2	50
	2011/2012 Operation	1.06	1.01	0.96	1.22	0.030	10	100	<0.010	<0.010	<0.010	0.015	0.0012	12	92
	2011/2012 Closure	0.97	1.02	0.56	1.16	0.045	14	100	0.005	0.004	0.002	0.015	0.0008	17	100
	2014/2015 Operation	1.01	0.97	0.96	1.13	0.039	4	100	0.006	0.006	0.005	0.007	0.0002	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	1.22	1.11	1.02	1.56	0.096	5	100	<0.010	<0.010	<0.010	0.013	0.0018	5	40
	2011/2012 Operation	1.03	1.04	0.37	1.55	0.042	22	100	<0.010	<0.010	<0.010	0.015	0.0009	20	55
	2011/2012 Closure	0.92	0.93	0.63	1.21	0.039	17	100	<0.010	<0.010	<0.010	0.016	0.0009	17	71
	2014/2015 Operation	0.91	0.94	0.75	1.06	0.024	15	100	<0.010	<0.010	<0.010	0.012	0.0006	15	60
	2014/2015 Closure	0.98	1.02	0.78	1.13	0.103	3	100	<0.010	<0.010	<0.010	<0.010	-	3	0
DR-D	2011 Flood	1.17	1.17	1.10	1.26	0.035	4	100	<0.010	<0.010	<0.010	0.014	0.0025	4	50
	2011/2012 Operation	0.96	1.01	0.36	1.16	0.049	16	100	0.011	0.011	<0.010	0.031	0.0019	15	73
	2011/2012 Closure	0.94	0.91	0.71	1.18	0.063	9	100	<0.010	<0.010	<0.010	0.015	0.0013	9	44
	2014/2015 Operation	0.85	0.84	0.70	1.01	0.030	11	100	<0.010	<0.010	<0.010	0.011	0.0008	11	45
	2014/2015 Closure	0.97	1.00	0.73	1.07	0.063	5	100	<0.010	<0.010	<0.010	<0.010	-	5	0
DR-E	2011 Flood	1.11	1.12	1.03	1.18	0.031	4	100	0.011	0.012	<0.0020	0.018	0.0036	4	75
	2011/2012 Operation	0.94	1.00	0.34	1.11	0.049	15	100	<0.010	<0.010	<0.010	0.017	0.0013	14	71
	2011/2012 Closure	0.93	0.93	0.58	1.22	0.046	15	100	<0.010	<0.010	<0.010	0.016	0.0009	15	60
	2014/2015 Operation	0.91	0.93	0.72	1.08	0.029	12	100	<0.010	<0.010	<0.010	0.031	0.0022	12	67
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Total Particulate Phosphorus (mg/L)							Total Phosphorus (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.010	0.010	0.010	0.010	-	1	100	0.013	0.013	0.013	0.013	-	1	100
	2011/2012 Operation	0.015	0.015	<0.010	0.025	0.0058	3	67	0.021	0.019	0.015	0.028	0.0038	3	100
	2011/2012 Closure	0.008	0.006	0.004	0.017	0.0019	7	100	0.015	0.014	0.010	0.020	0.0016	7	100
	2014/2015 Operation	0.009	0.008	0.006	0.013	0.0020	3	100	0.015	0.014	0.011	0.021	0.0029	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	0.014	0.010	<0.0010	0.054	0.0024	22	95	0.021	0.018	0.002	0.066	0.0026	22	100
	2011 Flood	<0.010	<0.010	<0.010	0.013	-	2	50	0.017	0.017	0.014	0.020	0.0030	2	100
	2011/2012 Operation	<0.010	<0.010	<0.010	0.019	0.0015	12	58	0.018	0.017	0.011	0.023	0.0011	12	100
	2011/2012 Closure	<0.010	<0.010	<0.010	0.016	0.0009	17	82	0.015	0.015	0.008	0.025	0.0010	17	100
	2014/2015 Operation	0.012	0.012	0.007	0.014	0.0008	9	100	0.018	0.019	0.012	0.021	0.0009	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.012	0.012	0.010	0.017	0.0012	5	100	0.020	0.022	0.017	0.023	0.0014	5	100
	2011/2012 Operation	<0.010	<0.010	<0.010	0.024	0.0013	20	50	0.018	0.019	0.010	0.029	0.0011	22	100
	2011/2012 Closure	0.010	<0.010	<0.010	0.019	0.0011	17	82	0.017	0.017	0.011	0.022	0.0009	17	100
	2014/2015 Operation	0.011	0.012	<0.010	0.016	0.0010	15	75	0.017	0.017	0.012	0.021	0.0007	15	100
	2014/2015 Closure	0.015	0.016	0.012	0.016	0.0013	3	100	0.020	0.021	0.017	0.021	0.0013	3	100
DR-D	2011 Flood	0.012	0.012	0.010	0.015	0.0010	4	100	0.022	0.022	0.017	0.025	0.0018	4	100
	2011/2012 Operation	0.015	0.013	<0.010	0.051	0.0030	15	73	0.025	0.019	0.010	0.070	0.0039	16	100
	2011/2012 Closure	0.012	0.011	<0.010	0.031	0.0026	9	67	0.020	0.017	0.015	0.036	0.0022	9	100
	2014/2015 Operation	0.015	0.014	<0.010	0.039	0.0027	11	91	0.022	0.020	0.016	0.044	0.0024	11	100
	2014/2015 Closure	0.015	0.016	0.012	0.018	0.0010	5	100	0.020	0.021	0.017	0.023	0.0010	5	100
DR-E	2011 Flood	0.012	0.014	<0.010	0.017	0.0026	4	75	0.023	0.025	0.018	0.026	0.0018	4	100
	2011/2012 Operation	0.010	0.011	<0.010	0.015	0.0011	14	86	0.019	0.018	0.012	0.031	0.0013	15	100
	2011/2012 Closure	0.012	0.012	<0.010	0.021	0.0015	15	87	0.018	0.020	0.008	0.025	0.0012	15	100
	2014/2015 Operation	0.013	0.014	<0.010	0.015	0.0009	12	92	0.021	0.020	0.016	0.031	0.0012	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Dissolved Fraction, Phosphorus (%)							TN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	23	23	23	23	-	1	100	185	185	185	185	-	1	100
	2011/2012 Operation	35	20	11	73	19.5	3	100	114	123	78	142	19.1	3	100
	2011/2012 Closure	48	56	17	62	6.8	7	100	144	109	76	261	27.5	7	100
	2014/2015 Operation	43	40	40	50	3.5	3	100	158	160	101	214	32.5	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	41	46	5	100	4.9	22	100	229	181	57	1174	48.1	22	100
	2011 Flood	39	39	7	70	31.4	2	100	148	148	119	176	28.7	2	100
	2011/2012 Operation	52	53	16	94	7.6	12	100	146	140	104	205	11.1	10	100
	2011/2012 Closure	36	32	15	88	4.6	17	100	142	134	0	316	22.7	16	100
	2014/2015 Operation	34	33	28	45	1.7	9	100	62	0	0	206	26.4	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	38	29	23	57	6.8	5	100	134	144	98	157	10.3	5	100
	2011/2012 Operation	47	42	17	120	5.5	20	100	134	123	43	236	9.7	22	100
	2011/2012 Closure	40	32	11	84	5.2	17	100	133	108	80	243	12.6	17	100
	2014/2015 Operation	37	32	25	75	3.5	15	100	119	110	86	192	6.9	15	100
	2014/2015 Closure	35	31	31	42	3.5	3	100	112	107	82	147	18.9	3	100
DR-D	2011 Flood	41	41	25	58	8.2	4	100	123	118	111	143	7.5	4	100
	2011/2012 Operation	47	38	21	100	6.4	15	100	103	103	36	192	11.4	16	100
	2011/2012 Closure	43	33	14	71	6.8	9	100	109	108	72	163	9.9	9	100
	2014/2015 Operation	36	31	11	65	4.8	11	100	91	93	42	123	7.4	11	100
	2014/2015 Closure	33	31	28	42	2.3	5	100	107	113	70	129	10.0	5	100
DR-E	2011 Flood	44	47	6	75	14.4	4	100	108	99	95	139	10.3	4	100
	2011/2012 Operation	47	44	19	83	5.6	14	100	113	110	41	195	9.2	15	100
	2011/2012 Closure	34	29	7	75	5.0	15	100	124	105	76	337	16.9	15	100
	2014/2015 Operation	38	28	25	100	6.2	12	100	100	101	60	135	5.1	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		DIN:DP Molar Ratio							DIN:TP Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	64	64	64	64	-	1	100	15	15	15	15	-	1	100
	2011/2012 Operation	10	11	5	14	2.6	3	100	3	3	1	4	0.7	3	100
	2011/2012 Closure	31	6	1	107	17.6	7	100	18	2	1	60	10.3	7	100
	2014/2015 Operation	26	13	1	63	19.1	3	100	13	5	1	32	9.8	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	68	26	3	388	20.2	21	100	35	7	0	388	18.2	21	100
	2011 Flood	110	110	34	186	76.5	2	100	18	18	13	23	5.1	2	100
	2011/2012 Operation	28	18	4	92	8.2	10	100	16	13	2	42	4.5	10	100
	2011/2012 Closure	79	45	1	291	22.5	16	100	26	20	0	77	6.6	16	100
	2014/2015 Operation	11	4	2	61	6.4	9	100	4	1	1	28	2.9	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	23	16	6	38	6.5	5	100	8	9	3	11	1.8	5	100
	2011/2012 Operation	34	23	11	111	6.0	20	100	14	13	3	35	1.8	22	100
	2011/2012 Closure	60	16	2	383	25.2	17	100	23	5	1	137	8.9	17	100
	2014/2015 Operation	13	14	2	66	4.1	15	100	5	4	1	28	1.8	15	100
	2014/2015 Closure	94	2	2	276	91.4	3	100	22	1	1	66	21.7	3	100
DR-D	2011 Flood	19	16	6	38	6.8	4	100	7	6	3	11	1.9	4	100
	2011/2012 Operation	22	15	3	88	6.5	15	100	8	5	1	25	1.7	16	100
	2011/2012 Closure	35	16	7	122	14.2	9	100	10	5	3	30	2.9	9	100
	2014/2015 Operation	12	15	2	24	1.9	11	100	4	4	1	10	0.7	11	100
	2014/2015 Closure	20	23	2	28	4.6	5	100	5	6	1	7	1.1	5	100
DR-E	2011 Flood	53	11	4	185	44.1	4	100	6	5	3	10	1.8	4	100
	2011/2012 Operation	17	16	6	40	2.9	14	100	8	5	3	30	1.9	15	100
	2011/2012 Closure	37	16	1	156	12.3	15	100	15	4	1	80	5.8	15	100
	2014/2015 Operation	12	7	2	54	4.2	12	100	4	3	1	18	1.3	12	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Total Inorganic Carbon (mg/L)							Total Organic Carbon (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	45.8	45.8	45.8	45.8	-	1	100	14.0	14.0	14.0	14.0	-	1	100
	2011/2012 Operation	43.9	43.1	41.4	47.3	1.75	3	100	13.7	14.0	12.9	14.1	0.38	3	100
	2011/2012 Closure	42.0	40.2	32.3	54.4	3.35	7	100	12.6	12.9	9.1	15.2	0.90	7	100
	2014/2015 Operation	43.4	41.9	36.4	52.0	4.57	3	100	12.5	12.7	10.0	14.8	1.39	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	44.1	43.0	38.0	53.0	0.93	22	100	16.1	15.7	9.6	22.0	0.78	22	100
	2011 Flood	47.0	47.0	46.5	47.5	0.50	2	100	14.7	14.7	14.3	15.0	0.35	2	100
	2011/2012 Operation	48.6	47.3	42.1	57.2	1.63	11	100	13.8	13.9	12.1	15.7	0.27	11	100
	2011/2012 Closure	46.1	46.1	35.8	55.8	1.54	17	100	13.9	14.5	11.0	16.3	0.36	17	100
	2014/2015 Operation	40.6	41.1	31.8	51.9	1.81	9	100	13.2	13.5	10.2	15.4	0.58	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	37.5	37.5	37.5	37.5	-	1	100	13.3	13.3	13.3	13.3	-	1	100
	2011/2012 Operation	44.0	43.0	42.1	46.8	1.44	3	100	13.4	13.3	13.2	13.8	0.19	3	100
	2011/2012 Closure	43.9	40.7	37.0	55.0	2.91	7	100	13.7	13.1	11.3	16.4	0.73	7	100
	2014/2015 Operation	41.6	40.3	35.4	50.8	2.54	5	100	11.7	12.4	10.0	12.6	0.52	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	32.3	32.3	32.3	32.3	-	1	100	13.9	13.9	13.9	13.9	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	100	-	-	-	-	-	0	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	40.8	40.8	40.8	40.8	-	1	100	14.7	14.7	14.7	14.7	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	46.5	46.5	46.5	46.5	-	1	100	14.6	14.6	14.6	14.6	-	1	100
	2011/2012 Operation	44.5	43.1	43.1	47.2	1.37	3	100	13.4	13.8	12.7	13.8	0.37	3	100
	2011/2012 Closure	42.7	40.6	35.7	53.0	2.73	7	100	13.0	13.4	10.1	15.1	0.74	7	100
	2014/2015 Operation	40.4	40.9	30.1	50.2	3.20	5	100	12.8	12.4	10.4	15.1	0.83	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Dissolved Organic Carbon (mg/L)							TOC:ON Molar Ratio						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	12.8	12.8	12.8	12.8	-	1	100	16	16	16	16	-	1	100
	2011/2012 Operation	12.2	11.9	11.7	13.0	0.40	3	100	16	17	15	17	0.9	3	100
	2011/2012 Closure	12.4	12.9	9.2	14.9	0.87	7	100	19	20	16	21	0.8	7	100
	2014/2015 Operation	12.1	12.4	9.4	14.5	1.48	3	100	16	17	12	18	1.9	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	15	12	7	31	1.3	21	100
	2011 Flood	12.5	12.5	12.5	12.5	-	1	100	18	18	16	20	2.0	2	100
	2011/2012 Operation	12.6	12.5	12.0	13.4	0.32	4	100	17	17	13	21	0.6	11	100
	2011/2012 Closure	13.4	13.1	10.8	16.3	0.79	7	100	20	20	15	24	0.6	17	100
	2014/2015 Operation	12.3	12.1	11.2	13.9	0.60	4	100	18	18	12	23	1.1	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	13.0	13.0	13.0	13.0	-	1	100	15	15	15	15	-	1	100
	2011/2012 Operation	12.4	12.3	12.0	12.9	0.26	3	100	16	15	15	17	0.5	3	100
	2011/2012 Closure	13.4	12.9	11.4	16.5	0.75	7	100	20	19	16	26	1.3	7	100
	2014/2015 Operation	11.7	12.4	9.6	12.8	0.59	5	100	16	16	12	19	1.4	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	13.0	13.0	13.0	13.0	-	1	100	16	16	16	16	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	100	-	-	-	-	-	0	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	13.9	13.9	13.9	13.9	-	1	100	18	18	18	18	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	13.8	13.8	13.8	13.8	-	1	100	16	16	16	16	-	1	100
	2011/2012 Operation	12.4	12.5	12.1	12.5	0.13	3	100	17	16	15	20	1.3	3	100
	2011/2012 Closure	12.5	12.4	9.7	14.6	0.69	7	100	19	19	13	23	1.4	7	100
	2014/2015 Operation	12.6	12.2	11.0	14.0	0.56	5	100	17	18	13	20	1.2	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		TOC:TN Molar Ratio							Laboratory pH						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	15	15	15	15	-	1	100	8.46	8.46	8.46	8.46	-	1	100
	2011/2012 Operation	16	17	14	17	0.9	3	100	8.54	8.55	8.52	8.56	0.012	3	100
	2011/2012 Closure	17	16	15	21	0.9	7	100	8.40	8.45	7.98	8.59	0.084	7	100
	2014/2015 Operation	14	14	12	18	1.7	3	100	8.58	8.56	8.50	8.67	0.050	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	13	12	7	21	1.0	22	100	8.28	8.37	7.48	8.66	0.063	22	100
	2011 Flood	16	16	15	16	0.7	2	100	8.33	8.33	8.25	8.40	0.075	2	100
	2011/2012 Operation	16	16	14	17	0.3	9	100	8.44	8.46	8.26	8.64	0.037	11	100
	2011/2012 Closure	17	16	15	23	0.6	14	100	8.28	8.26	7.90	8.53	0.042	17	100
	2014/2015 Operation	14	13	12	18	1.2	4	100	8.44	8.41	8.33	8.66	0.032	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	14	14	14	14	-	1	100	8.46	8.46	8.46	8.46	-	1	100
	2011/2012 Operation	15	15	15	16	0.5	3	100	8.52	8.53	8.47	8.57	0.029	3	100
	2011/2012 Closure	18	19	16	21	0.7	7	100	8.36	8.42	7.99	8.52	0.074	7	100
	2014/2015 Operation	15	14	12	19	1.3	5	100	8.48	8.46	8.35	8.68	0.057	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	15	15	15	15	-	1	100	8.43	8.43	8.43	8.43	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	100	-	-	-	-	-	0	100
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	18	18	18	18	-	1	100	8.48	8.48	8.48	8.48	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	15	15	15	15	-	1	100	8.40	8.40	8.40	8.40	-	1	100
	2011/2012 Operation	17	16	15	19	1.1	3	100	8.49	8.51	8.44	8.52	0.025	3	100
	2011/2012 Closure	17	17	13	23	1.2	7	100	8.33	8.42	7.92	8.53	0.088	7	100
	2014/2015 Operation	16	18	13	20	1.3	5	100	8.47	8.48	8.31	8.60	0.047	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Laboratory Conductivity (µmhos/cm)							Total Dissolved Solids (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	1080	1080	1080	1080	-	1	100	692	692	692	692	-	1	100
	2011/2012 Operation	1073	1100	1020	1100	26.7	3	100	670	670	616	725	31.5	3	100
	2011/2012 Closure	1053	1030	767	1320	69.9	7	100	618	602	466	761	40.2	7	100
	2014/2015 Operation	1009	955	922	1150	71.1	3	100	571	556	508	648	41.1	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	1508	1510	1230	1760	28.3	22	100	853	870	709	978	16.4	22	100
	2011 Flood	1245	1245	1090	1400	155	2	100	751	751	676	826	75.0	2	100
	2011/2012 Operation	1123	1110	1030	1210	15.9	11	100	690	686	618	776	16.0	11	100
	2011/2012 Closure	1128	1110	847	1390	37.3	17	100	639	600	479	794	29.0	13	100
	2014/2015 Operation	947	925	862	1140	25.6	9	100	549	538	521	645	14.1	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	1060	1060	1060	1060	-	1	100	704	704	704	704	-	1	100
	2011/2012 Operation	1080	1110	1020	1110	30.0	3	100	628	640	585	660	22.4	3	100
	2011/2012 Closure	1068	1020	885	1340	63.1	7	100	618	575	524	787	37.5	7	100
	2014/2015 Operation	955	918	850	1150	51.5	5	100	545	522	489	632	24.5	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	1030	1030	1030	1030	-	1	100	726	726	726	726	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	100	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	924	924	924	924	-	1	100	522	522	522	522	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	1090	1090	1090	1090	-	1	100	656	656	656	656	-	1	100
	2011/2012 Operation	1077	1100	1020	1110	28.5	3	100	650	640	640	670	10.0	3	100
	2011/2012 Closure	1060	1020	889	1340	59.4	7	100	619	593	529	780	33.6	7	100
	2014/2015 Operation	962	949	837	1160	53.6	5	100	531	516	481	602	21.1	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Total Suspended Solids (mg/L)							Laboratory Turbidity (NTU)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	3	3	3	3	-	1	100	3.9	3.9	3.9	3.9	-	1	100
	2011/2012 Operation	11	10	10	13	1.1	3	100	5.5	4.7	4.1	7.6	1.08	3	100
	2011/2012 Closure	5	5	<2.0	11	1.5	7	71	2.6	3.0	0.6	4.8	0.65	7	100
	2014/2015 Operation	5.1	5.4	<2.0	8.8	2.26	3	67	2.6	2.7	1.3	3.9	0.77	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	8	7	<5.0	16	1.0	22	91	3.7	3.4	1.1	6.7	0.40	22	100
	2011 Flood	4	4	3	6	1.6	2	100	2.8	2.8	2.1	3.4	0.65	2	100
	2011/2012 Operation	8	5	<2.0	26	2.3	12	50	4.2	3.3	1.0	10.8	0.95	12	100
	2011/2012 Closure	6	6	<5.0	12	0.8	16	88	2.6	1.9	0.8	6.7	0.45	13	100
	2014/2015 Operation	8.3	8.0	<2.0	14.0	1.16	9	89	4.6	4.6	1.8	7.4	0.66	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	6	8	<5.0	8	1.3	5	60	4.7	4.7	4.7	4.7	-	1	100
	2011/2012 Operation	9	8	<2.0	26	1.3	22	82	4.8	3.8	1.2	14.1	0.91	16	100
	2011/2012 Closure	7	8	<2.0	12	0.9	17	82	3.5	3.7	1.0	5.6	0.39	17	100
	2014/2015 Operation	7.2	6.4	2.2	17.8	0.67	23	100	4.2	3.7	2.6	9.7	0.58	23	100
	2014/2015 Closure	10	10	9	11	0.2	6	100	6.7	6.7	6.6	6.8	0.06	3	100
DR-D	2011 Flood	7	7	5	8	0.6	4	100	4.5	4.5	4.5	4.5	-	1	100
	2011/2012 Operation	19	10	3	69	4.6	18	100	5.0	3.7	1.6	13.5	1.17	11	100
	2011/2012 Closure	10	10	6	16	1.2	9	100	4.9	4.2	3.1	8.6	0.68	9	100
	2014/2015 Operation	10	9	5	24	1.3	16	100	8.6	5.5	3.0	31	0.58	16	100
	2014/2015 Closure	9	10	7	10	0.4	8	100	6.9	6.9	6.2	7.5	0.18	8	100
DR-E	2011 Flood	6	5	3	10	1.9	4	50	5.1	5.1	5.1	5.1	-	1	100
	2011/2012 Operation	11	9	4	23	1.5	17	100	5.3	4.3	2.0	14.0	1.01	12	100
	2011/2012 Closure	9	9	2	15	1.0	15	100	4.1	4.4	1.1	6.7	0.41	15	100
	2014/2015 Operation	15.9	11.2	4.2	46.0	3.31	14	100	11.2	5.4	2.9	38	0.94	14	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		True Colour (CU)							Chlorophyll *a* (µg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	8.1	8.1	8.1	8.1	-	1	100	7.93	7.93	7.93	7.93	-	1	100
	2011/2012 Operation	6.4	6.5	6.1	6.7	0.18	3	100	5.03	4.66	3.98	6.44	0.733	3	100
	2011/2012 Closure	7.4	6.6	5.7	11.1	0.75	7	100	4.00	4.52	0.71	7.12	0.885	7	100
	2014/2015 Operation	9.1	7.7	7.7	12.0	1.43	3	100	4.28	5.83	0.62	6.38	1.835	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	6.8	5.0	<5.0	17.0	1.07	22	55	5.52	5.86	1.15	9.00	0.802	12	100
	2011 Flood	8.4	8.4	6.0	10.8	2.40	2	100	4.06	4.06	1.15	6.97	2.91	2	100
	2011/2012 Operation	8.5	8.3	7.0	10.6	0.35	11	100	4.71	4.03	1.91	8.55	0.588	11	100
	2011/2012 Closure	9.3	9.0	5.2	17.3	0.95	13	100	3.23	4.02	0.47	6.44	0.476	17	100
	2014/2015 Operation	11.1	9.7	6.8	23.1	1.86	8	100	4.73	5.35	0.72	5.88	0.518	9	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	8.5	8.5	8.5	8.5	-	1	100	5.83	5.83	5.83	5.83	-	1	100
	2011/2012 Operation	7.0	6.6	6.3	8.1	0.56	3	100	4.22	4.22	4.21	4.22	0.003	3	100
	2011/2012 Closure	8.7	9.0	5.0	13.3	1.06	7	100	3.50	4.11	0.52	5.68	0.797	7	100
	2014/2015 Operation	9.4	10.1	7.3	11.4	0.76	5	100	3.74	4.22	0.80	5.45	0.779	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	10.4	10.4	10.4	10.4	-	1	100	5.98	5.98	5.98	5.98	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	9.7	9.7	9.7	9.7	-	1	100	5.10	5.10	5.10	5.10	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	6.4	6.4	6.4	6.4	-	1	100	5.75	5.75	5.75	5.75	-	1	100
	2011/2012 Operation	8.0	8.7	5.9	9.5	1.09	3	100	4.27	4.23	4.16	4.41	0.074	3	100
	2011/2012 Closure	9.3	9.5	6.0	12.3	0.88	7	100	3.70	4.82	0.56	5.23	0.802	7	100
	2014/2015 Operation	9.7	8.7	7.5	12.1	0.97	5	100	3.89	4.37	0.95	5.45	0.826	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Phaeophytin a (µg/L)							*In Situ* Dissolved Oxygen (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	1.38	1.38	1.38	1.38	-	1	100	12.1	12.1	12.1	12.1	-	1	100
	2011/2012 Operation	1.16	1.40	0.57	1.50	0.295	3	100	10.1	10.4	8.2	11.7	1.02	3	100
	2011/2012 Closure	1.20	1.26	0.55	1.83	0.211	7	100	10.1	9.6	9.0	12.0	0.46	7	100
	2014/2015 Operation	2.63	1.45	0.41	6.04	1.73	3	100	10.5	9.7	9.7	12.0	0.76	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	<0.50	<0.50	<0.50	1.22	0.106	12	17	9.3	9.4	7.4	11.9	0.31	22	100
	2011 Flood	0.96	0.96	<0.60	1.62	-	2	50	11.4	11.4	11.3	11.5	0.09	2	100
	2011/2012 Operation	1.16	1.36	<1.0	1.81	0.151	11	91	9.4	9.1	4.3	12.7	0.67	11	100
	2011/2012 Closure	0.95	0.69	<0.60	2.81	0.175	17	71	9.8	10.1	7.4	12.2	0.40	13	100
	2014/2015 Operation	0.97	1.04	0.30	1.53	0.163	9	78	9.4	9.2	7.3	11.4	0.54	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	1.79	1.79	1.79	1.79	-	1	100	11.1	10.4	8.7	14.1	0.84	7	100
	2011/2012 Operation	0.78	0.86	0.45	1.04	0.175	3	100	11.1	11.0	8.3	15.0	0.44	19	100
	2011/2012 Closure	1.17	1.05	0.51	2.70	0.292	7	100	9.8	9.4	6.3	13.0	0.43	17	100
	2014/2015 Operation	0.99	0.85	0.49	1.56	0.185	5	100	9.5	9.4	6.1	11.9	0.35	20	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.8	6.6	6.5	10.4	1.29	3	100
DR-D	2011 Flood	1.80	1.80	1.80	1.80	-	1	100	9.9	10.1	8.4	11.5	0.50	6	100
	2011/2012 Operation	-	-	-	-	-	0	-	9.6	9.7	7.2	13.3	0.42	15	93
	2011/2012 Closure	-	-	-	-	-	0	-	10.1	9.7	7.8	12.9	0.55	10	100
	2014/2015 Operation	1.36	1.36	1.36	1.36	-	1	100	8.3	8.3	5.2	11.3	0.48	13	100
	2014/2015 Closure	-	-	-	-	-	0	-	7.9	7.2	5.9	10.7	1.41	3	100
DR-E	2011 Flood	2.04	2.04	2.04	2.04	-	1	100	9.8	9.5	7.9	11.8	0.63	6	100
	2011/2012 Operation	0.75	0.83	0.26	1.15	0.260	3	100	10.1	10.5	7.2	13.3	0.51	14	93
	2011/2012 Closure	0.93	0.99	0.57	1.34	0.118	7	100	9.9	9.6	7.5	13.0	0.42	15	100
	2014/2015 Operation	1.19	1.10	0.53	1.81	0.226	5	100	9.2	9.2	7.5	11.5	0.33	14	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Chloride, Dissolved (mg/L)							Fluoride, Dissolved (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	204	204	204	204	-	1	100	0.160	0.160	0.160	0.160	-	1	100
	2011/2012 Operation	184	179	178	196	5.8	3	100	0.152	0.147	0.146	0.162	0.0052	3	100
	2011/2012 Closure	185	183	122	241	15.8	7	100	0.136	0.146	0.108	0.158	0.0078	7	100
	2014/2015 Operation	155	150	146	170	7.4	3	100	0.140	0.130	0.128	0.161	0.0107	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	311	318	223	376	9.6	22	100	-	-	-	-	-	0	-
	2011 Flood	248	248	205	291	43.0	2	100	0.156	0.156	0.156	0.156	-	1	100
	2011/2012 Operation	197	195	174	224	6.1	11	100	0.149	0.148	0.136	0.165	0.0059	4	100
	2011/2012 Closure	195	187	136	245	10.1	13	100	0.134	0.130	0.114	0.152	0.0067	7	100
	2014/2015 Operation	149	147	143	170	3.1	8	100	0.139	0.136	0.125	0.160	0.0076	4	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	206	206	206	206	-	1	100	0.153	0.153	0.153	0.153	-	1	100
	2011/2012 Operation	183	178	177	193	5.2	3	100	0.144	0.139	0.139	0.155	0.0053	3	100
	2011/2012 Closure	187	181	146	243	13.8	7	100	0.144	0.149	0.106	0.177	0.0096	7	100
	2014/2015 Operation	148	147	129	169	6.5	5	100	0.138	0.133	0.129	0.158	0.0052	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	198	198	198	198	-	1	100	0.158	0.158	0.158	0.158	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	143	143	143	143	-	1	100	0.125	0.125	0.125	0.125	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	205	205	205	205	-	1	100	0.153	0.153	0.153	0.153	-	1	100
	2011/2012 Operation	182	177	177	192	5.0	3	100	0.138	0.139	0.124	0.152	0.0081	3	100
	2011/2012 Closure	184	181	145	243	13.5	7	100	0.136	0.137	0.106	0.160	0.0072	7	100
	2014/2015 Operation	147	145	126	170	7.2	5	100	0.136	0.131	0.126	0.157	0.0054	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Sulphate, Dissolved (mg/L)							Hardness, as CaCO3 (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	94.2	94.2	94.2	94.2	-	1	100	319	319	319	319	-	1	100
	2011/2012 Operation	92.7	92.8	83.2	102.0	5.4	3	100	280	276	261	303	12.3	3	100
	2011/2012 Closure	76.7	72.3	57.0	96.5	4.9	7	100	249	242	178	306	17.0	7	100
	2014/2015 Operation	84.6	77.2	76.7	99.8	7.62	3	100	260	248	235	298	19.2	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	94.1	94.1	66.9	120	3.0	22	100	271	271	225	310	5.1	22	100
	2011 Flood	88.7	88.7	83.6	93.7	5.1	2	100	300	300	291	308	8.5	2	100
	2011/2012 Operation	97.1	101	82.6	105	2.3	11	100	296	301	251	350	12.3	7	100
	2011/2012 Closure	78.1	74.0	62.3	95.4	3.0	13	100	252	253	213	292	8.4	10	100
	2014/2015 Operation	76.5	76.1	68.8	97.3	3.27	8	100	241	236	223	290	7.8	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	93.9	93.9	93.9	93.9	-	1	100	358	358	358	358	-	1	100
	2011/2012 Operation	91.4	92.1	82.2	100	5.1	3	100	277	276	254	302	13.9	3	100
	2011/2012 Closure	77.0	73.8	66.1	94.5	3.9	7	100	259	246	211	328	14.5	7	100
	2014/2015 Operation	79.3	76.3	68.6	96.6	4.73	5	100	247	242	228	289	10.9	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	90.6	90.6	90.6	90.6	-	1	100	337	337	337	337	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	68.8	68.8	68.8	68.8	-	1	100	207	207	207	207	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	93.5	93.5	93.5	93.5	-	1	100	332	332	332	332	-	1	100
	2011/2012 Operation	91.1	91.7	81.7	100	5.3	3	100	273	282	254	282	9.3	3	100
	2011/2012 Closure	75.7	71.5	65.7	94.1	3.8	7	100	253	245	220	301	11.1	7	100
	2014/2015 Operation	79.0	76.1	67.8	98.9	5.26	5	100	245	242	222	276	8.7	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Aluminum, Dissolved (mg/L)							Aluminum, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0355	0.0355	0.0355	0.0355	-	1	100
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	0.0427	0.0400	0.0328	0.0552	0.00660	3	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	7	0	0.0193	0.0199	0.0065	0.0372	0.00397	7	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	0.0248	0.0249	0.0130	0.0364	0.00676	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	0.0084	0.0030	<0.0010	0.0450	0.00273	22	86	0.0379	0.0304	0.0120	0.0960	0.00468	22	100
	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	2	0	0.0368	0.0368	0.0291	0.0444	0.00765	2	100
	2011/2012 Operation	0.0020	<0.0020	<0.0020	0.0077	0.00064	11	36	0.0414	0.0280	0.0101	0.133	0.0117	11	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	<0.0020	-	13	0	0.0315	0.0319	0.0109	0.0591	0.00440	13	100
	2014/2015 Operation	0.0027	<0.0020	<0.0020	0.0144	-	8	13	0.0405	0.0329	0.0186	0.0718	0.00653	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.0039	0.0039	0.0039	0.0039	-	1	100	0.0621	0.0621	0.0621	0.0621	-	1	100
	2011/2012 Operation	0.0020	<0.0020	<0.0020	0.0040	-	3	33	0.0849	0.110	0.0108	0.134	0.0377	3	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	0.0069	-	7	14	0.0389	0.0346	0.0111	0.0595	0.00711	7	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	5	0	0.0376	0.0370	0.0298	0.0458	0.00257	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	0.0036	0.0036	0.0036	0.0036	-	1	100	0.0369	0.0369	0.0369	0.0369	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	0.0026	0.0026	0.0026	0.0026	-	1	100	0.0476	0.0476	0.0476	0.0476	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	<0.0020	<0.0020	<0.0020	<0.0020	-	1	0	0.0773	0.0773	0.0773	0.0773	-	1	100
	2011/2012 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	3	0	0.0958	0.133	0.0103	0.144	0.0429	3	100
	2011/2012 Closure	<0.0020	<0.0020	<0.0020	0.0054	-	7	14	0.0387	0.0397	0.0145	0.0577	0.00568	7	100
	2014/2015 Operation	<0.0020	<0.0020	<0.0020	<0.0020	-	5	0	0.0754	0.0787	0.0588	0.0860	0.00514	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Antimony, Dissolved (mg/L)							Antimony, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	3	0	<0.0002	<0.0002	<0.0002	<0.0002	-	3	33
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	0.00027	0.000026	7	29
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	0.00020	-	3	33	<0.0002	<0.0002	<0.0002	0.00025	-	3	33
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	0.00043	0.00050	<0.0002	0.00060	0.000036	22	82
	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	2	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	4	0	<0.0002	<0.0002	<0.0002	<0.0002	-	11	9
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	<0.0002	-	13	0
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	4	0	<0.0002	<0.0002	<0.0002	0.00038	0.000037	8	25
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	3	0	<0.0002	<0.0002	<0.0002	<0.0002	-	3	33
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	0.00027	0.000027	7	29
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	5	0	<0.0002	<0.0002	<0.0002	0.00024	0.000032	5	40
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	<0.00020	<0.00020	<0.00020	<0.00020	-	1	0	<0.0002	<0.0002	<0.0002	<0.0002	-	1	0
	2011/2012 Operation	<0.00020	<0.00020	<0.00020	<0.00020	-	3	0	<0.0002	<0.0002	<0.0002	<0.0002	-	3	33
	2011/2012 Closure	<0.00020	<0.00020	<0.00020	<0.00020	-	7	0	<0.0002	<0.0002	<0.0002	0.00024	-	7	14
	2014/2015 Operation	0.00021	0.00025	<0.00020	0.00029	0.000042	5	40	<0.0002	<0.0002	<0.0002	0.00020	-	5	20
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Arsenic, Dissolved (mg/L)							Arsenic, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.00312	0.00312	0.00312	0.00312	-	1	100	0.00262	0.00262	0.00262	0.00262	-	1	100
	2011/2012 Operation	0.00233	0.00218	0.00202	0.00278	0.000231	3	100	0.00214	0.00233	0.00163	0.00247	0.000260	3	100
	2011/2012 Closure	0.00182	0.00189	0.00118	0.00233	0.000140	7	100	0.00192	0.00204	0.00126	0.00265	0.000167	7	100
	2014/2015 Operation	0.00189	0.00173	0.00165	0.00228	0.000198	3	100	0.00196	0.00183	0.00169	0.00235	0.000201	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	0.00212	0.00190	0.00140	0.00396	0.000134	22	100
	2011 Flood	0.00287	0.00287	0.00287	0.00287	-	1	100	0.00301	0.00301	0.00274	0.00328	0.000270	2	100
	2011/2012 Operation	0.00252	0.00246	0.00223	0.00292	0.000156	4	100	0.00229	0.00250	0.00139	0.00279	0.000147	11	100
	2011/2012 Closure	0.00179	0.00191	0.00136	0.00224	0.000126	7	100	0.00190	0.00185	0.00140	0.00225	0.000066	13	100
	2014/2015 Operation	0.00180	0.00170	0.00163	0.00218	0.000128	4	100	0.00178	0.00171	0.00154	0.00216	0.000072	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.00293	0.00293	0.00293	0.00293	-	1	100	0.00251	0.00251	0.00251	0.00251	-	1	100
	2011/2012 Operation	0.00244	0.00242	0.00219	0.00272	0.000153	3	100	0.00239	0.00254	0.00203	0.00259	0.000179	3	100
	2011/2012 Closure	0.00179	0.00180	0.00137	0.00237	0.000128	7	100	0.00184	0.00189	0.00142	0.00232	0.000114	7	100
	2014/2015 Operation	0.00181	0.00170	0.00164	0.00220	0.000101	5	100	0.00181	0.00177	0.00166	0.00215	0.000087	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	0.00273	0.00273	0.00273	0.00273	-	1	100	0.00243	0.00243	0.00243	0.00243	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	0.00143	0.00143	0.00143	0.00143	-	1	100	0.00175	0.00175	0.00175	0.00175	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	0.00328	0.00328	0.00328	0.00328	-	1	100	0.00271	0.00271	0.00271	0.00271	-	1	100
	2011/2012 Operation	0.00230	0.00230	0.00194	0.00265	0.000205	3	100	0.00230	0.00225	0.00212	0.00252	0.000118	3	100
	2011/2012 Closure	0.00181	0.00177	0.00138	0.00231	0.000120	7	100	0.00179	0.00194	0.00134	0.00202	0.000103	7	100
	2014/2015 Operation	0.00172	0.00163	0.00155	0.00215	0.000109	5	100	0.00180	0.00167	0.00162	0.00225	0.000116	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

Site ID	Period	Barium, Dissolved (mg/L)							Barium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.0495	0.0495	0.0495	0.0495	-	1	100	0.0499	0.0499	0.0499	0.0499	-	1	100
	2011/2012 Operation	0.0459	0.0455	0.0435	0.0487	0.00151	3	100	0.0499	0.0482	0.0478	0.0538	0.00194	3	100
	2011/2012 Closure	0.0413	0.0398	0.0307	0.0502	0.00249	7	100	0.0432	0.0421	0.0304	0.0536	0.00307	7	100
	2014/2015 Operation	0.0441	0.0412	0.0390	0.0520	0.00402	3	100	0.0469	0.0407	0.0401	0.0600	0.00654	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	0.0515	0.0519	0.0360	0.0640	0.00127	22	100
	2011 Flood	0.0495	0.0495	0.0495	0.0495	-	1	100	0.0522	0.0522	0.0505	0.0538	0.00165	2	100
	2011/2012 Operation	0.0482	0.0475	0.0446	0.0533	0.00196	4	100	0.0524	0.0525	0.0453	0.0567	0.00107	11	100
	2011/2012 Closure	0.0406	0.0384	0.0339	0.0497	0.00226	7	100	0.0459	0.0448	0.0337	0.0550	0.00162	13	100
	2014/2015 Operation	0.0442	0.0439	0.0372	0.0520	0.00373	4	100	0.0427	0.0403	0.0380	0.0545	0.00202	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.0483	0.0483	0.0483	0.0483	-	1	100	0.0506	0.0506	0.0506	0.0506	-	1	100
	2011/2012 Operation	0.0473	0.0469	0.0428	0.0521	0.00269	3	100	0.0487	0.0464	0.0458	0.0538	0.00257	3	100
	2011/2012 Closure	0.0406	0.0380	0.0335	0.0493	0.00222	7	100	0.0440	0.0421	0.0355	0.0532	0.00238	7	100
	2014/2015 Operation	0.0420	0.0399	0.0370	0.0515	0.00261	5	100	0.0433	0.0411	0.0383	0.0549	0.00297	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	0.0472	0.0472	0.0472	0.0472	-	1	100	0.0486	0.0486	0.0486	0.0486	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	0.0374	0.0374	0.0374	0.0374	-	1	100	0.0371	0.0371	0.0371	0.0371	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	0.0497	0.0497	0.0497	0.0497	-	1	100	0.0530	0.0530	0.0530	0.0530	-	1	100
	2011/2012 Operation	0.0472	0.0476	0.0443	0.0497	0.00157	3	100	0.0476	0.0485	0.0448	0.0495	0.00143	3	100
	2011/2012 Closure	0.0410	0.0398	0.0355	0.0472	0.00172	7	100	0.0436	0.0410	0.0344	0.0561	0.00293	7	100
	2014/2015 Operation	0.0410	0.0398	0.0363	0.0506	0.00250	5	100	0.0428	0.0408	0.0390	0.0513	0.00219	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Boron, Dissolved (mg/L)							Boron, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	0.107	0.107	0.107	0.107	-	1	100	0.112	0.112	0.112	0.112	-	1	100
	2011/2012 Operation	0.108	0.111	0.084	0.129	0.0131	3	100	0.123	0.118	0.102	0.149	0.0138	3	100
	2011/2012 Closure	0.088	0.086	0.069	0.113	0.0055	7	100	0.091	0.091	0.072	0.109	0.0059	7	100
	2014/2015 Operation	0.094	0.096	0.091	0.096	0.00	3	100	0.098	0.098	0.097	0.098	0.0003	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	0.124	0.120	0.100	0.140	0.0023	22	100
	2011 Flood	0.098	0.098	0.098	0.098	-	1	100	0.109	0.109	0.104	0.114	0.0050	2	100
	2011/2012 Operation	0.111	0.111	0.086	0.137	0.0105	4	100	0.109	0.105	0.093	0.141	0.0048	11	100
	2011/2012 Closure	0.089	0.085	0.079	0.110	0.0038	7	100	0.095	0.090	0.079	0.121	0.0041	13	100
	2014/2015 Operation	0.088	0.087	0.081	0.096	0.0034	4	100	0.089	0.087	0.079	0.101	0.0026	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.125	0.125	0.125	0.125	-	1	100	0.117	0.117	0.117	0.117	-	1	100
	2011/2012 Operation	0.102	0.106	0.087	0.114	0.0080	3	100	0.114	0.117	0.098	0.127	0.0085	3	100
	2011/2012 Closure	0.093	0.091	0.081	0.117	0.0050	7	100	0.099	0.104	0.073	0.140	0.0090	7	100
	2014/2015 Operation	0.085	0.087	0.078	0.091	0.0024	5	100	0.090	0.088	0.082	0.104	0.0039	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	0.122	0.122	0.122	0.122	-	1	100	0.113	0.113	0.113	0.113	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	0.079	0.079	0.079	0.079	-	1	100	0.075	0.075	0.075	0.075	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	0.097	0.097	0.097	0.097	-	1	100	0.113	0.113	0.113	0.113	-	1	100
	2011/2012 Operation	0.105	0.106	0.093	0.115	0.0064	3	100	0.118	0.121	0.097	0.135	0.0111	3	100
	2011/2012 Closure	0.092	0.090	0.086	0.112	0.0034	7	100	0.097	0.093	0.072	0.126	0.0077	7	100
	2014/2015 Operation	0.087	0.087	0.080	0.097	0.0029	5	100	0.094	0.092	0.084	0.108	0.0040	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

		Cadmium, Dissolved (mg/L)							Cadmium, Total (mg/L)						
Site ID	Period	Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.000010	0.000012	-	3	33
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0	<0.000010	<0.000010	<0.000010	0.000012	0.0000011	7	29
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	<0.000040	<0.000040	<0.000010	<0.000040	-	22	5
	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	2	0
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	0.000010	-	4	25	<0.000010	<0.000010	<0.000010	0.000025	0.0000018	11	36
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0	<0.000010	<0.000010	<0.000010	0.000010	-	13	8
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	0.000022	-	4	25	<0.000010	<0.000010	<0.000010	<0.000010	-	8	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	0.000013	0.000013	0.000013	0.000013	-	1	100	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.0000070	0.000012	-	3	33
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0	<0.000010	<0.000010	<0.000010	0.000011	-	7	14
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	5	0	<0.000010	<0.000010	<0.000010	<0.000010	-	5	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0	<0.000010	<0.000010	<0.000010	<0.000010	-	1	0
	2011/2012 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	3	0	<0.000010	<0.000010	<0.0000070	0.000011	-	3	33
	2011/2012 Closure	<0.000010	<0.000010	<0.000010	<0.000010	-	7	0	<0.000010	<0.000010	<0.000010	0.000011	-	7	14
	2014/2015 Operation	<0.000010	<0.000010	<0.000010	<0.000010	-	5	0	<0.000010	<0.000010	<0.000010	0.000032	-	5	20
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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Table 17. Continued.

Site ID	Period	Calcium, Dissolved (mg/L)							Calcium, Total (mg/L)						
		Mean	Median	Min	Max	SE	n	%>DL	Mean	Median	Min	Max	SE	n	%>DL
DR-A	2011 Flood	46.0	46.0	46.0	46.0	-	1	100	45.6	45.6	45.6	45.6	-	1	100
	2011/2012 Operation	47.4	48.6	40.0	53.6	3.97	3	100	48.4	49.0	46.8	49.5	0.83	3	100
	2011/2012 Closure	44.2	47.6	32.1	50.2	2.57	7	100	46.5	44.5	36.6	60.1	2.99	7	100
	2014/2015 Operation	46.5	43.2	40.9	55.3	4.47	3	100	47.9	45.3	44.7	53.8	2.94	3	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-B	Historic [1]	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011 Flood	47.6	47.6	47.6	47.6	-	1	100	49.2	49.2	45.1	53.3	4.10	2	100
	2011/2012 Operation	46.8	48.5	40.0	50.3	2.31	4	100	50.5	49.6	44.6	55.8	1.18	11	100
	2011/2012 Closure	42.9	40.2	34.3	53.2	2.58	7	100	47.0	45.3	39.8	54.7	1.48	13	100
	2014/2015 Operation	43.3	40.6	39.1	52.8	3.20	4	100	43.1	41.5	39.1	52.9	1.60	8	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-C	2011 Flood	46.4	46.4	46.4	46.4	-	1	100	54.3	54.3	54.3	54.3	-	1	100
	2011/2012 Operation	46.9	49.5	40.1	51.1	3.43	3	100	45.4	46.3	43.7	46.3	0.87	3	100
	2011/2012 Closure	44.8	44.6	38.4	54.3	2.13	7	100	49.2	45.8	39.9	70.3	3.82	7	100
	2014/2015 Operation	45.0	42.6	41.6	53.7	2.23	5	100	43.6	42.1	41.2	50.4	1.72	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-D	2011 Flood	46.5	46.5	46.5	46.5	-	1	100	52.1	52.1	52.1	52.1	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
	2014/2015 Operation	36.2	36.2	36.2	36.2	-	1	100	37.5	37.5	37.5	37.5	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-
DR-E	2011 Flood	45.4	45.4	45.4	45.4	-	1	100	54.7	54.7	54.7	54.7	-	1	100
	2011/2012 Operation	46.5	48.6	41.8	49.1	2.35	3	100	46.1	46.2	44.5	47.7	0.92	3	100
	2011/2012 Closure	42.8	41.4	36.6	51.7	2.13	7	100	47.0	44.7	40.8	63.0	2.89	7	100
	2014/2015 Operation	44.1	42.9	38.3	54.9	2.83	5	100	44.7	42.5	41.6	49.9	1.64	5	100
	2014/2015 Closure	-	-	-	-	-	0	-	-	-	-	-	-	0	-

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