December 2013

HAMMOND REEF GOLD PROJECT
Hydrology Technical Support Document

VERSION 2

Submitted to:
Osisko Hammond Reef Gold Ltd.
155 University Avenue, Suite 1440
Toronto, Ontario M5H 3B7

Project Number: 13-1118-0010

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PART A

Introduction

Version 1 of the Hydrology Technical Support Document (TSD) was published on February 15, 2013 as part of Osisko Hammond Reef Gold's (OHRG) Draft Environmental Impact Statement/Environmental Assessment (EIS/EA) Report.

The Draft EIS/EA Report underwent a seven week public review comment period after which, on April 5, 2013, OHRG received comments from the public, Aboriginal groups and the Government Review Team (GRT) seeking clarification and requesting new information.

Approximately 25 comments regarding the Hydrology TSD and component of the EIS/EA Report were received from the GRT. Written responses have been prepared for each comment and are provided in Appendix 1.IV of the EIS/EA Report.

Version 1 of the Hydrology TSD has not been revised. The methods used to define baseline hydrologic conditions and predict potential changes to the water levels and stream flows in the project area are technically defensible and based on standard industry practices. The conclusions and results presented in the Hydrology TSD are sound and have remained the same after consideration of comments received.

The EIS/EA Report has been revised and updated based on comments received. Version 2 of the Hydrology TSD is comprised of the following:

- Part A: Introduction
- Part B: Supplemental Information Package (attached) that provides additional detail on new work undertaken related to the Hydrology component and the information presented in the Hydrology TSD.
- Part C: Version 1 of the Hydrology TSD. Part C was issued in February 2013, and is available online on OHRG's website; it has not been re-printed as part of this Version 2 of the Hydrology TSD. The Version 1 document should be reviewed within the context of this Version 2 document, and associated updated information as presented in Part A or Part B should be considered as correct should it differ from the information presented in Version 1.

A summary of the information found in Part B is provided below, including new work that has been carried out to update the estimated pit flooding duration. Throughout the EIS/EA Report, unless otherwise noted, all references made to the Hydrology TSD are to Part C.

Revised Pit Flooding Duration

The pit flooding model was updated to better reflect planned water management activities at closure. The previous estimated flooding duration of 78 years was based on the assumption that runoff from the Waste Rock Management Facility (WRMF), Tailings Management Facility (TMF) and other project infrastructure would be diverted to the pits in perpetuity. However, as explained in the Conceptual Closure and Rehabilitation Plan TSD, runoff from these areas will be released to the environment when water quality is deemed to be suitable for discharge. The pit flooding model was updated based on this plan. The model update resulted in an increase in the predicted flooding duration to approximately 218 years. This change is not reflected in the Hydrology TSD. A technical memorandum summarizing the revised pit flooding model results is provided in the Supplemental Information Package attached to the Conceptual Closure and Rehabilitation Plan TSD.

Worker Accommodation Camp Effluent Discharge Location

The locations of the worker accommodation camp effluent discharge and fresh water intake structures have been revised based on feedback received from the GRT. The revised locations are shown on Figure 5-1 of the EIS/EA Report. As a result of this change, the worker accommodation camp effluent discharge is no longer located at the mouth of Sawbill Creek. Therefore, when reviewing the Version 1 Hydrology TSD (Part C), the reader is directed to disregard all references to local impacts to Sawbill Creek due to the installation of the discharge structure or the discharge of effluent from the worker accommodation camp.

Supplemental Information

Several information requests from the Ontario Ministry of Environment and Transport Canada requested that more detail and information be provided on several aspects of the hydrological assessment. In response to these Information Requests, additional information was assembled and has been provided in the attached Supplemental Information Package. The table below provides a summary of the additional information requested and the corresponding documents in the Supplemental Information Package in which the information is provided.

Additional Information Requested	Location of Information in the Supplemental Information Package
Clarification on the methods and data used for watershed delineation	Response to Information Request MOE-HYDRO 1
Clarification on regional hydrometric stations and weighting factors used to develop flow time series' for natural watersheds	Response to Information Request MOE-HYDRO 3
Details of HEC-HMS modelling, including model calibration and validation	Newly-created Appendix 5.II
Clarification and revision to Figure 7-1	Response to Information Request MOE-TC-6
A new figure showing site watersheds and sample locations	Response to Information Request MOE-TC-7
A table showing predicted changes to navigable waters in the LSA	Response to Information Request MOE-TC-10
Water balance modelling results during dry periods; Specifically, during 1998 and 2010.	Technical Memorandum: Marmion Reservoir Outflows and Water Levels during Dry Years

Minor Corrections and Clarifications

The following minor text correction should be noted:

An objective of the hydrology monitoring program is to "Satisfy compliance monitoring requirements included in Certificates of Approval and Permits to Take Water issued by the Ontario Ministry of the Environment pursuant to the Ontario Water Resources Act and in Fisheries Act Authorizations issued by Fisheries and Oceans Canada and authorizations issued *by Transport Canada* pursuant to the Navigable Waters Act (if applicable)." The Version 1 TSD does not identify Transport Canada as the governing agency with respect to the Navigable Water Protection Act (Section 8.1, page 185). In response to Information Request DFO-38, the reader is directed to consider this clarification when reading the Version 1 Hydrology TSD.

Information Request TC-5 noted that, in Section 7.1 of the Version 1 Hydrology TSD, the second bullet of the second paragraph on page 164 is not entirely accurate. In response, the reader is directed to consider the following re-wording of this bullet when reviewing the Version 1 Hydrology TSD: “If a waterway or water body has the potential to be navigated, it *may* be determined navigable. *There are a number of other criteria which are also used by Transport Canada to assess navigability.*”

Supplemental Information Provided in Part B

- Response to Information Request MOE-Hydro 1
- Response to Information Request MOE-Hydro 3
- Newly-created Appendix 5.II
- Response to Information Request MOE-TC-6
- Response to Information Request MOE-TC-7
- Response to Information Request MOE-TC-10
- Technical Memorandum: Marmion Reservoir Outflows and Water Levels during Dry Years

PART B

Supplemental Information Package

INFORMATION REQUEST – MOE-HYDRO-1

Source: Ministry of Environment

Summary of Comment

Clarity into watershed delineation should be provided. Although NRVIS does contain topographic data which has been used to generate the provincial Ontario Base Maps, the methods used, including software or other tools should be outlined.

Potential Environmental Effects

Watershed delineation was used to identify potential areas which could be impacted. Understanding how the areas were determined, provides clarity as to the accuracy of the potential impact statements and may have implications to other aspects of the project, not found in the Hydrology TSD.

Proposed Action

Within the Land Information Ontario database several layers exist [pre-constructed sub-basins produced by WRIP (Water Resources Inventory Group within MNR), a 20m provincial DEM layer for the project area, provincial contours] such that the data source used, including the accuracy, should be provided (horizontal and vertical), as well as creation date, data source (and date) associated with the data layer used. Often, field validation can be used depending on the data source used to ensure the accuracy associated with historic data sets, or other newer techniques can be used to gather higher resolution digital terrain models.

Reference to EIS

Hydrology TSD, Version 1, Section 2.1.4, page 19

Response

Site watersheds were delineated manually from working maps, prepared using Project specific topography and MNR NRVIS topography (see attached figure) as described below. Watershed divides were identified by interpreting the topographical data. Watersheds delineated by hand were digitized using ArcView GIS software.

<u>Project specific topography</u>

Data collection method:	Contours derived from Aerial Photography Collection
Author of the data:	Aero Geometrics Ltd. – Mapping Services
Creation date:	August 2010
Data accuracy (horizontal):	20 cm over the mine site and 50 cm north and south of the central zone
Data accuracy (vertical):	1 m over the mine site and 5 m north and south of the central zone

MNR NRVIS topography

Data type: 10 m contour dataset

Creation date: 2006

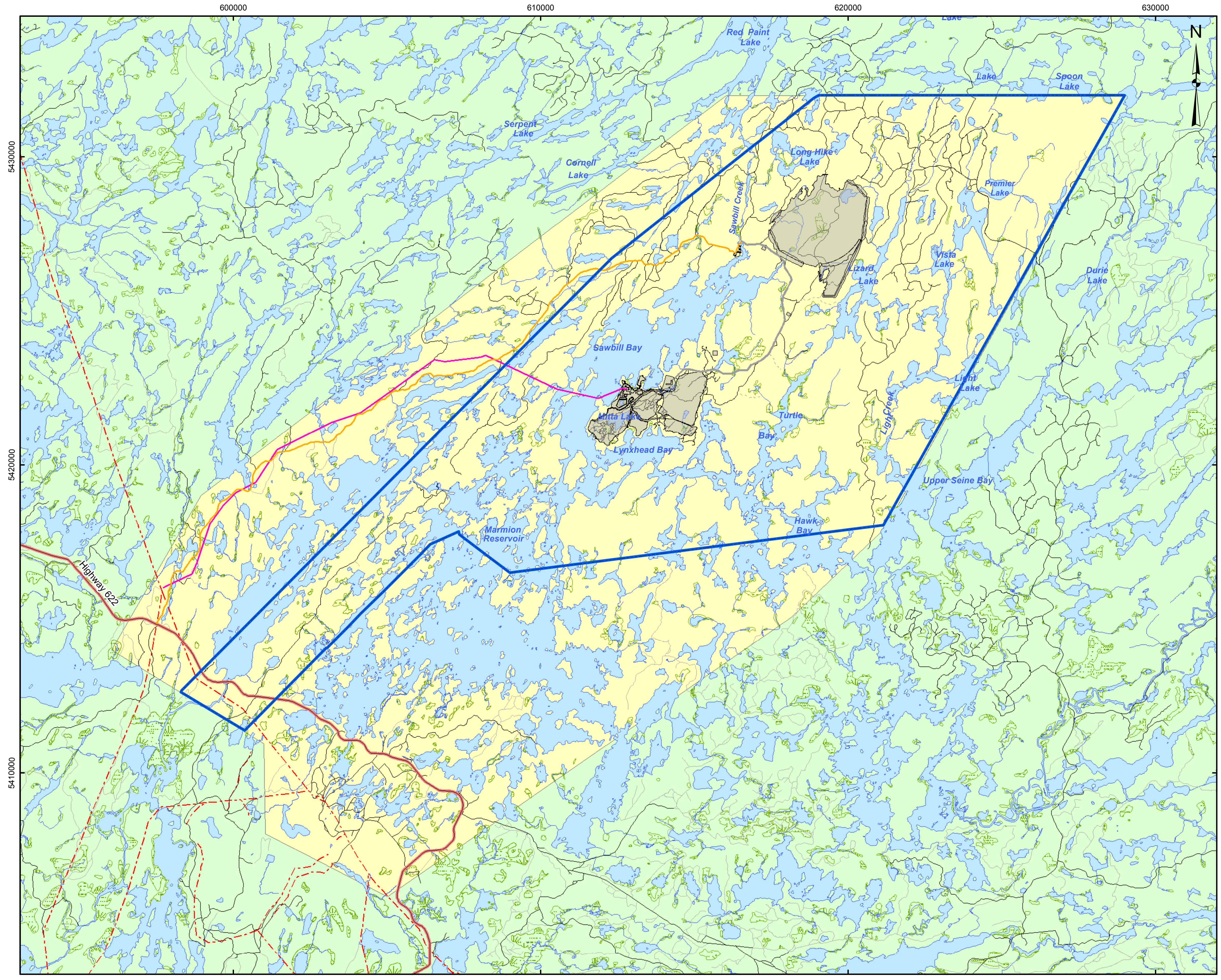
Date received: January 2008

Data accuracy (horizontal): ± 10 m

Data accuracy (vertical): ± 5 m

Attachments

Figure MOE-Hydro-1: Topography Data Sources



LEGEND

- Trail
- Road
- Power Transmission Line
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

Topography Data Sources

- Aero Geometrics Ltd. - Mapping Services
- Aero Geometrics Ltd. Central Zone
- MNR NRVIS

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000 6,000
SCALE 1:125,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

TOPOGRAPHY DATA SOURCES

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: MOE-HYDRO-1	
GIS	JO	11 Jun. 2013		
CHECK	SP	11 Jun. 2013		
REVIEW	SP	11 Jun. 2013		

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INFORMATION REQUEST – MOE-HYDRO-3

Source: Ministry of Environment

Summary of Comment

Under local site watersheds, flow metrics provided use regional curves to interpolate local conditions. Although it was mentioned that the basins used were thought to be the most similar to local watersheds, the further characterization of basin conditions would provide more understanding as to their selection (wetland area, storage, annual precipitation, similarity in flow patterns between sites of interest and potential index sites (when available). Typically, the similarity between datasets for overlapping periods has been used and is considered during the weighting process.

Potential Environmental Effects

It was described that daily time series data was generated using a weighted average of flow series derived from three nearby sites (Turtle River 4,870 km^2, Namakan River 13,400 km^2 and Atikokan River 332 km^2). Hughes and Smakhtin (1996) recommends using a weighting factor based on the degree of similarity between flow regimes and the destination site which was used. Providing further clarity on modelling methods increases confidence in modelling efforts used, and any subsequent impact assessment statements.

Proposed Action

Further refinement to modelling efforts could be completed dependent on their subsequent uses and required accuracy. The derivation of the weighting factor, as well as the weighting factor should be provided.

Reference to EIS

Hydrology TSD, Version 1, Section 5.1.1.3.3, 1st paragraph on page 57

Response

Spatial interpolation and regionalization methods were used to develop synthetic flows for the natural watershed areas tributary to Lac des Mille Lacs, Lower Marmion Reservoir and Upper Marmion Reservoir. These flows were used to estimate total inflows to the reservoir under the 2004 to 2014 Seine River Water Management Plan using water balance methods due to the high percentage (34%) of missing days in the record of outflows from Raft Lake Dam. (1st and 3rd paragraph of Section 5.1.1.3.3 on page 56).

Three synthetic daily mean time series were developed for the natural watershed areas tributary to the Upper and Lower Marmion Reservoirs, based on observed flows at Environment Canada hydrometric stations on Turtle River, Namakan River and Atikokan River, and monthly flow duration curves derived for these stations. A final time series for each natural watershed area was then calculated as the weighted average of the three daily mean time series. (Section 5.1.1.3.3, 1st paragraph on page 57).

The similarities between the source sites (Turtle River, Namakan River and Atikokan River) and the destination site (Seine River) were examined as part of the analysis. Watershed characteristics for the four sites are shown in Table 1 below. The similarities in flow regime are presented in the various tables and charts in Section 5.1.2.2.2 of the Hydrology TSD on pages 73 to 85.

Table 1: Watershed Characteristics

Characteristic	Seine River at Raft Lake Dam	Turtle River near Mine Centre	Namakan River at outlet of Lac La Croix	Atikokan River at Atikokan
Latitude (°N)	48.9176	48.8500	48.3825	48.7519
Longitude (°W)	91.5451	92.7236	92.1761	91.5839
Drainage Area (km^2)	4512	4843	13472	342
Perimeter (km)	578	603	708	225
Lake and Wetland Area (km^2)	1067	1098	1881	68
Lake and Wetland Coverage (%)	23%	23%	14%	19%
Length of Main Channel (km)	201	216	190	80
Length to Center (along main channel) (km)	103	95	66	46
Mean Slope of Watershed (%)	3.67	4.92	4.69	4.49
Mean Slope of Main Channel (%)	2.1	3.55	4.19	2.65

Table 2 shows the factors that were applied to derive weighted average time series for the natural watershed areas tributary to the Upper Marmion Reservoir and the Lower Marmion Reservoir.

Table 2: Weights for Source Sites

Source Site	Weighting Factors
Turtle River near Mine Centre	2.5
Namakan River at outlet of Lac La Croix	1.0
Atikokan River at Atikokan	1.5

These factors were determined by trial and error; annual mean outflows recorded at Raft Lake Dam in years with less than 10% missing days were compared with annual mean inflows to the reservoir calculated from synthetic data for the period September 1999 to August 2010 (Table 3) and factors giving comparable results were selected. The underlying assumption to this approach is that, over a period of one year, the inflows to the reservoir are equal to the outflows through the dam.

Table 3: Comparison of Recorded and Synthetic Flow Data

Year[(a)]	Annual Mean Flow (m^3/s)		Percent difference
	Recorded	Synthetic	
1999-2000	39.90	35.14	-12%
2000-2001	37.24	49.53	33%
2001-2002	40.10	44.53	11%
2002-2003	17.77	13.68	-23%
2005-2006	30.52	29.13	-5%
2010-2011	27.01	--[(b)]	--[(b)]

(a) For the period September 1 to August 31

(b) Not evaluated

APPENDIX 5.II

Hydrologic Modelling

TABLES

FIGURES

1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. is planning the development of an open pit gold mine, the Hammond Reef Gold Project (Project), in north-western Ontario. The Project is located approximately 170 km west of Thunder Bay, and 23 km northeast of the town of Atikokan, and will involve the development of the following main components: two open pits, a waste rock management facility, an ore processing facility, a tailings management facility, support and ancillary infrastructure, and linear infrastructure.

The Project is located on the right bank of the Seine River, mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The Project is situated on the divide between two local watersheds draining to Sawbill Bay and Lynxhead-Trap-Turtle Bays (Hydrology TSD, Ver. 1, Figure 2.3). Lumby Creek is the principal drainage system in the Lynxhead-Trap-Turtle Bays watershed and is characterized by numerous small lakes connected by short reaches of stream.

It has been identified that the Project could have an influence on flows in Lumby Creek, and on lake water levels in two small unnamed lakes as well as Lizard Lake (Hydrology TSD, Ver. 1, Figure 6-14). The bounding (worst case) scenario for changes in flows and lake water levels from existing conditions is expected to occur during the operations phase of the Project. Unnamed Lake 4 (API[1] #2) is located entirely within the footprint of the tailings management facility (TMF) and will be lost; this lake will be in-filled with and completely covered over by tailings. Lumby Creek, Unnamed Lake 5 (API #8) and Lizard Lake will be affected by the interception of runoff from the TMF footprint by the Project's water collection system.

Hydrologic modelling was completed to assess the potential changes in flows in Lumby Creek, and in lake water levels in Unnamed Lake 5 (API #8) and Lizard Lake, as a result of Project operations. Specifically, the objectives of the modelling effort were to:

- Develop long-term records of daily mean flows in Lumby Creek below Lizard Lake under existing conditions, and under future conditions during Project operations;
- Develop long-term records of daily mean lake water levels in Lizard Lake under existing conditions, and under future conditions during Project operations; and
- Develop long-term records of daily mean lake water levels in Unnamed Lake 5 (API #8) under existing conditions, and under future conditions during Project operations.

Changes occurring as a result of the Project were evaluated by comparison of the time series representing existing conditions, to the time series corresponding to future conditions during Project operations

This Appendix provides a description of the modelling software, the model inputs, model calibration, model validation and the hydrologic simulations, with respect to the prediction of changes in flows and lake water levels in the Lumby Creek drainage system.

[1] Area of Potential Impact as identified in the Aquatic Environment TSD.

2.0 HYDROLOGIC MODELLING SOFTWARE

Version 3.5 of the Hydrologic Modeling System developed by the United States Army Corps of Engineers Hydrologic Engineering Center (HEC-HMS) was used for continuous simulations of the precipitation-runoff processes in the Lynxhead-Trap-Turtle Bays watershed (US Army Corps of Engineers, 2010). The program supersedes the earlier HEC-1 software and provides significant advancements both in terms of computer science and hydrologic engineering.

The physical representation of a watershed is accomplished with a basin model. Hydrologic elements include subbasins, reaches, junctions, reservoirs, diversions, sources, and sinks, which are connected in a dendritic network. Computation proceeds from upstream elements in a downstream direction. The program includes a number of mathematical models that can be used to represent components of the hydrologic cycle. Methods are available for the simulation of canopy, surface and infiltration losses, for transforming excess precipitation into surface runoff, for representing baseflow contributions, and for hydrologic routing.

Meteorological data analysis is performed by a meteorologic model and includes precipitation, evapotranspiration, and snowmelt. Methods are available for analyzing historical precipitation, for producing synthetic precipitation, for computing potential evapotranspiration, and for tracking the accumulation and melt of a snowpack.

A hydrologic simulation is run by combining the basin model, the meteorologic model and control specifications, which include a start date and time, ending date and time, and a time interval. Simulation results are presented as global and element summary tables with information on peak flows and total volumes, and as time-series tables and graphs for elements.

The limitations of the program are due to the following two aspects of its design:

Simplified Model Formulation

- All mathematic models included in the program are deterministic. This means that the boundary conditions, initial conditions, and parameters of the models are assumed to be exactly known. Deterministic models can be compared to stochastic models where the same boundary conditions, initial conditions, and parameters are represented by probabilistic distributions.
- All mathematical models included in the program use constant parameters values, i.e. they are assumed to be time stationary. During long periods of time, it is possible for parameters describing a watershed to change as the result of human or other processes at work in the watershed.
- All mathematical models included in the program are uncoupled; the program first computes evapotranspiration and then computes infiltration. In the physical world, the two occur simultaneously and are interdependent.

Simplified Flow Representation

- The design of the basin model only allows for dendritic stream networks; each hydrologic element has only one downstream connection. In general, branching or looping stream networks cannot be simulated with the program.

- The design of the process for computing a simulation does not allow for backwater in the stream network. The compute process begins at the headwater sub-basins and proceeds down through the network. It is not possible for an upstream element to have knowledge of downstream flow conditions, which is the essence of backwater effects.

3.0 MODEL INPUTS

3.1 Basin Models

3.1.1 Drainage Networks

Figure 5.II-1 shows the subwatershed draining to the outlet of Lizard Lake, and Figure 5.II-2 shows the drainage network used to represent the subwatershed. This network was used to assess the potential changes in flows in Lumby Creek below Lizard Lake, and the changes in lake water levels in Lizard Lake, as a result of Project operations. The network consisted of nine subbasins, three reaches, one junction, one diversion and one reservoir. A subbasin (S-9), a reach (R-3), a diversion (D-1) and a reservoir (L-1) were used to model the direct precipitation onto, the travel time through, the evaporative loss from, and the stage-storage-discharge relationship for Lizard Lake, respectively.

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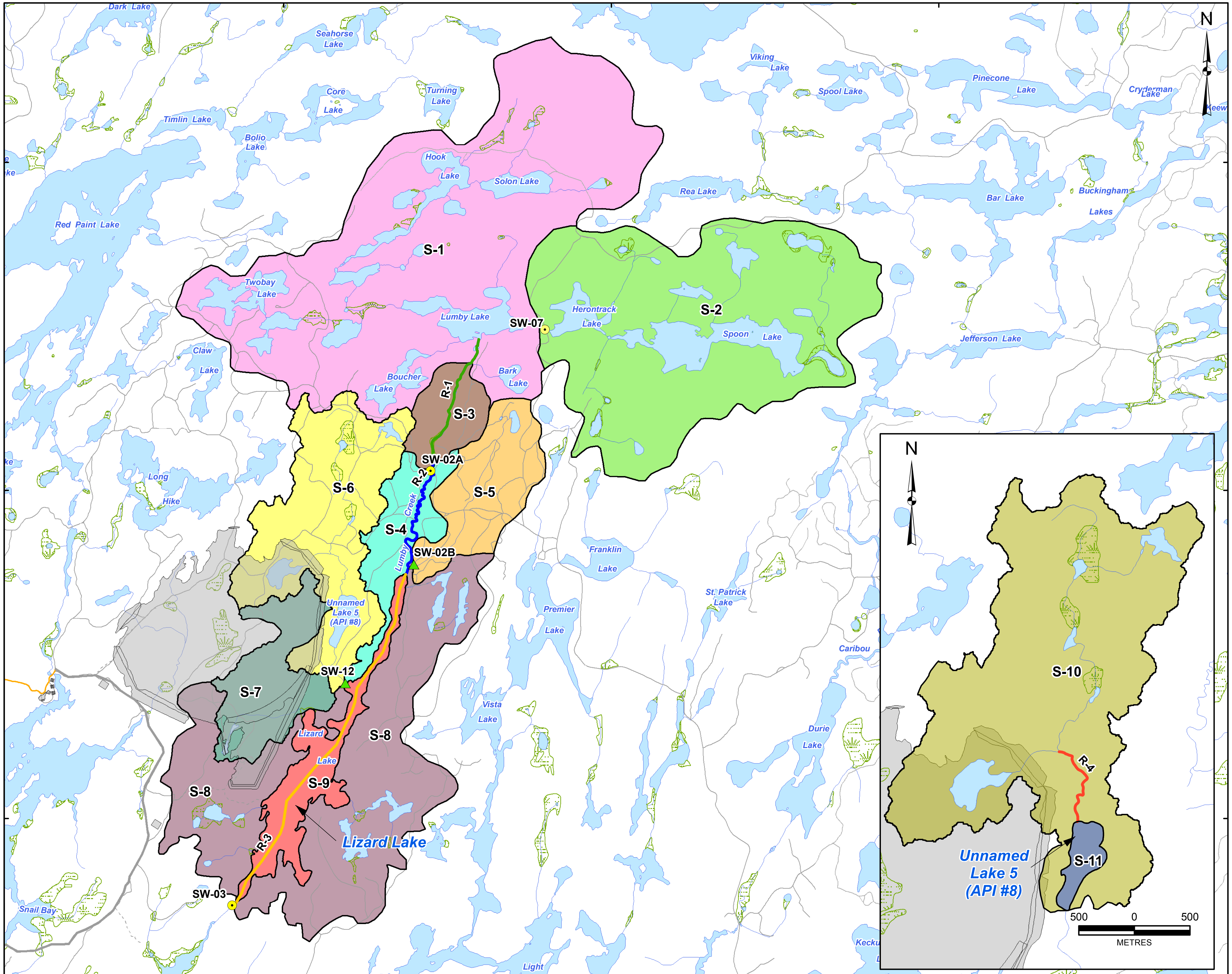

LEGEND

- Manual Gauging Station
- Recording Gauging Station
- Road
- Trail
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Facilities

Reaches

- R-1
- R-2
- R-3
- R-4

Subbasins

- S-1
- S-2
- S-3
- S-4
- S-5
- S-6
- S-7
- S-8
- S-9
- S-10
- S-11

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000
SCALE 1:60,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LIZARD LAKE AND UNNAMED LAKE 5 SUBWATERSHEDS

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	VERSION 2
DESIGN	CGE	14 Nov. 2008		
GIS	JO	6 Dec. 2013		
CHECK	AP	6 Dec. 2013		
REVIEW	THW	6 Dec. 2013		

Golder Associates
Mississauga, Ontario

FIGURE: 5.11-1

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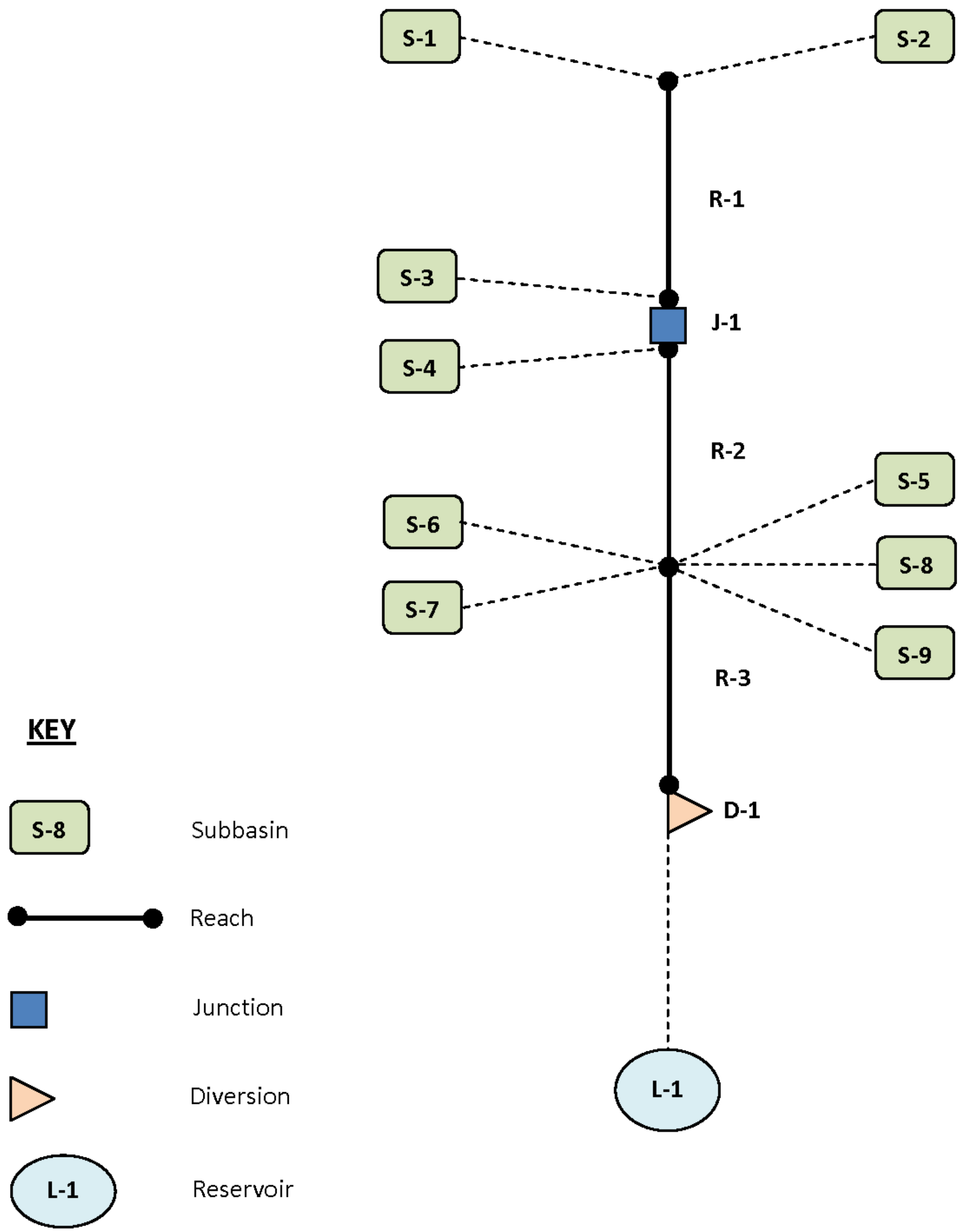

Figure 5.II-2: Lizard Lake Drainage Network

Figure 5.II-1 shows the subwatershed draining to the outlet of Unnamed Lake 5 (API #8) and Figure 5.II-3 shows the drainage network used to represent the subwatershed. This network was used to assess the potential changes in lake water levels in Unnamed Lake 5 (API #8). The network consisted of two subbasins, one reach, one diversion and one reservoir. A subbasin (S-11), a diversion (D-2), and a reservoir (L-2) were used to model the direct precipitation onto, the evaporative losses from, and the stage-storage-discharge relationship for Unnamed Lake 5 (API #8), respectively.

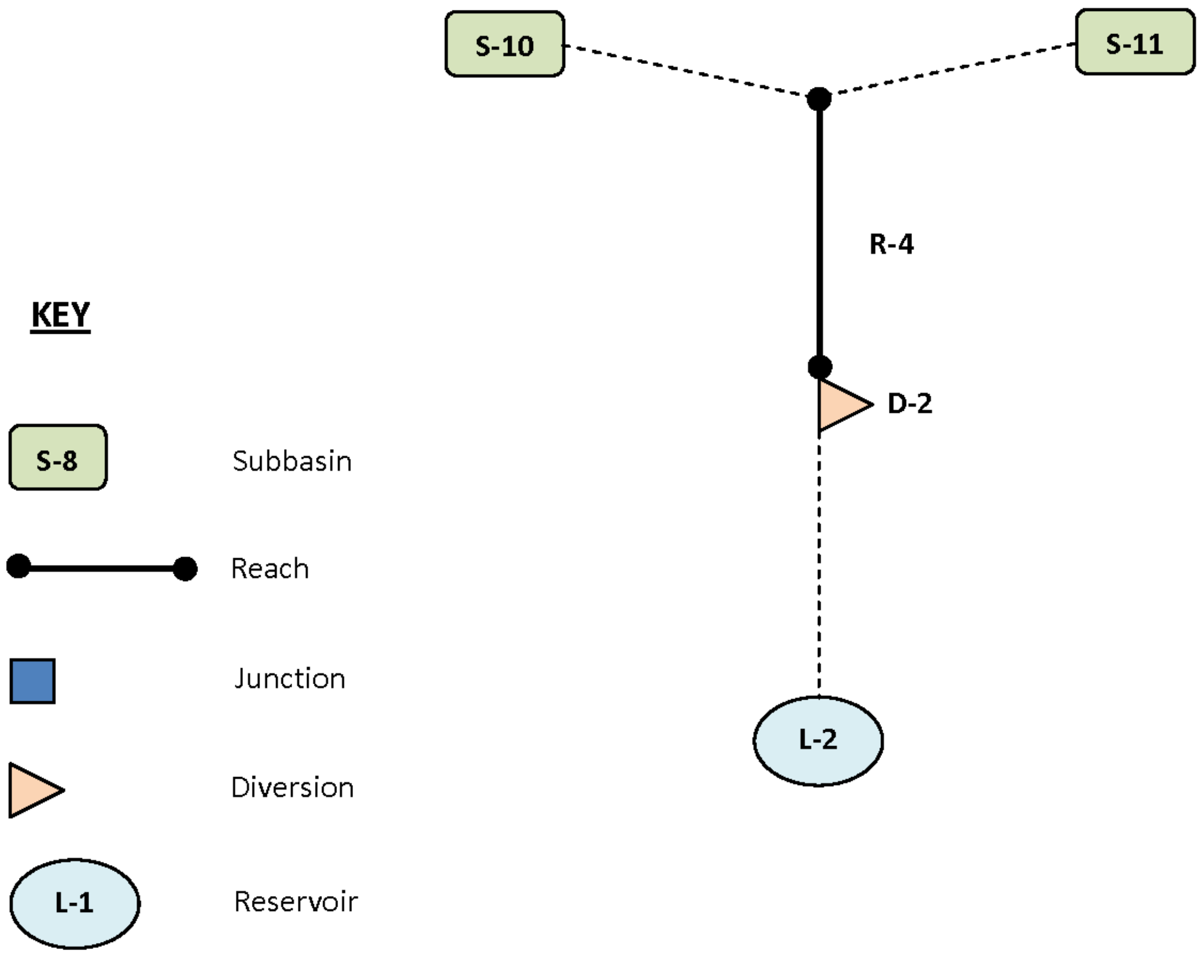

Figure 5.II-3: Unnamed Lake 5 (API #8) Drainage Network

3.1.2 Subbasins

Drainage areas for the subbasins in the Lizard Lake and Unnamed Lake 5 (API #8) drainage networks, under existing conditions and under conditions during Project operations, are shown in Table 5.II-A1 at the back of this Appendix.

Figure 5.II-4 shows, conceptually, the hydrological components and processes used to characterize the subbasins in the Lizard Lake and Unnamed Lake 5 (API #8) drainage networks.

Canopy Storage: Plants intercept precipitation, reducing the amount that falls to the ground surface, and the intercepted precipitation evaporates between precipitation events. **The Simple Canopy Method** in HEC-HMS was selected to represent canopy storage in the subbasins. In this method, all the precipitation is intercepted until the canopy storage capacity is filled; once the storage is filled, all other precipitation falls to the ground surface. The canopy consumes all potential evapotranspiration until the water in storage has been depleted. Unused potential evapotranspiration is then used by the surface depression and soil storage components (described below). Values assigned to parameters describing canopy storage in the subbasins are shown in Table 5.II-A2 at the back of this Appendix.

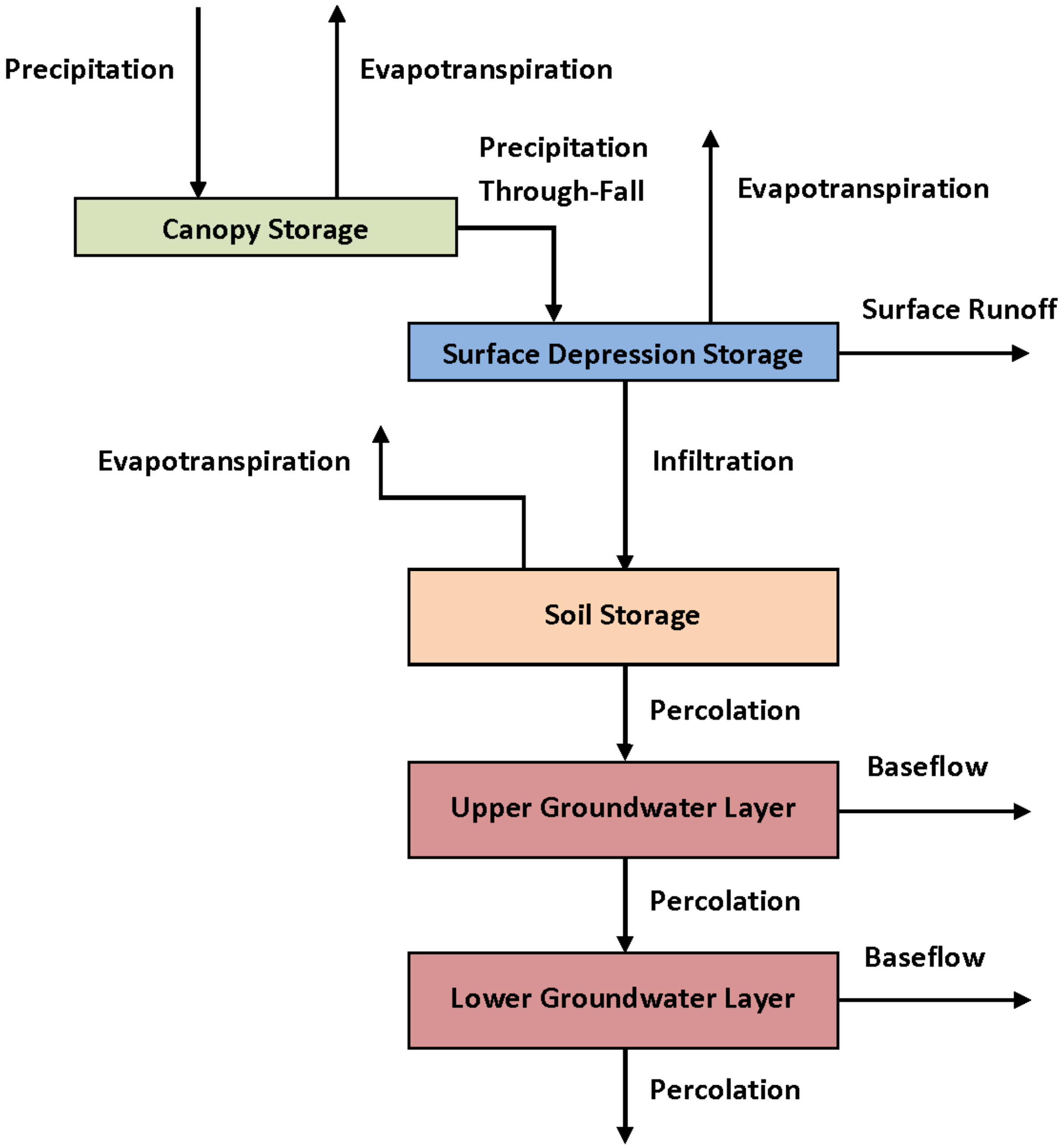

Figure 5.II-4: Hydrologic Components in Subbasins

Surface Depression Storage: The ground surface receives precipitation through-fall from the canopy. This accumulates in depression storage and infiltrates as the soil has capacity to accept water. Surface runoff occurs when the precipitation rate exceeds the infiltration rate, and the surface storage is filled. Precipitation that has accumulated in surface depression storage continues to infiltrate after precipitation stops and is subject to potential evapotranspiration. **The Simple Surface Method** in HEC-HMS was selected to represent surface depression storage. Values assigned to parameters describing surface depression storage in the subbasins are shown in Table 5.II-A3 at the back of this Appendix.

Infiltration and Percolation Losses: **The Soil Moisture Accounting Loss Method** in HEC-HMS was selected to represent infiltration and percolation losses from precipitation. The method uses three layers to represent the dynamics of water movement in the soil: a soil layer, an upper groundwater layer and a lower groundwater layer. The groundwater layers represent shallow interflow processes, and not aquifer processes. Water in surface depression storage infiltrates the soil layer, as the soil has capacity to accept water. The soil layer is subdivided into tension storage (storage that does not drain under gravity) and gravity storage. Water that infiltrates the soil layer first fills tension storage. From there it percolates into the upper groundwater layer (when tension storage is filled), or consumes any remaining potential evapotranspiration. Water percolating into the upper groundwater layer fills storage before percolating into the lower groundwater layer or contributing to lateral outflow (baseflow). Lateral outflow occurs when the percolation rate from the soil layer exceeds the percolation rate to the lower groundwater layer, and the storage in the upper groundwater layer is filled. Similarly, water percolating into the lower groundwater layer fills storage before percolating out of the system or contributing to lateral outflow. Lateral outflow occurs when the percolation rate from the upper groundwater layer exceeds the percolation rate out of the system, and the storage in the lower groundwater layer is filled. Values assigned to parameters describing infiltration and percolation losses in the subbasins are shown in Table 5.II-A4 at the back of this Appendix.

Surface Runoff: The program uses a transform method contained within the subbasins to convert excess precipitation from surface depression storage to surface runoff. **The Kinematic Wave Transform Method** in HEC-HMS was selected for hydrologic routing in the subbasins. A single plane was used to represent the pervious surface of each subbasin. The outflow from each plane was linked to a collector, representing the small open channels that are part of the drainage in the subbasin, and the outflow from each collector was linked to a main channel, representing the main stream in the subbasin. Outflows from planes and collectors are applied as lateral inflows to collectors and main channels, respectively. Values assigned to parameters describing the planes, collectors and channels under existing conditions, and under future conditions during Project operations, are shown in Table 5.II-A5 and Table 5.II-A6, respectively, at the back of this Appendix.

Baseflow: **The Linear Reservoir Baseflow Method** in HEC-HMS was selected to model the recession of baseflow after precipitation events. In the method, the infiltration loss described above is connected to the lateral outflows from the groundwater layers. Excess precipitation is routed through a number of groundwater reservoirs sequentially to model the attenuation of baseflow over time. Values assigned to parameters describing baseflow from the groundwater layers are shown in Table 5.II-A7 at the back of this Appendix.

3.1.3 Reaches

The reaches shown in Figure 5.II-2 and Figure 5.II-3 above conceptually represent segments of streams in the Lumby Creek drainage system; and receive the outflows from the main channels in the subbasins. **The Muskingum-Cunge Routing Method** in HEC-HMS was selected for hydrologic routing in the reaches, to account for the attenuation of flows due to storage in these channels. Values assigned to parameters describing the properties of the reaches are shown in Table 5.II-A8 at the back of this Appendix.

3.1.4 Junction

A junction was included in the Lizard Lake drainage network (Figure 5.II-1 and Figure 5.II-2) to represent the confluence of flows in reach ID R-1 and flows from subbasin ID S-3 at the baseline monitoring station SW-02A, (Appendix 5.I) in order to be able to compare simulated to observed data.

3.1.5 Diversions

Diversions were included in the drainage networks upstream of Lizard Lake and Unnamed Lake 5 (API #8), in order to model the evaporative losses from the surface areas of the lakes. Diverted flows represented the evaporative losses from the lake surfaces. **The Specified Flow Divert Method** in HEC-HMS was selected, in which a user-defined time series of discharges to be diverted can be entered. When the specified discharge exceeds the total inflow to the diversion, then the diversion is limited to the inflow volume. Daily time series of lake evaporation from Lizard Lake and Unnamed Lake 5 (API #8) were computed from a record of lake evaporation constructed for Environment Canada's climate station Atikokan 602379 (Hydrology TSD, Ver. 1, Section 4.2.1.1.3) and the surface areas of the lakes. Average monthly and annual lake evaporation is shown in Table 5.II-A9 at the back of this Appendix, together with similar total precipitation and potential evapotranspiration data for the Atikokan station.

3.1.6 Reservoirs

Lizard Lake and Unnamed Lake 5 (API #8) were modelled as reservoirs, and the **Outflow Curve Routing Method** in HEC-HMS was selected in order to input user-defined stage-storage-discharge relationships for the lakes. A stage-storage-discharge relationship for Lizard Lake was developed based on the rating curve derived for flow monitoring station SW-03 (Appendix 5.I) located at the lake outlet, and bathymetric survey data collected for the lake Golder (2012), during baseline data collection for the Project. Stage-storage-discharge data for Lizard Lake are presented in Table 5.II-A10 at the back of this Appendix.

The outflow from Unnamed Lake 5 (API #8) was not gauged, nor was a bathymetry survey of the lake completed. In order to develop a rating curve for the lake outlet, hydraulic modelling (backwater analysis to determine normal depth over a range of flows) was undertaken externally, using Version 4.10 of the River Analysis System developed by the United States Army Corps of Engineers Hydrologic Engineering Center (HEC-RAS). The hydraulic characteristics of the lake outlet and downstream channel were inferred from field observations of channel width, depth, obstructions and substrate, as well as overbank slopes and surrounding vegetation, that were collected during fish habitat mapping (Aquatic Environment TSD). The hydraulic model was calibrated using flows and water levels observed at the manual flow monitoring station SW-12 (Appendix 5.I), located approximately 0.7 km downstream of Unnamed Lake 5 (API #8) where the outflow enters Lizard Lake. A stage-storage relationship for the lake was developed based on field observations of lake depths that were also collected during fish habitat mapping. Table 5.II-A11 at the back of this Appendix presents stage-storage-discharge data used for hydrologic modelling of Unnamed Lake 5 (API #8).

3.2 Meteorologic Model

The same meteorologic model was applied to subbasins in the Lizard Lake and Unnamed Lake 5 (API #8) drainage networks. The model provides the meteorologic boundary conditions that act on the subbasins during a hydrologic simulation, and defines precipitation, evapotranspiration and snowmelt conditions.

Precipitation: **The Specified Hyetograph Method** in HEC-HMS was selected to model precipitation boundary conditions in the subbasins. A daily time series of total precipitation constructed for Environment Canada's climate station Atikokan 602379 (Hydrology TSD, Ver. 1, Section 4.2.1.1.1) was entered into the meteorologic model. Average monthly totals for the period 1982 to 2012 are shown in Table 5.II-A9 at the back of this Appendix, together with corresponding values for lake evaporation and potential evapotranspiration.

Evapotranspiration: **The Monthly Average Method** in HEC-HMS was selected to calculate evapotranspiration boundary conditions in the subbasins. The meteorologic model calculates potential evapotranspiration, and the subbasins compute actual evapotranspiration based on soil water limitations. A monthly time series of potential evapotranspiration was computed externally from latitude and temperature data for Environment Canada's Atikokan 602379 climate station (Hydrology TSD, Ver. 1, Section 4.2.1.1.3). Average monthly totals for the period 1982 to 2011 were entered into the meteorologic model; and are shown in Table 5.II-A9 at the back of this Appendix, together with coresponding values for total precipitation and lake evaporation.

Snowmelt: **The Temperature Index Method** in HEC-HMS was selected to simulate the accumulation and melt of the snowpack. The method used daily total precipitation and daily mean temperature records constructed for Environment Canada's Atikokan 602379 climate station (Hydrology TSD, Ver. 1, Section 4.2.1.1.1); average monthly values for the period 1982 to 2011 are shown in Table 5.II-A9 at the back of this Appendix. Other input parameters are shown in Table 5.II-A12, Table 5.II-A13 and Table 5.II-A14 at the back of this Appendix.

4.0 MODEL CALIBRATION

The hydrologic models of the Lizard Lake and Unnamed Lake 5 (API #8) subwatersheds were calibrated to flows observed at monitoring stations SW-02A, SW-02B, SW-03, SW-07 and SW-12, and to lake water levels observed at monitoring station SW-03, during baseline data collection from August 2010 to December 2011 (a period of 16 months) (Appendix 5.I). Monitoring stations SW-02A, SW-03 and SW-07 were recording stations and the models were calibrated to daily mean flows and lake water levels observed at these stations. Monitoring stations SW-02B and SW-12 were manual stations and only instantaneous flows observed at these stations were available for model calibration.

Model parameters describing surface depression storage, soil percolation, groundwater storage and percolation, and baseflow were adjusted to produce an acceptable fit (see discussion below) of simulated flows and lake water levels to the observed data at all the monitoring stations. Parameter calibration was an iterative process based on the following recommendations in Bennett (1998):

- For larger magnitude precipitation events, maximum infiltration rates were increased when simulated flows and lake water levels were greater than the observed values.
- For smaller magnitude precipitation events, when simulated flows were lower than the observed values, the depth of the soil layer (i.e. the total soil storage) was decreased so that the infiltration rate increased.
- If simulated runoff occurred more frequently than was observed, the depth of the tension zone in the soil layer (i.e. tension storage) was increased nearer to the depth of the soil layer (i.e. the total storage), to reduce evapotranspiration and percolation losses from, and thereby the infiltration rate into, the soil layer.
- The depths (i.e. groundwater storage) and percolation rates of the groundwater layers, as well as the transform and routing parameters were modified to refine the shape of groundwater flow contribution in the simulated hydrographs.
- Canopy storage and surface depression storage have less impact on the simulated hydrographs than parameters describing the soil and groundwater layers. Parameters describing these components were not adjusted during model calibration.
- Input parameters to compute the snowmelt component of the meteorological model were adjusted manually, rather than by using the optimization procedure in HEC-HMS to automatically estimate parameters.

Figure 5.II-5 to Figure 5.II-7 compare simulated and observed daily mean flows for stations SW-02A, SW-03 and SW-07; Figure 5.II-8 compares simulated and observed daily mean lake water levels for station SW-03. At all three stations, simulated values are overestimates of observed values in the first two to three months of the calibration period at all three stations. Thereafter, at stations SW-07 and SW-02A, simulated flows are generally overestimates of observed values during low flow periods, and are underestimates of observed values during high flow periods. At station SW-03, simulated flows and lake water levels are underestimates of observed values during the winter low flow period, and are typically overestimates of observed values in high flow periods.

Figure 5.II-9 and Figure 5.II-10 compare simulated daily mean flows for stations SW-02B and SW-12 to instantaneous flow measurements collected at these stations. Simulated flows are generally greater than instantaneous flows observed at the stations.

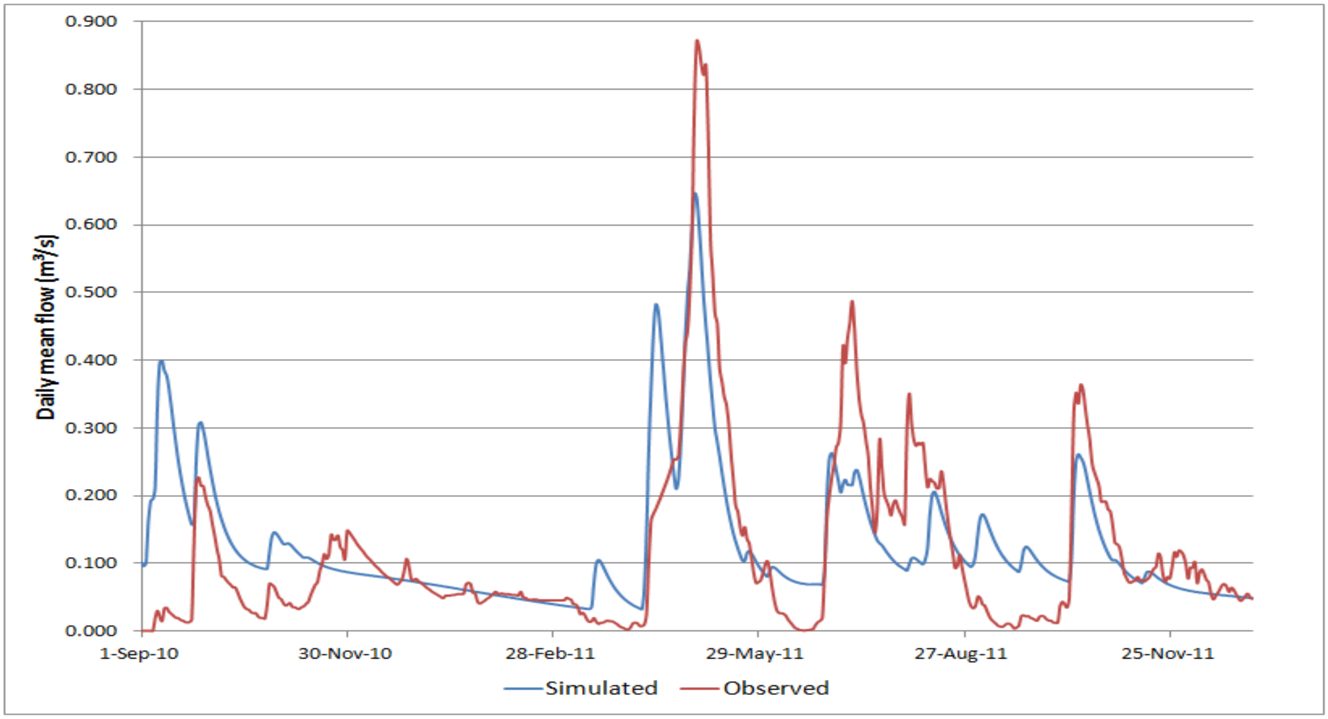

Figure 5.II-5: Comparison of Simulated and Observed Flows at Station SW-07

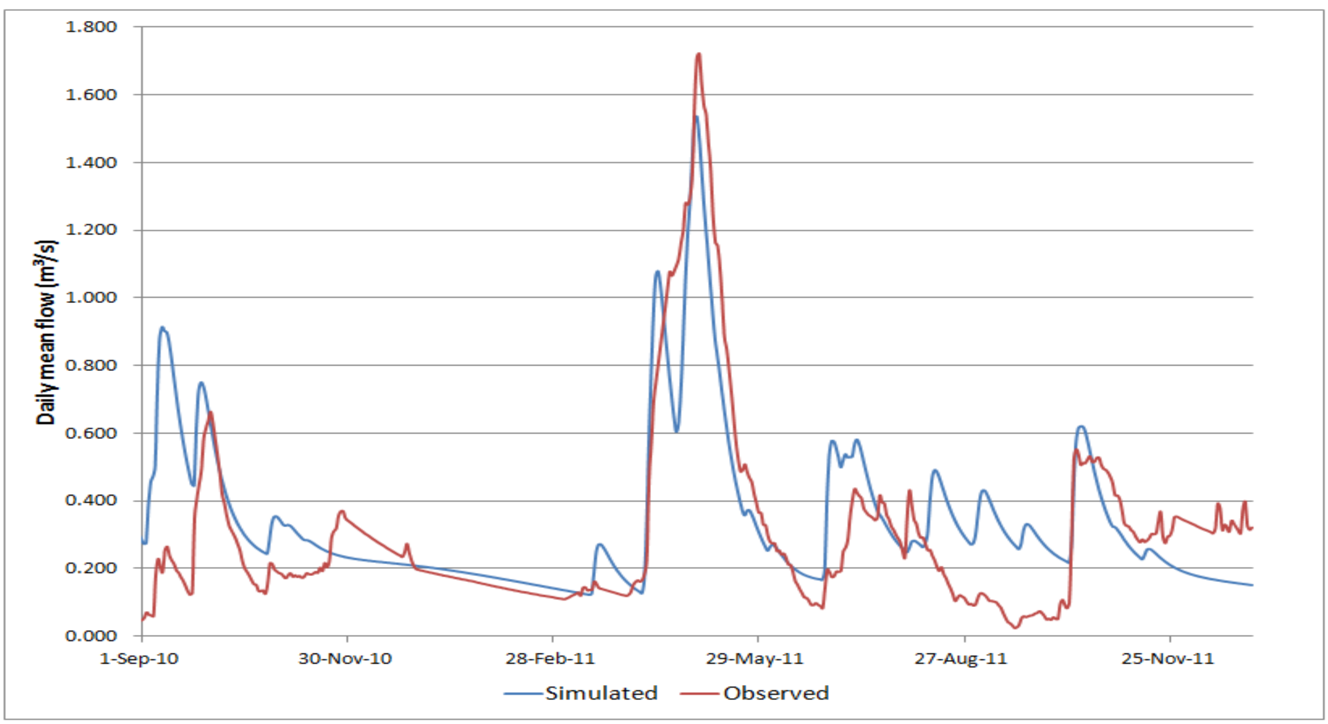

Figure 5.II-6: Comparison of Simulated and Observed Flows at Station SW-02A

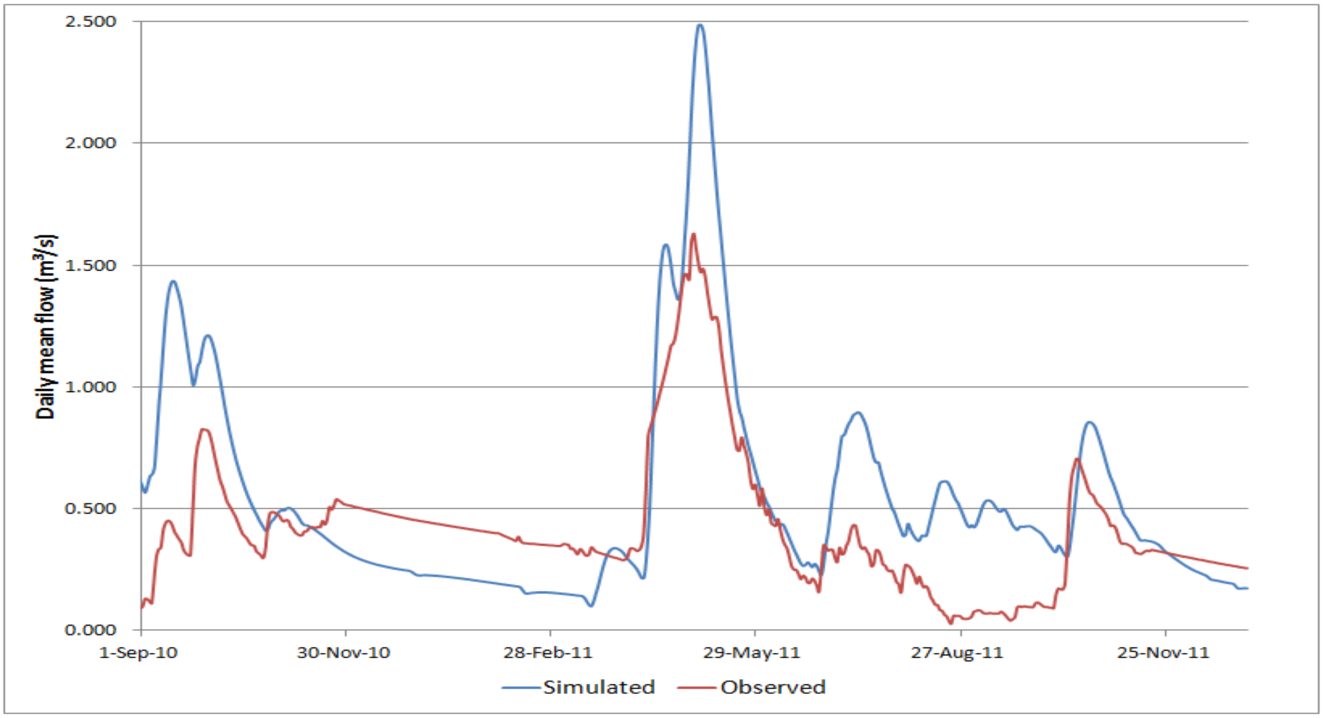

Figure 5.II-7: Comparison of Simulated and Observed Flows at Station SW-03

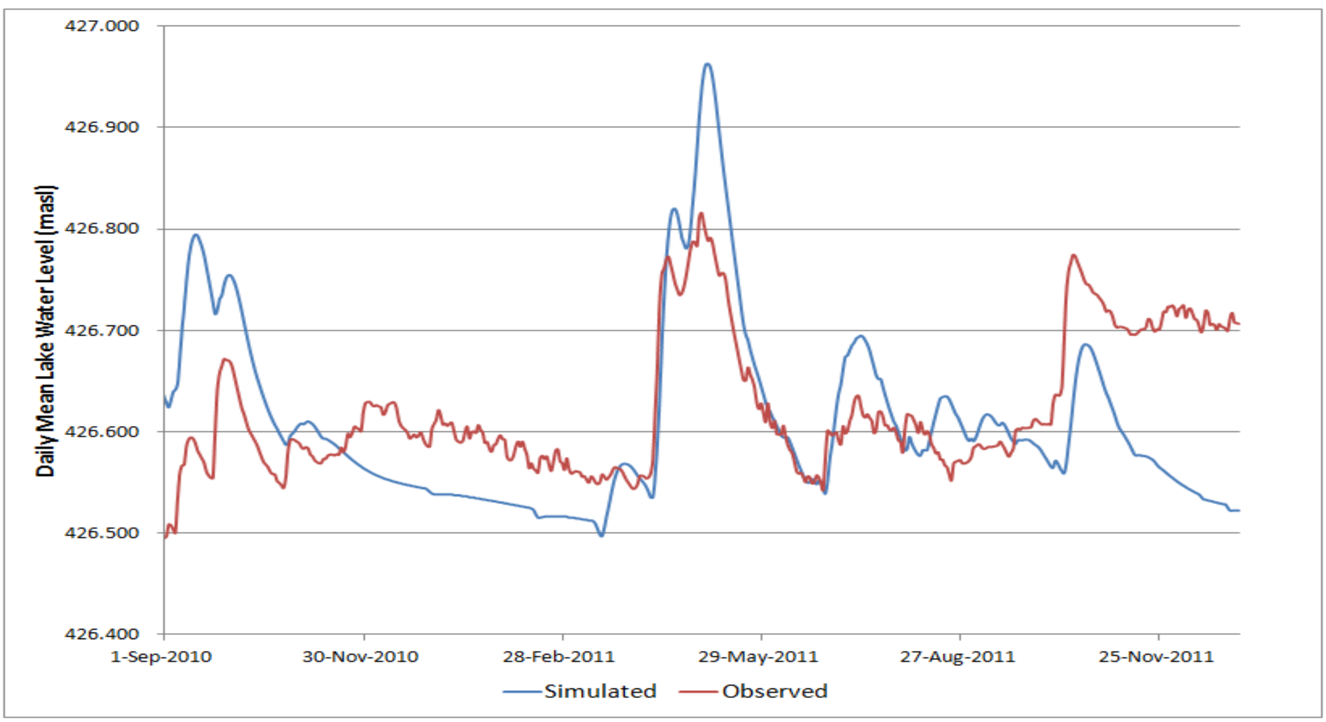

Figure 5.II-8: Comparison of Simulated and Observed Lake Water Levels at Station SW-03

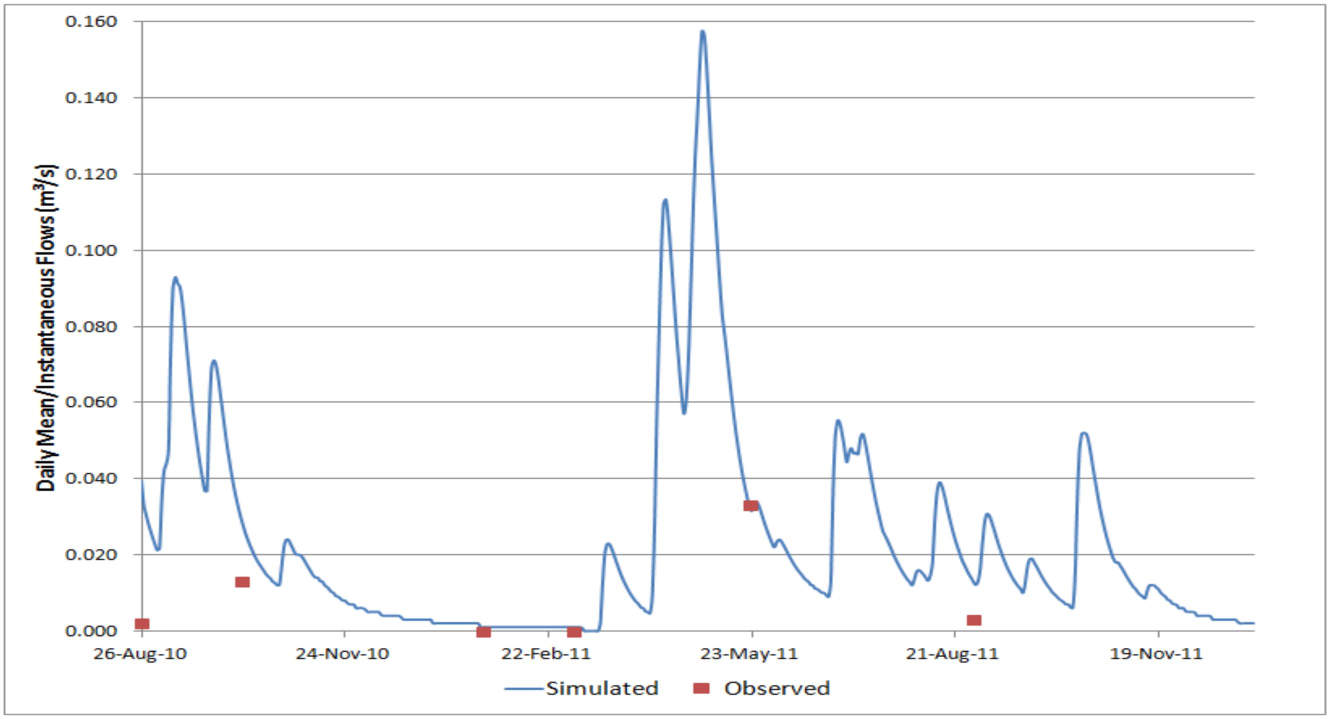

Figure 5.II-9: Comparison of Simulated and Observed Flows at Station SW-02B

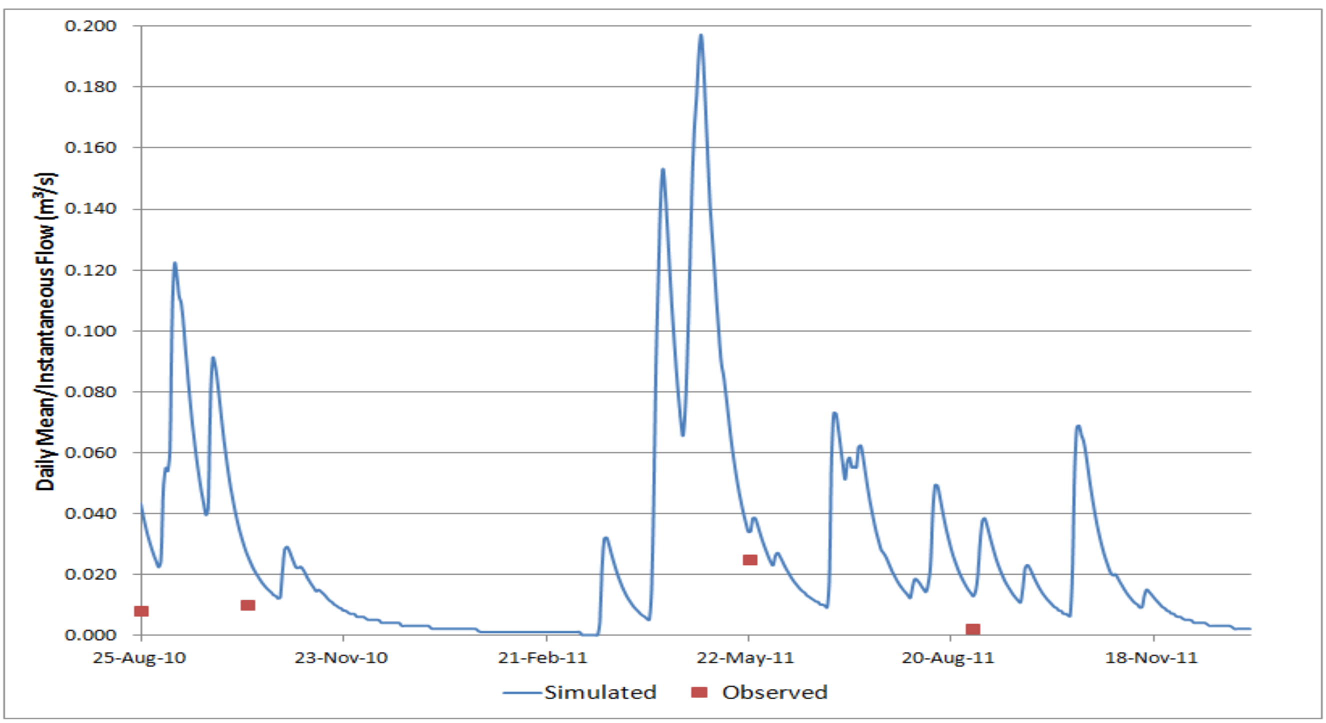

Figure 5.II-9: Comparison of Simulated and Observed Flows at Station SW-12

Table 5.II-1 compares summary statistics for simulated and observed flows and lake water levels at the recording stations over the calibration period.

Table 5.II-1: Statistics for Simulated and Observed Flows and Lake Water Levels

Summary Statistic	Time Series	Monitoring Station		
		SW-07	SW-02A	SW-03
Total Flow Volume (m^3)	Simulated	5,490,895	14,683,975	23,241,607
	Observed	4,859,104	12,836,020	17,617,270
Average Daily Mean Flow (m^3/s)	Simulated	0.128	0.346	0.546
	Observed	0.113	0.301	0.413
Average Daily Mean Lake Water Level (masl)	Simulated	--[(a)]	--[(a)]	426.611
	Observed	--[(a)]	--[(a)]	426.621

Note:

(a) Not applicable.

Total flow volumes and average daily mean flows at the monitoring stations calculated from the simulated data were greater than values calculated from the observed data. The percentage errors in the total flow volumes calculated from the simulated time series data are 13%, 14% and 32%, respectively, for monitoring stations SW-07, SW-02A and SW-03. Similar percentage errors were obtained for the average daily mean flows. The average daily mean lake water level calculated from the simulated data was slightly lower than the value calculated from the observed data. The error in the value calculated from the simulated data was only 0.010 m.

Table 5.II-2 shows values for criteria describing the goodness of fit of the simulated data to the observed data for the same stations.

Table 5.II-2: Goodness of Fit of Simulated to Observed Data

Station ID	Data Type	RMSE[(a)]	E[(b)]	R^{2}[(c)]
SW-07	Flow	0.004 m^3/s	0.487	0.499
SW-02A	Flow	0.008 m^3/s	0.589	0.618
SW-03	Flow	0.015 m^3/s	-0.294	0.541
SW-03	Lake Water Level	0.004 masl	-0.569	0.207

Note:

(a) Root mean square error, ranges from 0 to ∞, 0 signifies a perfect fit.

(b) Nash-Sutcliffe efficiency, ranges from -∞ to 1, 1 signifies a perfect fit.

(c) Coefficient of determination, ranges from 0 to 1, 1 signifies a perfect fit.

The root mean square errors (RMSE) in the simulated values for the stations approximate zero, which indicates a fairly good fit of simulated to observed data. The RMSEs represent less than 2% of the range in the observed values at the stations.

The Nash-Sutcliffe efficiency (E) of the simulated values for the stations are closer to one than to negative infinite, also indicating a fairly good fit of simulated to observed data. E values for stations SW-07 and SW-02A are greater than zero, whereas E values for station SW-03 are less than zero, which indicates a better fit of simulated to observed data for stations SW-07 and SW-02A.

The coefficients of determination (R^2) indicate that simulated flows for stations SW-02A and SW-03 provide a better fit to observed data, than simulated flows for station SW-07. Simulated lake water levels for station SW-03 show the worst fit of simulated to observed data, based on the R^2 value.

The deviation of simulated values from observed values at the stations may be explained in part by the following:

Modelling Assumptions

- The characteristics of the soil and groundwater layers are homogeneous throughout the subwatersheds.
- The subwatersheds are 100% pervious across their surface areas under existing conditions, and future conditions during Project operations.
- Storage provided by wetland areas in the subwatersheds has been neglected; channel cross-sections were weighted and adjusted to represent flow through wetland areas.
- Meteorological data collected at Environment Canada's Atikokan 602379 station is assumed to be representative of conditions across the subwatersheds.

Limitations in Observed Data

- Stations SW-07 and SW-03 were affected by beaver activity during baseline flow and lake water level monitoring. While best efforts were made to correct the observed data, error may have been introduced to the daily mean flows and lake water levels observed at these stations.
- All three stations were affected by ice from November 2010 to March 2011. Again, despite corrections being applied to the data, error may have been introduced to the daily mean flows and lake water levels observed at the stations.
- Measured flows were used to develop the rating curves for the stations. The maximum measured flows at stations SW-07, SW-02A and SW-03 represent only 41%, 65% and 46%, respectively, of the range in daily mean discharges computed for the stations. This increases the uncertainty in estimates of high flows at the stations.

5.0 MODEL VALIDATION

Validation of the hydrologic models of the Lizard Lake and Unnamed Lake 5 (API #8) subwatersheds could not be completed due to the short record of observed flow and lake water level data. Baseline data were collected in the subwatersheds over a period of less than two years, and were used for model calibration.

6.0 HYDROLOGIC SIMULATIONS

Hydrologic simulations of existing conditions, and future conditions under Project operations, in the Lizard Lake and Unnamed Lake 5 (API #8) subwatersheds were performed from July 1, 1982 to December 31, 2011 (a period of approximately 30 years), with a time interval of one day. Daily mean flows in Lumby Creek below Lizard Lake, and lake water levels in Lizard Lake and Unnamed Lake 5 (API #8), simulated under both scenarios, were compiled and monthly mean values were computed and compared.

Table 5.II-3 summarizes the simulated changes in monthly mean flows in Lumby Creek below Lizard Lake from existing conditions to future conditions under Project operations. The changes range from -7.7% to 0.0% with the greatest changes generally occurring in the spring and the smallest changes occurring in the winter.

Table 5.II-3: Changes in Monthly Mean Flows in Lumby Creek below Lizard Lake

Month	Maximum Change (%)	Minimum Change (%)
January	-3.3	-0.6
February	-2.2	0.0
March	-6.8	0.0
April	-7.7	-4.4
May	-7.6	-6.2
June	-7.5	-5.8
July	-7.4	-3.8
August	-7.1	-2.8
September	-6.7	-2.1
October	-6.8	-2.3
November	-6.1	-2.3
December	-5.5	-1.1
Overall	-7.7	0.0

Table 5.II-4 summarizes the simulated changes in monthly mean lake water levels in Lizard Lake from existing conditions to future conditions under Project operations. The changes range from -2.7 cm (May) to 0.0 cm (December through to March), with the greatest changes occurring during the spring and summer and the smallest changes occurring during the late fall/winter.

Table 5.II-4: Changes in Monthly Mean Lake Water Levels in Lizard Lake

Month	Maximum Change (cm)	Minimum Change (cm)
January	-0.3	0.0
February	-0.3	0.0
March	-1.0	0.0
April	-2.1	-0.2
May	-2.7	-0.5

Table 5.II-4: Changes in Monthly Mean Lake Water Levels in Lizard Lake (Continued)

Month	Maximum Change (cm)	Minimum Change (cm)
June	-2.1	-0.5
July	-2.0	-0.2
August	-2.2	-0.3
September	-2.3	-0.1
October	-1.9	-0.2
November	-1.3	-0.2
December	-0.8	0.0
Overall	-2.7	0.0

Table 5.II-5 shows the simulated changes in monthly mean lake water levels in Unnamed Lake 5 (API #8) from existing conditions to future conditions under Project operations. The changes range from -2.1 cm (May) to 0.0 cm (August), with the greatest changes occurring during the spring and summer and the smallest changes occurring during the late fall/winter.

Table 5.II-5: Changes in Monthly Mean Lake Water Levels in Unnamed Lake 5 (API #8)

Month	Maximum Change (cm)	Minimum Change (cm)
January	-0.6	-0.2
February	-0.3	-0.1
March	-1.0	-0.1
April	-1.7	-0.1
May	-2.1	-0.3
June	-1.6	-0.3
July	-1.5	-0.1
August	-1.7	0.0
September	-1.7	-0.1
October	-1.5	-0.2
November	-1.2	-0.3
December	-0.8	-0.2
Overall	-2.1	0.0

7.0 CONCLUSIONS & RECOMMENDATIONS

Flows and lake water levels in the Lumby Creek drainage system, in the Lynxhead-Turtle-Trap Bays watershed, are expected to be influenced by Project activities. The bounding (worst case) scenario for changes from existing conditions is expected to occur during the operations phase of the Project. Based on hydrologic modelling of the drainage system the following may be concluded:

- Changes in monthly mean flows ranging from -7.7% to 0.0% are possible in Lumby Creek below Lizard Lake;
- Changes in monthly mean flows are likely to be greatest during the spring, and smallest during the winter;
- Changes in monthly mean lake water levels ranging from -2.1 cm to 0.0 cm are expected in Unnamed Lake 5 (API #8);
- Changes in monthly mean lake water levels ranging from -2.7 to 0.0 cm are expected in Lizard Lake;
- Changes in monthly mean lake water levels are expected to be greatest during the spring and summer months and smallest during the late fall/winter.

Model calibration has been based on only 16 months of observed flow and lake water level data in the watersheds. Baseline data continues to be collected for the Project, and it is recommended that this additional data be used to refine model calibration and for model validation in the future.

Note that although model refinements are possible with additional calibration data, the predicted changes (relative differences) between existing conditions and future conditions during Project operations are not expected to vary appreciably. This is because potential errors in model calibration will apply equally to both scenarios; the only changes made to the model to simulate future conditions during Project operations are subbasin drainage areas, and lengths and slopes used in the Kinematic Wave Transform Method to convert excess precipitation to surface runoff.

8.0 REFERENCES

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Golder Associates Ltd. (2012). *Bathymetry and Side-Scan Sonar Survey Results*. Technical Memorandum, Doc. No. 2012-015, Project No. 10-1118-0020 (17000). March 7.

U.S. Army Corps of Engineers (2010). *Hydrologic Modelling System (HEC-HMS), User's Manual, Version 3.5*. Hydrologic Engineering Center. August.

TABLES

Table 5.II-A1: Subbasin Drainage Areas

Subbasin ID	Drainage Area (ha)	
	Existing Conditions	Future Conditions (Project Operations)
Lizard Lake		
S-1	2,024	2,024
S-2	1,440	1,440
S-3	136	136
S-4	138	138
S-5	290	290
S-6	620	473
S-7	273	19
S-8	1,359	1,324
S-9	178	178
Unnamed Lake 5 (API #8)		
S-10	555	427
S-11	18	18

Table 5.II-A2: Canopy Storage – Input Parameters (The Simple Canopy Method)

Subbasin ID	Initial Storage[a] (%)	Maximum Storage[b] (mm)
Lizard Lake		
S-1	0	4
S-2	0	4
S-3	0	4
S-4	0	4
S-5	0	4
S-6	0	4
S-7	0	4
S-8	0	10
S-9	0	0
Unnamed Lake 5 (API #8)		
S-10	0	4
S-11	0	0

Table 5.II-A3: Surface Depression Storage – Input Parameters (The Simple Surface Method)

Subbasin ID	Initial Storage[a] (%)	Maximum Storage[b] (mm)
Lizard Lake		
S-1	0	50
S-2	0	35
S-3	0	10
S-4	0	10
S-5	0	40
S-6	0	20
S-7	0	40
S-8	0	50
S-9	0	0
Unnamed Lake 5 (API #8)		
S-10	0	20
S-11	0	0

Table 5.II-A4: Infiltration and Percolation Losses – Input Parameters (The Soil Moisture Accounting Loss Method)

Subbasin ID	Percent Impervious (%)	Maximum Infiltration Rate[a] (mm/hr)	Soil Layer				Upper Groundwater Layer				Lower Groundwater Layer			
			Initial Storage([b]) (%)	Total Storage (mm)	Tension Storage[c] (mm)	Percolation Rate[d] (mm/hr)	Initial Storage([b]) (%)	Total Storage (mm)	Coefficient	Percolation Rate (mm/hr)	Initial Storage([b]) (%)	Total Storage (mm)	Coefficient	Percolation Rate (mm/hr)
Lizard Lake														
S-1	0	50	20	150	105	10	20	300	90	4	20	300	300	0.5
S-2	0	50	20	150	105	12	20	300	70	7	20	100	300	0.3
S-3	0	50	20	150	105	10	20	300	70	4	20	300	300	0.5
S-4	0	50	20	150	105	10	20	300	70	4	20	100	300	0.5
S-5	0	50	20	150	105	17	20	125	70	2	20	100	300	0.5
S-6	0	50	20	150	105	28	20	50	70	2	20	100	300	2.0
S-7	0	50	20	150	105	17	20	125	70	2	20	100	300	0.5
S-8	0	50	20	150	105	17	20	125	70	2	20	100	300	0.5
S-9	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]
Unnamed Lake 5 (API #8)														
S-10	0	50	20	150	105	28	20	50	70	2	20	100	300	2.0
S-11	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]

Note:

(a) Not applicable.

Table 5.II-A5: Surface Runoff–Input Parameters (The Kinematic Wave Transform Method), Existing Conditions

	Length (m)	Slope (m/m)	Roughness	Area (%)	Shape	Area (km^2)	Side slope (xH:1V)	Manning's n	Bottom width (m)
Lizard Lake									
Subbasin S-1									
Plane 1	490	0.059	0.8	100					
Collector	1,550	0.008			Trapezoid	1.64	1	0.08	81
Channel	8,000	0.002			Trapezoid		1	0.06	226
Subbasin S-2									
Plane 1	411	0.07	0.8	100					
Collector	1,364	0.015			Trapezoid	1.41	1		1
Channel	4,400	0.00045			Trapezoid		1	0.06	345
Subbasin S-3									
Plane 1	550	0.068	0.8	100					
Channel	1,900	0.0079			Trapezoid		1	0.06	20.1
Subbasin S-4									
Plane 1	583	0.054	0.8	100					
Channel	2,440	0.0008			Trapezoid		1	0.06	10
Subbasin S-5									
Plane 1	138	0.037	0.8	100					
Collector	300	0.018			Trapezoid	0.14	1	0.08	48
Channel	2,900	0.0086			Trapezoid		1	0.06	48
Subbasin S-6									
Plane 1	397	0.061	0.8	100					
Collector	1,133	0.004			Trapezoid	0.95	1	0.08	50
Channel	4,750	0.003			Trapezoid		1	0.06	58
Subbasin S-7									
Plane 1	925	0.031	0.8	100					
Channel	1,750	0.0057			Trapezoid		1	0.06	10
Subbasin S-8									
Plane 1	353	0.071	0.8	100					
Collector	1,490	0.008			Trapezoid	0.98	1	0.08	89
Channel	5,960	0.0003			Trapezoid		1	0.06	328.5
Subbasin S-9									
Plane 1	0	0	0	100					
Collector	0	0				0	0	0	0
Channel	0	0					0	0	0

Table 5.II-A5: Surface Runoff–Input Parameters (The Kinematic Wave Transform Method), Existing Conditions (Continued)

	Length (m)	Slope (m/m)	Roughness	Area (%)	Shape	Area (km^2)	Side slope (xH:1V)	Manning's n	Bottom width (m)
Unnamed Lake 5 (API #8)									
Subbasin S-10									
Plane 1	392	0.061	0.8	100					
Collector	1,150	0.004			Trapezoid	0.67	1	0.08	19
Channel	3,177	0.004			Trapezoid		1	0.06	58
Subbasin S-11									
Plane 1	0	0	0	100					
Collector	0	0				0	0	0	0
Channel	0	0					0	0	0

Table 5.II-A6: Surface Runoff - Input Parameters (The Kinematic Wave Transform Method), Project Operations

	Length (m)	Slope (m/m)	Roughness	Area (%)	Shape	Area (km^2)	Side slope (xH:1V)	Manning's roughness	Bottom width (m)
Lizard Lake									
Subbasin S-6									
Plane 1	391	0.055	0.8	100					
Collector	1,150	0.004			Trapezoid	0.67	1	0.08	19
Channel	4,750	0.003			Trapezoid		1	0.06	58
Subbasin S-7									
Plane 1	600	0.037	0.8	100					
Channel	150	0.0057			Trapezoid		1	0.06	10
Subbasin S-8									
Plane 1	342	0.071	0.8	100					
Collector	1,490	0.008			Trapezoid	0.98	1	0.08	89
Channel	5,960	0.0003			Trapezoid		1	0.06	328.5
Unnamed Lake 5 (API #8)									
Subbasin S-10									
Plane 1	400	0.065	0.8	100					
Collector	1,133	0.004			Trapezoid	0.95	1	0.08	50
Channel	3,177	0.004			Trapezoid		1	0.06	58

Table 5.II-A7: Baseflow – Input Parameters (The Linear Reservoir Baseflow Method)

Subbasin ID	Upper Groundwater Layer			Lower Groundwater Layer		
	Initial Baseflow (m^3/s)	Coefficient	Number of Reservoirs	Initial Baseflow (m^3/s)	Coefficient	Number of Reservoirs
Lizard Lake						
S-1	0	300	1	0	1,000	4
S-2	0	190	1	0.003	1,000	3
S-3	0	190	1	0	1,000	4
S-4	0	190	1	0.003	1,000	1
S-5	0	190	1	0	1,000	1
S-6	0	190	1	0	1,000	1
S-7	0	190	1	0	1,000	1
S-8	0	190	1	0	1,000	1
S-9	0	0	0	0	0	0
Unnamed Lake 5 (API #8)						
S-10	0	190	1	0	1000	1
S-11	0	0	0	0	0	0

Table 5.II-A8: Reaches – Input Parameters (The Muskingum-Cunge Routing Method)

Reach ID	Length (m)	Slope (m/m)	Manning's roughness	Bottom width (m)	Side slope
Lizard Lake					
R-1	1,900	0.0079	0.08	20.1	1
R-2	2,440	0.0008	0.08	10.0	1
R-3	5,960	0.0003	0.08	328.5	1
Unnamed Lake 5 (API #8)					
R-4	50	0.004	0.08	58	1

Table 5.II-A9: Atikokan Monthly Climatic Data

Month	Total Precipitation (mm)	Potential Evapotranspiration (mm)	Lake Evaporation (mm)	Air Temperature (°C)
Jan	31.7	0.0	3.6	-16.5
Feb	24.0	0.5	8.0	-12.9
Mar	34.9	4.3	26.3	-5.6
Apr	51.7	25.2	59.4	3.1
May	78.6	72.5	99.7	10.6
Jun	109.4	109.5	116.5	16.0
Jul	110.6	128.4	123.3	18.8
Aug	89.9	110.7	103.1	17.6
Sep	100.5	65.2	63.0	12.1
Oct	70.8	24.5	31.8	4.7
Nov	50.9	3.7	12.8	-4.3
Dec	35.5	0.1	5.2	-13.2
Year	788.5	544.5	652.9	2.6

Table 5.II-A10: Lizard Lake Stage-Storage-Surface Area-Discharge Relationship

Stage (masl)	Storage (m^3)	Surface Area (m^2)	Discharge (m^3/s)
426.900	11,564,356	1,998,425	2.073
426.850	11,433,614	1,989,763	1.762
426.800	11,304,350	1,981,100	1.466
426.750	11,176,548	1,972,438	1.185
426.700	11,050,190	1,963,775	0.923
426.650	10,925,261	1,955,113	0.680
426.600	10,801,744	1,946,450	0.459
426.550	10,679,624	1,937,788	0.266
426.500	10,558,884	1,929,125	0.107
426.450	10,439,510	1,920,462	0.003
426.400	10,321,485	1,911,800	0.000
426.367	10,244,320	1,906,083	0.000

Table 5.II-A11: Unnamed Lake 5 (API #8) Stage-Storage-Surface Area-Discharge Relationship

Stage (masl)	Storage (m^3)	Surface Area (m^2)	Discharge (m^3/s)
428.800	658,476	206,500	0.341
428.750	648,383	197,200	0.245
428.700	638,756	187,900	0.163
428.650	629,556	180,100	0.097
428.600	620,581	178,900	0.046
428.550	611,668	177,600	0.013
428.516	605,645	176,700	0.000

Table 5.II-A12: Snowmelt – Input Parameters, General (The Temperature Index Method)

Parameter	Value
PX Temperature	1.2 °C
Base Temperature	1 °C
Wet Meltrate	5 mm/°C-day
Rain Rate Limit	2 mm/day
ATI-Meltrate Coefficient	0.98
Cold Limit	20 mm/day
ATI-Cold Rate Coefficient	0.9995
Water Capacity	10%
Groundmelt	0 mm/day

Table 5.II-A-13: Snowmelt – Input Parameters, ATI Meltrate Function (The Temperature Index Method)

ATI (°C-day)	Meltrate (mm/°C-day)
0.0	0.00
0.3	0.00
0.5	0.00
1.0	6.00
5.0	2.71
8.0	2.37
15.0	2.12
30.0	1.97
50.0	1.91
100.0	1.86

Table 5.II-A-13: Snowmelt – Input Parameters, ATI Meltrate Function (The Temperature Index Method) (Continued)

ATI (°C-day)	Meltrate (mm/°C-day)
200.0	1.84
300.0	1.83
400.0	1.83

Table 5.II-A-14: Snowmelt – Input Parameters, Subbasin Elevation Bands (The Temperature Index Method)

Subbasin ID	Percent of Subbasin (%)	Average Elevation (masl)	Initial Snow Water Equivalent (mm)	Initial Cold Content (mm)	Initial Liquid Water (mm)	Initial Cold Content ATI (°C)	Initial Meltrate ATI (°C-day)
Lizard Lake							
S-1	100	482.50	0	0	0	0	0
S-2	100	465.00	0	0	0	0	0
S-3	100	457.50	0	0	0	0	0
S-4	100	455.00	0	0	0	0	0
S-5	100	452.50	0	0	0	0	0
S-6	100	450.00	0	0	0	0	0
S-7	100	445.00	0	0	0	0	0
S-8	100	445.00	0	0	0	0	0
S-9	100	426.50	0	0	0	0	0
Unnamed Lake 5 (API #8)							
S-10	100	450.00	0	0	0	0	0
S-11	100	430.00	0	0	0	0	0

\\golder.gds\gal\mississauga\active\2013\1118\13-1118-0010 osisko-hammond reef - ea support\006 environmental\2015 ea revision\01 tsds\hydrology tsd\supplemental information\appendix 5.ii\03 appendix 5.ii.docx

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INFORMATION REQUEST – TC-6

Source: Transport Canada

Summary of Comment

The legend does not include a definition of the symbols 'F' and 'P'. Are these supposed to be the fibre optics and project transmission line?

Potential Environmental Effects

Clarification

Proposed Action

Suggest these definitions be added to the legend.

Reference to EIS

Hydrology TSD, Version 1, Figure: 7-1, page 167

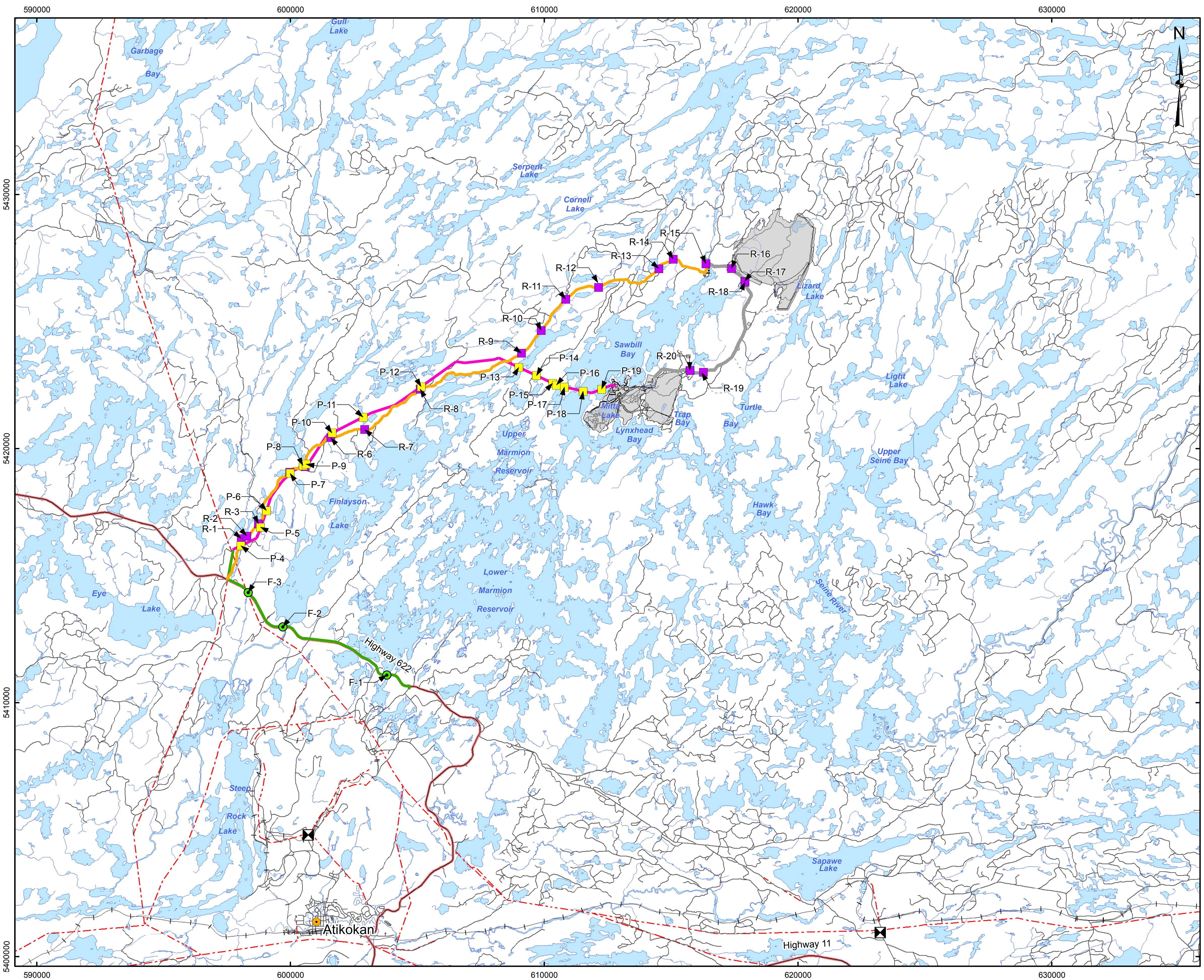
Response

A revised Figure 7-1 is attached with the following amendments:

- The symbols in the legend will be changed to show road crossings, project transmission line/fibre optics line crossings, and fibre optics line only crossings.
- Crossing ID #s B-1, B-2, B-3 and AF-2 will be renumbered to read R-16, R-17, R-18 and R-20 respectively.
- As per Information Request TC-8, crossing ID # F-4 will be added to the figure and renumbered as R-19. Crossing ID # AF-5 is already shown in the figure; it was incorrectly labelled as #AF-2.

Attachments

Revised Figure: 7-1 Water Crossings



LEGEND

- City/Town
- R Road Crossing
- F Fibre Optics Line Crossing
- P Project Transmission / Fibre Optics Line Crossing
- Existing Power Transmission Station
- Provincial Highway
- Road
- Trail
- Existing Railway
- Power transmission line
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Fibre Optics Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000 6,000 8,000
SCALE 1:150,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

WATER CROSSINGS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	VERSION 2
DESIGN	CGE	14 Nov. 2008		
GIS	JO	13 Jun. 2013		
CHECK	CC	13 Jun. 2013		
REVIEW	THW	13 Jun. 2013		

FIGURE: 7-1

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INFORMATION REQUEST – TC-7

Source: Transport Canada

Summary of Comment

The first column of the table states "Watercourse ID". Is this supposed to be "Watershed ID" (which would therefore relate back to the watershed figure)?

Potential Environmental Effects

Clarification.

Proposed Action

Suggest that this first column heading be clarified. It would also be very helpful if there was a corresponding map identifying the sample locations. In its current form, one would have to plot the UTM coordinates to ascertain the tributary location.

Reference to EIS

Hydrology TSD, Version 1, Section 7.2.2.1, Table 7-1, pages 170-172

Response

The heading for the first column should read 'Watershed ID'. The watershed ID's correspond to the watersheds in Figure 2-4 on page 20 in Section 2.1.4.

A new Figure: TC-7, Site Scale Watercourses, showing the UTM coordinates at the watershed outlets from Table 7-1 is attached.

Attachments

New Figure: TC-7, Site Scale Watercourses

LEGEND

- Sample Location
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Local Watershed Boundary

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000
SCALE 1:50,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SITE WATERSHEDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	VERSION 2
DESIGN	CGE	14 Nov. 2008	FIGURE: TC-7	
GIS	JO	12 Jun. 2013		
CHECK	CC	12 Jun. 2013		
REVIEW	THW	12 Jun. 2013		

G:\Projects\2013\13-1118-0010_Osisko_Hammond_Reef\GIS\MXDs\Reporting\Hydrology\SiteWatershedMap.mxd

INFORMATION REQUEST – TC-10

Source: Transport Canada

Summary of Comment

Although this table outlines project activities and the potential impacts to water bodies in general, it would be very helpful to have another table that specifically identifies each water body within the infrastructure feature and the impact of this structure/work on the water body.

Potential Environmental Effects

This information would provide a clearer understanding of the proposed works as they relate to each of the water bodies.

Proposed Action

A table such as Table 3-5 from the Aquatic Environment TSD, Ver. 1, (but tailored to navigable waters rather than fish) would be helpful. Please also include details of the actual works. For example: how Mitta Lake will be drained and how the TMF will be constructed to ensure that there is no seepage of materials from the site into adjacent navigable water bodies.

Please also include a column documenting any known navigational use of the water bodies and access to those water bodies (e.g. road, trails, portage, etc.).

Reference to EIS

Hydrology TSD, Version 1, Section 7.3.1, Table 7-8 on pages 177 to 181

Response

Tables 1 and 2 below provide information on the predicted changes to navigable watercourses and water bodies, respectively, in the Local Study Area during the operations phase of the Project. The operations phase is identified as the bounding (worst case) scenario for navigability in Section 7.3.1 on pages 177 to 182.

Table 1: Predicted Changes to Watercourses in the Local Study Area during the Operations Phase

Watercourse[1]	Mine Facility	Project Activity	Predicted Change
B	Mine Site Road	Transport of people and materials	Obstruction (width, depth and height restrictions) due to upgraded road crossings
	Tailings Management Facility (TMF)	Progressive expansion of the TMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 85%; watercourse lost
		Runoff collection from the TMF footprint	
C	Mine Site Road	Transport of people and materials	None; road alignment does not cross watercourse, and reduction in flows and water levels due to the reduction in tributary drainage area will be very small
		Runoff collection from Mine Site Road	

Watercourse[1]	Mine Facility	Project Activity	Predicted Change
E	Mine Site Road	Transport of people and materials	None; road alignment does not cross watercourse, and reduction in flows and water levels due to the reduction in tributary drainage area will be very small
		Runoff collection from Mine Site Road	
F	Mine Site Road	Transport of people and materials	Obstruction (width, depth and height restrictions) due to upgraded road crossing; very small reduction in flows and water levels due to the reduction in tributary drainage area
		Runoff collection from Mine Site Road	
H	Mine Site Road	Transport of people and materials	None; road alignment does not cross watercourse, and reduction in flows and water levels due to the reduction in tributary drainage area will be very small
		Runoff collection from Mine Site Road	
I	East Pit	Progressive expansion of the east pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 100%; watercourse lost
		Mine dewatering in the east pit footprint	
	Waste Rock Management Facility (WRMF)	Progressive expansion of the WRMF footprint	
		Runoff collection from the WRMF footprint	
J	Ore Processing Facility	Runoff collection from the ore processing facility footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 98%; watercourse lost
K	West Pit	Progressive expansion of the west pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 99%; watercourse lost
		Mine dewatering in the west pit footprint	
	East Pit	Progressive expansion of the east pit footprint	
		Mine dewatering in the east pit footprint	
L	Overburden Stockpile	Progressive expansion of the overburden stockpile footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 98%; watercourse lost
		Runoff collection from the overburden stockpile footprint	
	WRMF	Progressive expansion of the WRMF footprint	
		Runoff collection from the WRMF footprint	

Watercourse[1]	Mine Facility	Project Activity	Predicted Change
N	Mine Site Road	Transport of people and materials	None; road alignment does not cross watercourse, and reduction in flows and water levels due to the reduction in tributary drainage area will be very small
		Runoff collection from Mine Site Road	
Q	TMF	Progressive expansion of the TMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 95%; watercourse lost
		Runoff collection from the TMF footprint	
R	TMF	Progressive expansion of the TMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 24%
		Runoff collection from the TMF footprint	
AB	East Pit	Progressive expansion of the east pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 68%
		Mine dewatering in the east pit footprint	
	WRMF	Progressive expansion of the WRMF footprint	
		Runoff collection from the WRMF footprint	
AD	East Pit	Progressive expansion of the east pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 86%; watercourse lost
		Mine dewatering in the east pit footprint	
	Low Grade Ore Stockpile	Progressive expansion of the low grade ore stockpile footprint	
		Runoff collection from the low grade ore stockpile footprint	
AF	Mine Site Road	Transport of people and materials	Obstruction (width, depth and height restrictions) due to upgraded road crossing; reduction in flows and water levels due to reduction in tributary drainage area of up to 41%
		Runoff collection from Mine Site Road	
	WRMF	Progressive expansion of the WRMF footprint	
		Runoff collection from the WRMF footprint	
AH	WRMF	Progressive expansion of the WRMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 53%
		Runoff collection from the WRMF footprint	
AI	West Pit	Progressive expansion of the west pit footprint	Reduction in flows and water levels due to reduction in

Watercourse[1]	Mine Facility	Project Activity	Predicted Change
		Mine dewatering in the west pit footprint	tributary drainage area of up to 92%; watercourse lost
AJ	Emulsion Plant and Detonator Storage Area	Runoff collection from the emulsion plant and detonator storage area footprint	None; any reduction in flows and water levels due to the reduction in tributary drainage area will be very small
AK	WRMF	Progressive expansion of the WRMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 42%
		Runoff collection from the WRMF footprint	
AL	Overburden Stockpile	Progressive expansion of the overburden stockpile footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 57%
		Runoff collection from the overburden stockpile footprint	
AM	Overburden Stockpile	Progressive expansion of the overburden stockpile footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 39%
		Runoff collection from the overburden stockpile footprint	
AN	Low Grade Ore Stockpile	Progressive expansion of the low grade ore stockpile footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 64%
		Runoff collection from the low grade ore stockpile footprint	
AP	East Pit	Progressive expansion of the east pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 64%
		Mine dewatering in the east pit footprint	
	Ore Processing Facility	Runoff collection from the ore processing facility footprint	
AQ	West Pit	Progressive expansion of the west pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 43%
		Mine dewatering in the west pit footprint	
AR	West Pit	Progressive expansion of the west pit footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 73%
		Mine dewatering in the west pit footprint	
Sawbill Creek	Access Road	Transport of people and materials	Obstruction (width, depth and height restrictions) due to upgraded road crossing
Lumby Creek	TMF	Progressive expansion of the TMF footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 6.9%; a maximum predicted reduction in monthly flows of 7.7%
		Runoff collection from the TMF footprint	

Watercourse[1]	Mine Facility	Project Activity	Predicted Change
Seine River below Raft Lake Dam	All Mine Facilities	Progressive expansion of the Project footprint	Reduction in flows and water levels due to reduction in tributary drainage area of up to 0.33%; a maximum predicted reduction in monthly flows of 4.9%
		Runoff collection from the Project footprint	
		Water taking for potable and process water supply	
		Treated sewage and waste-water effluent	

Table 2: Predicted Changes to Water Bodies in the Local Study Area during the Operations Phase

Water Body	Mine Facility	Project Activity	Predicted Change
Mitta Lake (API #12)	West Pit	Runoff collection from footprint of west pit	Lake dewatered and sediment from the lake bottom removed and stockpiled during the construction phase; water body lost
Unnamed Lake #3 (API #11)	WRMF	Infilling with waste rock	Water body lost
		Runoff collection from footprint of WRMF	
Unnamed Lake #1 (API #13)	Ore Processing Facility	Use as the Process Plant Collection Pond; part of the water collection system	Water body lost
		Runoff collection from Ore Processing Facility and open pit	
Unnamed Lake #4 (API #2)	TMF	Infilling with tailings Runoff collection from footprint of TMF	Water body lost
Unnamed Lake #5 (API #8)	TMF	Progressive expansion of TMF footprint	Reduction in inflows, outflows and water levels due to reduction in tributary drainage area of up to 30%; a maximum predicted reduction in monthly water levels of 2.1 cm
		Runoff collection from footprint of TMF	
Lizard Lake	TMF	Progressive expansion of TMF footprint	Reduction in inflows, outflows and water levels due to reduction in tributary drainage area of up to 6.9%; a maximum reduction in monthly water levels of 2.7 cm
		Runoff collection from footprint of TMF	

Water Body	Mine Facility	Project Activity	Predicted Change
Upper Marmion Reservoir	All Mine Facilities	Progressive expansion of Project footprint	Reduction in inflows, outflows and water levels due to reduction in tributary drainage area of up to 0.33%; a maximum reduction in monthly water levels of 9.0 cm
		Runoff collection from Project footprint	
		Water taking for potable and process water supply	
		Treated sewage and waste-water effluent	

[1] Watercourses identified by a letter correspond to the main drainage channels in site watersheds identified by the same letter.

Mitta Lake will be drained by pumping with flows used to satisfy construction water requirements at the mine site and TMF, and to provide start-up water in the TMF Reclaim Pond.

The TMF will be contained by dams constructed from rockfill. The dams will be lined with a geomembrane filter to the starter dam height to prevent seepage losses during the early stages of mining. At higher stages, a beach will have developed which will restrict seepage losses from the TMF. A seepage collection system will be constructed against the toe of the dams around the perimeter of the TMF, and water collected will be pumped back into the facility.

Two water bodies within the study area are actively used for navigational purposes: Lizard Lake and Upper Marmion Reservoir. Access to Lizard Lake is through a boat launch approximately 10 km down Lizard Lake Road, the turnoff for which is located at the 35 km mark on Premier Road. Access to Upper Marmion Reservoir through the following five boat launches:

- The Anderson Dam bridge, located directly off Highway 622, approximately 1 km past the Atikokan Generating Station. Provides access via Lower Marmion Reservoir.
- The Sluice Gates via an access road off Highway 622.
- The Raft Lake Dam located approximately 25 km down an access road from Highway 622.
- Upper Seine Bay located approximately 40 km down Premier Road.
- Lower Seine Bay located approximately 10 km down Sapawe Road.

TECHNICAL MEMORANDUM

DATE December 11, 2013 **PROJECT No.** 13-1118-0010

TO Alexandra Drapack
Osisko Hammond Reef Gold Ltd. **DOC No.** **030 (Rev 0)**

CC Adam Auckland and Ken DeVos

FROM Adriana Parada and Terry Winhold **EMAIL** Adam_Auckland@golder.com

OSISKO HAMMOND REEF GOLD (OHRG) PROJECT – MARMION RESERVOIR OUTFLOWS AND WATER LEVELS DURING LOW WATER YEARS

1.0 INTRODUCTION

This technical memorandum has been prepared in response to questions raised during a teleconference on January 28, 2013 with Brookfield Renewable Energy Group, H2O Power LP, Ontario Power Generation, Ontario Ministry of Natural Resources (MNR), Osisko Hammond Reef Gold Ltd. (OHRG) and Golder Associates Ltd. (Golder). Concerns were expressed with regard to the potential effects of the proposed Hammond Reef Gold Project on inflows to Upper Marmion Reservoir, and on the ability to achieve reservoir management objectives with respect to minimum outflows and water levels in the reservoir, in low water years. This memorandum outlines the results of water balance modelling of the Project influenced condition during the specific low water years of 1998 and 2010.

2.0 WATER BALANCE MODELLING

Potential changes in the outflows and water levels in Upper Marmion Reservoir were assessed using spreadsheet monthly lake water balance models of the baseline condition and of the Project influenced condition. Two modelling approaches were employed:

- Continuous simulation of outflows from the reservoir over a 27-year period from 1984 to 2010 using historic time series of available hydrologic data, and
- Single year lake water balance modelling of the year 2010 to simulate fluctuations in water levels. Note that single year water balance modelling was not carried out for 1998 due to the absence of recorded (observed) outflow data for Lac des Mille Lacs.

In both cases, the Project water taking scenario in the dry year with a 100-year return period was assumed, to provide conservative results.

Continuous simulation of outflows from the reservoir was carried out using recorded outflows from Lac des Mille Lacs, recorded water levels in Upper and Lower Marmion Reservoirs, estimates of rainfall plus snowmelt and evaporation for Atikokan and assuming the target operating rules as described in Section 4.2.1.2.7 of the Hydrology TSD. The modelled outflows for the baseline conditions were compared to the modelled outflows

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under the Project influenced conditions for 1998 and 2010. The modelled outflows for the baseline conditions were also compared to recorded (observed) outflows from the reservoir, for the purposes of model validation. The main observations derived from the continuous water balance modelling results are presented in Section 3.0.

The single year water balance developed for 2010 employed recorded outflows from Lac des Milles Lacs, and recorded outflows from Upper Marmion Reservoir. Given that the recorded outflow data for Lac des Milles Lacs were not available beyond August, 2010, the full year of operation used in the water balance was set between September 2009 and August 2010. The water levels modelled for the baseline conditions were compared to the water levels modelled for the Project influenced condition. The modelled outflows for the baseline conditions were also compared to the recorded (observed) outflows for the purpose of model validation. The main observations derived from the single year water balance modelling results are presented in Section 3.0.

3.0 WATER BALANCE RESULTS

Figure 1 and Figure 2 show the results of continuous water balance modelling for the years 1998 and 2010, respectively. The figures compare the modelled outflows for the baseline conditions and the Project influenced condition for both years, and the modelled and recorded (observed) outflows for the baseline conditions.

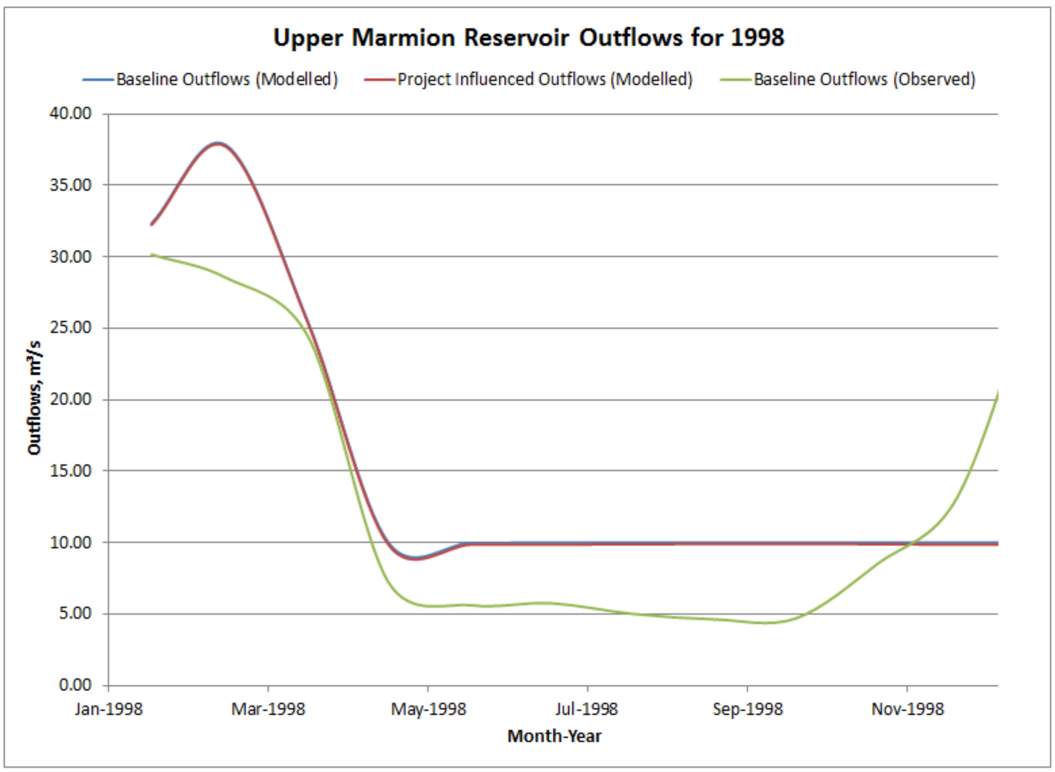

Figure 1: Continuous Water Balance Model Results - Upper Marmion Reservoir Outflows -1998

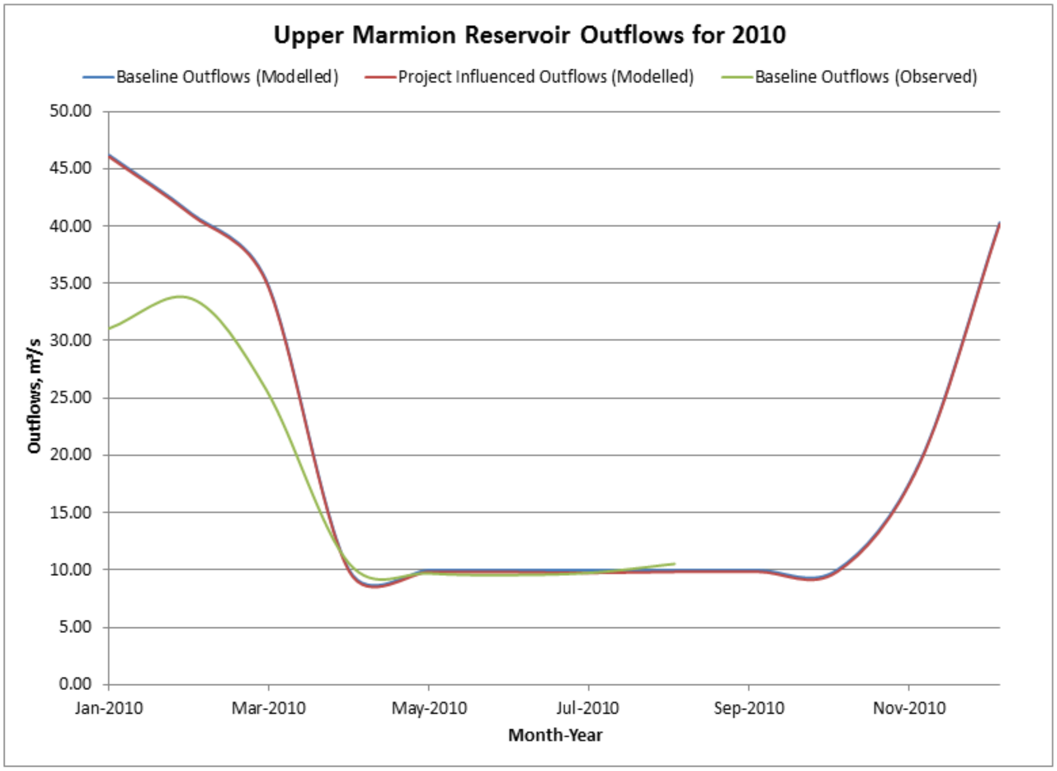

Figure 2: Continuous Water Balance Model Results - Upper Marmion Reservoir Outflows -2010

The following main observations derive from the continuous water balance modelling results:

- For the specific dry years selected of 1998 and 2010, the plotted data clearly and consistently shows the small difference in outflows between the modelled baseline conditions and the modelled Project effects conditions.
- For the year 1998, the model results follow the pattern of observed (recorded data) outflows fairly closely. However the modelled flows more closely adhere to the 10 m^3/s minimum outflow requirement under the current operating guidelines. The recorded flows indicate that Raft Lake Dam outflows were around 5 m^3/s for the entire summer.
- For the year 2010, the model results follow the pattern of observed (recorded data) outflows fairly closely. In fact, for most of the spring/summer season, the modelled and observed flows are both at the 10 m^3/s minimum outflow requirement. Note that the recorded data received (in this case provided by Brookfield) only extends to August.

Figure 3 shows the results of the single year water balance model for 2010. The figure compares the modelled water levels for the baseline conditions and the Project influenced condition, and the modelled and recorded (observed) outflows for the baseline conditions.

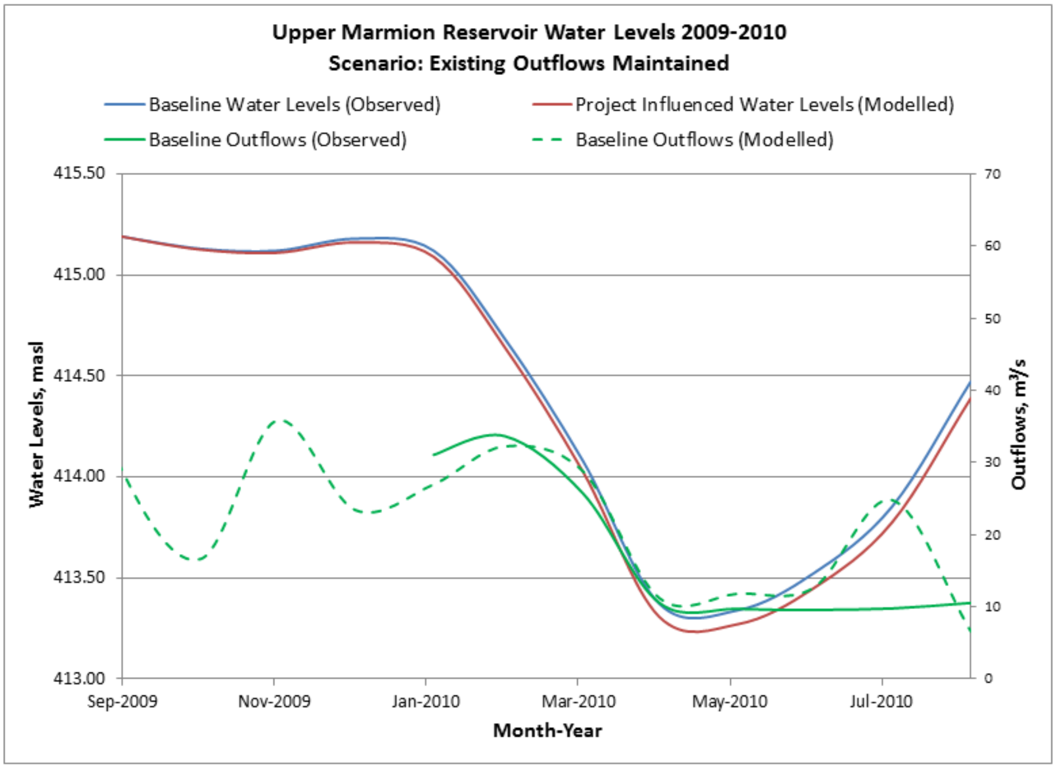

Figure 3: Single Year Water Balance Model Results - Upper Marmion Reservoir Outflows and Water Levels -2010

The following main observations derive from the single year water balance results for 2010:

- It is observed that at the start of the period the water levels in the reservoir for the baseline conditions and the Project influenced condition are the same. The maximum change in reservoir water levels is 9 cm and occurs at the end of the time period in August.
- The effect of water taking for the Project is cumulative since no adjustments have been assumed in existing reservoir outflows over the 12-month time period. In other words, water taking for the Project has been taken from the remaining reservoir storage after the outflows have occurred. Note that for this assessment, the most conservative Project operations scenario has been assumed (i.e. the 100-yr dry water taking scenario).
- The modelled and actual recorded (observed) outflows from the reservoir for the baseline conditions over the time period in the plot between January and August 2010 follow a fairly close pattern with the exception of July 2010.

4.0 SUMMARY

The above analysis demonstrates the effect of Project operations on Marmion Reservoir outflows and water levels during the low water years of 1998 and 2010. Depending on reservoir operation, Project operations will likely result in small changes to both baseline conditions water levels and outflows. In the Hydrology TSD Golder has estimated that the reduction in existing conditions monthly mean water levels will not exceed 9 cm, and the percentage reduction in existing conditions monthly mean outflows will not exceed 5%.

GOLDER ASSOCIATES LTD.

Adriana Parada
Water Resources Engineer

Terry Winhold
Senior Water Resources Engineer

AP/CC/TW/sp

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PART C

Hydrology Technical Support Document, Version 1

February 2013

OSISKO

HAMMOND REEF GOLD


HAMMOND REEF GOLD PROJECT

Hydrology Technical Support Document

VERSION 1

Submitted to:
Osisko Hammond Reef Gold Ltd.
155 University Avenue, Suite 1440
Toronto, Ontario M5H 3B7

Project Number: 10-1118-0020
Document No. 2012-078

Distribution:

Alexandra Drapack, Director Sustainable Development

Cathryn Moffett, Project Manager Sustainable Development

Golder Associates

Hammond Reef Gold Project
Hydrology Technical Support Document

Prepared by: Christine Campbell
Hydrologist
Golder Associates Ltd.
Date: February 15, 2013

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Associate, Senior Water Resources Engineer
Golder Associates Ltd.
Date: February 15, 2013

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1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. (OHRG) proposes the development of an open pit gold mine in north-western Ontario, herein referred to as the Hammond Reef Gold Project (Project). This Technical Support Document (TSD) is one of a series of reports in support of the Project's Environmental Impact Statement/Environmental Assessment Report (EIS/EA Report).

The following reports have been prepared to support the EIS/EA Report:

- Atmospheric Environment TSD.
- Geochemistry, Geology and Soil TSD.
- Hydrogeology TSD.
- **Hydrology TSD.**
- Water and Sediment Quality TSD.
- Site Water Quality TSD.
- Lake Water Quality TSD.
- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Aboriginal Interests TSD.
- Cultural Heritage Resources TSD.
- Human Health and Ecological Risk Assessment TSD.
- Socio-economic Environment TSD.
- Alternatives Assessment Report.
- Conceptual Closure and Rehabilitation Plan.

The EIS/EA Report will summarize the findings of this Hydrology TSD and of the above-listed supporting reports.

1.1 Purpose and Scope

The purpose of this TSD is to fulfill the assessment scope outlined in the Project's Terms of Reference (ToR) approved by the Ontario Minister of the Environment (July 2012), and in the Environmental Impact Statement Guidelines (EIS Guidelines) prepared for the Project by the Canadian Environmental Assessment Agency (CEA Agency) (December 2011).

This TSD provides a description of the existing hydrologic conditions including environmental processes, interrelations and interactions of subcomponents of the hydrologic environment, and their predicted variability over Project phases. The hydrologic assessment is broken down into the following subcomponents:

- Streamflows.
- Lake water levels.
- Navigability.

The overall objective of the programs completed and described in this TSD is to provide specific information at a level sufficient for inclusion in the EIS/EA Report in order to guide decision-making regarding the potential for environmental effects of the Project, or to allow for further analyses as part of other TSDs or work related to the environmental assessment. The information developed will be used in the Hydrogeology, Site Water Quality, Lake Water Quality, Aquatic Environment, Terrestrial Ecology and Socio-economic Environment TSDs.

The assessment of environmental effects, the determination of significance of these effects, and the proposed mitigation measures will be addressed in the EIS/EA Report and in the Aquatic Environment, Terrestrial Ecology and Socio-economic Environment TSDs. An explanation of this approach is provided in Section 1.7 of this report.

1.2 Report Organization

This TSD is structured as follows:

- Section 1 presents the purpose and scope of the TSD, an overview of the Project, the general assessment approach, VECs, and the assessment boundaries of the TSD, and other Project characteristics relevant to the hydrological evaluation.
- Section 2 provides descriptions of the regional, local and site scale watersheds in which the Project is located.
- Section 3 provides an overview of existing surface water management in the Lake of the Woods and Rainy River watershed, including agreements under the International Joint Commission, provincial and federal legislation, and the current Seine River Water Management Plan.
- Section 4 evaluates key components of the hydrological water balance, and presents annual water balances for local scale watersheds and a monthly water balance for the Upper Marmion Reservoir.
- Section 5 characterizes existing flows in regional, local and site scale watercourses and provides estimates of the expected changes in flows occurring as a result of the Project.
- Section 6 characterizes existing lake water levels in regional, local and site scale water bodies and provides estimates of the potential changes occurring as a result of the Project.
- Section 7 characterizes existing conditions in navigable waters and provides a qualitative assessment of potential changes in navigability occurring as a result of the Project.

- Section 8 outlines the requirements for monitoring of surface water quantity during the Project's life cycle.

1.3 Project Overview

The Project overview and Project Description are provided in Chapter 5 of the EIS/EA Report. Project aspects that influence the hydrologic evaluation are described in Sections 1.3 to 1.8.

1.3.1 Project Location

The Project is set within the Thunder Bay Mining District in north-western Ontario, approximately 170 km west of Thunder Bay and 23 km northeast of the Town of Atikokan (Figure 1-1).

Access to the Hammond Reef property is presently via two routes: the Premier Lake Road, a gravel road that intersects Highway 623 near Sapawe and the Hardtack-Sawbill Road, a gravel road that intersects Highway 622 northwest of the Town of Atikokan. The exploration camp is located at the northern end of Sawbill Bay in Upper Marmion Reservoir. The property is also accessible by water from the southwest end of the Marmion Reservoir at its access point from Highway 622. The existing Hardtack-Sawbill Road located to the north of Finlayson Lake has been upgraded to provide an improved and more direct linkage to the Project site in support of the expanded exploration program.

The Hammond Reef deposit is located mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The peninsula containing the deposit is surrounded by the Upper Marmion Reservoir on three sides with Sawbill Bay to the northwest and Lynxhead Bay to the southeast. The property also contains a number of smaller lakes. Mitta Lake is a small, steep-sided waterbody located atop mineralized zones of the deposit. Due to its location, the open pit mine will encompass Mitta Lake.

1.3.2 Climate

The Project is located in a typical boreal climate region, which is characterized by long, usually very cold winters, and short, cool to mild summers. The average annual temperature is 1.6°C for Atikokan with a seasonal maximum of 16.2°C (average) for summer and a minimum of minus 15.4°C (average) for winter. Temperatures lower than minus 37°C have been recorded during the fall and winter. The annual normal total for precipitation is 788 mm (568 mm of rainfall and 220 mm of snowfall) for Atikokan, with a seasonal maximum of 299 mm for the summer period.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.;
Base Data - MNR NRVIS, obtained 2004. Produced by Golder Associates Ltd
under licence from Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

100 0 100 200 300 400

SCALE 1:10,000,000 KILOMETRES

Golder Associates
Mississauga, Ontario

DATE	February, 2013	TITLE	PROJECT LOCATION
DESIGN	CGE		
GIS	JO		
PROJECT No. 10-1118-0020	CHECK CC	PROJECT HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA	FIGURE: 1-1
SCALE AS SHOWN VERSION 1	REVIEW THW		

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1.3.3 Project Phases

The Project is comprised of four phases: construction, operations, closure and post-closure. With regards to the hydrology evaluation, the most relevant Project phases are construction, operations and post-closure.

Activities expected to have the greatest influence include:

- Runoff collection.
- Water taking.
- Effluent discharge.
- Mine dewatering.

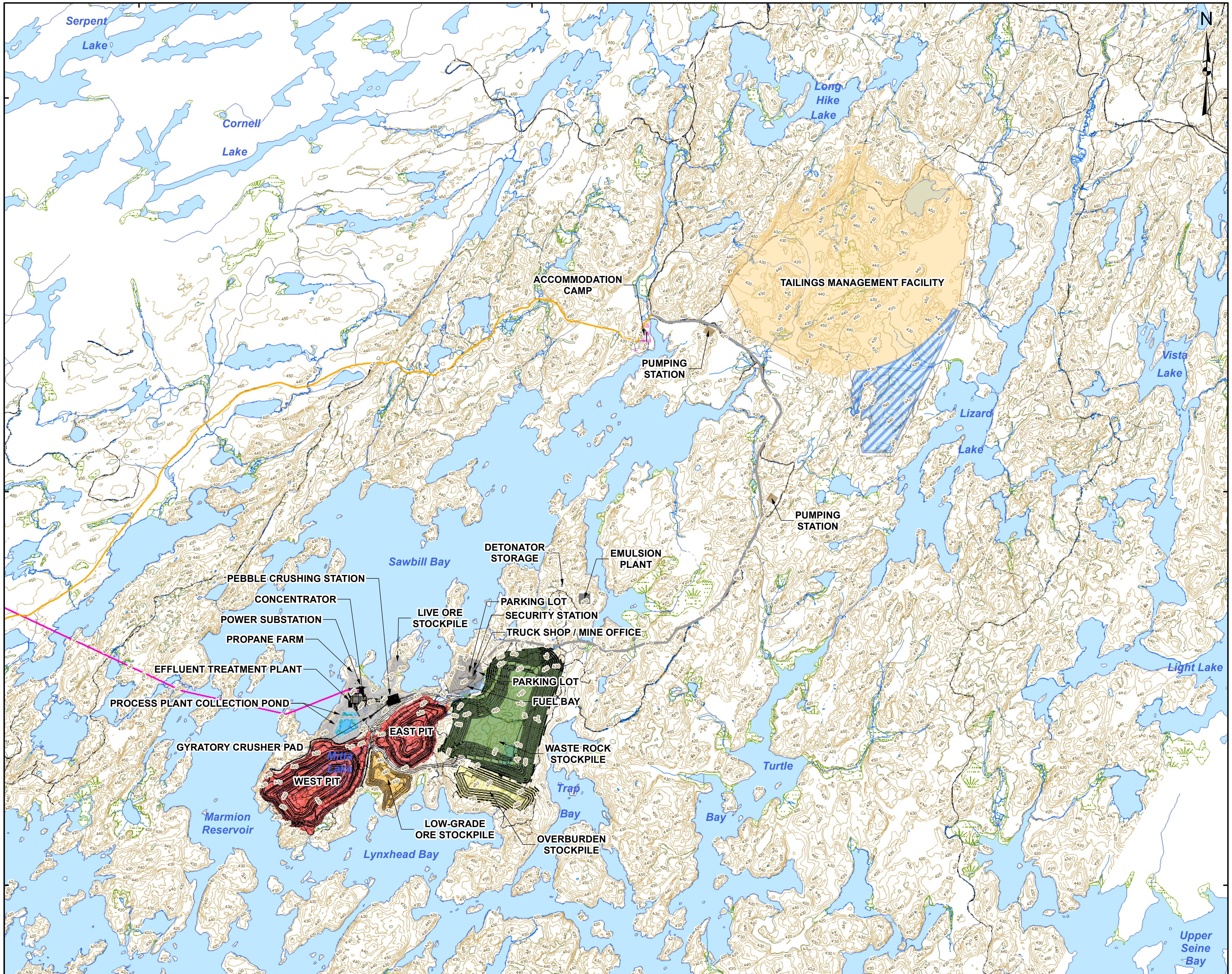
Additional details regarding activities expected to take place in each phase of the Project are provided in Chapter 5 of the EIS/EA Report.

1.3.4 Project Components

The Project consists of the following eight main components:

- Mine, including two open pits (i.e. east pit and west pit).
- Waste Rock Management Facility (WRMF).
- Ore Processing Facility.
- Tailings Management Facility (TMF).
- Support and Ancillary Infrastructure.
- Water Management System.
- Linear Infrastructure.
- Borrow Sites.

Of these, the key component related to hydrology is the Water Management System. Project components are shown in Figure 1-2. A detailed description of Project components is provided in Chapter 5 of the EIS/EA Report.



LEGEND

- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Accommodation Camp
- Laydown Area
- Office and Truck Shop, Explosives Storage and Processing Plant
- Open Pits
- Low-Grade Ore Stockpile
- Overburden Stockpile
- Process Plant Collection Pond
- Pumping Station
- Tailings Management Facility
- Tailings Management Facility Reclaim Pond
- Waste Rock Stockpile

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:50,000 METERS

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SITE LAYOUT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 1-2	
GIS	JO	4 Feb. 2013		
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REVIEW	THW	4 Feb. 2013		

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1.4 General Assessment Approach

The Project has the potential to affect the hydrologic environment. The approach for this TSD follows six key steps:

- Step 1: Screening of Project activities to determine which activities have the potential to produce changes to the hydrologic environment.
- Step 2: Identify temporal and spatial boundaries within which potential changes to the hydrologic environment may occur.
- Step 3: Identify parameters used to characterize these potential changes.
- Step 4: Design and carry out field studies and/or background research to characterize the existing hydrologic environment, and to support the prediction of changes on the hydrologic environment as a result of the Project.
- Step 5: Carry out predictive modelling of potential changes to the hydrologic environment during Project phases identified as bounding scenarios.
- Step 6: Outline the monitoring requirements for each Project phase to confirm predicted changes to the hydrologic environment and to ensure that requirements are being met for identified parameters.

This TSD is intended to support the EIS/EA Report and, as such, does not assess the significance of potential effects on the hydrologic environment, nor does it identify mitigation measures. These topics are addressed in the EIS/EA Report and in other TSDs.

1.5 Incorporation of Traditional Knowledge

Traditional knowledge in combination with other information sources is valuable in achieving a better understanding of the Project's potential effects on the biophysical and socio-economic environment. It also contributes to the description of the existing biophysical and human environment, natural cycles, resource distribution and abundance, and the use of land and water resources. A detailed discussion on traditional knowledge, including any aspects relevant to the hydrologic environment, is included in the Aboriginal Interests TSD (Appendix 5.II of the EIS/EA Report).

1.6 Selection of Valued Ecosystem Components

The Valued Ecosystem Components (VECs) selected for the Hydrology TSD are surface water quantity and navigability. Table 1-1 provides the rationale for selection of these VECs along with proposed indicators and measures.

Table 1-1: Valued Ecosystem Components Selected for the Hydrologic Environment

VEC	Rationale for Selection	Indicators
Surface water quantity	The Project may result in changes to surface water quantity	Monthly streamflows Monthly water levels Catchment areas
Navigability	The Project may result in the obstruction of navigable watercourses or water bodies. Potential exists for changes in flow, width, depth or gradient of watercourses or water bodies.	Presence of obstructions Flow, width, depth or gradient of watercourse or water body

1.7 Effects Assessment

Surface water quantity and navigability are subcomponents of the hydrologic environment which lead to or influence the assessment of effects of the Project, but are not in and of themselves endpoints of the assessment. Therefore, potential effects of the Project on the VECs selected for hydrology are not discussed in this TSD. The effects assessment on the endpoints of changes to surface water quantity and navigability are presented in the EIS/EA Report and in the following TSDs:

- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Socio-economic Environment TSD.

1.8 Temporal and Spatial Boundaries

1.8.1 Temporal Boundaries

Temporal boundaries define the temporal extents within which changes to the environment resulting from Project activities are considered. Temporal boundaries for the hydrologic assessment are directly related to the Project phases and the duration of these phases, namely:

- Construction phase: 2.5 years.
- Operations phase: 11 years.
- Closure phase: 2 years.
- Post-closure phase: 10 years.

1.8.2 Spatial Boundaries

Spatial boundaries define the geographical extents within which potential environmental changes may occur. As such, spatial boundaries become the Project's hydrology study areas.

The study areas for the hydrologic assessment were selected based on the following factors:

- The Project footprint.
- The proposed locations for water intakes and effluent discharges.

This TSD has three study areas, as described in the following sections:

1.8.2.1 Local Study Area

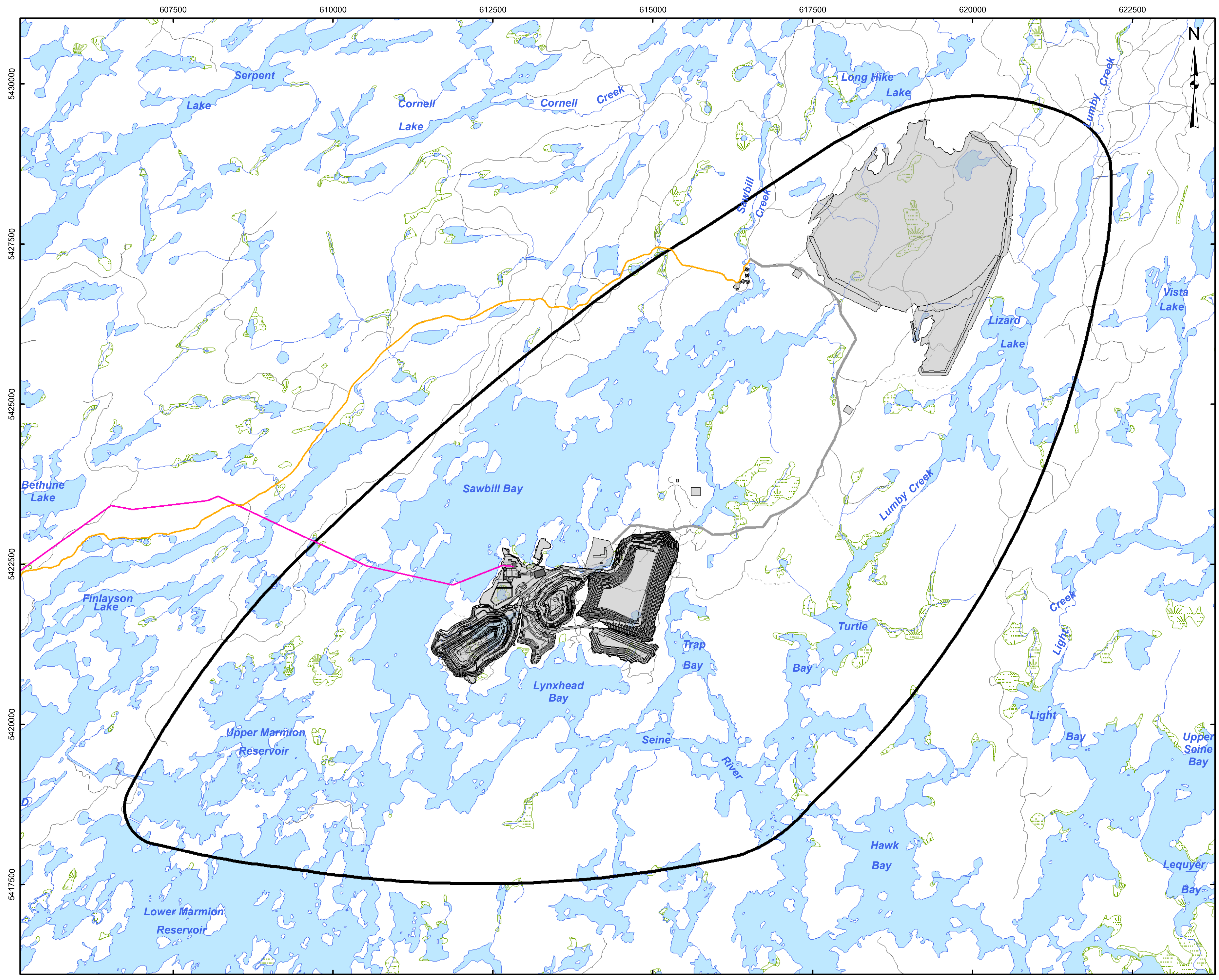
The Local Study Area (LSA) encompasses the site scale watersheds in the Project footprint, the lower reaches of Sawbill Creek, Lizard Lake, the lower reaches of Lumby Creek, and Upper Marmion Reservoir from Turtle Bay to the Raft Lake Dam. The LSA is shown in Figure 1-3.

1.8.2.2 Mine Study Area

The Mine Study Area (MSA) encompasses the footprints of the Mine, the Waste Rock Management Facility, the Ore Processing Facility, the Tailings Management Facility, and the Support and Ancillary Infrastructure (Figure 1-4). Borrow Pits are not included, as they are subject to a separate permitting process.

1.8.2.3 Linear Infrastructure Study Area

The Linear Infrastructure Study Area (LISA) encompasses the footprints of the access road and project transmission line. The LISA is represented by a Y-shaped area that extends 30 m on either side of the central line of the access road and the project transmission line (Figure 1-5).



LEGEND

- Road
- Trail
- River/Stream
- Lake
- Wetland
- Local Study Area
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:60,000 METERS

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 1-3	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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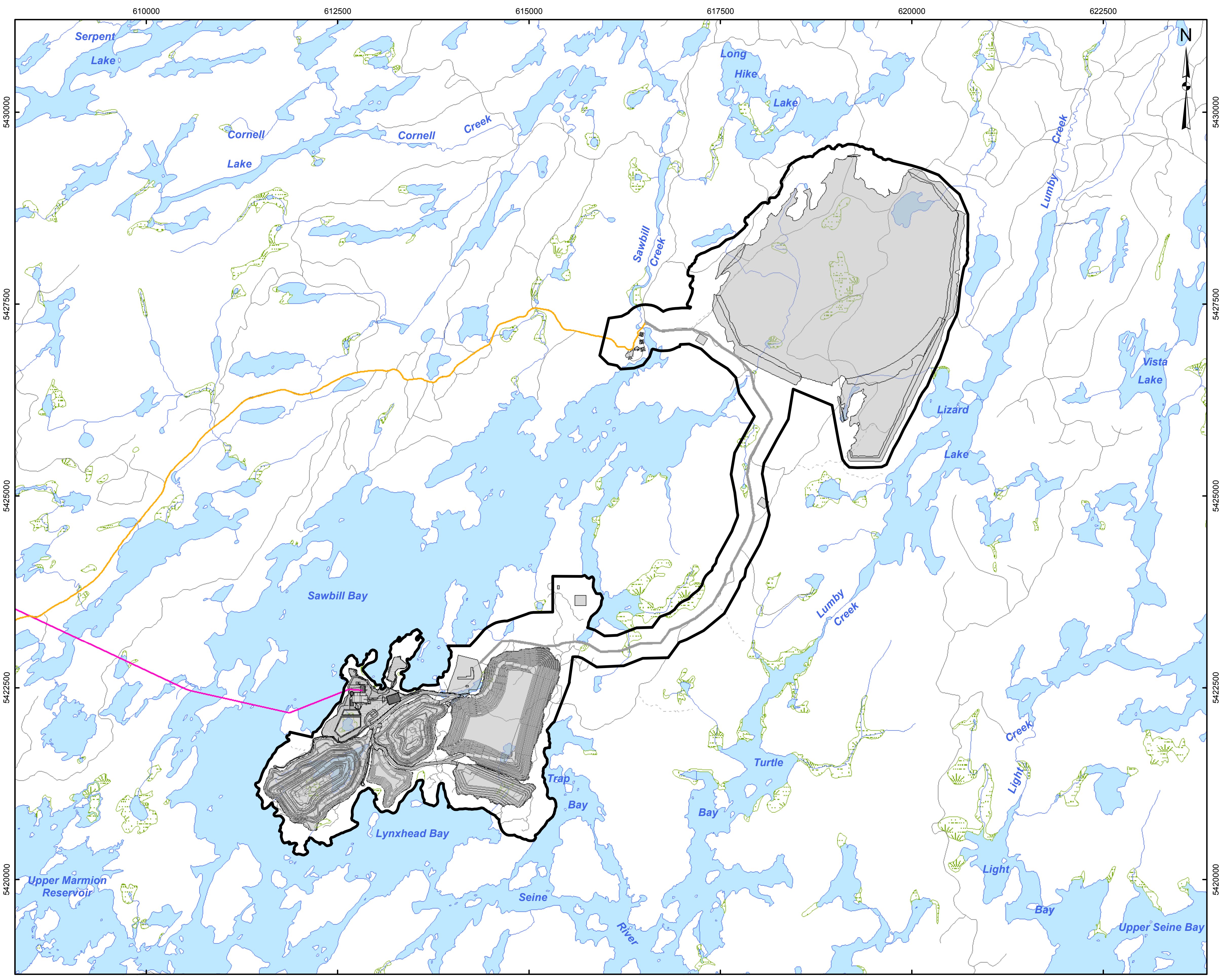

LEGEND

- Road
- Trail
- River/Stream
- Lake
- Wetland
- Mine Study Area
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:50,000 METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
MINE SITE STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
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CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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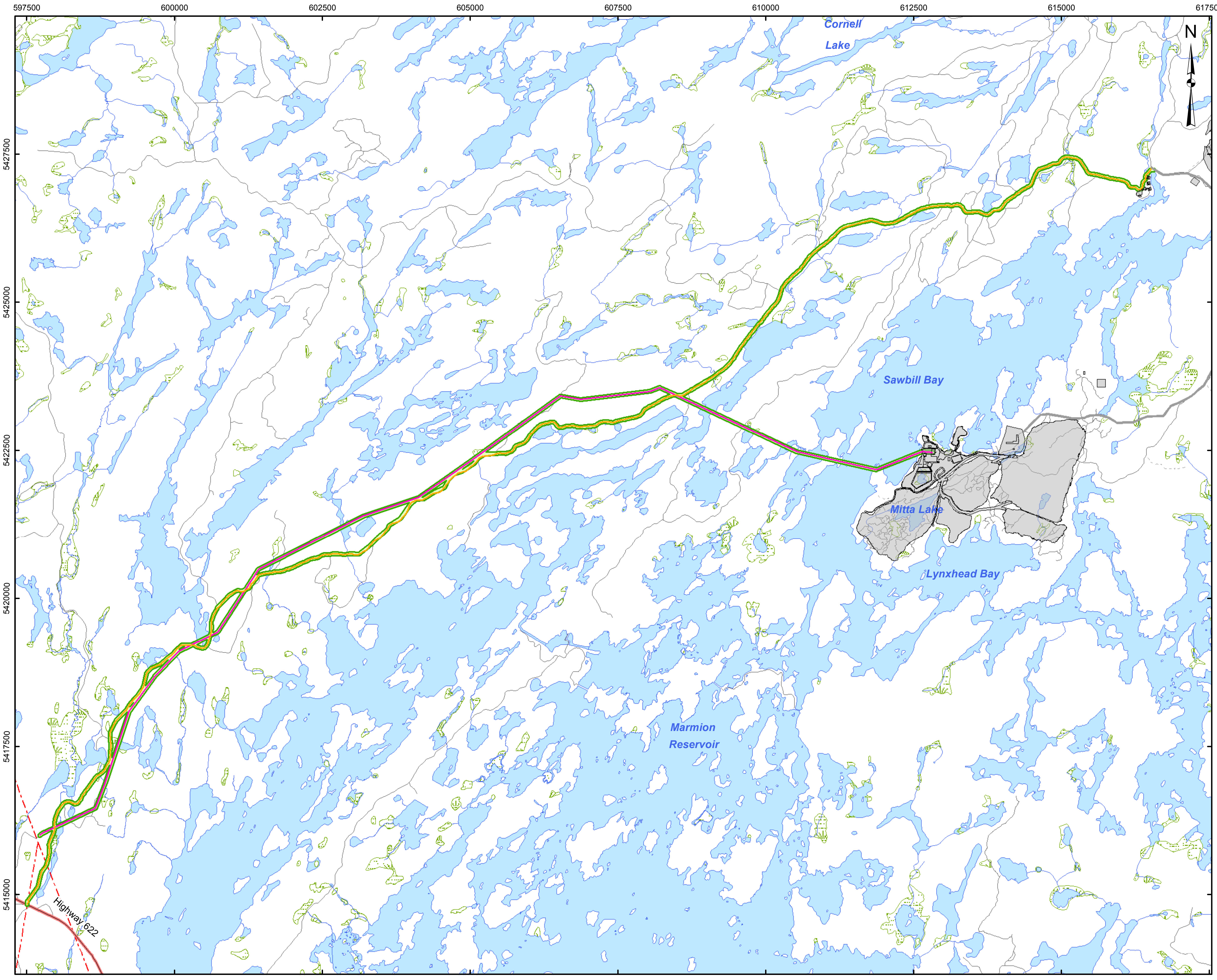

LEGEND

- Road
- Trail
- River/Stream
- Lake
- Wetland
- Linear Infrastructure Study Area
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:65,000 METERS

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

LINEAR INFRASTRUCTURE STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 1-5	
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REVIEW	THW	4 Feb. 2013		

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2.0 DRAINAGE BASINS

2.1 Existing Conditions

2.1.1 Methods

2.1.1.1 Secondary Data Review

Characterization of the drainage basins at the regional, local and site scales was based on review of the following:

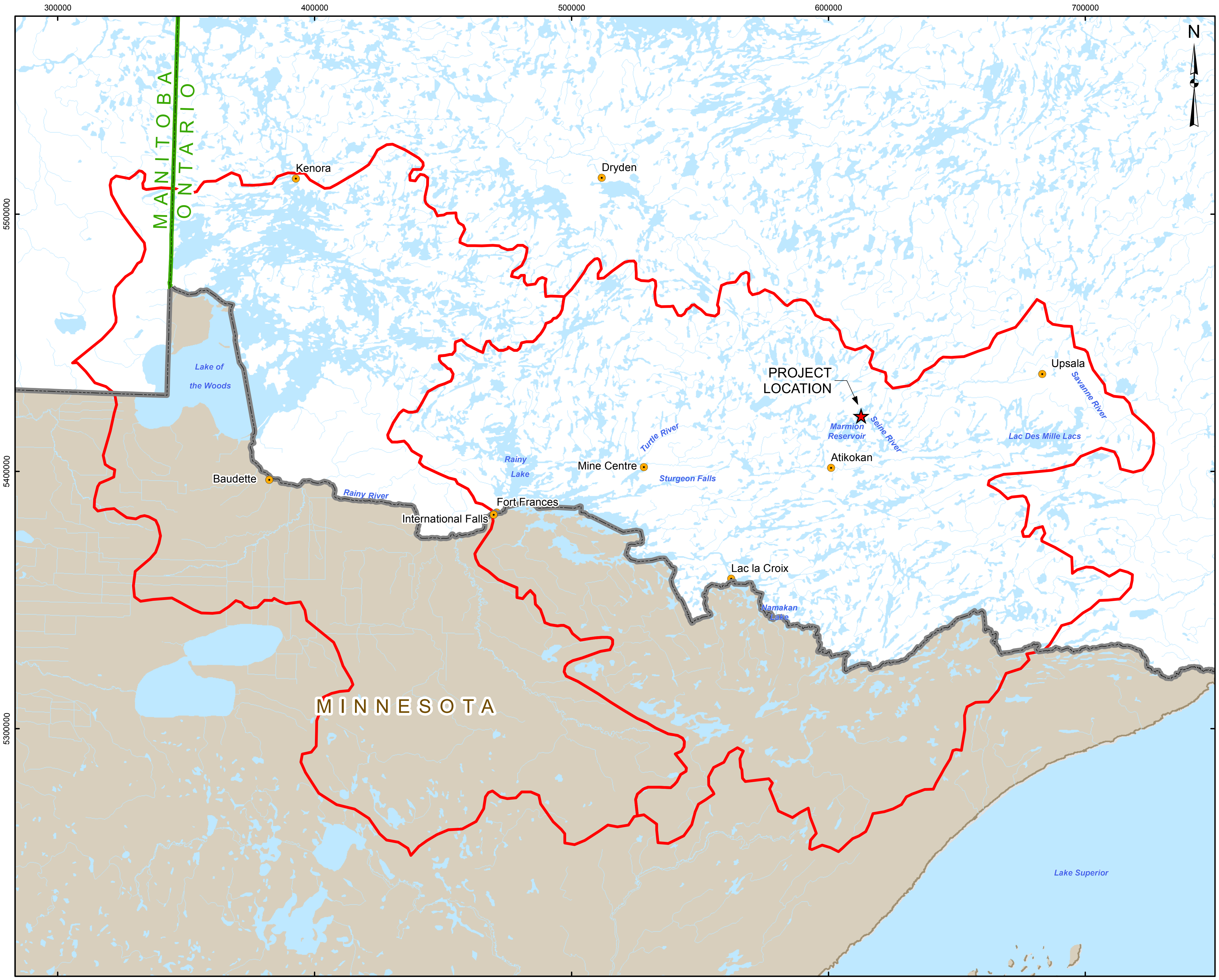
- International Lake of the Woods and Rainy River Watershed Task Force (2011), Final Report to the International Joint Commission on Bi-national Management of Lake of the Woods and Rainy River Watershed, July 15.
- Boileau, David (2004), 2004 to 2014 Seine River Water Management Plan, March 31.
- Ontario Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS) 1:20,000 topographical data.
- Stea Surficial Geology Services (2009); Surficial Geology of the Hammond Reef Property, West-Central Ontario.
- Observations collected during field surveys of the small watercourses draining the Hammond Reef peninsula (Appendix 2.I).

2.1.2 Regional Watersheds

2.1.2.1 Lake of the Woods and Rainy River Watershed

The Seine River drains the eastern portion of the Lake of the Woods and Rainy River watershed (Figure 2-1). It originates as the Savanne River near Upsala and flows westerly before emptying into Rainy Lake southeast of the town of Mine Centre. Rainy Lake is drained by the Rainy River at its outlet near the towns of Fort Frances and International Falls, and empties into Lake of the Woods northwest of the town of Baudette. Lake of the Woods extends across the border between Ontario and Manitoba; and Rainy Lake, Rainy River and Lake of the Woods are transboundary waters between Canada and the United States of America (USA.). The tributary drainage area to the Lake of the Woods and Rainy River watershed at its outlet near the town of Kenora is 70,400 km² of which approximately 59% is in Canada and 41% in the USA.

Virtually all the surficial geology in the Lake of the Woods and Rainy River watershed is glacial in origin. Glacial Lake Agassiz covered many of the present large lakes in the watershed and deposited laminated sediments of clay and silt in the lowlands adjacent to Rainy Lake, the Rainy River and Lake of the Woods. In other areas, clay and silt deposits occur only as small pockets. Large peat bogs occur in the Agassiz lacustrine plain with beaches of sand and gravel occurring along the northern boundary of the clay plain. The most widespread soil substrate is a shallow discontinuous ground moraine composed of sand mixed with gravel stones and boulders less than a metre deep. Soil depths are shallow to extremely shallow.



LEGEND

- Project Location
- City/Town
- Provincial Border
- International Border
- River/Stream
- Lake
- Sub-basin
- United States

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Drainage Basin and Sub-Basin digitized from Winnipeg River Drainage Basin, Lake of Woods Control Board (2000/12/01)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

20 0 20 40 60 80
KILOMETERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LAKE OF THE WOODS AND RAINY RIVER WATERSHED

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	SC	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

FIGURE: 2-1

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Land use characteristics include approximately 81% vegetation, 14% water bodies, and 5% cropland and shrubland/woodland. Burnt or sparse vegetation, wetlands, urban and built-up areas, consolidated rock and sparse vegetation account for less than 0.1% of the total. Vegetation is predominantly forest. In the USA, a significant proportion of the land base is within national, state and county forest. On the Canadian side of the border, approximately 75% of the watershed is Crown land.

The drainage pattern in the watershed is dendritic which is characteristic of relatively flat lying and/or homogenous rocks and impervious soils. The highest density of streams, lakes and ponds are found in the far eastern portion of the watershed (i.e. the Turtle River and Seine River watersheds), a characteristic of the poorly drained Cambrian shield topography. The average annual yield from the Lake of the Woods and Rainy River watershed, at the Lake of the Woods outlet near Kenora, is 6.53 L/s/km².

2.1.2.2 Seine River Watershed

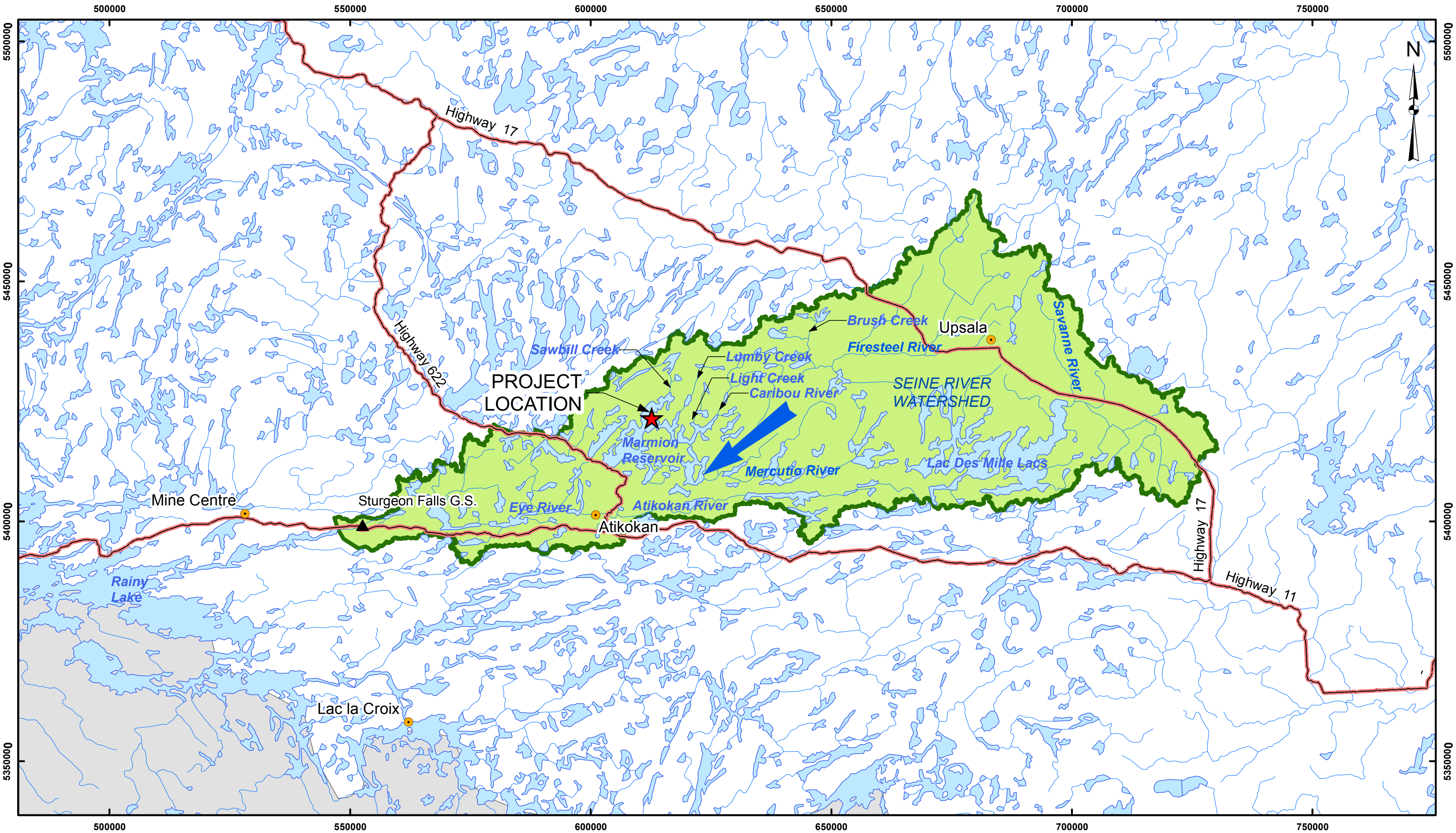
The Seine River originates as the Savanne River near Upsala and flows westerly for about 250 km before emptying into Rainy Lake southeast of the town of Mine Centre (Figure 2-2). Its watershed encompasses approximately 6,250 km². The watershed has an average slope of 0.55 m/km over the length of its main channel. The total drop between Lac des Mille Lacs and Rainy Lake is approximately 120 m.

The Seine River watershed is located on bedrock of the Precambrian shield which is covered by glacial deposits. Outwash deposits characterized by high contents of coarse sand and gravel make up 19% of the watershed area, and are found at the eastern end of the watershed. Aeolian and beach deposits are found mostly in the south-eastern and central portions of the watershed. These finer textured soils are the most common type of deposit and cover 49% of watershed area. Ground moraine deposits dominated by sand and boulders cover the lower reaches of the watershed and account for 29% of its total area. The remaining 3% is covered by lacustrine deposits, end moraine and exposed bedrock. Most of the watershed area (77%) is covered by forest. The remainder is covered by water (14.5%), wetlands (7%) and settled areas (0.5%). There is essentially no agricultural land.

The river exhibits a dendritic drainage pattern. Its major tributaries are the Firesteel River (north) and the Mercutio River (south), which confluence with the Seine River between Lac des Mille Lacs and Upper Marmion Reservoir, and the Atikokan River (south) and the Eye River (north) which join the main river downstream of Upper Marmion Reservoir. Four minor north tributaries join the river at Upper Marmion Reservoir in the vicinity of the Project; the Caribou River, Light Creek, Lumby Creek and Sawbill Creek. The Seine River is generally characterized by cool water lakes connected by short reaches of river. The exception is the long reach between Lac des Mille Lacs and Upper Marmion Reservoir. Lakes range in size from 245 km² at Lac des Mille Lacs to 0.90 km² at Little McCaulay Lake. The average annual watershed yield in the Seine River at Sturgeon Falls Generating Station is 7.61 L/s/km².

2.1.3 Local Watersheds

Four minor north tributaries to the Seine River flow southwards into Upper Marmion Reservoir between Upper Seine Bay and Sawbill Bay. These are the Caribou River, Light Creek, Lumby Creek and Sawbill Creek. The local watersheds associated with these tributaries and draining directly into the small embayments surrounding the Project Site are shown in Figure 2-3.



LEGEND

- Project Location
- City/Town
- Flow Direction
- Waterpower Facility
- Provincial Highway
- River/Stream
- Lake
- Watershed Boundary

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC, CANVEC
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

20 10 0 20 40 60

SCALE 1:1,150,000 Kilometres

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SEINE RIVER WATERSHED

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	16 Mar. 2012		
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

FIGURE: 2-2

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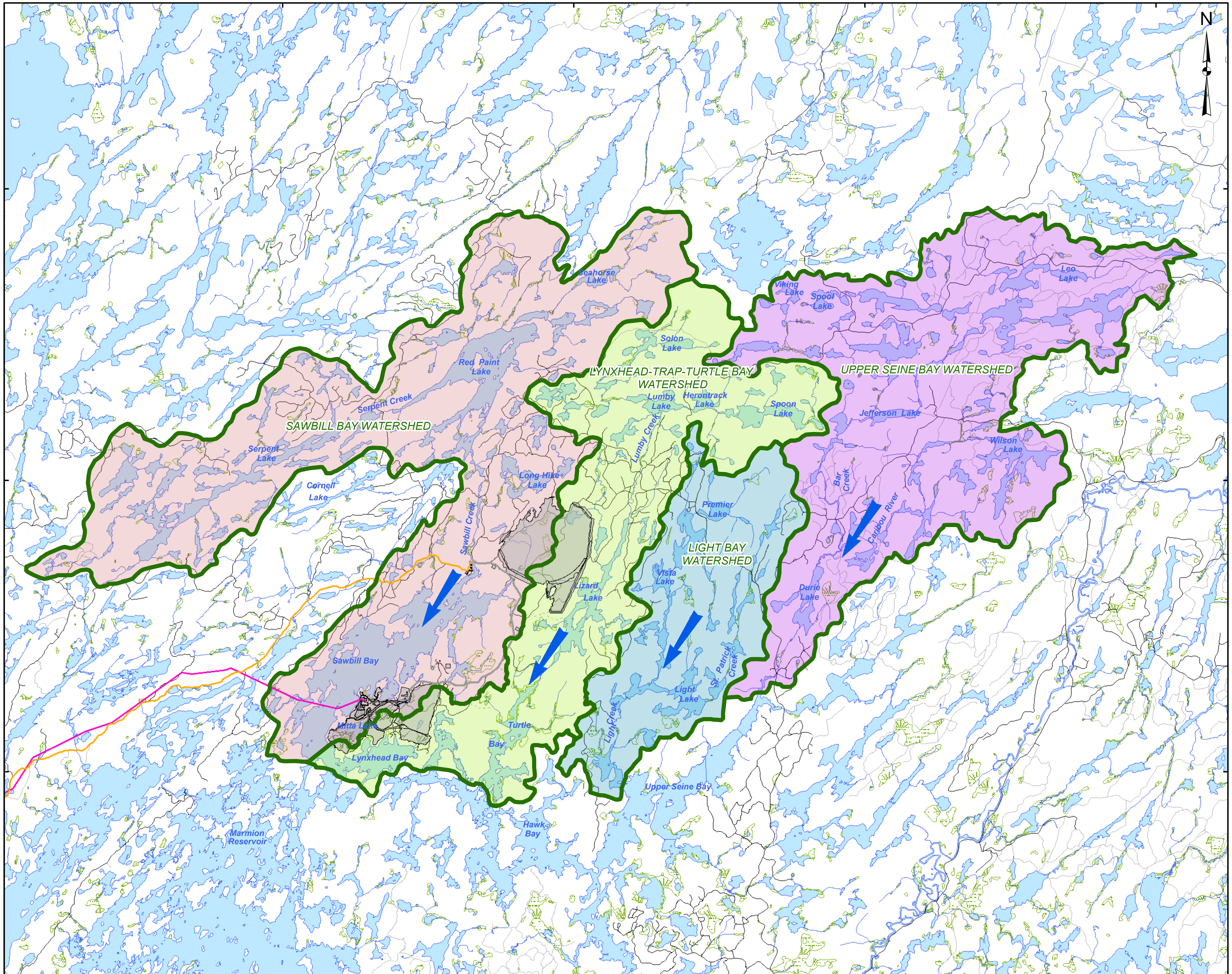

LEGEND

- Flow Direction
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:135,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LOCAL WATERSHEDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	REV. ION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 2-3	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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2.1.3.1 Upper Seine Bay Watershed

The Caribou River is the principal drainage system in the Upper Seine Bay watershed. The Caribou River flows south-westerly from its headwaters in Wilson Lake before emptying into Upper Seine Bay. Bar Creek is its major tributary (north) and originates at Viking Lake in the northwest part of the drainage basin and flows generally southwards to converge with the Caribou River upstream of Durie Lake. A major east tributary converges with Bar Creek at Jefferson Lake, which has its headwaters in Spool Lake to the northwest, immediately east of Viking Lake, and in Leo Lake in the northeast part of the drainage basin. The Caribou River drainage system exhibits a trellis pattern in the upper reaches and a dendritic drainage pattern in the lower reaches.

The drainage area to the Caribou River at Upper Seine Bay is 113 km², 60% of which is drained by the Bar Creek system. The watershed slope is 1.3 m/km along the Caribou River (a drop of 20 m over 15 km). The slope along Bar Creek is 3.6 m/km from Viking Lake to its confluence with the Caribou River (a 50 m drop over 14 km). The drainage basin is characterized by numerous small lakes interconnected by short stream reaches. The surficial geology consists of bedrock outcrops interspersed with unsorted glacial deposits of boulders/gravel/mud (till). Land use is predominantly forest.

2.1.3.2 Light Bay Watershed

Light Creek is the principal drainage system in the Light Bay watershed. Light Creek originates approximately 2.5 km north of Premier Lake in the northwest part of its drainage basin, and flows southwards for about 12 km before emptying into Light Bay. Light Creek passes through Premier Lake, Vista Lake and Light Lake on the journey to its mouth. Its major tributary is St. Patrick Creek (east) which has its headwaters in St. Patrick Lake to the northeast and flows southwards to its confluence with Light Creek in Light Lake. The Light Creek drainage system exhibits a parallel drainage pattern.

The drainage area to Light Creek above Light Bay is 41.4 km², 24% of which is drained by St. Patrick Creek. The watershed slope along Light Creek is 3.1 m/km (37 m in 12 km) and along St. Patrick Creek is 6.3 m/km (63 m in 10 km). The drainage basin is mainly covered by bedrock outcrops interspersed with deposits of glacial till (boulders/gravel/mud). Peat and muck also occur as bogs and muskegs, low-lying floodplains and lakeshore swamps. Forest is the predominant land use.

2.1.3.3 Lynxhead-Trap-Turtle Bays Watershed

Lumby Creek is the principal drainage system in the Lynxhead-Trap-Turtle Bays watershed. Lumby Creek originates approximately 2 km north of Spoon Lake in the northeast part of the drainage basin. It flows westerly through Herontrack Lake into Lumby Lake where it confluences with a major west tributary that originates at Solon Lake in the northwest. From Lumby Lake, the creek drains southwards through Lizard Lake before emptying into Marmion Reservoir at Turtle Bay. The drainage system exhibits a trellis pattern in the upper reaches and a dendritic pattern in the lower reaches.

The Lumby Creek drainage basin extends over an area of 62.8 km². The watershed slope is 2.2 m/km (a drop of 39 m over 18 km) along Lumby Creek. The drainage basin is mainly covered by bedrock outcrops interspersed with unsorted glacial deposits of boulders/gravel/mud (till). There is also some organic terrain; areas where peat and muck occur as bogs and muskegs, low lying floodplains and lakeshore swamps. Glacial deposits of sand and gravel from outwash deltas and meltwater channels also occur northwest of Lizard Lake. Land use is predominantly forest.

2.1.3.4 Sawbill Bay Watershed

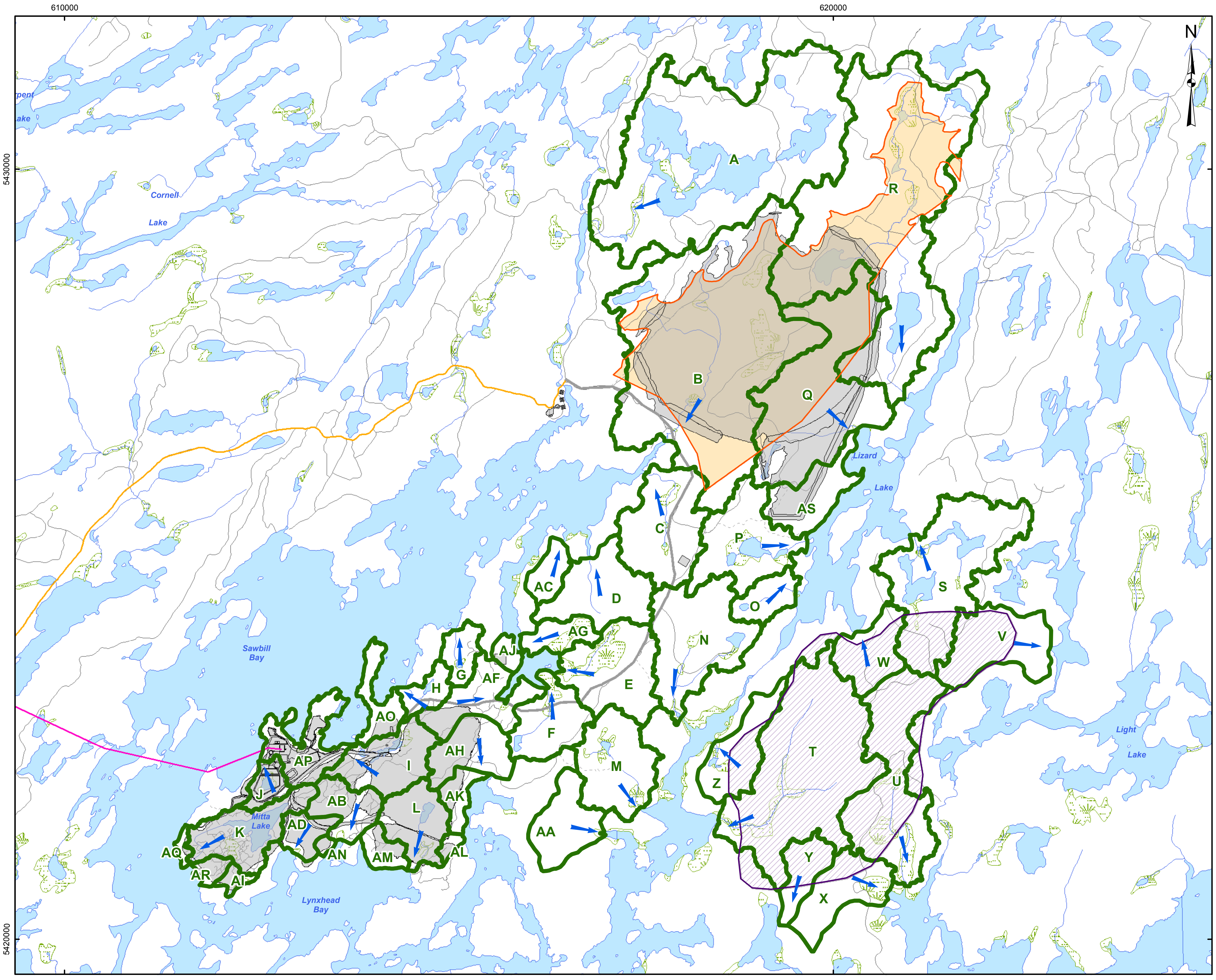
Sawbill Creek is the principal drainage system in the Sawbill Bay watershed. Sawbill Creek has its headwaters in Long Hike Lake and flows southerly into Sawbill Bay. Serpent Creek is its major tributary (west) which originates about 4 km west of Serpent Lake in the northwest part of the drainage basin. Serpent Creek flows easterly for about 18 km to Red Paint Lake where it is joined by a minor east tributary originating at Seahorse Lake to the northeast. A 5 km reach flows southwards from Red Paint Lake to converge with Sawbill Creek. The Sawbill Creek drainage system exhibits a trellis pattern.

The drainage area to Sawbill Creek at Sawbill Bay is 106 km², more than half of which is drained by Serpent Creek. The watershed has a slope of 9.8 m/km along Sawbill Creek (a drop of 39 m in 4 km). The slope along Serpent Creek and the reach between Red Paint Lake and its confluence with Sawbill Creek is 1 m/km (23 m in 23 km). The drainage basin is predominantly covered by bedrock outcrops interspersed with glacial till (unsorted deposits of boulders/gravel/mud). Sand and gravel deposits from outwash deltas and meltwater channels and pockets of organic terrain (peat and muck occurring as bogs, muskegs, low-lying floodplains and lakeshore swamps) are also found. The predominant land use is forest.

2.1.4 Site Watersheds

A total of 44 small watersheds have been identified in the vicinity of the Project (Figure 2-4). Of these, existing conditions were assessed in 34 watersheds (watersheds AJ to AS were not assessed due to scheduling constraints). Watersheds A to AI range in size from 0.10 km² (watershed AI) to 6.33 km² (watershed R) and are typically drained by channels with slopes from 0.4% to 5.8%. Watershed AI is the exception being drained by a steep channel sloping at 12.7%. Bedrock outcrop interspersed with glacial till (unsorted deposits of boulders/gravel/mud) typically covers 65% to 95% of the surface area of these watersheds; the balance is covered by organic terrain. Exceptions are watersheds B, D, R, AC, AF, AG, AH which are covered by 20% to 65% sand and gravel deposits (from outwash deltas and meltwater channels) and 35% to 60% bedrock outcrops interspersed with glacial till. Organic terrain (45%) and sand and gravel deposits (40%) are found in watershed Q. The vegetative cover consists mainly of a mix of grass, shrubs and/or trees. The percentage of the watershed area covered by lakes and wetlands generally ranged from 0% to 15%, but exceeded 20% in five watersheds (A, K, Q, W and AG).

The site watersheds are drained by small watercourses originating along parallel ridges trending southwest-northeast on either side of Lumby Creek, and flowing either easterly or westerly into Marmion Reservoir, Lizard Lake or Light Lake. Drainage channels were not evident in watersheds G, X and AG. Channel widths are typically 1.0 m to 5.0 m wide at the mouths (channel widths in watersheds O and AH were less than 0.5 m, greater than 5.0 m wide in watersheds J, F, E, S and as much as 20 m wide in watershed T). Channel depths at the mouths of the streams ranged from 0.15 m to 0.85 m, with the exception of the channel draining watershed T which was 1.6 m deep. The floodplains are flat, wide and grassed or narrow and treed at the stream mouths. Only nine of the 34 watercourses are perennial (flowing year round); these are watercourses A, D, E, I, P, Q, S, T and AF. The remainder can be described as intermittent (flowing seasonally) or ephemeral (flowing only after significant precipitation events).



LEGEND

- Flow Direction
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Tailings Management Facility Alternative 1
- Tailings Management Facility Alternative 2
- Local Watershed Boundary

WATERSHED AREAS

SITE WATERSHEDS	
Watershed ID	*Watershed Area (ha)*
A	590.00
AA	73.34
AB	51.99
AC	29.24
AD	29.91
AF	77.52
AG	34.18
AH	68.19
AI	10.17
AJ	12.64
AK	25.92
AL	7.19
AM	24.29
AN	4.64
AO	37.88
AP	72.03
AQ	6.86
AR	12.87
AS	71.97
B	609.82
C	134.96
D	104.31
E	122.80
F	78.00
G	30.53
H	27.27
I	85.24
J	25.56
K	89.03
L	70.53
M	111.72
N	158.55
O	38.76
P	124.90
Q	272.96
R	623.45
S	230.85
T	336.68
U	200.68
V	106.27
W	66.90
X	82.32
Y	45.66
Z	74.75

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000

SCALE 1:50,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SITE WATERSHEDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 2-4	
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3.0 SURFACE WATER MANAGEMENT AND USE

3.1 Existing Conditions

3.1.1 Methods

3.1.1.1 Secondary Data Review

Information on surface water management and use in the Lake of the Woods, Rainy Lake and Seine River watersheds was obtained from review of the following:

- The International Joint Commission's website, http://www.ijc.org/.
- The Canadian Lake of the Woods Control Board's website, http://www.lwcb.ca/.
- The Seine River Watershed Information website, http://www.seineriverwmp.com/.
- Information on Permits to Take Water received from the Ontario Ministry of the Environment on August 30, 2011 in response to a written request from Golder.

3.1.2 Agreements under the International Joint Commission

The International Joint Commission (IJC) prevents and resolves disputes between Canada and the United States of America (USA) under the 1909 *Boundary Waters Treaty* and pursues the common good of both countries as an independent and objective advisor to the two governments. The IJC:

- Rules upon applications for approval of projects affecting boundary or transboundary waters and may regulate the operation of these projects.
- Assists the two countries in the protection of the transboundary environment.
- Alerts the governments to emerging issues along the boundary that may give rise to bilateral disputes.

The IJC has established various boards and task forces, consisting of experts from both countries, to help it carry out its responsibilities. Three boards and one completed task force may have relevance to the Project:

- International Lake of the Woods Control Board.
- International Rainy Lake Board of Control.
- International Rainy River Water Pollution Board.
- International Lake of the Woods and Rainy River Watershed Task Force.

3.1.2.1 International Lake of the Woods Control Board

The governments of Canada and the USA referred the matter of fluctuating water levels in Lake of the Woods to the IJC in 1912. The IJC conducted a five year study which concluded with recommendations for the regulation of the lake. A treaty between the two governments, the 1925 *Lake of the Woods Convention and Protocol,* was signed. This established the International Lake of the Woods Control Board and elevation and discharge requirements for the regulation of the lake based on the IJC recommendations. Whenever the level of the lake rises above or falls below specified elevations, the rate of discharge of water from the lake is subject to the approval of the International Lake of the Woods Control Board. Under normal conditions, i.e. when the level of the lake is in between the specified elevations, the Canadian Lake of the Woods Control Board (Section 3.1.3) has responsibility for regulation of the lake.

3.1.2.2 International Rainy Lake Board of Control

The 1938 Rainy Lake Convention between Canada and the USA gave the IJC power to:

- Determine when emergency conditions, whether by high or low water, exist in the Rainy Lake watershed;
- Adopt such measures of control with respect to the two dams at Kettle Falls and the dam at International Falls-Fort Frances along the Ontario-Minnesota border.

The International Rainy Lake Board of Control was created by the IJC in 1941 to examine and report on the issue of emergency conditions, and the study led to the issue of the 1949 *Order Prescribing the Method of Regulating Boundary Waters (Rainy and Namakan Lakes).* The order was later amended by supplementary orders in 1957, 1970 and 2000. The original order and the three supplementary orders were later consolidated into one document, the 2001 *Consolidated Order.*

Under the *Consolidated Order*, the International Rainy Lake Board of Control monitors and at times directs the regulation (water levels and outflows) of Rainy and Namakan Lakes. Regulation is carried out jointly by H2O Power LP in Canada and Boise Inc. in the USA who own and operate the dams on the lakes. The order specifies a water level band with upper and lower rule curves for each lake, minimum outflow requirements under normal low flow conditions, and a ‘drought line’ defining lake levels below which outflows may be reduced to absolute minimums at the discretion of the board.

3.1.2.3 International Rainy River Water Pollution Board

The IJC was given authorization to establish and maintain supervision over water quality in the Rainy River in letters from the governments of Canada and the USA dated December 13, 1965. The IJC created the International Rainy River Water Pollution Board in the following year to report on progress in addressing pollution in the river on the basis of approved water quality objectives, and to report on other water quality problems that might come to its attention. Specifically the board’s duties are to:

- Maintain supervision over water quality in the Rainy River.
- Carry out inspections, evaluations and assessments to determine the extent to which the water quality objectives for the Rainy River are being met.
- Identify other water quality problems caused by pollutants for which water quality objectives have not been established.
- Notify the IJC of instances where water quality objectives are not being met and of corrective actions being taken by those responsible for sources of pollution and by regulatory agencies.
- Review the water quality in the Rainy River and recommend amendments and additions to the water quality objectives.

3.1.2.4 International Lake of the Woods and Rainy River Watershed Task Force

The IJC created the International Lake of the Woods and Rainy River Watershed Task Force to review and make recommendations on the bi-national management of the Lake of the Woods and Rainy River Basin, and on the IJC's potential role in this management. The task force completed its work with the submission of a final report to the IJC in July 2011 (International Lake of the Woods and Rainy River Watershed Task Force 2011). The IJC immediately held public hearings on the report and made its recommendations to the governments of Canada and the USA in January 2012 (International Joint Commission 2012). A key recommendation was the merging of the International Rainy Lake Board of Control and the International Rainy River Water Pollution Board. This single integrated board would have an expanded geographic mandate with respect to water quality that encompasses the entire Lake of the Woods and Rainy River Basin. It was proposed that the board monitors and reports on conditions throughout the entire watershed that could potentially affect the quality of boundary waters. The governments responded to the IJC in June/July 2012 and have agreed to the creation of an International Lake of the Woods and Rainy River Watershed Board.

3.1.3 Federal and Provincial Legislation

A Canadian Lake of the Woods Control Board was first established by Canadian federal Order-in-Council in 1919. Subsequent discussions between the federal government and the provincial governments of Ontario and Manitoba led to the 1921 *Lake of the Woods Control Board Act, Canada*, the 1922 *Lake of the Woods Control Board Act, Ontario* and the 1922 *Canada-Ontario-Manitoba Tripartite Agreement*. The two acts established the Canadian Lake of the Woods Control Board and gave the board jurisdiction over Lake of the Woods and the Winnipeg River, among others. The tripartite agreement defined cost-sharing arrangements among the parties.

The later 1925 *Lake of the Woods Convention and Protocol,* a treaty between the governments of Canada and the USA, provided for two boards in the regulation of Lake of the Woods' water levels. Under this treaty, the Canadian Lake of the Woods Control Board was given responsibility for regulating lake levels on an ongoing basis, but its decisions were to be subject to the approval of the International Lake of the Woods Control Board whenever lake levels rise or fall below specified limits (Section 3.1.2.1).

The passing of the 1930 Manitoba *Natural Resources Act* gave Manitoba control over its natural resources. This led to the 1958 *Lake of the Woods Control Board Act, Manitoba* and amendments to the Canada and Ontario versions of the act in the same year. The new and amended acts provided for Manitoba to appoint a member to the board.

3.1.4 Seine River Water Management

3.1.4.1 History of Waterpower Development on the Seine River

Waterpower development on the Seine River commenced in 1909, with the construction of a dam across the Rainy River at Fort Frances. In 1926, the Calm Lake, Sturgeon Falls and Moose Lake generating stations were built, and the Marmion Reservoir was created to serve as the primary storage basin for power regulation at these generating stations. In 1943, the Seine River was diverted around the Steep Rock mining operations and the Moose generating station was decommissioned. The Raft Lake Dam was built to replace the Moose Lake structures as the principal control works for the system. Between 1944 and 1961, Lower Marmion Reservoir was isolated from Upper Marmion Reservoir to minimize the amount of material from dredging operations in the East Arm of Steep Rock from entering the Seine River. The Valerie Falls generating station was built in 1993 to 1994 and captures 65% of the available drop previously utilized by the Moose Lake generating station.

3.1.4.2 Power Generation Facilities and Water Control Structures

Figure 3-1 shows the power generation facilities and associated water control structures on the Seine River in operation today. There are three waterpower facilities with associated power dams:

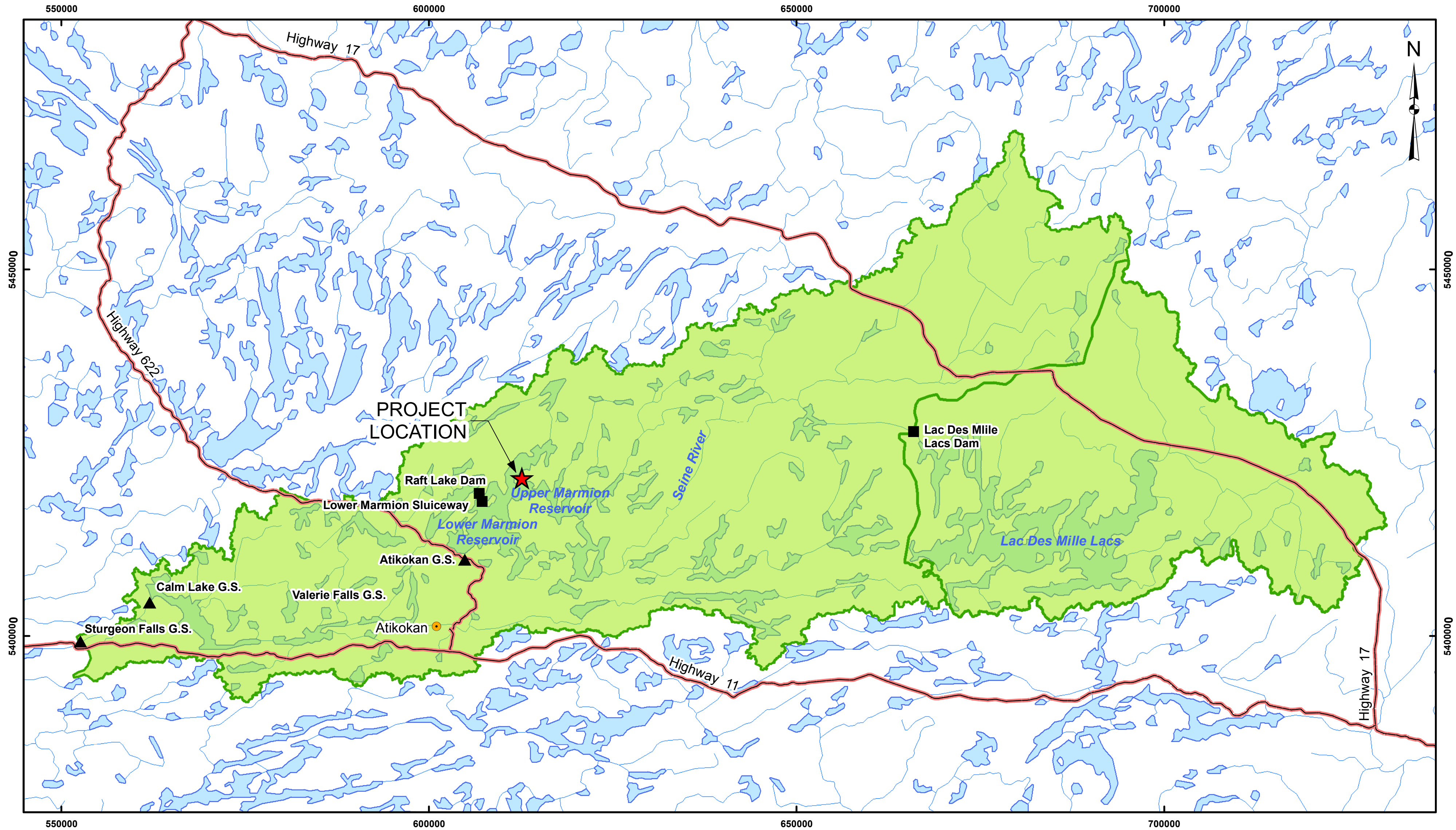
- **Valerie Falls Generating Station**, located on the man-made diversion of the river around the site of the former Steep Rock Mine, and owned and operated by Valerie Falls LP (Brookfield Renewable Energy Group).
- **Calm Lake Generating Station**, located on the Seine River at the outlet of Calm Lake, and owned and operated by H2O Power LP.
- **Sturgeon Falls Generating Station**, located about 90 km east of Fort Frances, also owned and operated by H2O Power LP.

The head ponds to the waterpower facilities have modest storage capacity and water levels are typically held close to full supply to maximize the amount of drop that water has to fall. The ability to store water in the head ponds beyond a few days is limited. Therefore, the waterpower facilities rely on two upstream reservoirs (Lac des Mille Lacs and Upper Marmion Reservoir) for “peaking” operations as well as to produce even flows to the head ponds throughout the year. Water is held back at the reservoirs during periods of high flows (spring and autumn) for use by the generating stations in periods of low flows. (Boileau 2004)

Water levels in a third reservoir (Lower Marmion Reservoir) are managed to provide suction head to cooling water pumps for the coal-fired Atikokan Generating Station. The plant is located near the town of Atikokan and is owned and operated by Ontario Power Generation. The facility draws in cooling water from Moose Lake and discharges the water into Snow Lake. From Snow Lake, the discharge flows into Icy Lake, Abie Lake and Lower Marmion Reservoir, then back to Moose Lake. The five lakes form a closed circuit system for water circulation.

Water levels and outflows from Lac des Mille Lacs are controlled at Lac des Mille Lacs Dam. Water levels and outflows from Lower Marmion Reservoir are controlled by the Lower Marmion Sluiceway. Water levels and outflows from Upper Marmion Reservoir are controlled at Raft Lake Dam. Raft Lake Dam is downstream of the other two water control structures. In general, Upper Marmion Reservoir and Lower Marmion Reservoir are operated as a single water body during the open-water season (May to October). The Lower Marmion Sluiceway is closed during the winter months to maintain the water level in Lower Marmion Reservoir above a minimum value.

The waterpower facilities and reservoirs on the Seine River are organized in a “cascade” system such that the storage on the river system is cascaded through multiple facilities. The release of water from an upstream reservoir will move through successive downstream stations with a time delay corresponding to the distances between the facilities and the flow rates. The management of flows and levels at one facility or structure can affect the operating abilities of others on the river system. The structures must be operated in a coordinated fashion.



LEGEND

- Project Location
- City/Town
- Waterpower Facility
- Water Control Dam Location
- Provincial Highway
- River/Stream
- Lake
- Watershed Boundary

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC, CANVEC
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SEINE RIVER POWER GENERATION FACILITIES AND WATER CONTROL STRUCTURES

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	16 Mar. 2012		
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

FIGURE: 3-1

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3.1.4.3 2004 to 2014 Seine River Water Management Plan

An amendment to the *Lakes and Rivers Improvement Act* in 2000 established the statutory authority of the Ontario Minister of Natural Resources to order owners of waterpower facilities and associated water control structures to prepare water management plans for the affected river systems. The plans provide a formal framework for managing existing waterpower facilities jointly with other riverine interests by recognizing and accommodating multiple uses of the river systems and ensuring that existing imbalances between environmental, social and economic interests are identified and resolved. (Ontario Ministry of Natural Resources 2002).

Structures that have operational control on water levels and flows in the Seine River are currently owned by H2O Power LP, Valerie Falls LP (Brookfield Renewable Energy Group) and the Ontario Ministry of Natural Resources. These proponents cooperatively prepared the *2004 to 2014 Seine River Water Management Plan* (Plan), which specifies operating rules for each water control structure on the Seine River, supporting the sustainable development of water resources for waterpower and other uses while protecting and enhancing the natural ecosystems.

Prior to the Plan, the Seine River water control structures were operated under voluntary agreements with targets for water levels and flows that recognized the multiple uses of the river and the regulatory and lease obligations of the structure's owner. These consisted of operational targets in the 1994 revision of the *Lac des Mille Lacs Lake Management Plan* and others set by the Seine River Water Level Technical Committee in 1995 to 1997.

In developing operating rules for the water control structures on the Seine River, the proponents recognized that a natural flow regime is the best option for the aquatic ecosystem. However, it was also evident that the water control structures in the system provide a variety of benefits related to power production, flood mitigation, navigation, recreation and other social benefits.

Operating rules for Lac des Mille Lacs Dam are presented in Table 3-1 and Figure 3-2 (Boileau 2004).

Table 3-1: Operating Rules for Lac des Mille Lacs Dam

Enforceable Rules	
Minimum outflows	Daily mean outflow ≥ 1.5 m^3/s Daily mean outflow to be steady or rising April 15 to June 15
Maximum up ramping rate	20 $m^3/s/d$ to reduce flood impacts 5 $m^3/s/d$ during rest of year
Maximum down ramping rate	15 $m^3/s/d$ to reduce flood impacts 5 $m^3/s/d$ during rest of year
Open-water season water levels	Daily maximum and minimum water levels in Figure 3-2 Lake levels will be stable or rising April 15 to June 15 Maximum seasonal water level fluctuation 0.35 m
Winter season water levels	Daily maximum and minimum water levels in Figure 3-2 Maximum seasonal water level fluctuation 0.50 m

Table 3-1: Operating Rules for Lac des Mille Lacs Dam (Continued)

Best Management Targets	
Bankfull Flows (1 in 1-Year)	15 m^3/s
Riparian Flow (1 in 10-Year)	40 m^3/s
Flood Events	Maintain flood freeboard before and during spring freshet Stage discharge to allow uncontrolled basin flows between Lac des Mille Lacs Dam and Raft Lake Dam to pass Utilize the 30 cm flood reserve in Lac des Mille Lacs when the inflow is rising and uncontrolled basin flows downstream of the dam are steady or rising
Open-water season water levels	Manage water levels to target the middle of the operating band during the summer Water level rise ≤ 5 cm/d during summer Water level fall ≥ 2 cm/d
Winter season water levels	Draw down lake levels after ice-in

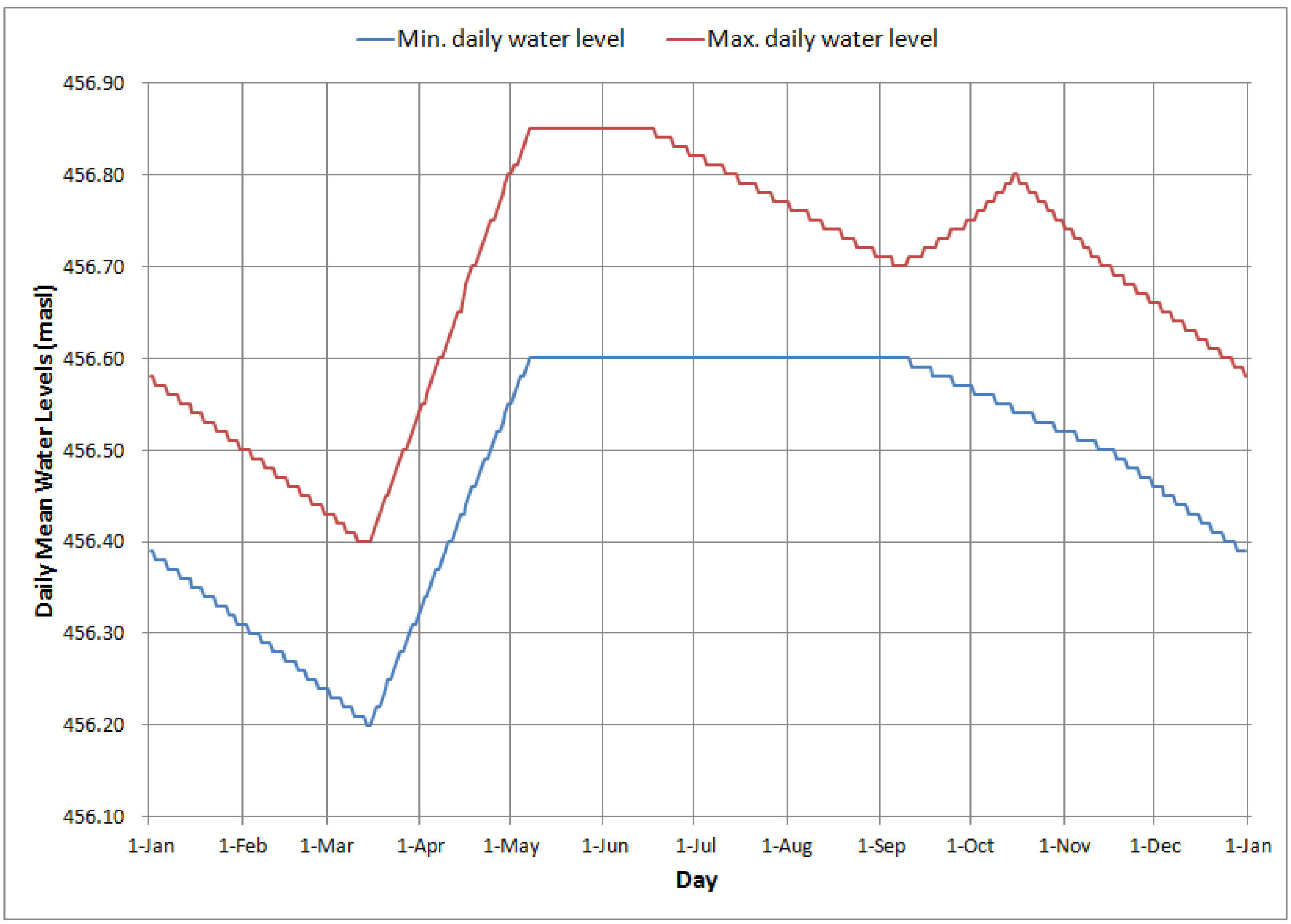


Figure 3-2: Enforceable Maximum and Minimum Daily Mean Water Levels in Lac des Mille Lacs

Operating rules for Lower Marmion Sluiceway are presented in Table 3-2 and Figure 3-3 (Boileau 2004).

Table 3-2: Operating Rules for Lower Marmion Sluiceway

Enforceable Rules	
Minimum outflow	Daily mean outflow ≥ 0.2 m^3/s
Maximum up ramping rate	2 $m^3/s/d$
Maximum down ramping rate	2 $m^3/s/d$
Open-water season water levels	Daily maximum and minimum water levels in Figure 3-3 Lake levels will be stable or rising April 15 to June 15 Maximum seasonal water level fluctuation 0.50 m
Winter season water levels	Daily maximum and minimum water levels in Figure 3-3 Maximum seasonal water level fluctuation 0.70 m
Best Management Targets	
Bankfull Flows (1 in 1-Year)	2 m^3/s
Riparian Flow (1 in 10-Year)	5 m^3/s

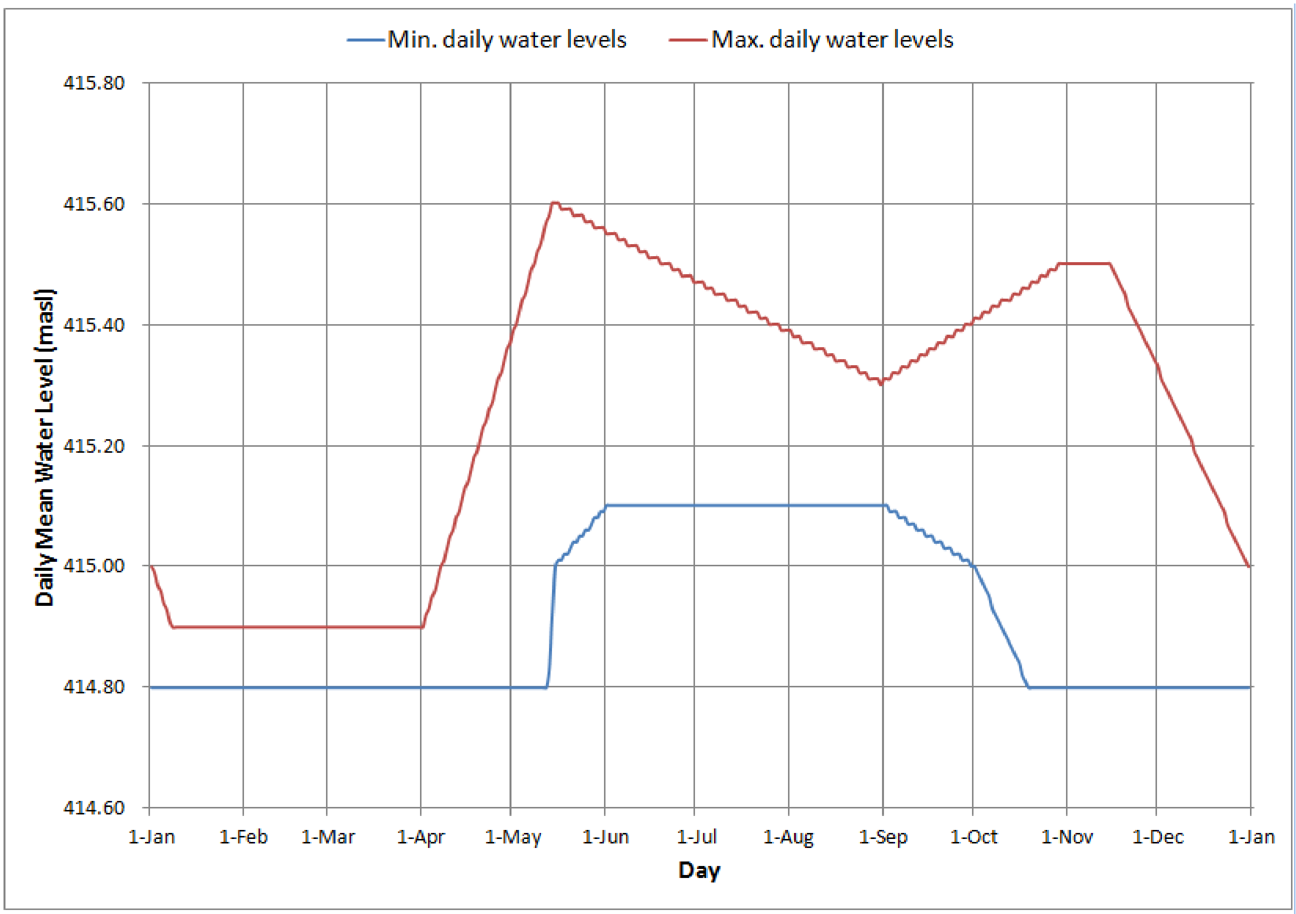


Figure 3-3: Enforceable Maximum and Minimum Daily Mean Water Levels in Lower Marmion Reservoir

Operating rules for Lower Marmion Sluiceway are presented in Table 3-3 and Figure 3-4 (Boileau 2004).

Table 3-3: Operating Rules for Raft Lake Dam

Enforceable Rules	
Minimum outflow	Daily mean outflow ≥ 10 m^3/s[a] Daily mean outflow to be steady or rising April 15 to June 15
Maximum outflow	Average of daily mean outflows over any two-week period between November 15 and April 15 ≤ 38 m^3/s[b]
Maximum up ramping rate	15 $m^3/s/d$
Maximum down ramping rate	15 $m^3/s/d$
Open-water season water levels	Daily maximum and minimum water levels in Figure 3-4 Lake levels will be stable or rising April 15 to June 15 Maximum seasonal water level fluctuation 0.50 m
Winter season water levels	Daily maximum and minimum water levels in Figure 3-4 Maximum seasonal water level fluctuation 3.00 m
Best Management Targets	
Bankfull Flows (1 in 1-Year)	70 m^3/s
Riparian Flow (1 in 10-Year)	120 m^3/s
Flood Events	Flood freeboard maintained before and during freshet

Notes:

(a) Minimum outflow could be reduced to 7 m3/s during poor freshet conditions.

(b) Exceptions may occur to reduce flood situations with written notification from the Ontario Ministry of Natural Resources.

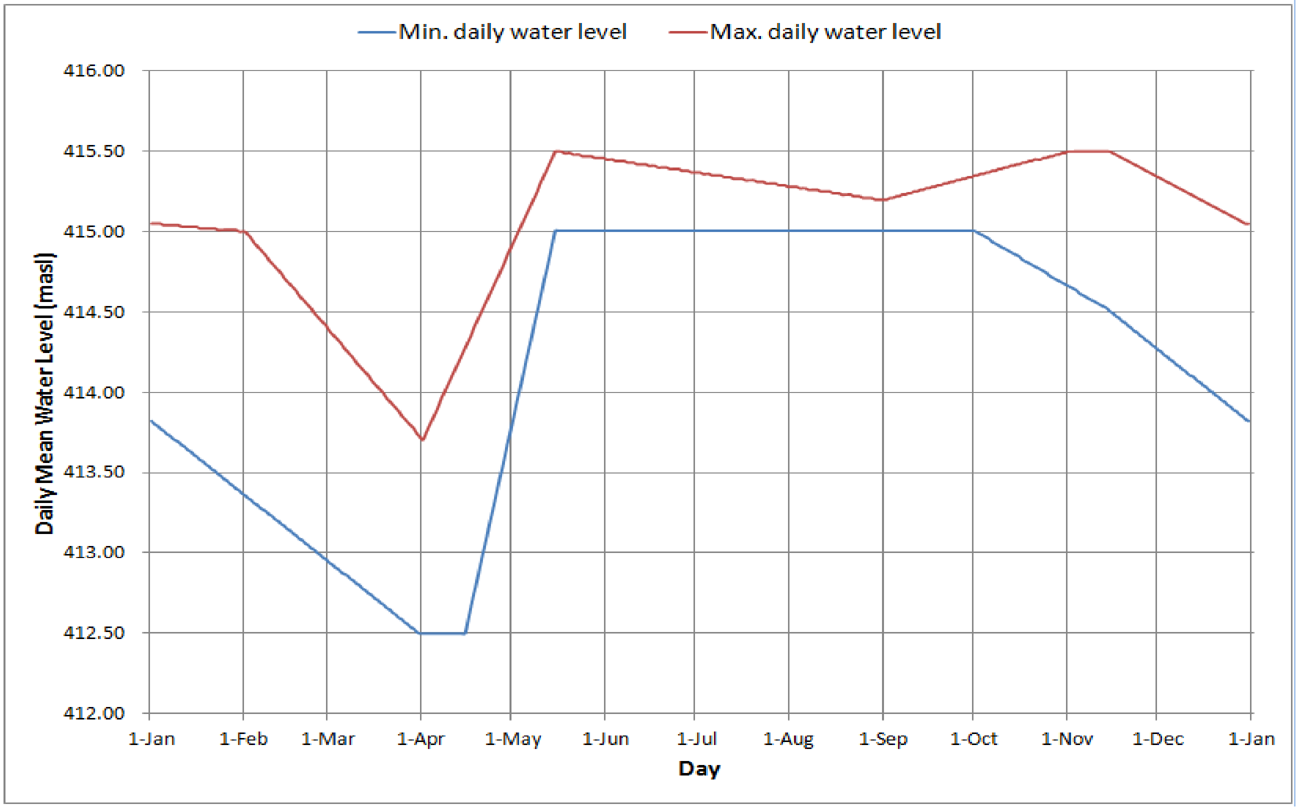


Figure 3-4: Enforceable Maximum and Minimum Daily Mean Water Levels in Upper Marmion Reservoir

According to the Plan, the operating rules are intended to guide the management of water in the reservoirs under normal flow and water level conditions. Flows and levels that are identified as best management targets will not be enforced. All other flows/levels will be enforced as per the compliance plan. The following compliance levels are used to determine normal flow and water level conditions in the reservoirs:

- **Lower Compliance Level**: Reservoir outflows are at minimum values specified in the plan and water levels are below the minimum specified elevation for that day in Lac des Mille Lacs, Upper Marmion Reservoir, Lower Marmion Reservoir, Calm Lake and Laseine Lake.
- **Upper Compliance Level**: Outflow from Lac des Mille Lacs is above 70 m^3/s and the water level is above the maximum specified elevation for that day. Outflow from Upper Marmion Reservoir is above 150 m^3/s and the water level is above maximum specified for that day. Outflow from Calm Lake is above 200 m^3/s and the water level is above the maximum specified elevation for that day.

3.1.5 Ontario Ministry of the Environment Permits to Take Water

Water takings in Ontario are governed by the *Ontario Water Resources Act* and the Water Taking and Transfer Regulation (O. Reg. 387/04), a regulation under the Act. Section 34 of the Act requires anyone taking more than a total of 50,000 litres of water in a day, with some exceptions, to obtain a permit from a Director appointed by the Minister of the Environment (Ontario Ministry of the Environment 2005).

Information on Permits to Take Water within a 20 km radius of the Project was provided by the Ontario Ministry of the Environment Northern Region. There is only one active permit for surface water taking, No. 8855-777HGF, owned by Ontario Power Generation Inc. for industrial cooling water to be taken at a maximum rate of 607,000 m^3 from Moose Lake (UTM 15 E604417 N5409666) which expires on September 29, 2017. There were no permitted drinking water sources in the information provided.

4.0 HYDROLOGICAL COMPONENTS, PROCESSES AND INTERACTIONS

4.1 Hydrological Components

Precipitation (rainfall and snowfall) represents the primary input to the hydrological water balances for regional, local and site scale watersheds and water bodies. The primary outputs are actual evapotranspiration, lake evaporation and surface runoff. Based on the surficial geology of the area, groundwater inflows and outflows are considered to be negligible (Hydrogeology TSD). Surface water taking and effluent discharges are minimal since the area is largely undeveloped.

Several different terms are commonly used to describe evapotranspiration and evaporation losses and for clarity these are defined below:

- **Potential evapotranspiration** is the amount of water that would be evaporated or transpired from a vegetated surface if there is sufficient moisture in the soil at all times for the use of the vegetation.
- **Actual evapotranspiration** is the actual amount of water that is evaporated or transpired from a vegetated surface depending on the availability of moisture in the soil for the use of vegetation.
- **Pan evaporation** is the measured evaporative water loss from a standard container filled with water. The use of evaporation pans provides an indirect method of estimating the transfer of water vapour from land and vegetation to the atmosphere. However, even though the pan responds in a similar fashion to the same climatic parameters affecting actual evapotranspiration and lake evaporation, there are differences in the loss of water as a result of the storage of heat within the pan and heat transfer through the sides of the pan among other factors. Therefore, pan evaporation is greater than actual evapotranspiration and lake evaporation.
- **Reference crop evapotranspiration** is a climatic parameter expressing the evaporative power of the atmosphere. It is the evapotranspiration rate from a hypothetical vegetated surface (reference crop) with an assumed crop height of 0.12 m, a fixed surface resistance of 70 sm^{-1} and an albedo of 0.23, closely resembling the evapotranspiration from an extensive surface of green grass of uniform height, actively growing, well-watered and completely shading the ground.
- **Lake evaporation**, as discussed in this report, represents the water loss from ponds and small reservoirs which have negligible heat storage capacities.

4.2 Existing Conditions

4.2.1 Methods

4.2.1.1 Secondary Data Review

4.2.1.1.1 Secondary Data

Precipitation and Temperature

An automatic weather station was installed by Genivar Inc., Montréal, at the end of March 2011. Table 4-1 provides information about the on-site meteorological station.

Table 4-1: On-site Automatic Weather Station

Latitude/ Longitude	Altitude	Period of Record	Parameters Measured
48.9565° N 91.4249° W	435 m	March 24, 2011 to June 30, 2012	All season precipitation Air temperature Dew-point temperature Wind speed Wind direction Incoming solar radiation Atmospheric pressure

Only one year of climatic data collected at the on-site meteorological station was available and it was necessary to consider data recorded at regional meteorological stations operated by Environment Canada.

Precipitation and temperature records collected at Atikokan and Upsala were examined. Data collected at Atikokan was considered to represent climatic conditions at the Project Site and in the surrounding area, whereas data collected at Upsala represents climatic conditions in the Lac des Mille Lacs area in the upper Seine River watershed. Table 4-2 provides summary information on the active and discontinued meteorological stations operated by Environment Canada at Atikokan and Upsala. Only two stations are currently active, Atikokan (AUT) and Upsala (AUT), and these have less than 10 years of data. Also they record only total precipitation, and not rainfall and snowfall as was done at the discontinued stations.

Long-term precipitation and temperature records for Atikokan 6020379 were constructed by joining the records for all the Atikokan stations. Atikokan 6020379 was selected as the base station since short-duration precipitation and evaporation data are available for this station from Environment Canada. Similar long-term records were constructed for Upsala 6049096 by joining the records for all the Upsala stations. The data were corrected using linear regression equations derived from overlapping periods of records at the stations where these existed.

Table 4-2: Meteorological Stations at Atikokan and Upsala

Station ID	Station Name	Latitude/ Longitude	Altitude (masl)	Distance from project (km)	Operating Years	Length of Record (years)	Station Status
6049096	Upsala	49.06° N / 90.47° N	484	84	1947 to 1972	26	Discontinued
6049098	Upsala TCPL62	49.03° N / 90.52° W	493	79	1970 to 1986	17	Discontinued
6049095	Upsala (AUT)	49.03° N / 90.47° N	489	83	1972 to 1975 2003 to 2011	13	Active
6020381	Atikokan CLI	48.73° N / 91.63° W	391	27	1914 to 1971	58	Discontinued
6020379	Atikokan	48.75° N / 91.62° W	395	25	1966 to 1988	23	Discontinued
6020384	Atikokan Marmion	48.80° N / 91.58° W	442	19	1979 to 1985	7	Discontinued
6020LPQ	Atikokan (AUT)	48.76° N / 91.62° W	389	25	2005 to 2011	7	Active

Double mass analysis was used to check and correct the consistency of the constructed records for Atikokan and Upsala with records for nearby meteorological stations located in adjacent watersheds that are operated by Environment Canada (Table 4-3). The records for these stations were also used to fill missing periods in the constructed data sets for Atikokan and Upsala. All of the meteorological stations are located within 150 km of the Project as shown in Figure 4-1.

Table 4-3: Other Regional Scale Meteorological Stations

Station ID	Station Name	Latitude/ Longitude	Altitude (masl)	Distance from project (km)	Operating Years	Length of Record (years)	Station Status
6037768	Sioux Lookout	50.13° N / 91.87° W	365	138	1914 to 1932	19	Discontinued
6037770	Sioux Lookout	50.13° N / 91.87° W	374	138	1930 to 1938	9	Discontinued
6037775	Sioux Lookout A	50.12° N / 91.90° W	383	137	1938 to 2011	74	Active
6032117	Dryden	49.78° N / 92.83° W	372	150	1914 to 1997	84	Discontinued
6032119	Dryden A	49.83° N / 92.75° W	413	149	1970 to 2004	35	Discontinued
6032120	Dryden A (AUT)	49.83° N / 92.74° W	413	148	2004 to 2011	8	Active

Table 4-3: Other Regional Scale Meteorological Stations (Continued)

Station ID	Station Name	Latitude/ Longitude	Altitude (masl)	Distance from project (km)	Operating Years	Length of Record (years)	Station Status
6025203	Mine Centre	48.77° N / 92.62° W	343	100	1914 to 2005	92	Discontinued
6025205	Mine Centre SW	48.76° N / 92.62° W	361	100	2005 to 2011	7	Active

Daily precipitation and temperature data for the regional scale meteorological stations were sourced from Environment Canada. Short-duration rainfall and rainfall plus snowmelt depth-duration-frequency data (describing storm and snowmelt events) for Atikokan 6020379 were also sourced from Environment Canada.

Pan and Lake Evaporation Data

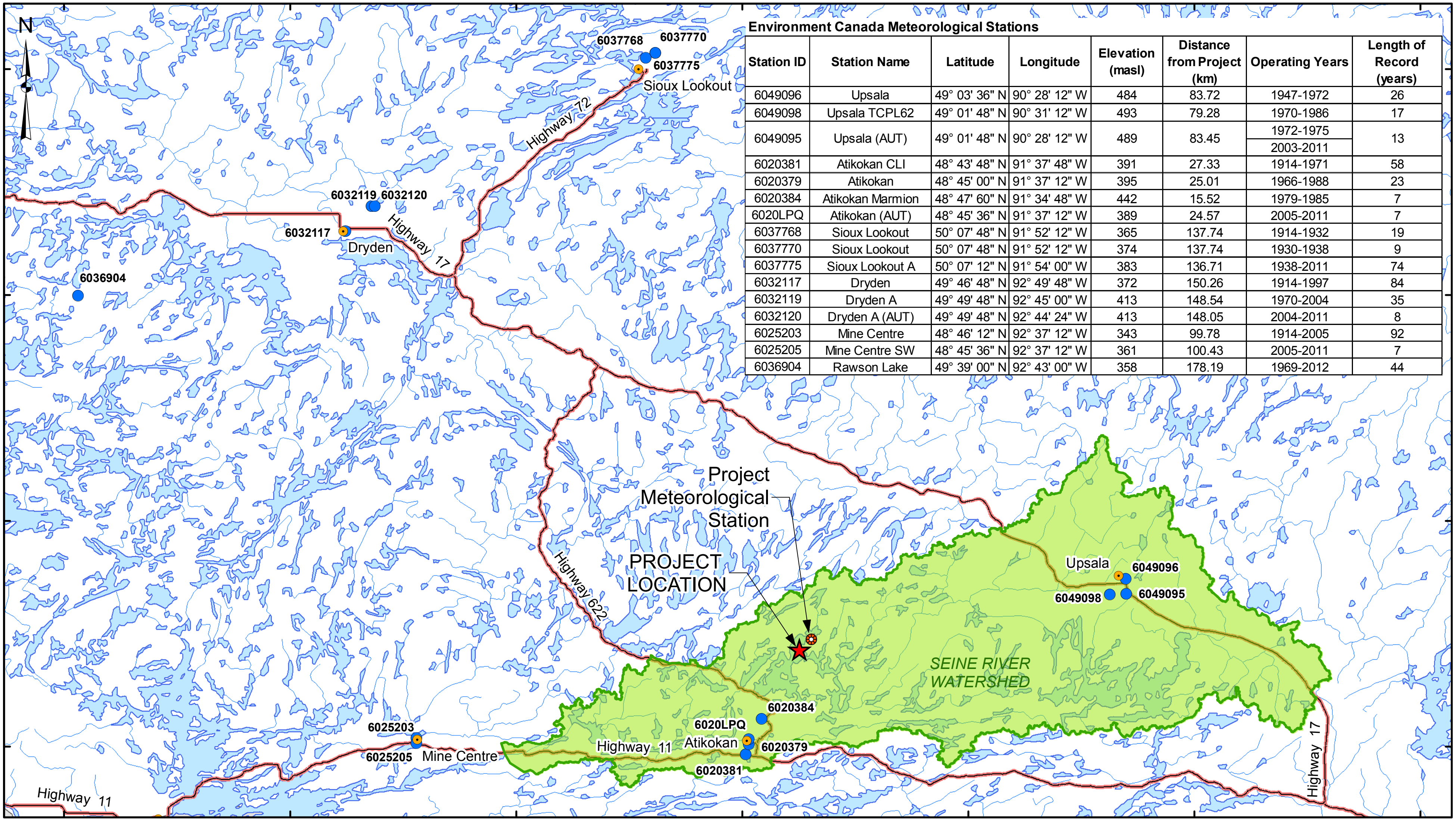
Pan evaporation is not currently collected at Atikokan; however historical data were available for Atikokan 6020379 and for a second meteorological station, Rawson Lake, located 185 km northwest of the Project (Table 4-4). These pan evaporation data were sourced together with lake evaporation data from Environment Canada, which calculates lake evaporation using the observed values of pan evaporative water loss, the mean temperatures of the water in the pan and of the nearby air, and the total wind run over the pan.

Table 4-4: Meteorological Stations with Pan and Lake Evaporation Data

Station Name	Station ID	Latitude/ Longitude	Distance from Project site (m)	Altitude (m)	Record	Years
Atikokan	6020379	48.75 N / 91.62 W	26	395.3	1966 to 1988	23
Rawson Lake	6036904	49.65 N / 93.72 W	182	358.1	1969 to 1999	31

Flow Data

Eight automatic recording flow monitoring stations were installed on watercourses in local scale watersheds and were operated between 2010 and 2012 for the purpose of characterizing existing flow conditions. In addition, flow records for the Seine River at Lac des Mille Lacs Dam and Raft Lake Dam and long-term flow records for six regional scale Water Survey of Canada flow monitoring stations within 100 km of the Project were sourced and examined. The flow monitoring stations and flow records are described in detail in Section 5.0.



Environment Canada Meteorological Stations

Station ID	Station Name	Latitude	Longitude	Elevation (masl)	Distance from Project (km)	Operating Years	Length of Record (years)
6049096	Upsala	49° 03' 36" N	90° 28' 12" W	484	83.72	1947-1972	26
6049098	Upsala TCPL62	49° 01' 48" N	90° 31' 12" W	493	79.28	1970-1986	17
6049095	Upsala (AUT)	49° 01' 48" N	90° 28' 12" W	489	83.45	1972-1975 2003-2011	13
6020381	Atikokan CLI	48° 43' 48" N	91° 37' 48" W	391	27.33	1914-1971	58
6020379	Atikokan	48° 45' 00" N	91° 37' 12" W	395	25.01	1966-1988	23
6020384	Atikokan Marmion	48° 47' 60" N	91° 34' 48" W	442	15.52	1979-1985	7
6020LPQ	Atikokan (AUT)	48° 45' 36" N	91° 37' 12" W	389	24.57	2005-2011	7
6037768	Sioux Lookout	50° 07' 48" N	91° 52' 12" W	365	137.74	1914-1932	19
6037770	Sioux Lookout	50° 07' 48" N	91° 52' 12" W	374	137.74	1930-1938	9
6037775	Sioux Lookout A	50° 07' 12" N	91° 54' 00" W	383	136.71	1938-2011	74
6032117	Dryden	49° 46' 48" N	92° 49' 48" W	372	150.26	1914-1997	84
6032119	Dryden A	49° 49' 48" N	92° 45' 00" W	413	148.54	1970-2004	35
6032120	Dryden A (AUT)	49° 49' 48" N	92° 44' 24" W	413	148.05	2004-2011	8
6025203	Mine Centre	48° 46' 12" N	92° 37' 12" W	343	99.78	1914-2005	92
6025205	Mine Centre SW	48° 45' 36" N	92° 37' 12" W	361	100.43	2005-2011	7
6036904	Rawson Lake	49° 39' 00" N	92° 43' 00" W	358	178.19	1969-2012	44

10 5 0 10 20 30 40

SCALE 1:1,250,000 Kilometres

LEGEND

- Project Location
- City/Town
- Project Meteorological Station
- Environment Canada Meteorological Station
- Provincial Highway
- River/Stream
- Lake
- Watershed Boundary

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC, CANVEC
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

METEOROLOGICAL STATIONS

PROJECT NO. 10-1118-0020			SCALE AS SHOWN / VERSION 1
DESIGN	CGE	16 Mar. 2012	
GIS	JO	4 Feb. 2013	
CHECK	CC	4 Feb. 2013	
REVIEW	THW	4 Feb. 2013	

Golder Associates
Mississauga, Ontario

FIGURE: 4-1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Hydrology\TSD\EC_MetStations.mxd

4.2.1.1.2 Quality Assurance

The following quality assurance procedures were applied to the meteorological data:

- Review of the percentage of missing and estimated data in the record for each station.
- Checks on the homogeneity of data using double mass analysis to compare annual precipitation and evaporation totals, and temperature averages, for each station to similar data at surrounding stations.
- Checks on the stationarity of the data collected at each station using scatter plots of annual precipitation and evaporation totals, and temperature averages, against time.

The precipitation records are generally of good quality with less than 10% of the precipitation records missing at all the stations. The exceptions were Atikokan (AUT) where 16% of the record was missing and Upsala (AUT) where 31% of the data was missing.

The temperature records are also generally of good quality with less than 10% of the records missing at all the stations. The exceptions were Atikokan Marmion where 19% of the record was missing, Upsala (AUT) where 57% of the record was missing and Upsala TCPL62 where 12% of the data was missing.

Review of the evaporation records, revealed that less than 10% of the records was missing for Atikokan and estimated data accounted for less than 1.5% of the remainder. For Rawson Lake, 15% or less of the records was missing and estimated data accounted for 3% or less of the remainder.

Precipitation and temperature time series exhibited trends indicating the data were non-stationary. However; the significance of the trends was not tested and the data were not adjusted.

Quality assurance procedures applied to flow data are described in Section 5.0.

4.2.1.1.3 Data Analysis

The following computations and data analysis were completed:

- Comparison of total precipitation and temperature recorded at the on-site meteorological station and Atikokan.
- Frequency analysis of annual total precipitation at Atikokan to determine wet and dry years with selected return periods.
- Computation of daily snowmelt at Atikokan and Upsala from total precipitation, maximum and minimum temperatures using the method described in Johnstone and Louie (1983).
- Computation of potential evapotranspiration at Atikokan from maximum and minimum temperatures, using the Thornthwaite equation as described in Johnstone and Louie (1983).
- Computation of lake evaporation at Atikokan and Upsala from maximum and minimum temperatures. Reference crop evapotranspiration was calculated using the Hargreaves equation (Allen et al. 1998) for the period 1966 to 1988 and correlated with lake evaporation provided by Environment Canada. The linear regression equation derived was then used to compute lake evaporation for later time periods.

- Frequency analysis of annual lake evaporation at Atikokan to determine wet and dry years with selected return periods.
- Computation of runoff coefficients for local and regional scale watersheds using flow data described in Section 5.0.
- Calculation of annual actual evapotranspiration for local and regional scale watersheds from precipitation and runoff data (Section 5.0) by means of water balances.
- Computation of average monthly and annual water balances for Upper Marmion Reservoir using precipitation, evaporation, flow and water level data (Section 5.0).
- Estimation of the base flows in local scale watercourses using hydrograph separation techniques.

4.2.1.2 Secondary Data Review Results

4.2.1.2.1 Comparison of On-site and Atikokan Data

Air temperature recorded at the on-site meteorological station from March 2011 to June 2012 correlates well with air temperature recorded at Atikokan (AUT) (Figure 4-2). Air temperature at the on-site meteorological station is slightly cooler than at Atikokan.

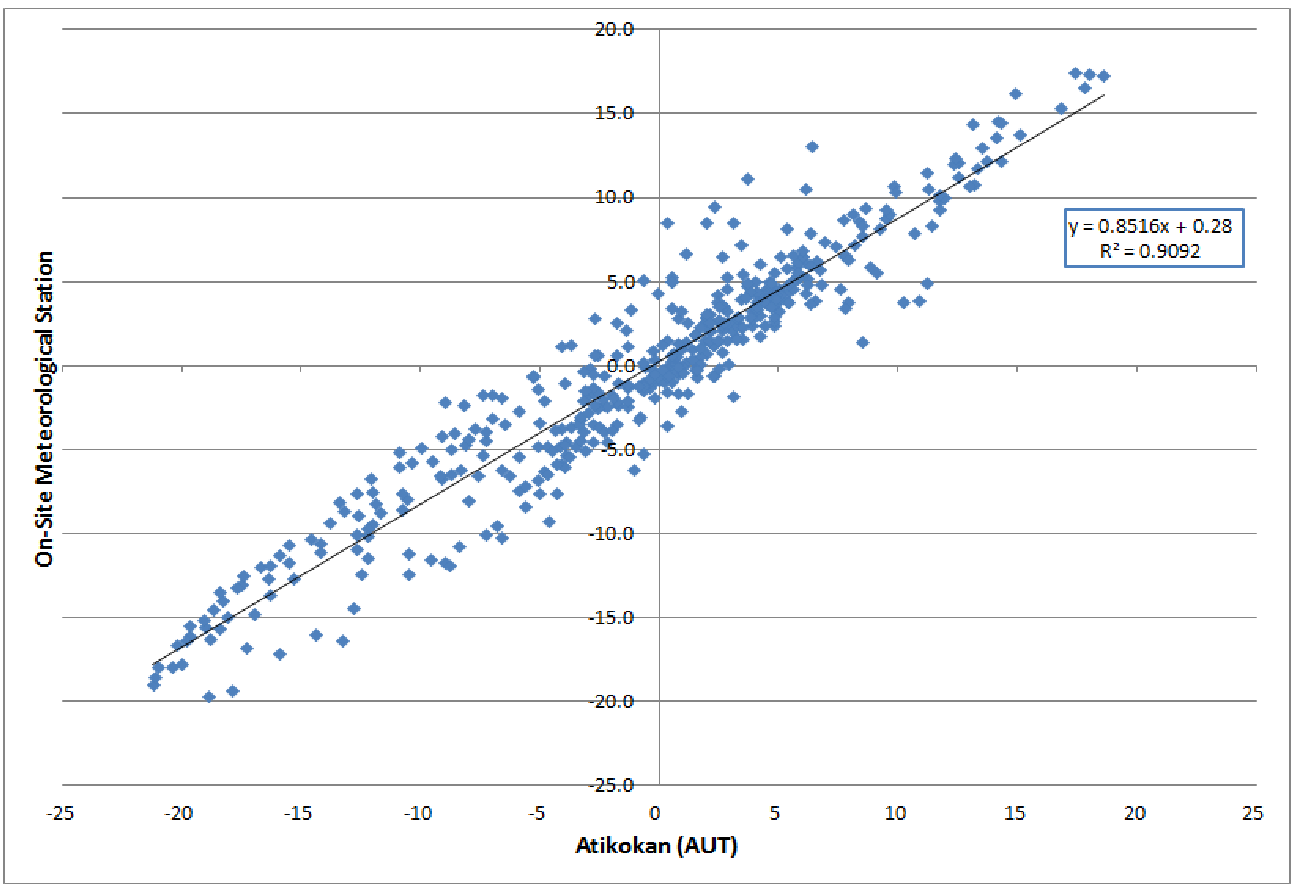


Figure 4-2: Comparison of On-site and Atikokan Hourly Air Temperature

There is a similar, although weaker, correlation between total precipitation recorded at the on-site meteorological station from June 2011 to June 2012 and data collected at Atikokan (Figure 4-3). Total precipitation recorded on-site is slightly less than that recorded at Atikokan.

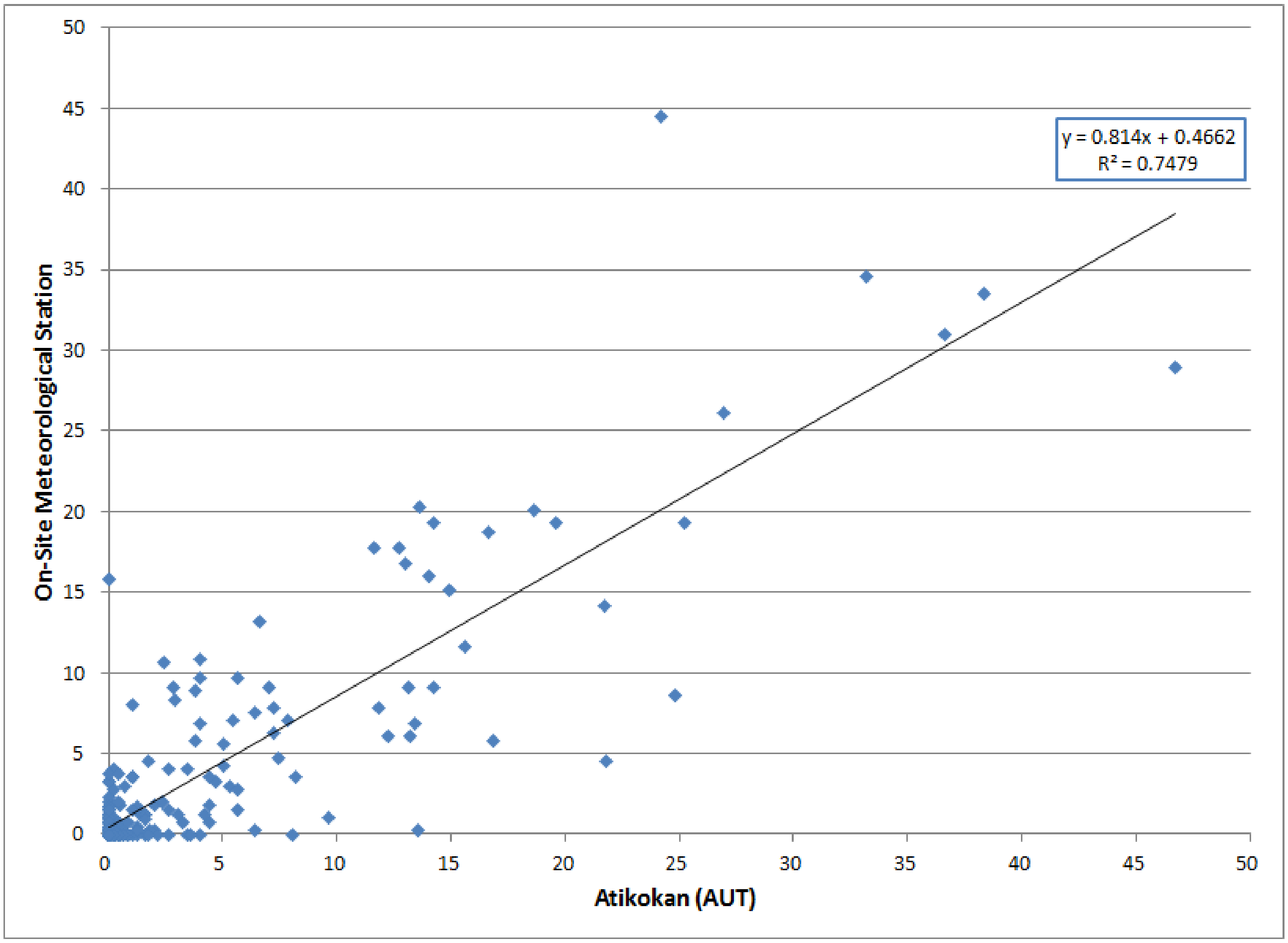


Figure 4-3: Comparison of On-site and Atikokan Daily Total Precipitation

4.2.1.2.2 Monthly and Annual Precipitation

Table 4-5 shows the 30-year average monthly and annual precipitation (1981 to 2010) at Atikokan and Upsala, which represents the most recent decade of climate normals for these stations. Precipitation amounts and distributions are similar at these stations. Rainfall accounts for about 75% of annual total precipitation at both stations and occurs mainly between April and October. June and July are the months with the highest total precipitation; approximately 30% of the annual total occurs in these two months. February is the month with the lowest total precipitation; only about 3% of the annual total occurs in this month.

Table 4-5: Average Precipitation at Atikokan and Upsala, 1981 to 2010

Month/ Year	Atikokan			Upsala		
	Rain (mm)	Snow (cm)	Total Precipitation (mm)	Rain (mm)	Snow (cm)	Total Precipitation (mm)
January	0.5	37.5	31.7	0.3	34.9	29.6
February	2.6	27.5	24	1.8	24.9	19.7
March	13.6	25.3	34.9	8.2	26.9	28.8
April	32.2	22	51.7	27.1	17.1	44.5
May	76.5	2.4	78.6	74.4	3	76.4
June	109.4	0	109.4	114.3	0	106.9
July	110.6	0	110.6	104.2	0	109.7
August	89.9	0	89.9	85.6	0	81.6
September	99.3	1.6	100.5	93.9	1.6	99.1
October	61.2	11.8	70.8	54.7	13.1	67.7
November	15.5	40.6	50.9	14.2	40.1	50.1
December	3.9	38.6	35.5	2.3	36	33.7
Year	615.2	207.3	788.5	581	197.6	747.8

Annual total precipitation for wet and dry years with different return periods at Atikokan is shown in Table 4-6. The data were obtained from frequency analysis of annual total precipitation between 1915 and 2012. The Pearson III Probability Distribution best fit the data with a coefficient of determination of 0.989.

Table 4-6: Annual Total Precipitation for Wet and Dry Years at Atikokan

Return Period (years)	Annual Total Precipitation (mm)	
	Wet Years	Dry Years
2	722	722
5	825	626
10	881	578
25	943	529
50	985	498
100	1,022	471

4.2.1.2.3 Short-duration Precipitation Events

Table 4-7 shows the short-duration rainfall depth-duration-frequency data for Atikokan and Table 4-8 shows similar data for rainfall plus snowmelt. Both data sets were provided by Environment Canada.

Table 4-7: Rainfall Depth-Duration-Frequency Data for Atikokan

Duration	Return Period (years)					
	2	**5**	**10**	**25**	**50**	**100**
	Rainfall Depth (mm)					
5 minutes	8.6	11.1	12.7	14.8	16.4	17.9
10 minutes	12.6	15.5	17.4	19.9	21.7	23.5
15 minutes	15.8	20.1	22.9	26.5	29.1	31.8
30 minutes	20.4	25.5	28.9	33.2	36.4	39.6
1 hour	25.1	31.3	35.4	40.5	44.4	48.2
2 hours	31.5	39.1	44.1	50.5	55.2	59.9
6 hours	39.7	52.5	60.9	71.6	79.5	87.4
12 hours	47.2	64.6	76	90.5	101.3	112
24 hours	51.8	68.9	80.2	94.5	105.1	115.7

Table 4-8: Rainfall plus Snowmelt Depth-Duration-Frequency Data for Atikokan

Return Period (years)	Duration (days)				
	1	**3**	**7**	**15**	**30**
	Rainfall plus Snowmelt (mm)				
2	26.1	50.4	72.3	90.7	100.9
5	33.9	70.4	102.6	128.1	141.1
10	39.1	83.7	122.7	153.0	167.9
25	45.7	100.5	148.0	184.3	201.5
50	50.5	113.0	166.7	207.6	226.5
100	55.4	125.3	185.4	230.7	251.4

Table 4-9 shows estimates of the Probable Maximum Precipitation for the Project site obtained from Ontario Ministry of Natural Resources (2006).

Table 4-9: Probable Maximum Precipitation at the Project Site

Duration (hours)	Drainage Area (km²)					
	25	250	500	1,000	2,000	5,000
	Probable Maximum Precipitation (mm)					
6	458	428	386	343	318	246
12	478	475	437	434	365	298
24	528	483	478	463	411	361

4.2.1.2.4 Monthly and Annual Potential Evapotranspiration

Table 4-10 shows estimated 30-year average monthly and annual potential evapotranspiration (1981-2010) at Atikokan, which represents the most recent decade of climate normals for this station. Approximately 64% of the annual total occurs between June and August. July is the month with the highest evaporative loss; 24% of the annual total occurs in this month. Potential evapotranspiration is low from November through to March.

Table 4-10: Average Potential Evapotranspiration at Atikokan, 1981 to 2010

Month/Year	Potential Evapotranspiration (mm)
January	0.0
February	0.5
March	4.3
April	25.2
May	72.5
June	109.5
July	128.4
August	110.7
September	65.2
October	24.5
November	3.7
December	0.1
Year	544.5

4.2.1.2.5 Monthly and Annual Lake Evaporation

Table 4-11 shows estimated 30-year average monthly and annual lake evaporation (1981-2010) at Atikokan and Upsala, which represents the most recent decade of climate normals for these stations. Approximately 68% of the annual total at both stations occurs between May and August. June and July are the months with the highest evaporative loss; 36% of the annual total occurs in these two months. Evaporation is lowest between December and February.

Table 4-11: Average Lake Evaporation at Atikokan and Upsala, 1981 to 2010

Month/Year	Lake Evaporation (mm)	
	Atikokan	Upsala
January	3.6	3.5
February	8.0	7.8
March	26.3	26.0
April	59.4	58.5
May	99.7	99.3
June	116.5	112.7
July	123.3	117.3
August	103.1	98.3
September	63.0	60.9
October	31.8	31.3
November	12.8	12.7
December	5.2	5.4
Year	652.9	633.6

Annual lake evaporation at Atikokan for wet and dry years with different return periods is shown in Table 4-12. The data were determined from frequency analysis of calculated annual total depths between 1981 and 2010. The Normal Probability Distribution best fit the data with a coefficient of determination of 0.931.

Table 4-12: Annual Total Lake Evaporation for Wet and Dry Years at Atikokan, 1981 to 2010

Return Period (years)	Annual Total Lake Evaporation (mm)	
	Dry Year	Wet Years
2	653	653
5	690	616
10	709	597
25	730	576
50	743	563
100	755	551

4.2.1.2.6 Annual Runoff Coefficients

Average annual runoff coefficients for the local scale flow monitoring stations (Section 5.1.1.2) and the regional scale flow monitoring station on Atikokan River (Section 5.1.1.3), for the period September 1, 2010 to August 31, 2012 are shown in Table 4-13. Annual total precipitation was 710 in 2010 to 2011 (an average year with a return period of 1.9 years) and 807 in 2011 to 2012 (a wet year with a return period of 4.5 years). The runoff coefficients have been calculated as the ratio of annual unit runoff and annual total precipitation.

Table 4-13: Average Annual Runoff Coefficients, 2010 to 2012

Station ID	Station Name	Drainage Area (km²)	Average Annual Mean Flow, (m^3/s)	Average Annual Unit Runoff (mm)	Average Annual Runoff Coefficient
SW-01	Sawbill Creek at Sawbill Bay	106	0.981	290.9	0.38
SW-07	Lumby Creek below Herontrack Lake	14.4	0.191	418.1	0.55
SW-02A	Lumby Creek above Lizard Lake	36.0	0.434	380.4	0.50
SW-03	Lumby Creek below Lizard Lake	62.8	0.449	225.4	0.30
SW-04	Premier Lake-Vista Lake	14.1	0.087	194.6	0.26
SW-06	Light Creek below Light Lake	41.4	0.226	172.3	0.23
SW-09	Bar Creek above Caribou River	68.7	0.670	307.4	0.41
SW-08 U/S	Caribou River at Upper Seine Bay	113	1.008	282.2	0.37
SW-08 D/S	Caribou River at Upper Seine Bay	113	0.878	245.8	0.32
05PB018	Atikokan River at Atikokan	332	2.87	273.1	0.36

In general, runoff coefficients at the local scale flow monitoring stations are fractionally higher than the runoff coefficient for Atikokan River. The exceptions are SW-04 and SW-06 in the Light Bay watershed, which indicate lower surface yields from this drainage basin.

Table 4-14 shows average monthly runoff coefficients for the local scale flow monitoring stations for the period September 1, 2010 to August 31, 2012. These have been calculated as the ratio of monthly unit runoff and the sum of monthly rainfall plus snowmelt. The highest monthly runoff coefficients typically occur in May/June due to the spring freshet (snowmelt) and rains, and in December which is a reflection of steady stream base flows.

Table 4-14: Monthly Runoff Coefficients for Local Scale Flow Monitoring Stations

Station ID	Runoff Coefficients											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW-01	0.25	0.29	0.09	0.25	0.35	0.41	0.23	0.15	0.05	0.32	0.29	0.44
SW-02A	0.54	0.35	0.13	0.29	0.43	0.53	0.33	0.20	0.12	0.53	0.53	1.04
SW-03	0.43	0.48	0.11	0.16	0.25	0.24	0.13	0.05	0.09	0.47	0.39	0.72
SW-04	0.26	0.36	0.08	0.15	0.22	0.28	0.16	0.07	0.05	0.32	0.29	0.46

Table 4 14: Monthly Runoff Coefficients for Local Scale Flow Monitoring Stations (Continued)

Station ID	Runoff Coefficients											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW-06	0.31	0.37	0.07	0.15	0.23	0.24	0.12	0.04	0.04	0.33	0.14	0.41
SW-07	0.30	0.31	0.17	0.26	0.44	0.61	0.75	0.34	0.08	0.41	0.40	0.69
SW-08 U/S	0.29	0.27	0.08	0.21	0.36	0.41	0.19	0.14	0.28	0.49	0.33	0.53
SW-08 D/S	0.28	0.22	0.08	0.22	0.34	0.33	0.16	0.14	0.10	0.40	0.26	0.52
SW-09	0.38	0.32	0.10	0.24	0.37	0.40	0.30	0.22	0.15	0.49	0.38	0.65

4.2.1.2.7 Annual and Monthly Water Balances

Local Scale Watersheds

Table 4-15 shows annual water balances for the local scale watersheds assuming negligible groundwater inflows and outflows. These are based on total precipitation at Atikokan and annual mean flows at SW-01, SW-03, SW-06 and SW-08 D/S which represent the lowest local scale flow monitoring stations in the watersheds (Section 5.1.1.2). Table 4-15 shows that actual evapotranspiration is in the range of 470 to 590 mm, and is about 60 to 180 mm lower than annual lake evaporation at Atikokan (Table 4-11).

Table 4-15: Water Balances for Local Scale and Seine River Watersheds

Watershed	Total Precipitation (mm)	Surface Runoff (mm)	Actual Evapotranspiration (mm)
Sawbill Bay	758.5	290.9	467.6
Lynxhead-Trap-Turtle Bays	758.5	225.4	533.1
Light Bay	758.5	172.3	586.2
Upper Seine Bay	758.5	245.8	512.7

Upper Marmion Reservoir

Table 4-16 shows the average monthly and annual water balances for Upper Marmion Reservoir for the period 2005 to 2010. The water balances are based on the following:

- Recorded outflows from Lac des Mille Lacs.
- Simulated inflows from the watershed area downstream of Lac des Mille Lacs, tributary to Upper Marmion Reservoir.
- Simulated inflows from the tributary watershed area to Lower Marmion Reservoir.
- Rainfall plus snowmelt and lake evaporation for Atikokan.
- Recorded water levels in Upper and Lower Marmion Reservoirs.
- The assumption that the Upper and Lower Marmion Reservoirs operate as a single water body between May and October (the open water season).

Table 4-16: Average Monthly and Annual Water Balances for the Marmion Reservoir

Month	Lac des Mille Lacs Outflow	Unregulated Inflows	Lower Marmion Outflows	Rainfall plus Snowmelt on the Lake Surface	Evaporation from the Lake Surface	Change in Lake Storage	Raft Lake Dam Outflow
	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
January	7.0	11.6	0.0	0.2	0.1	-6.7	25.4
February	9.7	9.5	0.0	0.2	0.2	-7.3	28.5
March	4.4	8.6	0.0	1.6	0.6	-14.5	28.6
April	2.7	24.1	0.0	1.7	1.4	-1.5	28.6
May	20.6	55.2	-0.9	1.8	1.9	22.5	52.3
June	19.8	46.1	-0.7	1.9	2.5	8.2	56.4
July	6.4	28.7	1.9	2.6	2.6	2.3	34.6
August	4.3	16.4	1.6	1.2	2.2	-0.3	21.5
September	5.0	10.1	2.4	2.0	1.5	-1.8	20.1
October	13.7	18.1	1.0	1.5	0.6	0.7	32.9
November	15.2	19.3	0.0	0.7	0.3	0.8	34.2
December	6.8	15.6	0.0	0.1	0.1	-2.9	25.4
Year	9.6	22.0	0.4	1.3	1.2	0.0	32.4

4.2.1.2.8 Surface Water – Groundwater Interactions

Base flow is that part of stream flow that is not attributable to direct runoff from rainfall or snowmelt. It is widely considered to represent groundwater discharge, but may also consist of interflow and the delayed release of runoff from lake and wetland storage.

The base flow index represents the ratio of base flow to total flow. Annual base flow indices were computed from daily mean flow data recorded at the local scale flow monitoring stations (Section 5.1.1.2) using an automated base flow separation technique (Arnold et al. 1995). Table 4-17 shows the average annual base flow indices estimated for the local scale flow monitoring stations for the period September 1, 2010 to August 31, 2012. Table 4-17 indicates that base flow ranged from 61 mm to 279 mm and accounted for between 33% and 71% of annual mean flow in the local scale watercourses.

Table 4-17: Annual Base Flows at Local Scale Flow Monitoring Stations, 2010 to 2012

Station ID	Drainage Area (km^2)	2010 to 2011			2011 to 2012		
		Base Flow Index	Annual Mean Flow (m^3/s)	Base Flow (mm)	Base Flow Index	Annual Mean Flow (m^3/s)	Base Flow (mm)
SW-01	106	0.64	0.745	142	0.62[(a)]	1.217	224
SW-07	14.4	0.38	0.125	104	0.33	0.257	186
SW-02A	36.0	0.54	0.317	150	0.58	0.550	279
SW-03	62.8	0.67	0.465	156	0.64	0.433	139
SW-04	14.1	0.61	0.074	101	0.65	0.100	145
SW-06	41.4	0.67	0.284	145	0.48	0.168	61
SW-09	68.7	0.66	0.694	210	0.71	0.646	211
SW-08 U/S	113	0.57	0.818	130	0.62	1.197	207
SW-08 D/S	113	0.59	0.807	133	0.63	0.950	167

Notes:

(a) Based on 10 months of daily mean flow data; data from August to October 2011 are missing.

Pyrce (2004) reports that the annual minimum 30-day mean flow with a 2-year return is considered to provide a reasonable estimate of annual average base flow in any given year. Based on the relationship between the annual minimum 30-day mean flow with a 2-year return period and tributary drainage area (Figure 5-13), derived from flow data recorded at the Water Survey of Canada flow monitoring stations, base flows of 98 mm/year may be expected in watercourses regionally.

A major contribution to flows in watercourses in the region is the delayed release of runoff from lakes and wetland areas, which act as effective attenuators of overland flow and interflow. As such, the above estimates of base flow are considered to be conservative in the context of groundwater discharge. Actual groundwater discharge to watercourses is likely to be lower.

5.0 STREAMFLOWS

5.1 Existing Conditions

5.1.1 Methods

5.1.1.1 Parameters

Flow Regime

The existing flow regime was characterized in terms of the monthly and seasonal fluctuations in flows and the year-to-year variability in flows. Monthly and seasonal fluctuations in flows are described in terms of:

- The long-term average monthly and seasonal unit runoff (flow per unit area).

The year-to-year variability in flows is described by:

- The long-term range in annual mean flows (the difference between the maximum and minimum annual mean flows).
- Annual mean flows with different return periods (average recurrence intervals).

Normal Flows

The following statistics were used as descriptors of the range of normal flows in streams:

- The 25th exceedance percentile (Q_{25}) or daily mean flow equaled or exceeded 25% of the time. The Q_{25} is commonly used to represent the upper bound of normal flow conditions in streams.
- The 75th exceedance percentile (Q_{75}) or daily mean flow equaled or exceeded 75% of the time. The Q_{75} is commonly used to represent the lower bound of normal flow conditions in streams.

Flood Flows

The following statistics were used as descriptors of the flood properties of streams:

- The instantaneous peak flow with a 1.5 year return period (Q1.5). The Q1.5 typically represents the "bankfull flow" or point of incipient flooding when the rising water level begins to flow out of the stream channel and over the flood plain. The bankfull flow is generally considered to be the channel forming flow. Boileau (2004) considers the instantaneous peak flow with a one year return period (Q1) as a best management target bankfull flow for Seine River water control structures.
- The instantaneous peak flow with a return period of 10 years (Q10). The Q10 represents a best management target riparian flow for Seine River water control structures (Boileau 2004).
- The instantaneous peak flow with a return period of 25 years (Q25). The Q25 is commonly used as the design flood for road drainage structures.
- The instantaneous peak flow with a return period of 100 years (Q100). The Q100 is often used as the design flood for floodplain and stormwater management purposes.

Low Flows

The following statistics were used to describe the drought properties of streams:

- The annual minimum 7-day mean flow with a return period of 2 years (7Q2). The Ontario Ministry of Natural Resources (OMNR) uses the 7Q2 as a measure of aquatic habitat/ecosystem maintenance or systems extinction (Pyrce 2004). The flow represents a period of stress that causes some reduction in populations.
- The annual minimum 7-day mean flow with a 20 year return period (7Q20). The OMNR also uses the 7Q20 as a measure of aquatic habitat/ecosystem maintenance or systems extinction; this flow represents a period of significant stress on the system (Pyrce 2004). The Ontario Ministry of the Environment (MOE) uses the 7Q20 as a limiting condition for stormwater or wastewater discharges (Ontario Ministry of the Environment 2000) and as a criterion for Category 2 water takings from 3rd order or higher streams (Ontario Ministry of the Environment 2005).
- The 90th exceedance percentile (Q_{90}) or daily mean flow equalled or exceeded 90% of the time. This flow is used as a minimum flow for aquatic habitat/ecosystem maintenance to be satisfied in outflows from Seine River water control structures (Boileau 2004).
- The annual minimum 30-day mean flow with a 2 year return period (30Q2). This flow is considered to provide a reasonable estimate of annual average base flow in any given year (Pyrce 2004).

5.1.1.2 Field Studies

Field studies consisted of the following two components:

- Surveys of the small watercourses in the site scale watersheds.
- The installation and operation of 13 flow monitoring stations in site and local scale watersheds.

Site Scale Watercourse Surveys

Figure 2-4 shows the site scale watersheds in the Project vicinity. Year-round monitoring of flows in the small watercourses draining these watersheds was not considered practical given the number of streams and their small drainage areas (6.3 km² and less). Instead, surveys of 34 of the watercourses were completed in May and August 2012, and were limited to the reach 200 m upstream of the mouth of each watercourse. The following information was collected:

- Direct flow measurements.
- In situ water quality (water temperature, pH, electrical conductivity and dissolved oxygen).
- Observations of fluvial geomorphology, for example:
  - Channel bankfull depth and width.
  - Channel substrate (left and right bank, bed).
  - Channel thalweg.

- Vegetative cover on channel banks.
- Vegetative cover and extent of floodplain.

The field information collected was supplemented by the results of a desk study and direct flow measurements collected by the Aquatic Environment team during fish habitat studies of these watercourses. The surveys, desk study and supplementary information are fully documented in Appendix 2.I.

Local Scale Flow Monitoring

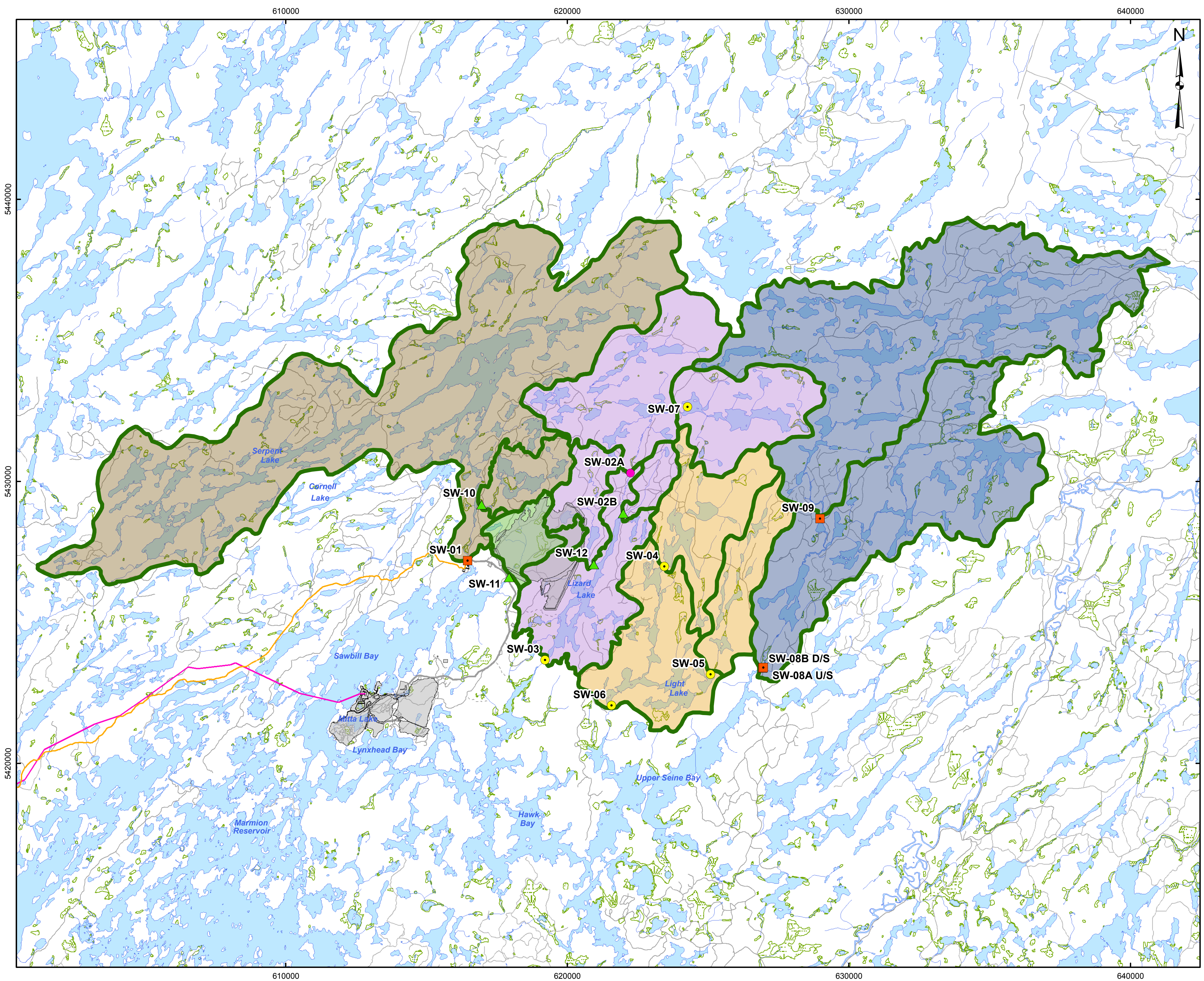
Figure 5-1 shows the 13 flow monitoring stations installed to gauge flows in the local watersheds. These stations were operated for a period of two years from August 2010 to August 2012. The monitoring program was designed in the late spring/early summer of 2010 when definition of the Project was at an early stage. At that time, five alternative locations for the Tailings Management Facility (TMF) were under consideration, which necessitated that the program be designed to cover a wide area. Since then, a preferred location and two alternative locations for the TMF have been selected.

Eight of the monitoring stations were continuous recording stations and collected water level data at intervals of 15 minutes. The recorded water levels were converted into flows using a rating curve (plot of flow versus water level) developed for each recording station; rating curves were developed from direct flow measurements and manual water level readings that were collected during periodic visits to the stations. The other five stations were manual gauges where direct flow measurements were also collected during periodic site visits. Table 5-1 provides summary information on the flow monitoring stations.

Table 5-1: Local Scale Flow Monitoring Stations

Local Watershed	Station ID #	Station Name	Latitude/ Longitude	Distance from Project (km)[(a)]	Drainage Area (km²)	Station Type	Final Data Product
Sawbill Bay	SW-01	Sawbill Creek at Sawbill Bay	48.9867° N 91.4082° W	6	106.3	Recording	Daily mean flow
Sawbill Bay	SW-10	Sawbill Creek below Long Hike Lake	49.0044° N 91.4009° W	8	5.87	Manual	Instantaneous flow
Sawbill Bay	SW-11	Sawbill Bay Tributary at Reef Road	48.9811° N 91.3883° W	7	4.62	Manual	Instantaneous flow
Lynxhead-Trap-Turtle Bays	SW-02A	Lumby Creek above Lizard Lake	49.0135° N 91.3283° W	12	35.98	Recording	Daily mean flow
Lynxhead-Trap-Turtle Bays	SW-02B	Lumby Creek East Tributary at Lizard Lake	49.0007° N 91.3322° W	11	2.86	Manual	Instantaneous flow
Lynxhead-Trap-Turtle Bays	SW-03	Lumby Creek below Lizard Lake/Lizard Lake near outlet	48.9541° N 91.3720° W	7	62.83	Recording	Daily mean flow
Lynxhead-Trap-Turtle Bays	SW-07	Lumby Creek below Herontrack Lake	49.0325° N 91.3037° W	15	14.41	Recording	Daily mean flow
Lynxhead-Trap-Turtle Bays	SW-12	Lizard Lake West Tributary	48.9846° N 91.3470° W	9	6.21	Manual	Instantaneous flow
Light Bay	SW-04	Premier Lake-Vista Lake	48.9831° N 91.3134° W	12	14.10	Recording	Daily mean flow
Light Bay	SW-05	St. Patrick Creek above Upper Light Lake	48.9532° N 91.2881° W	13	9.82	Manual	Instantaneous flow
Light Bay	SW-06	Light Creek below Light Lake	48.9390° N 91.3399° W	9	41.36	Recording	Daily mean flow
Upper Seine Bay	SW-08 U/S	Caribou River at Upper Seine Bay	48.9505° N 91.2659° W	14	112.64	Recording	Daily mean flow
Upper Seine Bay	SW-08 D/S	Caribou River at Upper Seine Bay	48.9504° N 91.2662° W	14	112.64	Recording	Daily mean flow
Upper Seine Bay	SW-09	Bar Creek above Caribou River	48.9976° N 91.2367° W	17	68.73	Recording	Daily mean flow

Notes:
[(a)] Taken as the distance to the proposed location of the Process Plant.



LEGEND

- Barologger and Stream Gauging Station
- Spot Flow Measurement Location
- Stream Gauging Station
- Stream Gauging and Water Level Monitoring Station

Surface Water Drainage Areas

- Contributing to SW-01
- Contributing to SW-03
- Contributing to SW-06
- Contributing to SW-08
- Contributing to SW-11

- Road
- Trail
- River/Stream
- Lake
- Wetland
- Local Watershed Boundary
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

NOTES:

1. Stream Gauging Stations and Associated Drainage Area:

Station ID	Station Name	Drainage Area (ha)
SW-01	SAWBILL CREEK AT SAWBILL BAY	10,634.14
SW-02A	LUMBY CREEK ABOVE LIZARD LAKE	3,597.52
SW-03	LUMBY CREEK AT TURTLE BAY	6,282.83
SW-04	PREMIER LAKE-VISTA LAKE	1,409.88
SW-05	ST. PATRICK CREEK AT LIGHT LAKE	981.55
SW-06	LIGHT CREEK AT LIGHT LAKE	4,135.96
SW-07	LUMBY CREEK AT HERONTRACK LAKE	1,440.58
SW-08DS/US	CARIBOU RIVER AT UPPER SEINE BAY	11,264.36
SW-09	BAR CREEK NEAR CARIBOU RIVER	6,872.60

2. Spot Flow Measurement Stations:

Station ID	Station Name	Drainage Area (ha)
SW-02B	LUMBY CREEK TRIBUTARY AT LIZARD LAKE	285.81
SW-10	SAWBILL CREEK AT LONG HIKE LAKE	587.07
SW-11	SAWBILL BAY TRIBUTARY AT REEF ROAD	461.80
SW-12	LIZARD LAKE TRIBUTARY	620.95

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000
SCALE 1:135,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LOCAL SCALE FLOW AND WATER LEVEL MONITORING STATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 5-1	
GIS	JO	9 Oct. 2012		
CHECK	CC	9 Oct. 2012		
REVIEW	THW	9 Oct. 2012		

\\golder.gds\GAL\Mississauga\GIS\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Hydrology\TSD\LocalScaleFlowandWaterLevel_Mon_Stations.mxd

A total of 10 site visits were completed over the two-year period that the stations were operating. During the site visits, direct flow measurements and manual observations of water levels were collected at all the flow monitoring stations, and water level data was downloaded from recording stations. In situ water quality testing (pH, temperature and electrical conductivity) was also carried out. Site visits were timed to observe as wide a range of flow conditions as possible. The first site visit was in August 2010 (summer low flows) to install the monitoring stations and collect observations of fluvial geomorphology. Additional site visits were completed in:

- October 2010 (fall medium flows).
- January and March 2011 (winter low flows).
- April and May 2011 (spring high flows).
- August 2011 (summer low flows).
- February 2012 (winter low flows).
- May 2012 (spring high flows).
- August 2012 (summer low flows).

Flow monitoring is described fully in Appendix 5.I which provides details of station locations, equipment installations, field and data processing methods, quality assurance-quality control activities, program limitations, as well as field observations and the final data product.

The data collected are summarized in Section 5.1.2.1.2. The statistics presented include the observed annual, seasonal and monthly mean flows; annual instantaneous peak flows, minimum 7-day and 30-day mean flows; and annual base flow indices.

5.1.1.3 Secondary Data Review

5.1.1.3.1 Secondary Data

At the regional scale, daily mean outflows from Lac des Mille Lacs at Lac des Mille Lacs Dam and from Upper Marmion Reservoir at Raft Lake Dam on the Seine River are monitored by Valerie Falls LP (Brookfield Renewable Energy Group) and H2O Power LP respectively as part of compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. Data are published charted on the Seine River Watershed Information website and discrete data records were sourced from Brookfield Renewable Energy Group and the Ontario Ministry of Natural Resources Atikokan in 2011. Outflows from Lower Marmion Reservoir at Lower Marmion Sluiceway are not recorded.

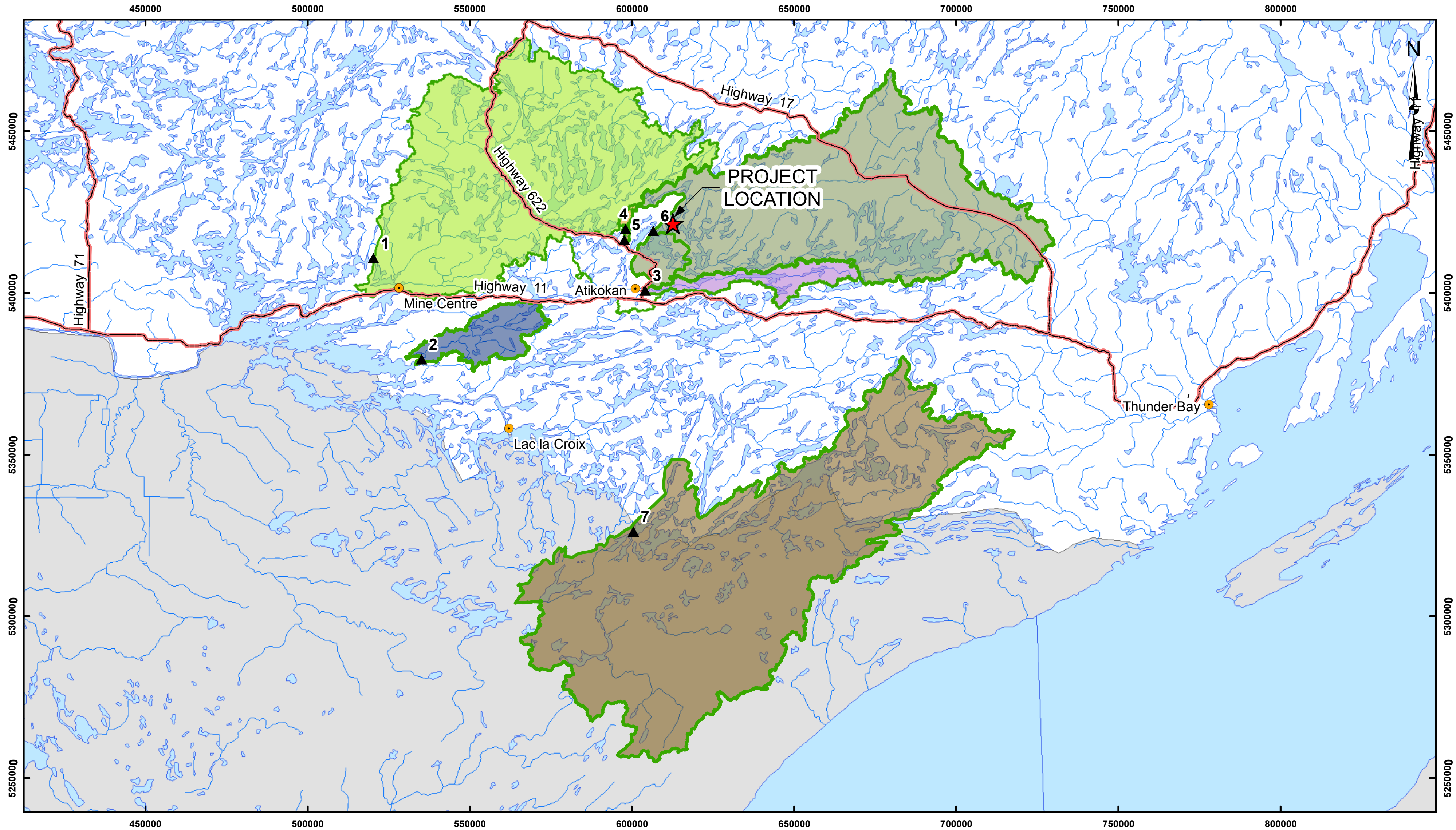
The flow records sourced for the Seine River at Lac des Mille Lacs Dam and Raft Lake Dam represent regulated outflows from Lac des Mille Lacs and Upper Marmion Reservoir. In order to develop reliable statistics describing the natural (unregulated) flow regime, and normal, flood and drought properties of watercourses, it was necessary to consider long-term flow records collected at six regional scale Water Survey of Canada (Environment Canada) flow monitoring stations within 100 km of the Project. These data were used to place the short-term flow records (Sections 5.1.2.1.1 and 5.1.2.1.2) in context, and to develop regional relationships that could be applied to the watercourses to determine summary flow statistics. Daily mean flows and instantaneous peak flows for the six stations were downloaded from Water Survey of Canada's online database.

Table 5-2 shows details of the six regional Water Survey of Canada flow monitoring stations, together with information on the stations at Lac des Mille Lacs Dam and Raft Lake Dam on the Seine River. The locations of these stations are shown in Figure 5-2.

Table 5-2: Regional Scale Hydrometric Stations

Regional Watershed	Station ID	Station Name	Latitude/ Longitude	Distance from Project (km)[a]	Drainage Area (km²)	Data Record
Namakan Lake	05PA012	Basswood River near Winton	48.0825° N 91.6511° W	96	4,510	1-Mar-1924 to 31-Dec-2010
Rainy Lake	05PB014	Turtle River near Mine Centre	48.8500° N 92.7236° W	95	4,870	1-Aug-1914 to 31-May-2012[b]
Rainy Lake	05PB015	Pipestone River above Rainy Lake	48.5686° N 92.5242° W	90	443	1-May-1963 to 31-Jul-1998
Rainy Lake	05PB018	Atikokan River at Atikokan	48.7519° N 91.5839° W	23	332	1-Jan-1978 to 31-May-2012[b]
Rainy Lake	05PB021	Eye River near Hardtack Lake	48.9250° N 91.6622° W	17	19.8	1-Jan-1985 to 31-Dec-1994
Rainy Lake	05PB022	Eye River near Coulson Lake	48.8944° N 91.6675° W	18	27.9	1-Jan-1985 to 31-Dec-1993
Rainy Lake	—[e]	Seine River at Lac des Mille Lacs Dam	48.9796° N 90.7306° W[c]	54	1,775	1-Jan-2005 to 31-Aug-2010
Rainy Lake	—[e]	Seine River at Raft Lake Dam	48.9176° N 91.5451° W[c]	7	4,581[d]	1-Jan-1980 to 19-Oct-2011

Notes:
(a) Taken as the distance to the proposed location of the Process Plant.
(b) Provisional data from January 2011 to May 2012.
(c) Estimated from Google Earth.
(d) Includes Upper and Lower Marmion Reservoirs.
(e) Not applicable.



LEGEND

- Project Location
- City/Town
- Flow Monitoring Station
- Provincial Highway
- River/Stream
- Lake
- Watershed Boundary

Flow Monitoring Stations

Station ID	Station Name	Latitude ° N	Longitude ° W	Watershed Area km²
1	Turtle River near Mine Centre	48.85	92.7236	4870
2	Pipestone River above Rainay Lake	48.5686	92.5242	443
3	Atikokan River at Atikokan	48.7519	91.5839	332
4	Eye River near Hardtack Lake	48.925	91.6622	19.8
5	Eye River near Coulson Lake	48.8944	91.6675	27.9
6	Seine River at Raft Lake Dam	48.9176	91.5451	4581
7	Basswood River near Winton	48.0825	91.6511	4510

25 12.5 0 25 50 75

SCALE 1:1,700,000 Kilometres

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC, CANVEC
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

REGIONAL SCALE FLOW MONITORING STATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020		
DESIGN	CGE	16 Mar. 2012
GIS	JO	4 Feb. 2013
CHECK	CC	4 Feb. 2013
REVIEW	THW	4 Feb. 2013

SCALE AS SHOWN | VERSION 1

FIGURE: 5-2

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5.1.1.3.2 Quality Assurance

The following quality assurance procedures were applied to the secondary data:

- Review of the percentage of missing and estimated data in the record for each station.
- Checks on the homogeneity of data using double mass analysis to compare annual mean flows at each station to annual mean flows at surrounding stations.
- Checks on the stationarity of the data collected at each station using scatter plots of annual mean flows against time.

The quality of the data sourced from Water Survey of Canada was generally good. Less than 4% of the flow record was missing at all the stations with the exception of Pipestone River above Rainy Lake. This station had 47% of its flow record missing since it was operated seasonally between 1963 and 1983. At all the stations, 8% or less of the available flow record was estimated. Double mass analysis of annual mean flows indicated consistency between the data for the stations. Significant trends were not evident in plots of annual mean flows against time.

The flow records for the Seine River at Lac des Mille Lacs Dam are complete for the period of record. However, there are periods of missing data in the flow records for the Seine River at Raft Lake Dam; 54% from January 1, 1980 (flow observations prior to March 1999 were periodic) and 34% since the 2004 to 2014 Seine River Water Management Plan has been in effect.

5.1.1.3.3 Data Analysis

Limited data are available describing the outflows from Upper Marmion Reservoir since 2004, and could not be used to directly estimate inflows to the reservoir using water balance techniques. Inflows to the reservoir under the 2004 to 2014 Seine River Water Management Plan were estimated using water balances based on the regulated outflows from Lac des Mille Lacs and synthetic flows developed for the natural watershed areas tributary to Upper and Lower Marmion Reservoirs.

The tributary drainage area to Lac des Mille Lacs Dam accounts for 40% of the tributary drainage area to Upper Marmion Reservoir. However, outflows from the former are regulated. Inflows from the remaining tributary drainage area are uncontrolled and were estimated using spatial interpolation and regionalization methods. Upper Marmion Reservoir also receives inflows from Lower Marmion Reservoir for approximately half of the year. The two reservoirs generally operate as a single water body between May and October (the open-water season). Inflows from the tributary drainage area to Lower Marmion Reservoir were also estimated using spatial interpolation and regionalization methods.

The spatial interpolation and regionalization methods used are described in Metcalfe et al. (2003), Hughes and Smakhtin (1996), Smakhtin and Hughes (1997) and Smakhtin (1999). The underlying assumption to the methods is that flows occurring simultaneously at sites which are reasonably close to each other and are hydrologically similar correspond to similar percentage points on their respective flow duration curves. The method consisted of the following steps:

- Deriving monthly flow duration curves (FDC's) for nearby regional scale flow monitoring stations.
- Normalizing monthly FDC's by dividing the flow ordinates by the long-term average monthly mean flows.

- Constructing regional non-dimensional monthly FDC's by averaging the normalized FDC's for the source sites.
- Estimating the long-term average monthly mean flows from the natural watershed areas tributary to Upper and Lower Marmion Reservoirs by linear regression of flow on drainage area.
- Deriving monthly flow duration curves for the natural watershed areas by multiplying the non-dimensional ordinates of the regional FDC's by estimates of the long-term average monthly flows for these areas.
- Converting the derived FDC's for the natural watershed areas into continuous records of daily mean flows by spatial interpolation.

Three synthetic daily mean flow time series were developed for each of the natural watershed areas tributary to Upper and Lower Marmion Reservoirs, based on the observed flows at Turtle River, Namakan River and Atikokan River and the monthly FDC's for these rivers. A final time series for each natural watershed area was then calculated as the weighted average of the three time series.

Monthly inflows to Upper Marmion Reservoir between 2005 and 2010, the period for which flow data are available for Seine River at Lac des Mille Lacs, were calculated as the sum of the outflows from the dam at Lac des Mille Lacs, the inflows from the natural watershed area tributary to Upper Marmion Reservoir downstream of this dam, and the outflows from Lower Marmion Reservoir between May and October. Water balance methods were used to verify the results; these consisted of computing the outflows from Upper Marmion Reservoir based on observed lake water levels and comparing these to observed outflows, where the latter were available.

Statistical analysis of the flow data for the Water Survey of Canada monitoring stations was completed in order to place the short-term flow records for the local scale monitoring stations in context, and to develop regional relationships from which parameters describing the natural flow regime and normal, flood and drought properties (Section 5.1.1.1) of site, local and regional scale watercourses potentially affected by the Project could be estimated. Data analysis included derivation of the following regional relationships:

- Drainage area and the long-term average annual mean flow, and drainage area and the long-term range in annual mean flows.
- A regional frequency curve relating the ratios of annual mean flows with different return periods to the annual mean flow with a 2-year return period (an “average” year) to describe the year-to-year variability in flows. Frequency curves were developed for each station and the regional curve was computed as the arithmetic mean of the curves for all the stations.
- Drainage area and long-term average seasonal mean flows, and drainage area and monthly mean flows;
- Long-term average seasonal and monthly flow distributions as percentages of annual unit runoff (flow per unit area), for the description of seasonal and monthly fluctuations in flows.
- A regional flow duration curve showing the probabilities of exceedance of daily mean flows expressed as a ratio of long-term average monthly mean flows, to estimate exceedance percentiles describing the normal and drought properties of watercourses. Monthly flow duration curves were developed for each station and

were normalized by dividing by the long-term average monthly mean flow. The regional curve was computed as the arithmetic mean of the curves for all the stations.

- Regional frequency curves relating the ratios of instantaneous peak flows with different return periods to the instantaneous peak discharge with a 2-year return period, to estimate parameters describing the flood properties of watercourses. A frequency curve was developed for each station and the regional curves were computed as the arithmetic means of the curves for stations with tributary drainage areas less than 450 km² and tributary drainage areas greater than 450 km².
- Drainage area and annual minimum 7-day mean flows with return periods of 2 and 20 years, and drainage area and annual minimum 30-day mean flows with a 2-year return period, for description of the drought properties of watercourses.

5.1.2 Results

5.1.2.1 Field Studies Results

5.1.2.1.1 Site Scale Watercourse Surveys

Table 5-3 summarizes the direct flow measurements collected in the small watercourses draining the site scale watersheds during the 2012 surveys. Based on field observations, only 9 of the 34 watercourses assessed are perennial. Unit runoff from the corresponding watersheds ranged from 3.4 to 9.9 L/s/km² in May and from 1.2 to 18 L/s/km² in August.

Table 5-3: Direct Flow Measurements in Site Scale Watercourses

Water-shed ID	UTM NAD83 Zone 15N	Drainage Area (km²)	Stream Classification	Flow, May 2012		Flow, August 2012	
				m³/s	L/s/km²	m³/s	L/s/km²
A	616953 E; 5429178 N	5.81	Perennial	0.027	4.6	0.019	3.3
B	617837 E; 5426538 N	6.08	Intermittent/ephemeral	0.042	6.9	0.143	23
C	617657 E; 5426048 N	1.35	Intermittent/ephemeral	0.005	3.7	0.000	0.0
D	616838 E; 5424955 N	1.04	Perennial	0.006	5.8	0.007	6.7
E	616502 E; 5423489 N	11.67	Perennial	0.011	9.4	0.006	5.1
F	616259 E; 5423255 N	0.743	Intermittent/ephemeral	0.005	6.7	0.019	26
G	615083 E; 5424006 N	0.305	—[a]	—[a]	—[a]	—[a]	—[a]
H	614430 E; 5423290 N	0.273	Intermittent/ephemeral	0.003	11	0.000	0.0
I	613817 E; 5422546 N	0.852	Perennial	0.003	3.5	0.001	1.2
J	612538 E; 5422318 N	0.256	Intermittent/ephemeral	0.003	12	0.000	0.0
K	611642 E; 5421001 N	0.890	Intermittent/ephemeral	0.003	3.4	0.000	0.0
L	614480 E; 5420879 N	0.705	Intermittent/ephemeral	0.005	7.1	0.000	0.0
M	617450 E; 5421757 N	1.12	Intermittent/ephemeral	0.004	3.6	0.000	0.0
N	618028 E; 5422875 N	1.59	Intermittent/ephemeral	0.008	5.0	0.000	0.0
O	619403 E; 5424440 N	0.388	Intermittent/ephemeral	0.000	0.0	0.000	0.0
P	619565 E; 5425142 N	1.25	Perennial	0.004	3.4	0.010	8.0
Q	620234 E; 5426671 N	2.73	Perennial	0.027	9.9	0.048	18
R	620936 E; 5427051 N	6.33	Intermittent/ephemeral	0.026	4.1	0.000	0.0
S	621005 E; 5425285 N	2.31	Perennial	0.023	10	0.010	4.3
T	618506 E; 5421573 N	3.37	Perennial	—[b]	—[b]	0.064	19
U	620932 E; 5420684 N	1.57	Intermittent/ephemeral	0.010	6.4	0.000	0.0
V	622814 E; 5423793 N	1.02	Intermittent/ephemeral	—[c]	—[c]	0.000	0.0
W	620313 E; 5423976 N	1.15	Intermittent/ephemeral	0.000	0.0	0.000	0.0
X	620680 E; 5420578 N	0.823	Intermittent/ephemeral	—[a]	—[a]	0.022	27
Y	619285 E; 5420256 N	0.457	Intermittent/ephemeral	0.006	13	0.000	0.0
Z	618468 E; 5422540 N	0.748	Intermittent/ephemeral	0.004	5.4	0.000	0.0
AA	616878 E; 5421353 N	0.733	Intermittent/ephemeral	0.000	0.0	0.000	0.0
AB	613579 E; 5421293 N	0.520	Intermittent/ephemeral	0.002	3.8	0.000	0.0
AC	616459 E; 5425159 N	0.292	Intermittent/ephemeral	0.002	6.8	0.000	0.0
AD	612992 E; 5421115 N	0.293	Intermittent/ephemeral	—[a]	—[a]	0.000	0.0
AF	615619 E; 5423121 N	0.775	Perennial	0.003	3.9	0.009	12
AG	616332 E; 5423726 N	0.342	—[a]	—[a]	—[a]	—[a]	—[a]
AH	615549 E; 5422139 N	0.600	Intermittent/ephemeral	0.000	0.0	0.000	0.0
AI	612133 E; 5420545 N	0.103	Intermittent/ephemeral	0.002	19	0.000	0.0

Notes:
[a] No stream found during field survey(s).
[b] High flow, unsafe to measure high flow.
[c] Low flow, could not be measured with available meter.

5.1.2.1.2 Local Scale Flow Monitoring

Annual Mean Flows

Table 5-4 shows the annual mean flows observed at the recording stations for the period September 1, 2010 to August 31, 2012.

Table 5-4: Annual Mean Flows at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Drainage Area (km^2)	Annual Mean Flow in m^3/s ($L/s/km^2$)		
			2010 to 2011	2011 to 2012	Average
SW-01	Sawbill Creek at Sawbill Bay	106	0.745 (7.0)	1.217 (11)	0.981 (9.2)
SW-07	Lumby Creek below Herontrack Lake	14.4	0.125 (8.7)	0.257 (18)	0.191 (13)
SW-02A	Lumby Creek above Lizard Lake	36.0	0.317 (8.8)	0.550 (15)	0.434 (12)
SW-03	Lumby Creek below Lizard Lake	62.8	0.465 (7.4)	0.433 (6.9)	0.449 (7.2)
SW-04	Premier Lake-Vista Lake	14.1	0.074 (5.3)	0.100 (7.1)	0.087 (6.2)
SW-06	Light Creek below Light Lake	41.4	0.284 (6.9)	0.168 (4.1)	0.226 (5.5)
SW-09	Bar Creek above Caribou River	68.7	0.694 (10)	0.646 (9.4)	0.670 (9.8)
SW-08 U/S	Caribou River at Upper Seine Bay	113	0.818 (7.3)	1.197 (11)	1.008 (8.9)
SW-08 D/S	Caribou River at Upper Seine Bay	113	0.807 (7.2)	0.950 (8.4)	0.878 (7.8)

Annual unit runoff from the local scale watersheds ranged from 5.3 to 10 $L/s/km^2$ in 2010 to 2011 and from 4.1 to 18 $L/s/km^2$ in 2011 to 2012. The yields in both years from the Light Bay watershed were lower than the yields from the other local watersheds, indicating physiographic differences between the watersheds. The higher yields in 2011 to 2012 are consistent with precipitation data; annual total precipitation at Atikokan between September 2010 and August 2011 corresponded to a return period of 1.9 years indicating a fairly average year, whereas annual total precipitation at Atikokan between September 2011 and August 2012 had a return period of 4.5 years indicating a wet year.

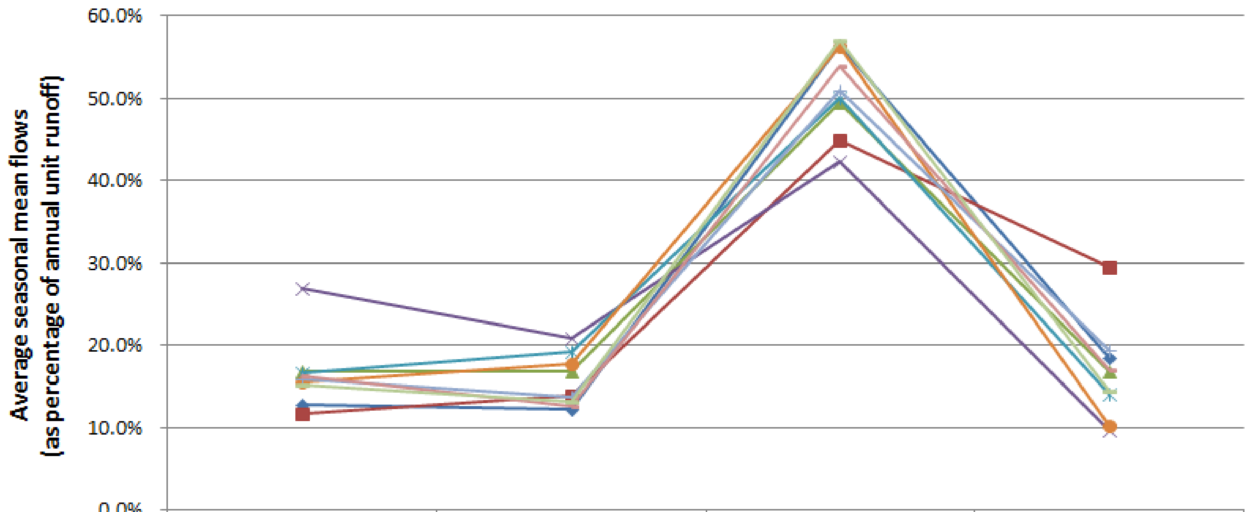
Seasonal Mean Flows

Table 5-5 shows the average seasonal mean flows recorded at the local scale flow monitoring stations between September 1, 2010 and August 31, 2012.

Table 5-5: Average Seasonal Mean Flows at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Drainage Area (km^2)	Average Seasonal Mean Flow (m^3/s)			
			Fall (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Sep)
SW-01	Sawbill Creek at Sawbill Bay	106	0.479	0.462	2.105	0.688
SW-07	Lumby Creek below Herontrack Lake	14.4	0.094	0.113	0.361	0.237
SW-02A	Lumby Creek above Lizard Lake	36.0	0.294	0.300	0.870	0.295
SW-03	Lumby Creek below Lizard Lake	62.8	0.471	0.373	0.742	0.171
SW-04	Premier Lake-Vista Lake	14.1	0.059	0.068	0.175	0.049
SW-06	Light Creek below Light Lake	41.4	0.140	0.162	0.502	0.091
SW-09	Bar Creek above Caribou River	68.7	0.422	0.368	1.353	0.513
SW-08 U/S	Caribou River at Upper Seine Bay	113	0.652	0.515	2.151	0.682
SW-08 D/S	Caribou River at Upper Seine Bay	113	0.529	0.470	1.992	0.508

Figure 5-3 shows the same flows expressed as a percentage of annual unit runoff.



	Fall	Winter	Spring	Summer
SW-01	12.9%	12.2%	56.5%	18.5%
SW-07	11.7%	13.9%	44.9%	29.5%
SW-02A	16.8%	16.9%	49.6%	16.8%
SW-03	26.9%	20.9%	42.4%	9.8%
SW-04	16.7%	19.2%	50.0%	14.0%
SW-06	15.7%	17.8%	56.3%	10.2%
SW-09	15.9%	13.7%	51.0%	19.4%
SW-08 US	16.3%	12.7%	53.9%	17.1%
SW-08 DS	15.2%	13.2%	57.1%	14.5%

Figure 5-3: Seasonal Distribution of Runoff at Local Scale Monitoring Stations, 2010-2012

Flows were highest during the spring (42% to 57% of annual unit runoff) as a result of the freshet (snowmelt) and spring rains, and were generally lowest during the winter (12% to 21% of annual unit runoff) due to diminishing baseflows.

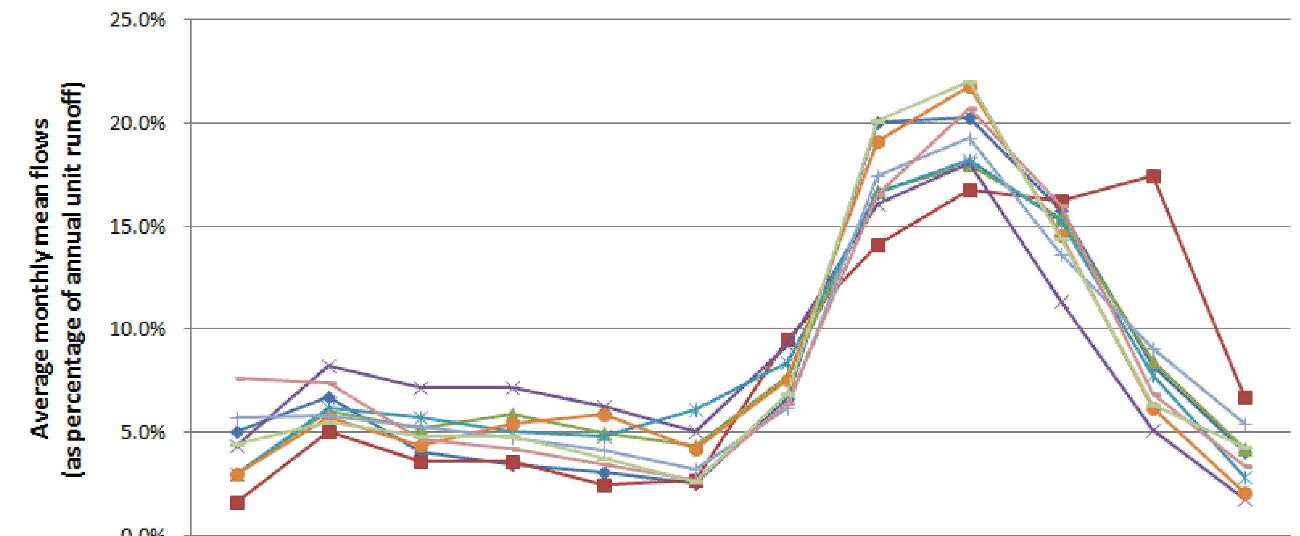
Monthly Mean Flows

Table 5-6 shows the average monthly mean flows recorded at the local scale monitoring stations between September 1, 2010 and August 31, 2012.

Table 5-6: Average Monthly Mean Flows at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Drainage Area (km^2)	Average Monthly Mean Flow (m^3/s)											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW-01	Sawbill Creek at Sawbill Bay	106	0.335	0.311	0.730	2.283	2.235	1.793	0.913	0.447	0.578	0.741	0.466	0.382
SW-07	Lumby Creek below Herontrack Lake	14.4	0.056	0.067	0.214	0.327	0.377	0.378	0.392	0.152	0.039	0.114	0.085	0.082
SW-02A	Lumby Creek above Lizard Lake	36.0	0.256	0.246	0.395	0.880	0.917	0.810	0.433	0.215	0.157	0.307	0.275	0.300
SW-03	Lumby Creek below Lizard Lake	62.8	0.333	0.296	0.490	0.878	0.955	0.623	0.272	0.093	0.237	0.437	0.394	0.379
SW-04	Premier Lake-Vista Lake	14.1	0.050	0.069	0.087	0.177	0.187	0.162	0.080	0.029	0.032	0.064	0.061	0.052
SW-06	Light Creek below Light Lake	41.4	0.156	0.125	0.201	0.525	0.579	0.400	0.166	0.056	0.083	0.153	0.119	0.146
SW-09	Bar Creek above Caribou River	68.7	0.327	0.280	0.490	1.421	1.521	1.110	0.718	0.426	0.467	0.460	0.431	0.375
SW-08 U/S	Caribou River at Upper Seine Bay	113	0.410	0.359	0.766	2.024	2.459	1.959	0.814	0.403	0.933	0.882	0.574	0.496
SW-08 D/S	Caribou River at Upper Seine Bay	113	0.389	0.300	0.708	2.151	2.278	1.538	0.659	0.442	0.475	0.569	0.520	0.498

Figure 5-4 shows the same flows expressed as percentages of annual unit runoff.



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
SW-01	5.1%	6.7%	4.1%	3.5%	3.0%	2.6%	6.6%	20.1%	20.3%	15.7%	8.3%	4.1%
SW-07	1.7%	5.1%	3.6%	3.6%	2.5%	2.7%	9.5%	14.1%	16.8%	16.3%	17.4%	6.7%
SW-02A	3.0%	6.0%	5.2%	5.9%	5.0%	4.4%	7.7%	16.7%	18.0%	15.4%	8.5%	4.2%
SW-03	4.3%	8.3%	7.2%	7.2%	6.3%	5.1%	9.3%	16.1%	18.0%	11.4%	5.1%	1.8%
SW-04	3.0%	6.2%	5.7%	5.0%	4.8%	6.1%	8.4%	16.6%	18.2%	15.2%	7.8%	2.8%
SW-06	3.0%	5.8%	4.3%	5.5%	5.9%	4.3%	7.6%	19.1%	21.8%	14.6%	6.2%	2.1%
SW-09	5.7%	5.8%	5.3%	4.8%	4.1%	3.2%	6.2%	17.4%	19.3%	13.6%	9.1%	5.4%
SW-08 US	7.6%	7.4%	4.7%	4.2%	3.5%	2.7%	6.5%	16.5%	20.7%	16.0%	6.9%	3.4%
SW-08 DS	4.4%	5.5%	4.9%	4.8%	3.8%	2.6%	6.8%	20.1%	22.0%	14.4%	6.4%	4.3%

Figure 5-4: Monthly Distribution of Runoff at Local Scale Monitoring Stations, 2010 to 2012

The monthly distribution of flows follows a weak bimodal pattern with a primary peak in May and a small secondary peak in October. Flows in May represented 17% to 20% of annual unit runoff. The lowest flows occurred in February accounting for only 3% to 6% of annual unit runoff.

Flood Flows

Table 5-7 summarizes the instantaneous peak flows observed at the local scale monitoring stations between September 1, 2010 and August 31, 2012.

Table 5-7: Instantaneous Peak Flows at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Drainage Area (km²)	2010 to 2011		2011 to 2012	
			Flow in m^3/s ($L/s/km^2$)	Date	Flow in m^3/s ($L/s/km^2$)	Date
SW-01	Sawbill Creek at Sawbill Bay	106	4.132 (39)	3-May	4.568 (43)	4-Apr
SW-07	Lumby Creek below Herontrack Lake	14.4	0.936 (65)	3-May	2.606 (181)	30-May
SW-02A	Lumby Creek above Lizard Lake	36.0	2.516 (70)	4-May	5.745 (160)	31-May
SW-03	Lumby Creek below Lizard Lake	62.8	1.725 (28)	2-May	1.919 (31)	31-May
SW-04	Premier Lake-Vista Lake	14.1	0.315 (22)	2-May	0.349 (25)	30-Mar
SW-06	Light Creek below Light Lake	41.4	1.230 (30)	2-May	0.826 (20)	30-Mar
SW-09	Bar Creek above Caribou River	68.7	2.582 (38)	1-May	2.412 (35)	30-May
SW-08 U/S	Caribou River at Upper Seine Bay	113	4.079 (36)	3-May	5.991 (34)	31-May
SW-08 D/S	Caribou River at Upper Seine Bay	113	3.678 (33)	3-May	3.880 (53)	31-May

In both years, the instantaneous peak flows occurred during the spring freshet at all the stations. In general, the flows in 2011 to 2012 were higher due to more rainfall occurring during the spring of that year.

Low Flows

Table 5-8 shows the annual minimum 7-day and 30-day mean flows observed at the local scale monitoring stations for the period May 1, 2011 to April 30, 2012. At most stations, low flows occurred during the summer and early fall. At SW-01, low flows occurred towards the end of the winter.

Table 5-8: Annual Minimum 7-Day and 30-Day Mean Flows at Local Scale Monitoring Stations

Station ID	Station Name	Drainage Area (km²)	Annual Minimum 7-Day Mean Flow in m³/s (L/s/km²)		Annual Minimum 30-Day Mean Flow in m³/s (L/s/km²)	
			Value	Date	Value	Date
SW-01	Sawbill Creek at Sawbill Bay	106	0.223 (2.10)	Mar 6-12, 2012	0.236 (2.23)	Feb 14-Mar 14, 2012
SW-07	Lumby Creek below Herontrack Lake	14.4	0.001 (0.082)	Jun 15-21, 2011	0.014 (0.955)	Sep 8-Oct 7, 2011
SW-02A	Lumby Creek above Lizard Lake	36.0	0.036 (0.986)	Sep 15-21, 2011	0.059 (1.65)	Sep 12-Oct 11, 2011

Table 5-8: Annual Minimum 7-Day and 30-Day Mean Flows at Local Scale Monitoring Stations (Continued)

Station ID	Station Name	Drainage Area (km²)	Annual Minimum 7-Day Mean Flow in m³/s (L/s/km²)		Annual Minimum 30-Day Mean Flow in m³/s (L/s/km²)	
			Value	Date	Value	Date
SW-03	Lumby Creek below Lizard Lake	62.8	0.048 (0.761)	Aug 22-28, 2011	0.058 (0.929)	Aug 22-Sep 20, 2011
SW-04	Premier Lake-Vista Lake	14.1	0.002 (0.138)	Sep 14-20, 2011	0.004 (0.272)	Sep 10-Oct 9, 2011
SW-06	Light Creek below Light Lake	41.4	0.000 (0.00)	Oct 2-8, 2011	0.000 (0.007)	Sep 13-Oct 12, 2011
SW-09	Bar Creek above Caribou River	68.7	0.084 (1.22)	Sep 14-20, 2011	0.106 (1.11)	Sep 8-Oct 7, 2011
SW-08 U/S	Caribou River at Upper Seine Bay	113	0.016 (0.141)	Aug 21-27, 2011	0.126 (1.00)	Jul 31-Aug 29, 2011
SW-08 D/S	Caribou River at Upper Seine Bay	113	0.079 (0.698)	Oct 1-7, 2011	0.113 (1.54)	Sep 13-Oct 12, 2011

Other Data

Table 5-9 below shows direct flow measurements at manual gauges over the two-year monitoring period.

Table 5-9: Direct Flow Measurements at Manual Gauges

Station ID	Station Name	Drainage Area (km²)	Direct Flow Measurement (m³/s)									
			Aug 2010	Oct 2010	Jan 2011	Mar 2011	Apr 2011	May 2011	Aug 2011	Feb 2012	May 2012	Aug 2012
SW-02B	Lumby Creek Tributary	2.85	0.002	0.013	0.000	0.000	0.202	0.033	0.003	0.000	0.010	0.002
SW-05	St. Patrick Creek	9.82	0.007	0.041	—[(a)]	—[(a)]	—[(a)]	0.099	0.003	—[(a)]	0.076	0.013
SW-10	Sawbill Creek	5.87	0.070	0.037	0.035	0.080	0.162	0.074	0.030	0.001	0.026	0.019
SW-11	Sawbill Bay Tributary	4.62	0.002	0.019	0.000	0.000	0.315	0.071	0.001	—[(b)]	0.042	0.123
SW-12	Lizard Lake Tributary	6.21	0.008	0.010	—[(a)]	—[(a)]	—[(a)]	0.025	0.002	—[(a)]	0.026	0.000

Notes:

(a) Station inaccessible due to unsafe ice conditions.

(b) Station not visited due to time constraints.

At these stations, the lowest flows were measured in the winter months (January and March 2011, February 2012) and the highest flows in the spring (April/May 2011 and May 2012).

5.1.2.2 Secondary Data Review Results

5.1.2.2.1 Regulated Flow Regime

Marmion Reservoir Inflows

Table 5-10 shows monthly mean outflows from Lac des Mille Lacs for the period 2005 to 2010. These data represent reservoir operations under the 2004 to 2014 Seine River Water Management Plan. The outflows from Lac des Mille Lacs contribute to inflows to the Upper Marmion Reservoir, which surrounds the Project Site. The tributary drainage area to Lac des Mille Lacs accounts for 40% of the tributary drainage area to the Upper Marmion Reservoir.

Table 5-10: Monthly Mean Outflows from Lac des Mille Lacs, 2005 to 2010

Year	Monthly Mean Outflows (m³/s)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	12.2	11.1	7.11	3.22	34.5	10.9	4.81	1.50	1.50	4.28	15.8	10.8
2006	10.2	9.18	2.68	3.54	6.59	6.96	2.01	1.74	1.05	0.75	0.69	0.76
2007	2.00	12.6	2.50	1.68	1.53	22.9	13.8	1.92	13.8	46.8	20.7	9.22
2008	9.24	7.12	4.18	2.29	36.5	46.7	11.9	2.23	4.79	14.9	18.9	7.48
2009	8.40	9.06	8.16	3.42	43.2	30.7	2.07	16.4	3.69	1.89	20.0	5.95
2010	5.34	9.08	2.04	1.83	1.51	0.80	3.63	1.81	1.81	—[a]	—[a]	—[a]
Avg.	7.89	9.69	4.45	2.66	20.6	19.8	6.37	4.26	4.44	13.7	15.2	6.85

Notes:
[a] Flow data not available.

Table 5-11 shows the estimated 2005-2010 average monthly mean inflows to Upper Marmion Reservoir derived from the flows in Table 5-10 above and synthetic inflows from the natural watershed areas tributary to Upper and Lower Marmion Reservoirs during the time period, using water balance techniques.

Table 5-11: Average Monthly Mean Inflows to Upper Marmion Reservoir, 2005 to 2010

Month	Lac des Mille Lacs Outflows (m³/s)	Unregulated Inflows (m³/s)	Lower Marmion Outflows (m³/s)	Total Inflows (m³/s)	Lac des Mille Lacs Outflows (% Total Inflows)
January	7.0	11.6	0.0	18.6	38
February	9.7	9.5	0.0	19.2	51
March	4.4	8.6	0.0	13.1	34
April	2.7	24.1	0.0	26.7	10
May	20.6	55.2	-0.9	75.0	28
June	19.8	46.1	-0.7	65.2	30

Table 5-11: Average Monthly Mean Inflows to Upper Marmion Reservoir, 2005 – 2010 (Continued)

Month	Lac des Mille Lacs Outflows (m^3/s)	Unregulated Inflows (m^3/s)	Lower Marmion Outflows (m^3/s)	Total Inflows (m^3/s)	Lac des Mille Lacs Outflows (% Total Inflows)
July	6.4	28.7	1.9	36.9	17
August	4.3	16.4	1.6	22.2	19
September	5.0	10.1	2.4	17.4	29
October	13.7	18.1	1.0	32.7	42
November	15.2	19.3	0.0	34.5	44
December	6.8	15.6	0.0	22.5	30
Year	9.6	22.0	0.4	32.1	30

Under the 2004 to 2014 Seine River Water Management Plan, average monthly mean inflows to Upper Marmion Reservoir have been in the range 13.1 m^3/s to 75.0 m^3/s. Outflows from Lac des Mille Lacs have accounted for between 10% and 51% of the total inflows. Inflows to the reservoir are highest in May and June corresponding to increased runoff from the spring freshet and spring rains. Inflows are lowest in March and August/September.

Marmion Reservoir Outflows

Annual Mean Outflows

Table 5-12 shows annual mean outflows from Upper MarmionReservoir for six years for which there was a sufficient record of daily mean flows to compute the annual mean flow. The years 2005 to 2006 and 2010 to 2011 represent reservoir operations under the 2004 to 2014 Seine River Water Management Plan. Annual total precipitation at Atikokan and its return period are also shown to give an indication of the hydrological conditions in these years.

Table 5-12: Annual Mean Outflows from the Marmion Reservoir

Year (September to August)	Annual Mean Outflow in m^3/s ($L/s/km^2$)	Annual Total Precipitation at Atikokan (mm)	Return Period of Precipitation (years)
1999 to 2000	39.9 (8.71)	818	5.0
2000 to 2001	37.2 (8.13)	972	43
2001 to 2002	40.1 (8.75)	781	3.4
2002 to 2003	17.8 (3.88)	810	4.6
2005 to 2006	30.5 (6.66)	785	3.5
2010 to 2011	27.0 (5.90)	710	1.9

Total precipitation at Atikokan in 2001 to 2002, 2005 to 2006 and 2010 to 2011 were similar and represented near-average hydrological conditions. However, the annual mean outflow from the reservoir in 2001 to 2002 was much higher than the outflows in the other two years. The year 2000 to 2001 was a very wet year; annual total precipitation had a return period of 43 years. However, this is not reflected in the annual mean outflow from the reservoir as shown in Table 5-12. These apparent anomalies may be attributable in part to flow regulation after 2004. However, no explanation, beyond possible source data error can be offered for the comparatively low outflow (versus precipitation) in 2000-2001.

Seasonal Mean Outflows

Table 5-13 shows seasonal mean outflows from the Marmion Reservoir for eight years for which there was a sufficient record of daily mean flows to compute the seasonal mean flows. The data are also shown charted in Figure 5-5.

Table 5-13: Seasonal Mean Outflows from the Marmion Reservoir

Year	Seasonal Mean Outflows (m³/s)			
	Fall (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Sep)
2000	—[(a)]	27.8	44.2	41.5
2001	29.2	27.9	61.3	27.2
2002	23.0	34.2	52.2	43.7
2003	33.7	19.9	—[(a)]	17.8
2005	33.6	41.6	79.3	21.8
2006	9.77	38.4	35.3	14.1
2010	32.8	30.0	9.94	14.9
2011	—[(a)]	27.9	29.0	13.6

Notes:
(a) Insufficient record of daily mean flows.

Table 5-13 and Figure 5-5 show that prior to reservoir operation under the 2004 to 2014 Seine River Water Management Plan, outflows from Upper Marmion Reservoir were typically highest in the spring and except for 2005 were higher in magnitude. Outflows from the reservoir since 2004 were typically lower in both the spring and summer seasons than in previous years. A distinct pattern differentiating pre- and post- 2004 outflows in the fall/winter period is not apparent.

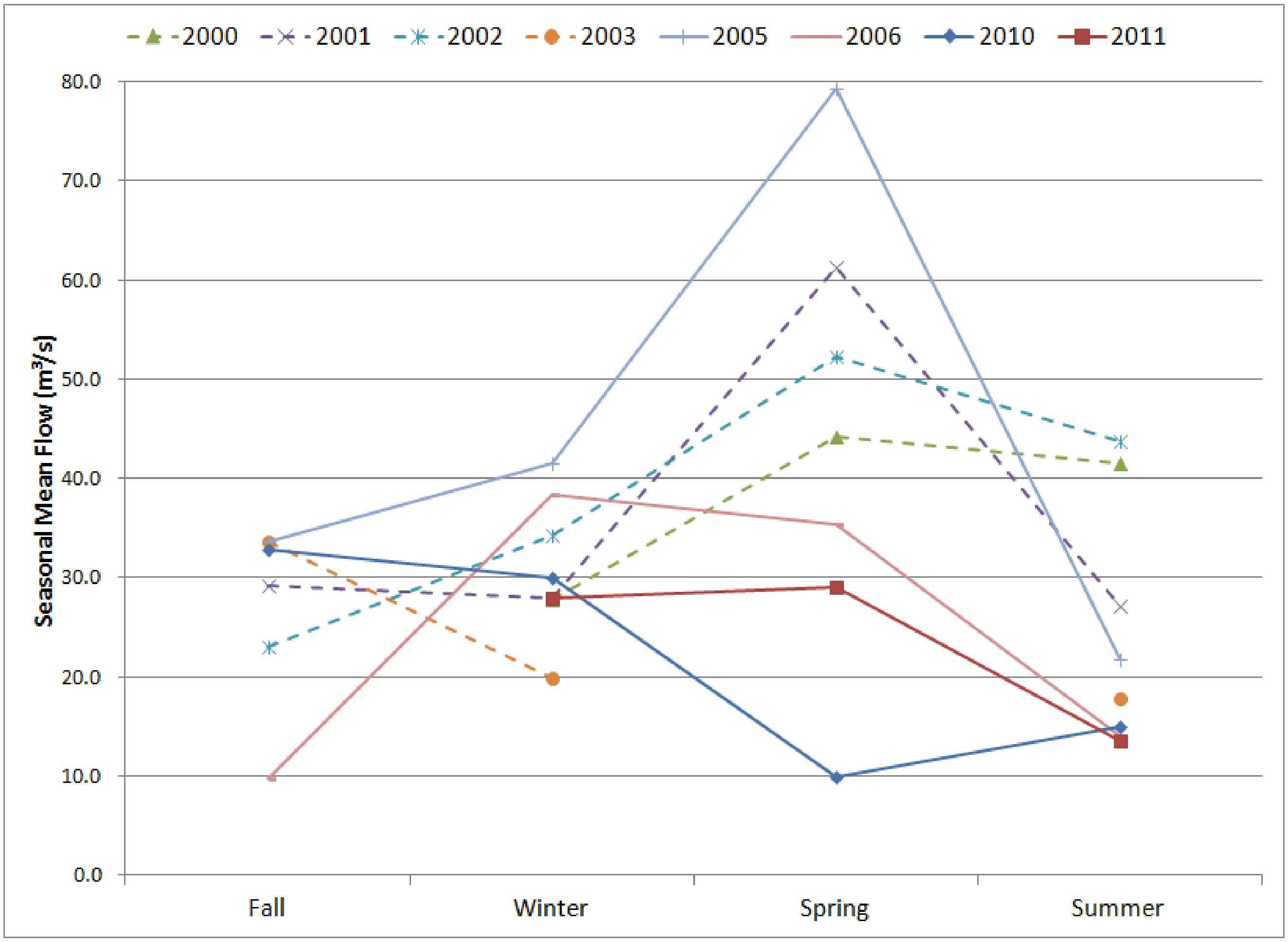


Figure 5-5: Seasonal Mean Outflows from the Marmion Reservoir

Monthly Mean Outflows

Table 5-14 shows monthly mean outflows from the Upper Marmion Reservoir for 10 years for which there was a sufficient record of daily mean flows to compute monthly mean flows. The data are also shown charted in Figure 5-6. Table 5-14 and Figure 5-6 show that outflows from Upper Marmion Reservoir are generally highest in May/June as a result of the spring freshet. Outflows from the reservoir were lowest in April prior to operations under the 2004 to 2014 Seine River Water Management Plan, but have been lowest in months during the late spring/summer/early fall since 2004. Outflows in May and June have been generally lower since 2004 compared to previous years.

Table 5-14: Monthly Mean Outflows from the Marmion Reservoir

Year	Monthly Mean Flows (m^3/s)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999			22.6	21.4	54.0	76.9	47.8	24.5	36.6	—[a]	42.2	41.0
2000	35.4	30.6	17.6	13.3	35.2	84.3	63.6	40.4	19.9	25.2	38.4	—[a]
2001	29.1	25.6	28.8	18.8	92.5	71.8	28.1	31.6	21.9	22.3	33.6	31.9
2002	34.1	33.0	35.3	13.3	18.3	124.8	92.6	19.8	18.0	19.6	18.0	31.3
2003	24.3	18.5	16.7	8.55	10.8	—[a]	12.2	17.3	24.1	37.5	32.1	31.5
2004	39.6	38.3	37.6	24.9	40.8	74.8	48.8	16.2	—[a]	—[a]	—[a]	—[a]
2005	38.3	45.2	41.6	47.3	101.6	89.0	40.7	12.9	11.5	12.1	41.4	47.4
2006	41.4	38.9	34.8	32.8	36.5	36.7	16.3	17.2	8.64	7.49	10.7	11.1
2010	31.1	33.7	25.7	10.6	9.70	9.6	9.76	10.5	24.8	33.8	28.3	36.2
2011	28.4	30.2	25.3	19.1	52.4	15.6	16.1	14.5	10.0	—[a]	—[a]	—[a]

Notes:
[a] Insufficient record of daily mean flows.

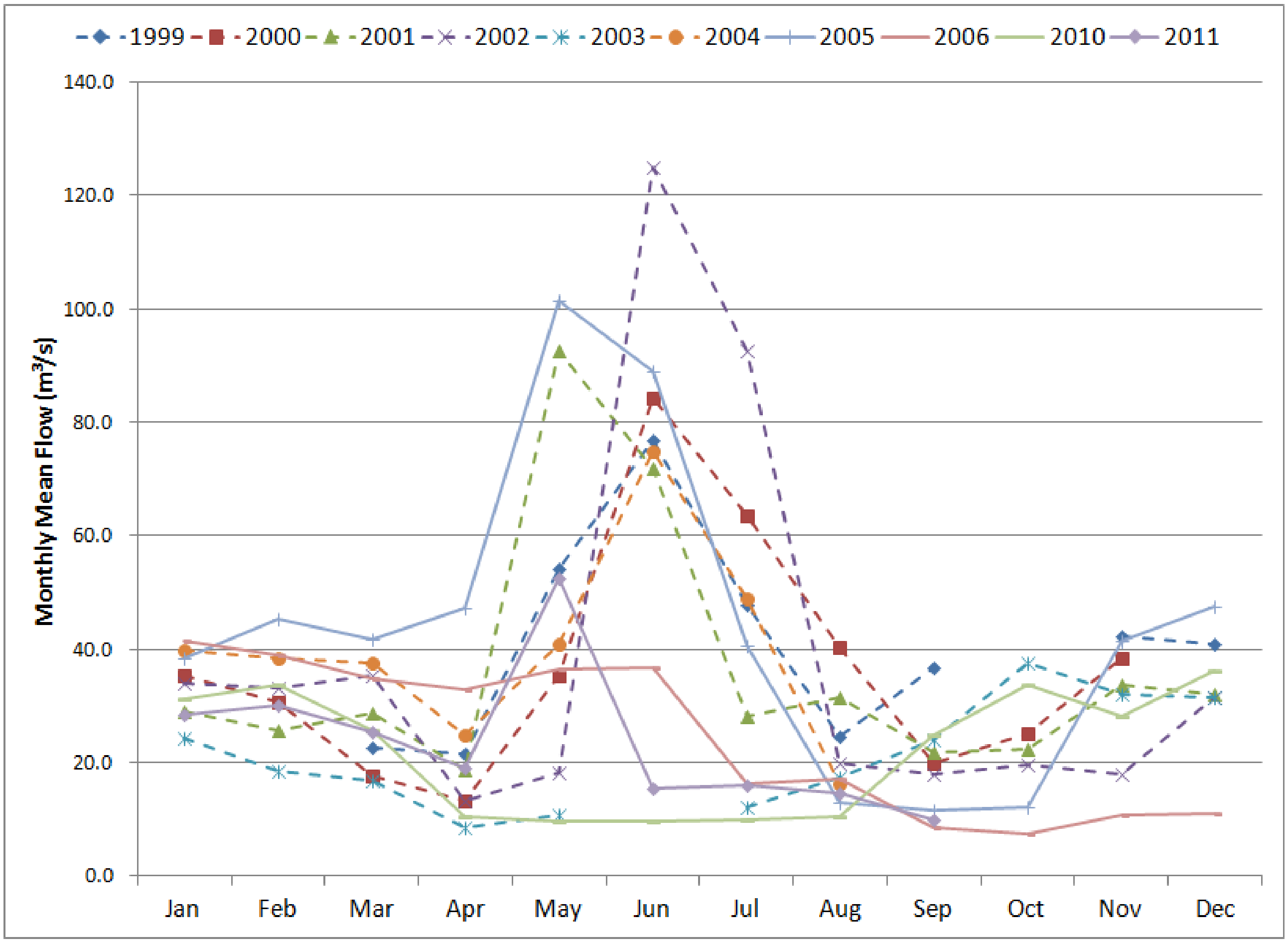


Figure 5-6: Monthly Mean Outflows from the Marmion Reservoir

Minimum Daily Mean Outflows

The 2004 to 2014 Seine River Water Management Plan specifies operating rules to guide the management of water in Lac des Mille Lacs and the Upper Marmion Reservoir under normal flow and water level conditions (Section 3.2.2.3). Rules for Lac des Mille Lacs specify a minimum daily mean outflow of greater than or equal to 1.5 m^3/s. Rules for Raft Lake Dam specify a minimum daily mean outflow of greater than or equal to 10 m^3/s from the Upper Marmion Reservoir, which could be reduced to 7 m^3/s under poor freshet conditions.

Daily mean outflows from Lac des Mille Lacs between January 1, 2005 and September 6, 2010 and from Raft Lake Dam between January 1, 2004 and October 19, 2011 were compared to minimum outflow requirements under the Plan. Table 5-15 summarizes the frequency of occurrence of minimum and below-minimum daily mean outflows from both reservoirs.

Table 5-15: Frequency of Minimum and Below-Minimum Outflows

Year	Upper Marmion Reservoir		Lac des Mille Lacs		Return Period of Annual Precipitation (years)	
	Days at or Below Minimum	Percent Time at or Below Minimum	Days at or Below Minimum	Percent Time at or Below Minimum	Wet Year	Dry Year
2004	0	0.0	—[a]	—[a]	14	—[b]
2005	5	1.4	61	16.7	24	—[b]
2006	61	16.7	130	35.6	—[b]	2.9
2007	1	0.3	54	14.8	2.5	—[b]
2008	0	0.0	1	0.3	—[b]	2.1
2009	12	3.3	2	0.5	—[b]	3.1
2010	75	20.5	46	12.6	2.1	—[b]
2011	38	10.4	—[a]	—[a]	—[b]	6.1

Notes:
(a) No data.
(b) Not applicable.

Minimum and below-minimum daily mean outflows from Upper Marmion Reservoir occurred for more than 10% of the time (approximately one month) in three of the eight years of record, i.e. in 2006, 2010 and 2011. The years 2006 and 2011 were dry years receiving annual total precipitation with return periods of approximately 3 and 6 years respectively. However, the year 2010 was an average year, receiving annual total precipitation with a return period of 2 years. Minimum and below minimum daily mean outflows occurred in the late summer/early fall (September to November) in 2006 and 2011, suggesting lower than normal summer/fall rains. Minimum and below minimum daily mean outflows occurred in the spring and summer (April to August) in 2010, suggesting that the high number of days with minimum or below-minimum outflows was possibly a result of poor freshet conditions.

Minimum and below-minimum daily mean outflows from Lac des Mille Lacs occurred for more than 10% of the time in four of the six years of record, i.e. in 2005, 2006, 2007 and 2010. Minimum and below minimum daily mean outflows occurred in the summer and fall (August to December) in 2006, and in the spring (May to July) in 2010. Minimum and below minimum daily mean outflows occurred in the summer and early fall (August to October) in 2005, and in the winter and spring (January to June) in 2007. The simultaneous occurrence of minimum and below minimum daily mean outflows from both Lac des Mille Lacs and the Upper Marmion Reservoir in 2006 and 2010 may indicate that natural inflows to both reservoirs were outside of normal conditions in these years.

5.1.2.2.2 Natural Flow Regime

Annual Mean Flows

Table 5-16 shows the long-term average annual mean flows and the ranges in annual mean flows observed at the regional scale Water Survey of Canada stations with natural flow records. Both the average and range increase with tributary drainage area. Annual unit runoff (L/s/km²) decreases with tributary drainage area. Basswood River and Turtle River have similar tributary drainage areas to the Seine River below Raft Lake Dam and flows are similar to those in Tables 5-13 and 5-14 for reservoir operations prior to the 2004 to 2014 Seine River Water Management Plan.

Table 5-16: Annual Mean Flows at Regional Scale Flow Monitoring Stations

Station ID	Station Name	Drainage Area (km²)	Period	Average Annual[(a)] Mean Flow in m³/s (L/s/km²)	Range in Annual[(a)] Mean Flows (m³/s)
05PA006	Namakan River at outlet of Lac La Croix	13,400	1921 to 2010	107.8 (8.04)	173
05PA012	Basswood River near Winton	4,510	1924 to 2010	38.6 (8.56)	63.8
05PB014	Turtle River near Mine Centre	4,870	1914 to 2010	38.2 (7.84)	66.6
05PB015	Pipestone River above Rainy Lake	443	1963 to 1998	3.49 (7.88)	3.96
05PB018	Atikokan River at Atikokan	332	1978 to 2010	2.96 (8.92)	3.95
05PB021	Eye River near Hardtack Lake	19.8	1985 to 1993	0.225 (11.36)	0.224
05PB022	Eye River near Coulson Lake	27.9	1985 to 1994	0.300 (10.75)	0.154

Notes:
(a) Annual mean flows were computed from September 1 to August 31.

Figure 5-7 shows the linear relationships between the long-term average annual mean flow and tributary drainage area, and the range in annual mean flows and tributary drainage area.

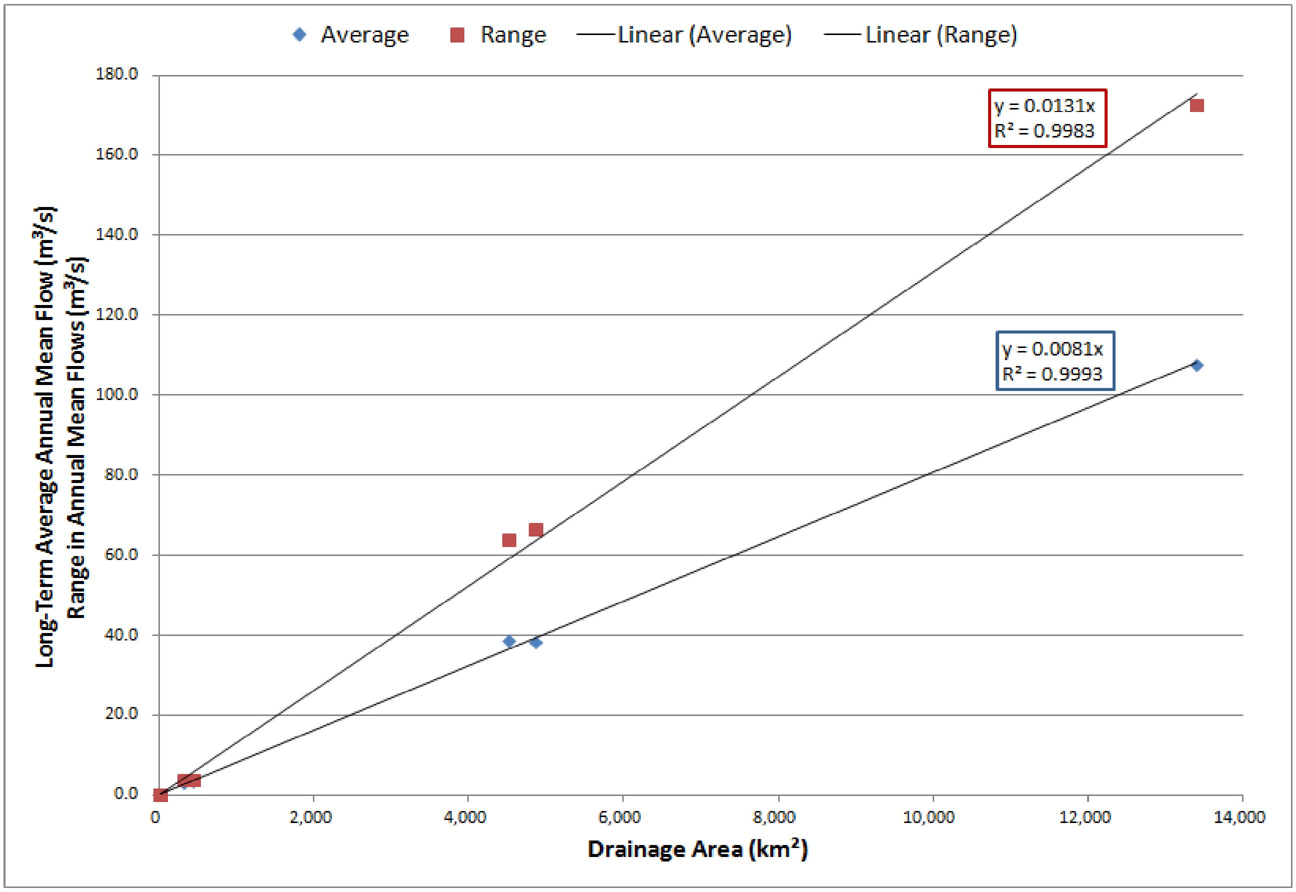


Figure 5-7: Long-Term Average Annual Mean Flow/Range in Annual Mean Flows versus Drainage Area

Provisional (unpublished) flows in Atikokan River and Turtle River for 2011 and 2012 were sourced from Water Survey of Canada. Table 5-17 shows the annual mean flows in both rivers between September 1, 2010 and August 31, 2012, the period over which flows at the local scale stations were monitored. Also shown are the return periods for the annual mean flows, to give an indication of the prevailing hydrological conditions in these years.

Table 5-17: Annual Mean Flows in Atikokan River and Turtle River, 2010 to 2012

Station ID	Station Name	Drainage Area (km^2)	2010 to 2011		2011 to 2012	
			Annual[(a)] Mean Flow in m^3/s ($L/s/km^2$)	Return Period of Flow (years)	Annual[(a)] Mean Flow in m^3/s ($L/s/km^2$)	Return Period of Flow (years)
05PB018	Atikokan River at Atikokan	332	2.36 (7.10)	3.5 (dry)	3.39 (9.54)	3.5 (wet)
05PB014	Turtle River near Mine Centre	4,870	46.4 (10.22)	3.0 (wet)	34.8 (7.15)	2.5 (dry)

Notes:
(a) Annual mean flows were computed from September 1 to August 31.

Annual mean flows in Atikokan River indicate a dry year in 2010-2011 and a wet year in 2011-2012, whereas annual mean flows in Turtle River indicate the reverse. The reason for this inconsistency is unknown, but may be due to quality assurance issues since the source data have not yet been published. Examination of precipitation records for Atikokan indicate annual total precipitation amounts (September-August) to be near average (return period of 1.9 years) and above average (return period of 4.5 years) in 2010-2011 and 2011-2012, respectively, suggesting that the Atikokan River flows are more consistent with precipitation records.

Frequency analysis of annual mean flows was completed at all the stations. The Normal Probability Distribution best fit the data with coefficients of determination ranging from 0.943 to 0.991. Frequency curves (plots of the ratio of annual mean flows with different return periods to the annual mean flow with a 2-year return period) are shown in Figures 5-8 and 5-9.

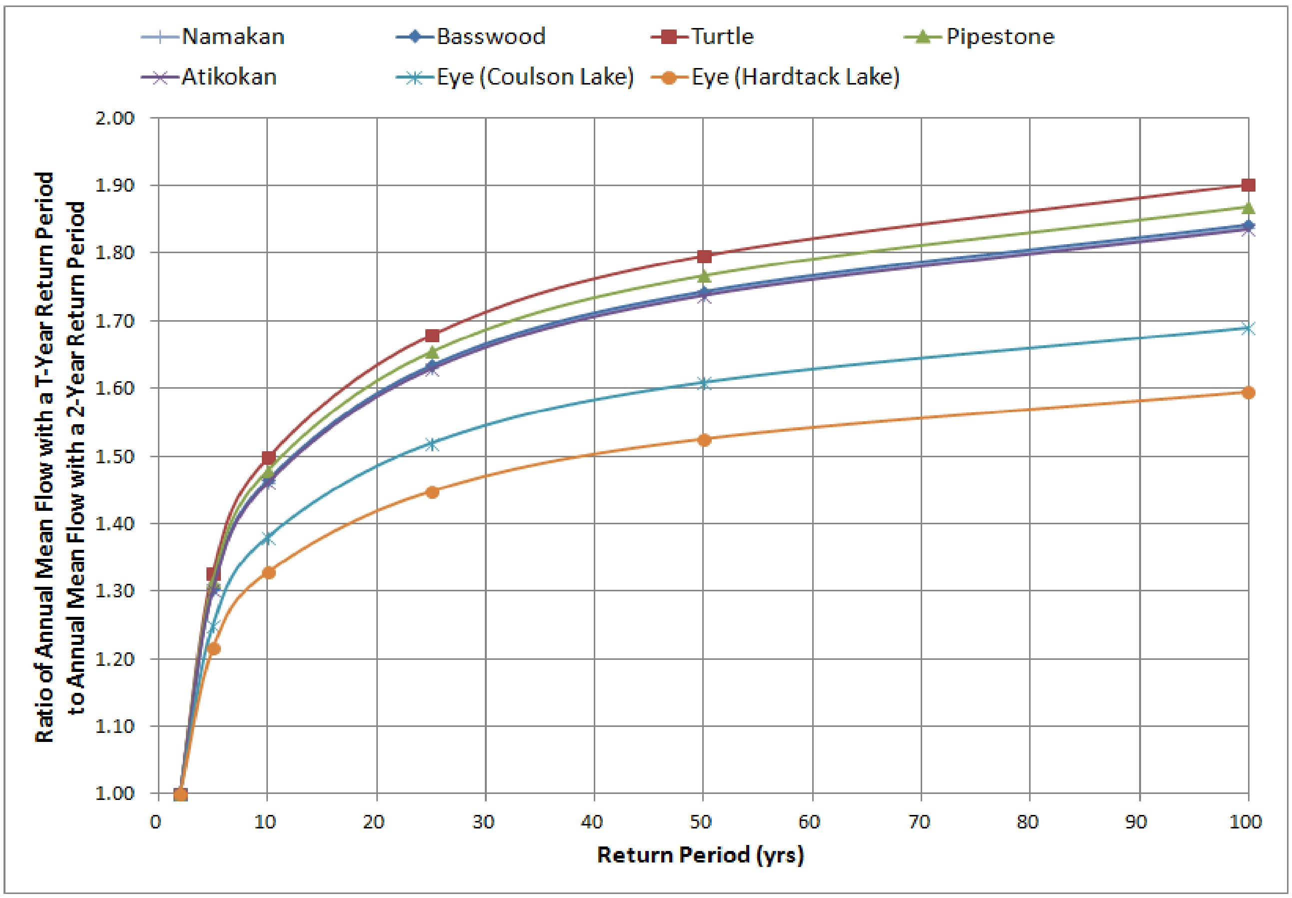


Figure 5-8: Frequency Curves for Wet Years at Regional Scale Flow Monitoring Stations

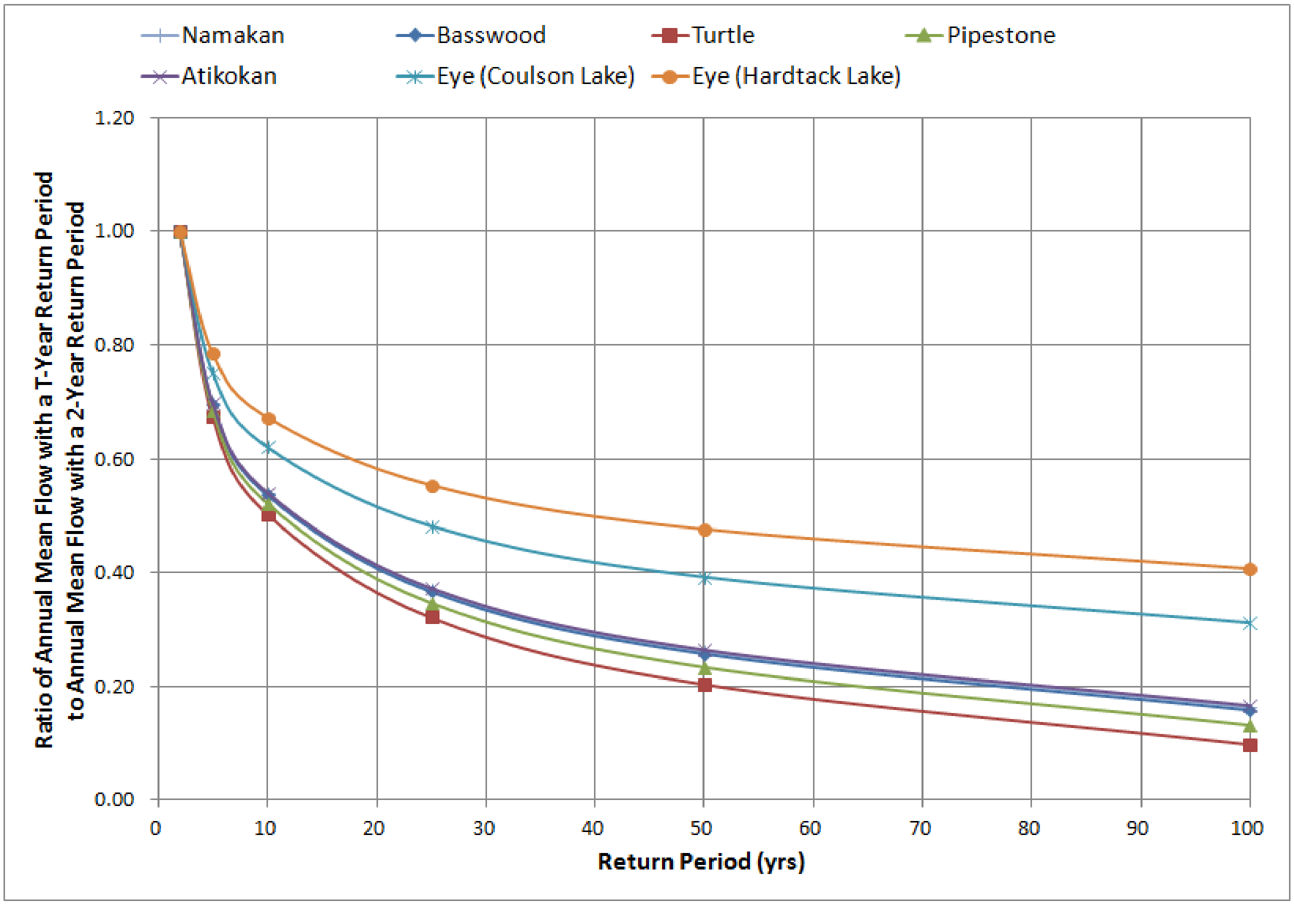


Figure 5-9: Frequency Curves for Dry Years at Regional Scale Flow Monitoring Stations

Frequency curves for all the stations, with the exception of Eye River at Coulson Lake and Eye River at Hardtack Lake, form a tight band indicating similar variability in annual mean flows. The lower ratios for the Eye River stations indicate less variability in annual mean flows compared to the other stations which is likely due to physiographic differences in the tributary watersheds.

Seasonal Mean Flows

Table 5-18 shows long-term average seasonal mean flows observed at the regional scale stations with natural flow records. The data are also shown in Figure 5-10 as percentages of annual unit runoff.

Table 5-18: Long-Term Average Annual and Seasonal Mean Flows at Regional Scale Monitoring Stations

Station ID	Station Name	Drainage Area (km^2)	Period	Seasonal Mean Flows, m^3/s			
				Fall (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Sep)
05PA006	Namakan River at outlet of Lac La Croix	13,400	1921-2010	80.6	54.7	171	123
05PA012	Basswood River near Winton	4,510	1924-2010	27.5	17.8	71.6	36.1
05PB014	Turtle River near Mine Centre	4,870	1914-2010	29.6	16.9	63.4	42.3
05PB015	Pipestone River above Rainy Lake	443	1963-1998	2.89	1.32	6.82	3.36
05PB018	Atikokan River at Atikokan	332	1978-2010	2.58	1.62	4.75	2.96
05PB021	Eye River near Hardtack Lake	19.8	1985-1993	0.203	0.081	0.606	0.375
05PB022	Eye River near Coulson Lake	27.9	1985-1994	0.152	0.061	0.478	0.263

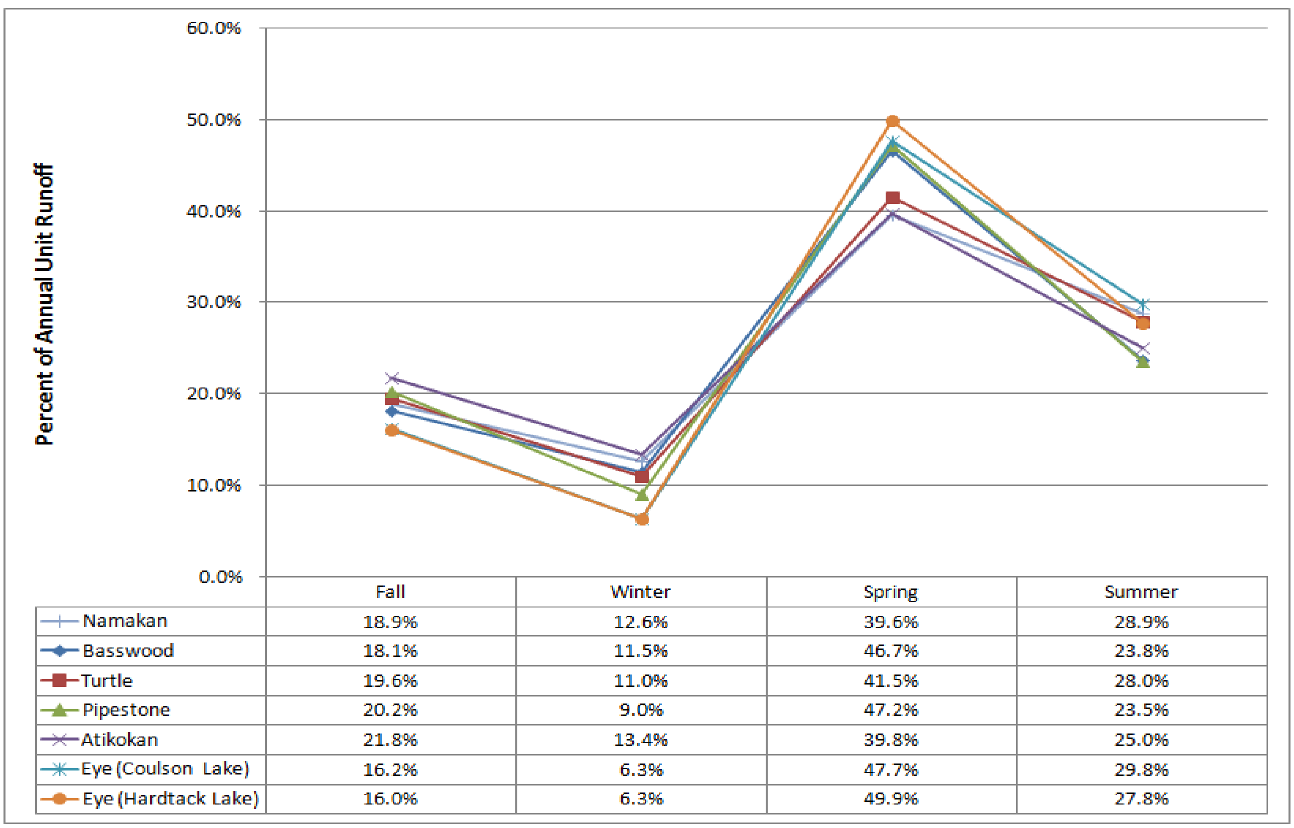


Figure 5-10: Seasonal Distribution of Flows at Regional Scale Monitoring Stations

Flows are highest during the spring when 40% to 50% of annual unit runoff occurs as a result of the freshet (snowmelt) and spring rains. Conversely, flows are lowest during the winter when only 6% to 13% of annual unit runoff occurs due to diminishing baseflows. Medium flows occur in the summer (24% to 29% of annual unit runoff) and the fall (16% to 22% of annual unit runoff) in response to rainfall.

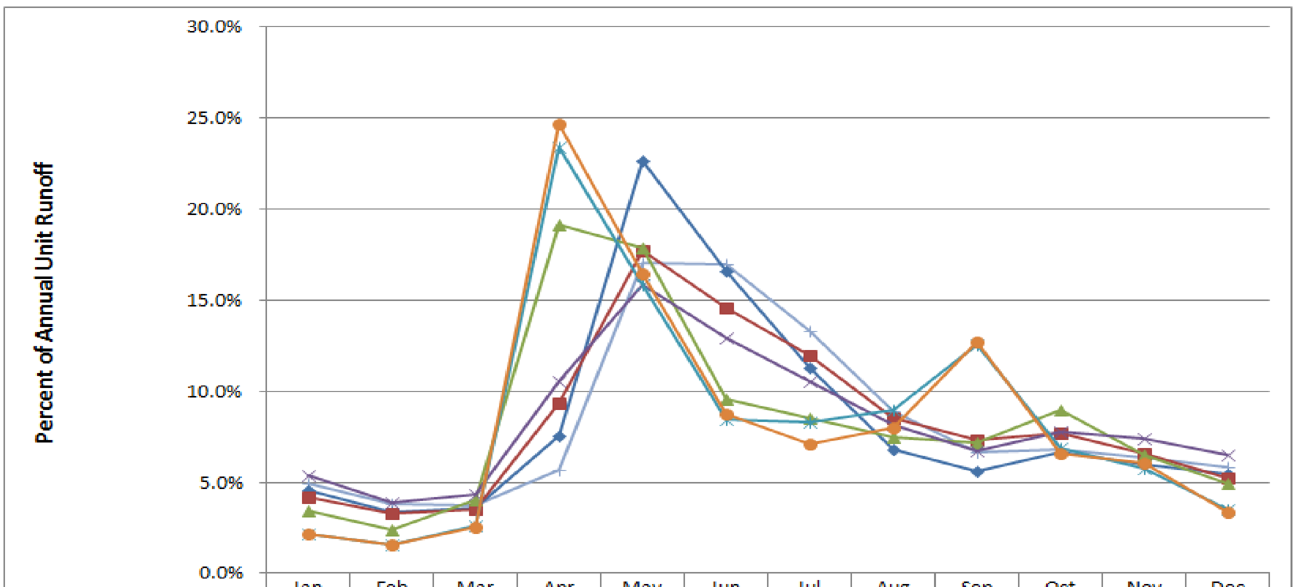
Linear regression analysis provided the relationships between long-term average seasonal mean flows (Q) and tributary drainage area (DA) shown in Table 5-19.

Table 5-19: Relationships between Long-Term Average Seasonal Mean Flows and Tributary Drainage Area

Season	Equation	Coefficient of Determination
Fall	Q = 0.0060 * DA	1.000
Winter	Q = 0.0040 * DA	0.997
Spring	Q = 0.0131 * DA	0.993
Summer	Q = 0.0090 * DA	0.998

Monthly Mean Flows

Table 5-20 shows the long-term average monthly mean flows at the regional scale Water Survey of Canada stations with natural flow records. The data are also shown in Figure 5-11 as percentages of annual unit runoff.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Namakan	4.9%	3.8%	3.8%	5.7%	17.0%	17.0%	13.3%	8.9%	6.7%	6.8%	6.3%	5.8%
Basswood	4.5%	3.4%	3.6%	7.5%	22.6%	16.6%	11.3%	6.8%	5.6%	6.6%	6.0%	5.5%
Turtle	4.2%	3.3%	3.5%	9.3%	17.7%	14.6%	12.0%	8.5%	7.3%	7.7%	6.6%	5.2%
Pipestone	3.4%	2.4%	4.1%	19.1%	17.9%	9.6%	8.5%	7.4%	7.2%	9.0%	6.5%	4.9%
Atikokan	5.4%	3.9%	4.4%	10.6%	15.8%	12.9%	10.5%	8.2%	6.7%	7.8%	7.4%	6.5%
Eye (Coulson Lake)	2.2%	1.6%	2.6%	23.4%	15.8%	8.4%	8.3%	8.9%	12.6%	6.9%	5.8%	3.5%
Eye (Hardtack Lake)	2.2%	1.6%	2.5%	24.7%	16.5%	8.8%	7.1%	8.0%	12.7%	6.6%	6.1%	3.4%

Figure 5-11: Monthly Distribution of Flows at Regional Scale Monitoring Stations

Table 5-20: Long-Term Average Monthly Mean Flows at Regional Scale Monitoring Stations

Station ID	Station Name	Drainage Area (km^2)	Period	Monthly Mean Flows (m^3/s)											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
05PA006	Namakan River at outlet of Lac La Croix	13,400	1921 to 2010	62.2	53.8	47.7	74.2	215.0	221.7	168.2	112.3	86.9	85.7	82.8	73.4
05PA012	Basswood River near Winton	4,510	1924 to 2010	20.4	16.8	16.0	35.0	101.9	77.2	50.7	30.8	26.2	29.8	28.0	24.7
05PB014	Turtle River near Mine Centre	4,870	1914 to 2010	18.8	16.4	15.7	43.3	79.6	67.5	53.8	38.3	33.8	34.7	30.4	23.4
05PB015	Pipestone River above Rainy Lake	443	1963 to 1998	1.44	1.13	1.71	8.31	7.52	4.17	3.58	3.13	3.13	3.77	2.83	2.06
05PB018	Atikokan River at Atikokan	332	1978 to 2010	1.89	1.50	1.53	3.83	5.55	4.69	3.69	2.86	2.43	2.73	2.67	2.27
05PB021	Eye River near Hardtack Lake	19.8	1985 to 1993	0.081	0.064	0.097	0.903	0.591	0.325	0.309	0.334	0.485	0.256	0.222	0.132
05PB022	Eye River near Coulson Lake	27.9	1985 to 1994	0.060	0.049	0.071	0.717	0.462	0.254	0.199	0.225	0.369	0.185	0.176	0.095

The monthly flows exhibit a weak bimodal distribution with a primary peak in April/May and a small secondary peak in September/October. The lowest flows occur in February/March. The monthly distributions for the Eye River stations are dissimilar from the other stations, peaking one month earlier, which may be a result of physiographic differences between the tributary drainage areas. Figure 5-12 shows that between 16% and 23% of annual unit runoff occurs in May and between 2% and 4% in February.

Linear regression analysis provided the relationships between long-term average monthly mean flows (Q) and tributary drainage area (DA) that are shown in Table 5-21.

Table 5-21: Relationships between Long-Term Average Monthly Mean Flows and Tributary Drainage Area

Season	Equation	Coefficient of Determination
January	Q = 0.0045*DA	0.9956
February	Q = 0.0039*DA	0.9956
March	Q = 0.0035*DA	0.9987
April	Q = 0.0061*DA	0.9295
May	Q = 0.0167*DA	0.9798
June	Q = 0.0163*DA	0.9956
July	Q = 0.0123*DA	0.9967
August	Q = 0.0082*DA	0.9953
September	Q = 0.0065*DA	0.9976
October	Q = 0.0065*DA	0.9979
November	Q = 0.0062*DA	0.9999
December	Q = 0.0054*DA	0.9977

Normal Flows

Monthly flow duration curves were developed for the regional scale stations with natural flow records. The curves were standardized by dividing by the long-term average monthly mean flows. The curves were generally similar and a dimensionless flow duration curve was computed as the arithmetic mean of the curves for all the stations.

Ratios of the 75^{th} and 25^{th} exceedance percentile daily mean flows to the long-term average monthly mean flows for each month were read from the curves and are shown in Figure 5-12. These percentiles represent the lower and upper bounds of the normal range of flows at the regional scale monitoring stations.

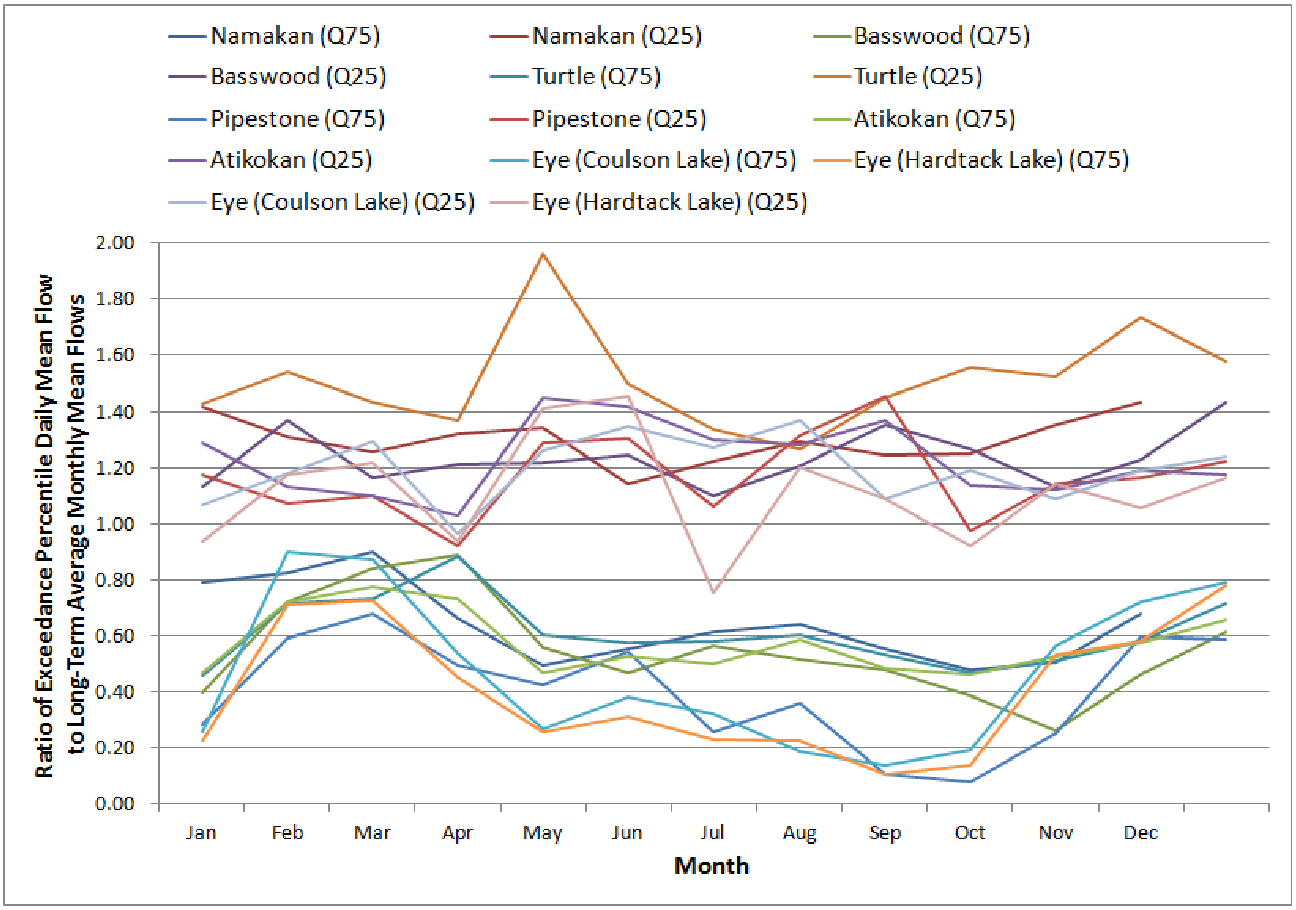


Figure 5-12: Upper and Lower Bounds of Normal Flows at Regional Scale Monitoring Stations

Figure 5-12 shows similar inter-quartile ranges of flows at the stations. The 75th exceedance percentile daily mean flows for the Pipestone River and Eye River stations were generally lower than at the other stations. The 25th percentile daily mean flows in Turtle River were generally higher than at the other stations. Differences in the percentile flows are due to physiographic differences between the watersheds.

Flood Flows

Figure 5-13 shows the linear relationship between the annual instantaneous peak flow with a 2-year return period and tributary drainage area, and Figure 5-14 shows the frequency curves relating instantaneous peak flows with different return periods to the instantaneous peak with a 2-year return period.

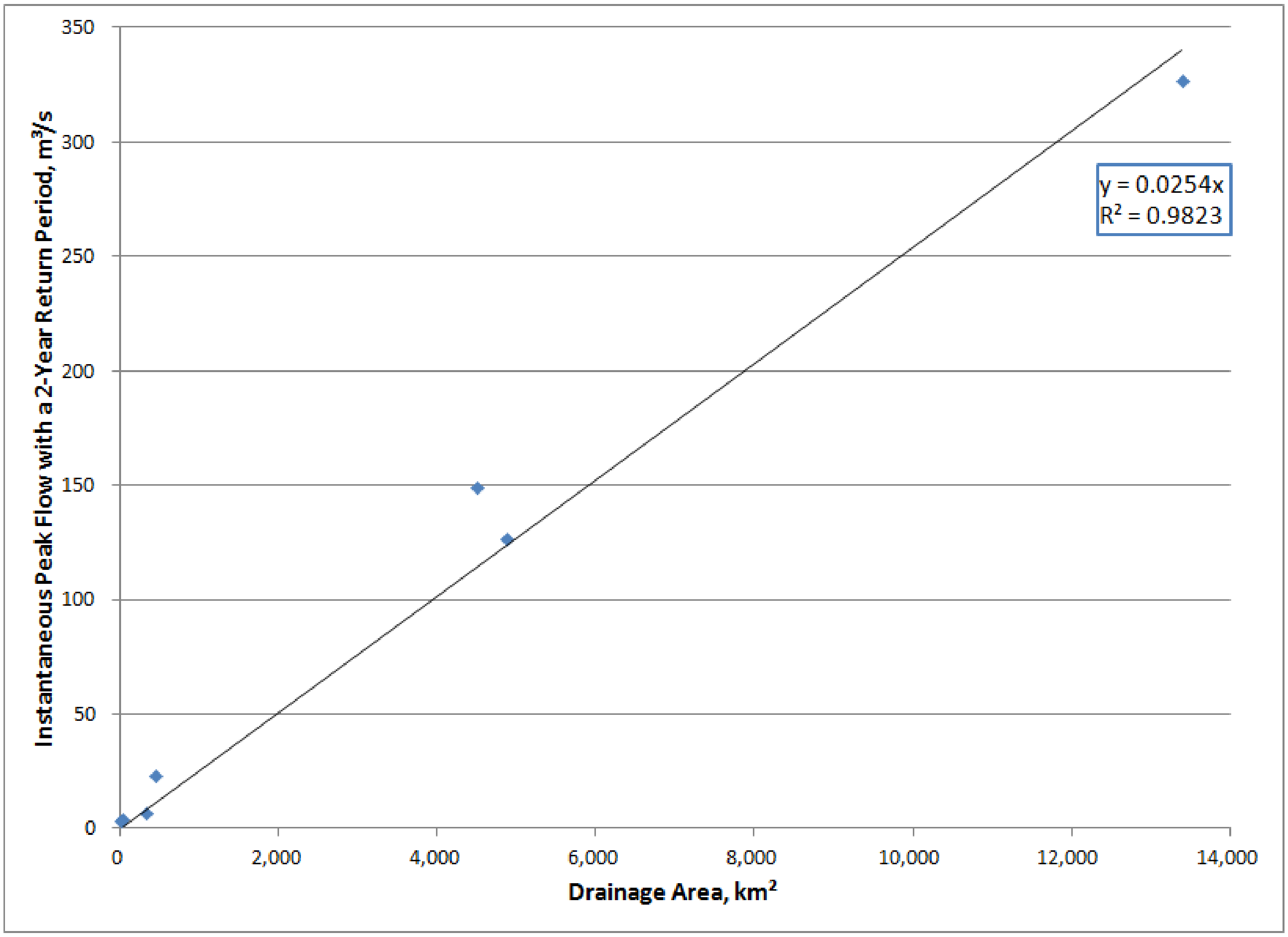


Figure 5-13: Instantaneous Peak Flow with a 2-Year Return Period versus Tributary Drainage Area

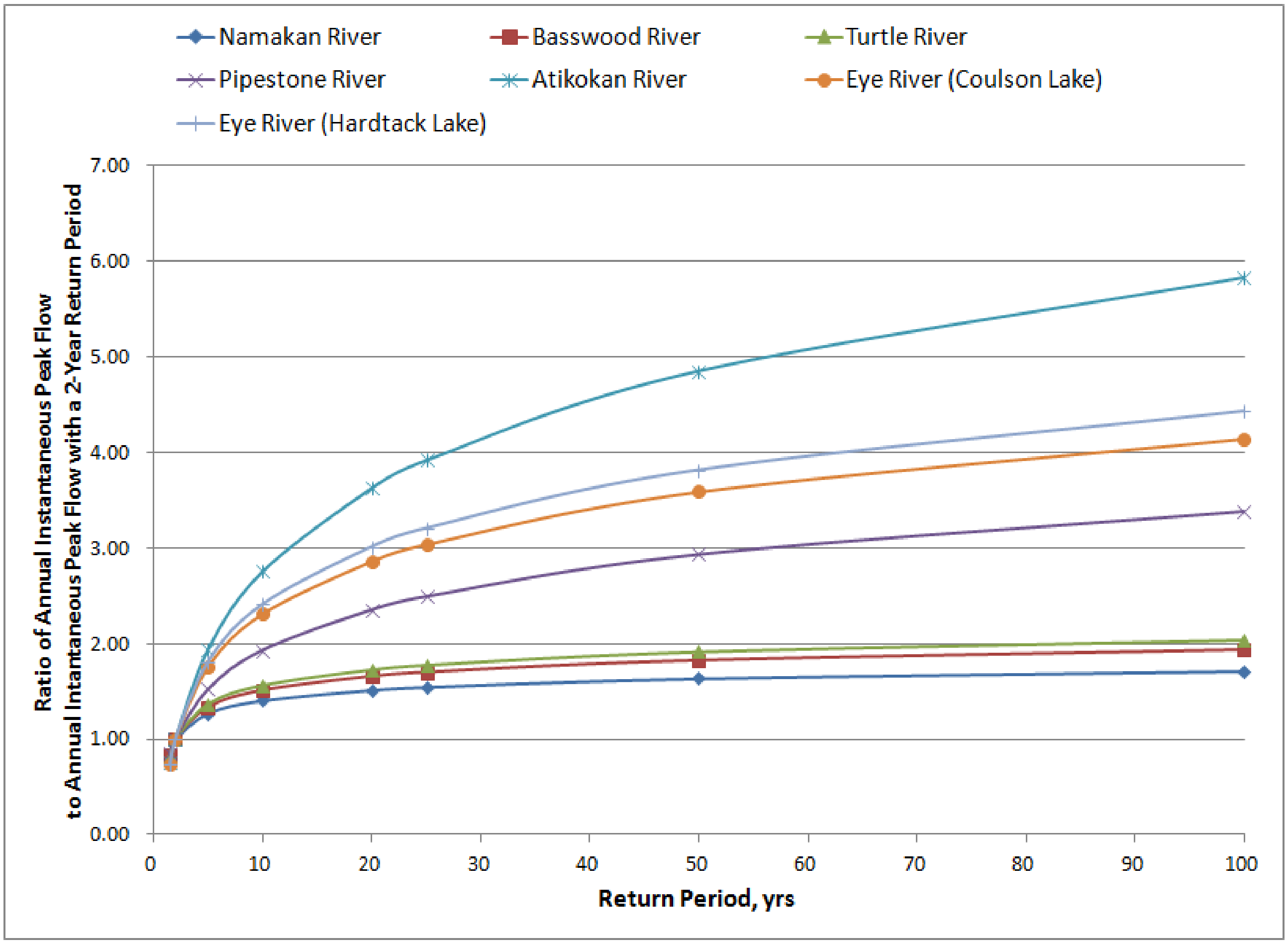


Figure 5-14: Frequency Curves for Instantaneous Peak Flows at Regional Scale Monitoring Stations

The curves for Namakan River, Basswood River and Turtle River form a tight band and are relatively flat, indicating similarly low variability in flood flows which may be due to the large tributary drainage areas to these stations. The curves for these stations will likely be representative of unregulated flood flows in the Seine River. The curve for Atikokan River is the steepest showing a higher variability in flood flows; possibly influenced by the diversion of flows into the river from the Steep Rock area of the adjacent watershed via a system of tunnels (Sowa et al. 2001). The curves for Pipestone River and Eye River are considered to be most representative of the response of local scale watersheds to flood conditions.

Low Flows

Low flow indices for the regional scale monitoring stations correlate well with tributary drainage area. Figure 5-15 shows the linear relationships between the annual minimum 7-day mean flows with return periods of 2 and 20 years and tributary drainage area, and between the annual minimum 30-day mean flow with a 2-year return period and tributary drainage area. Table 5-22 summarizes the linear relationships between the monthly 90th exceedance percentile daily mean flows and tributary drainage area.

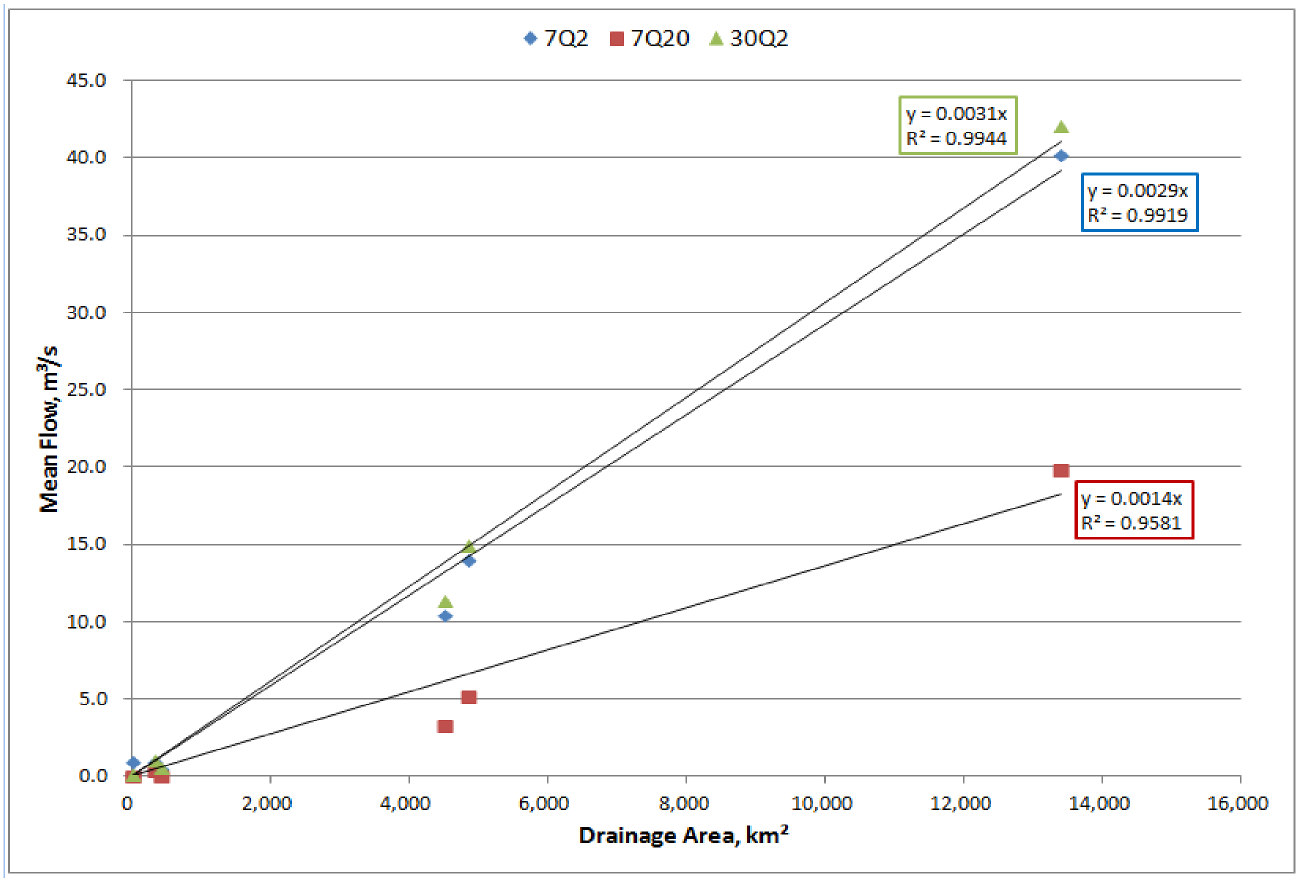


Figure 5-15: Relationships between Low Flow Indices and Tributary Drainage Area

Table 5-22: Relationships between 90th Exceedance Percentile Daily Flows and Tributary Drainage Area

Month	Equation	Coefficient of Determination
January	Q_{90} = 0.0023*DA	0.9993
February	Q_{90} = 0.0021*DA	0.9998
March	Q_{90} = 0.0023*DA	0.9991
April	Q_{90} = 0.0032*DA	0.9927
May	Q_{90} = 0.0039*DA	0.9658
June	Q_{90} = 0.0053*DA	0.9855
July	Q_{90} = 0.0049*DA	0.9651
August	Q_{90} = 0.0038*DA	0.9567
September	Q_{90} = 0.0025*DA	0.9623
October	Q_{90} = 0.0022*DA	0.9645
November	Q_{90} = 0.0023*DA	0.9852
December	Q_{90} = 0.0025*DA	0.9985

5.1.2.3 Summary of Existing Conditions

5.1.2.3.1 Watercourses of Interest

A total of 16 watercourses that may be affected by Project activities were identified following review of the Project Description prepared for and issued to the Canadian Environmental Assessment Agency (April 2011) and the Project components (Figure 5-16).

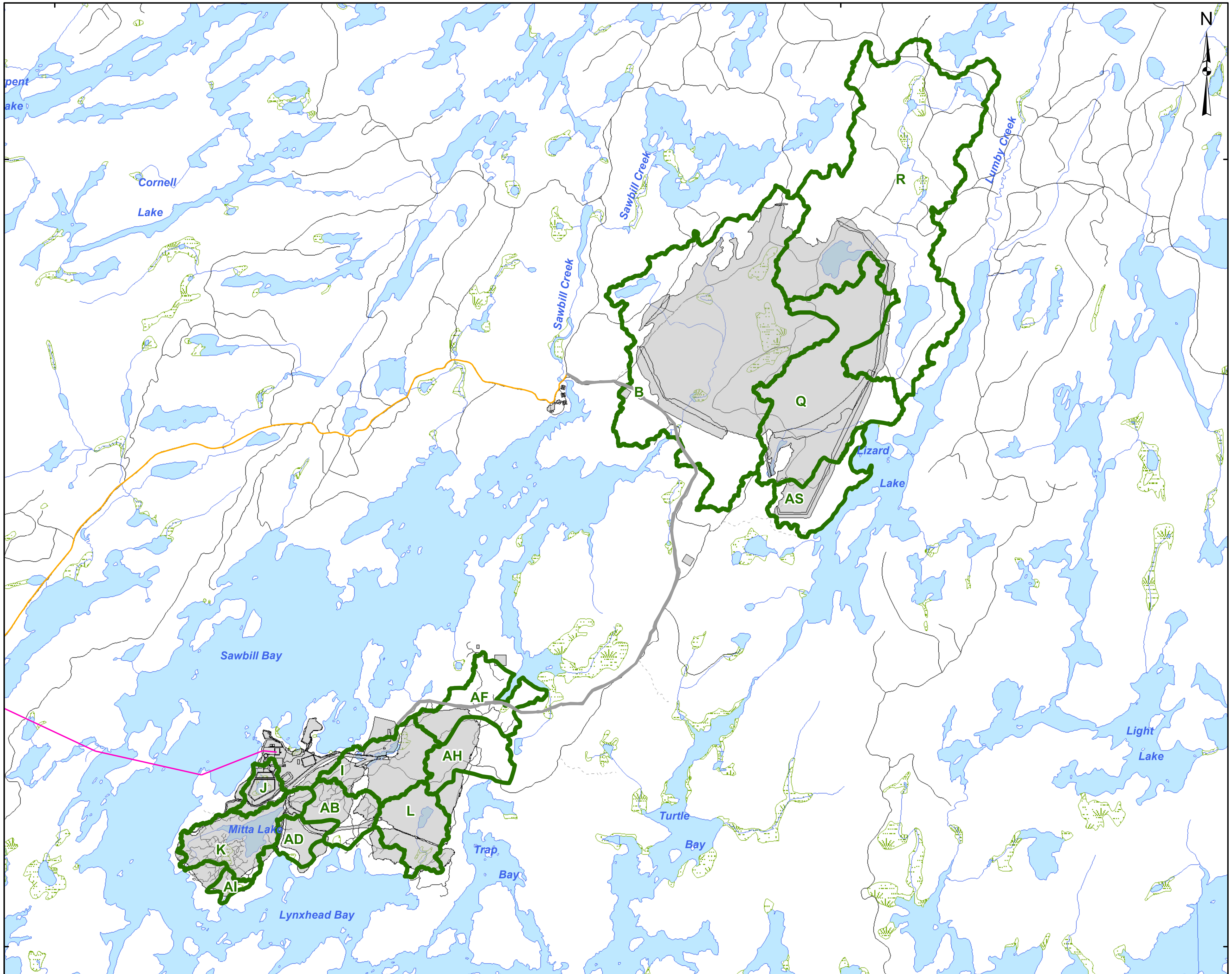
At the site scale, watercourses B, I, J, K, L, Q, R, AB, AD, AF, AH and AI (Figure 2-4) may be affected. Of these 12, only three are perennial (watercourses I, Q and AF). Watercourses B and R were included in the local scale flow monitoring program and correspond to stations SW-11 (Sawbill Bay East Tributary) and SW-12 (Lizard Lake West Tributary) respectively.

At the local scale, the following three watercourses may be affected by the Project:

- Sawbill Creek above Sawbill Bay (SW-01).
- Lumby Creek above Lizard Lake (SW-02A) and below Lizard Lake (SW-03).
- Light Creek below Light Lake (SW-06).

Light Creek below Light Lake (SW-06) is located to the east of Tailings Management Alternative #2, and will only be affected if this alternative replaces the preferred (base case) location. While existing flow conditions in this watercourse are characterized in this TSD, potential changes in flows as a result of the Project have not been assessed.

At the regional scale, the Project may have an effect on Upper Marmion Reservoir inflows and consequently regulated outflows from Raft Lake Dam and flows in the Seine River downstream of the dam.



LEGEND

- Trail
- Road
- River/Stream
- Lake
- Wetland
- Local Watershed Boundary
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000

SCALE 1:50,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

WATERCOURSES OF INTEREST

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 5-16	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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5.1.2.3.2 Annual Mean Flows

Table 5-23 shows the estimated long-term average and range of annual (September to August) mean flows for the 15 unregulated watercourses identified in Section 5.1.2.3.1.

Table 5-23: Long-term Average and Range of Annual Mean Flows

Watercourse ID	Drainage Area (km²)	Average Annual Mean Flow (m³/s)	Range in Annual Mean Flows (m³/s)
Site Scale Watercourses			
B (SW-11)	4.62	0.037	0.061
I	0.852	0.007	0.011
J	0.256	0.002	0.003
K	0.890	0.007	0.012
L	0.705	0.006	0.009
Q	2.73	0.022	0.036
R (SW-12)	6.21	0.050	0.081
AB	0.520	0.004	0.007
AD	0.293	0.002	0.004
AF	0.775	0.006	0.010
AH	0.600	0.005	0.008
AI	0.103	0.001	0.001
Local Scale Watercourses			
SW-01	106	0.859	1.389
SW-02A	36.0	0.292	0.472
SW-03	62.8	0.509	0.823
SW-06	41.4	0.335	0.542

The long-term average and range of annual mean flows in the unregulated watercourses were estimated using the linear relationships from the regional flow analysis in Figure 5-7. Corresponding values for Upper Marmion Reservoir inflows and outflows could not be computed due to the paucity of available data.

Tables 5-24 and 5-25 show the annual mean flows for the same watercourses for wet and dry years with return periods of 2, 10, 25, 50 and 100 years. Flows were estimated using the frequency curves in Figures 5-8 and 5-9 and the long-term average annual flows in Table 5-23 above.

Table 5-24: Annual Mean Flows for Wet Years

Watercourse ID	Annual Mean Flows (m³/s)				
	2-yr	10-yr	25-yr	50-yr	100-yr
Site Scale Watercourses					
B (SW-11)	0.037	0.054	0.060	0.064	0.067
I	0.007	0.010	0.011	0.012	0.012
J	0.002	0.003	0.003	0.004	0.004
K	0.007	0.010	0.012	0.012	0.013
L	0.006	0.008	0.009	0.010	0.010
Q	0.022	0.032	0.035	0.038	0.040
R (SW-12)	0.050	0.072	0.080	0.086	0.090
AB	0.004	0.006	0.007	0.007	0.008
AD	0.002	0.003	0.004	0.004	0.004
AF	0.006	0.009	0.010	0.011	0.011
AH	0.005	0.007	0.008	0.008	0.009
AI	0.001	0.001	0.001	0.001	0.001
Local Scale Watercourses					
SW-01	0.859	1.23	1.37	1.46	1.54
SW-02A	0.292	0.419	0.466	0.496	0.523
SW-03	0.509	0.732	0.813	0.866	0.913
SW-06	0.335	0.482	0.536	0.571	0.602

Table 5-25: Annual Mean Flows for Dry Years

Watercourse ID	Annual Mean Flows (m³/s)				
	2-yr	10-yr	25-yr	50-yr	100-yr
Site Scale Watercourses					
B (SW-11)	0.037	0.021	0.015	0.011	0.008
I	0.007	0.005	0.004	0.003	0.002
J	0.002	0.001	0.001	0.001	0.001
K	0.007	0.005	0.004	0.003	0.002
L	0.006	0.004	0.003	0.002	0.002
Q	0.022	0.016	0.012	0.009	0.007
R (SW-12)	0.050	0.028	0.020	0.015	0.010
AB	0.004	0.003	0.002	0.002	0.001
AD	0.002	0.002	0.001	0.001	0.001
AF	0.006	0.004	0.004	0.003	0.002
AH	0.005	0.003	0.003	0.002	0.001
AI	0.001	0.001	0.000	0.000	0.000

Table 5 25: Annual Mean Flows for Dry Years (Continued)

Watercourse ID	Annual Mean Flows (m³/s)				
	2-yr	10-yr	25-yr	50-yr	100-yr
Local Scale Watercourses					
SW-01	0.859	0.482	0.345	0.256	0.176
SW-02A	0.292	0.164	0.117	0.087	0.060
SW-03	0.509	0.286	0.204	0.152	0.104
SW-06	0.335	0.188	0.135	0.100	0.069

5.1.2.3.3 Seasonal Mean Flows

Table 5-26 shows the long-term average seasonal mean flows in the watercourses of interest. The long-term average seasonal mean flows were estimated using the linear equations from the regional flow analysis in Table 5-19 relating flows to tributary drainage areas.

Table 5-26: Long-Term Average Seasonal Mean Flows

Watercourse ID	Drainage Area (km²)	Average Seasonal Mean Flows (m³/s)			
		Fall (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Sep)
Site Scale Watercourses					
B (SW-11)	4.62	0.028	0.018	0.061	0.042
I	0.852	0.005	0.003	0.011	0.008
J	0.256	0.002	0.001	0.003	0.002
K	0.890	0.005	0.004	0.012	0.008
L	0.705	0.004	0.003	0.009	0.006
Q	2.73	0.016	0.011	0.036	0.025
R (SW-12)	6.21	0.037	0.025	0.081	0.056
AB	0.520	0.003	0.002	0.007	0.005
AD	0.293	0.002	0.001	0.004	0.003
AF	0.775	0.005	0.003	0.010	0.007
AH	0.600	0.004	0.002	0.008	0.005
AI	0.103	0.001	0.000	0.001	0.001
Local Scale Watercourses					
SW-01	106	0.636	0.424	1.389	0.954
SW-02A	36.00	0.216	0.144	0.472	0.324
SW-03	62.80	0.377	0.251	0.823	0.565
SW-06	41.40	0.248	0.166	0.542	0.373

5.1.2.3.4 Monthly Mean Flows

Table 5-27 shows the estimated long-term average monthly mean flows in the watercourses. These flows were estimated using the linear equations in Table 5-21 relating flow to tributary drainage area, determined during regional flow analysis.

5.1.2.3.5 Normal Flows

The 75th and 25th exceedance percentile daily mean flows, describing the normal range of flow conditions in the watercourses, are shown in Table 5-28. Ratios of the 75th and 25th exceedance percentile flows to the long-term average flows for each month were read from the dimensionless flow duration curves developed during regional flow analysis.

Table 5-27: Long-Term Average Monthly Mean Flows (m^3/s)

Watercourse ID	Drainage Area (km^2)	Long-Term Average Monthly Mean Flows (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site Scale Watercourses													
B (SW-11)	4.62	0.021	0.018	0.016	0.028	0.077	0.075	0.057	0.038	0.030	0.029	0.029	0.025
I	0.852	0.004	0.003	0.003	0.005	0.014	0.014	0.010	0.007	0.006	0.005	0.005	0.005
J	0.256	0.001	0.001	0.001	0.002	0.004	0.004	0.003	0.002	0.002	0.002	0.002	0.001
K	0.890	0.004	0.003	0.003	0.005	0.015	0.015	0.011	0.007	0.006	0.006	0.006	0.005
L	0.705	0.003	0.003	0.002	0.004	0.012	0.011	0.009	0.006	0.005	0.004	0.004	0.004
Q	2.73	0.012	0.011	0.010	0.017	0.046	0.044	0.034	0.022	0.018	0.017	0.017	0.015
R (SW-12)	6.21	0.028	0.024	0.022	0.038	0.104	0.101	0.076	0.051	0.040	0.039	0.039	0.034
AB	0.520	0.002	0.002	0.002	0.003	0.009	0.008	0.006	0.004	0.003	0.003	0.003	0.003
AD	0.293	0.001	0.001	0.001	0.002	0.005	0.005	0.004	0.002	0.002	0.002	0.002	0.002
AF	0.775	0.003	0.003	0.003	0.005	0.013	0.013	0.010	0.006	0.005	0.005	0.005	0.004
AH	0.600	0.003	0.002	0.002	0.004	0.010	0.010	0.007	0.005	0.004	0.004	0.004	0.003
AI	0.103	0.000	0.000	0.000	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Local Scale Watercourses													
SW-01	106	0.477	0.413	0.371	0.647	1.770	1.728	1.304	0.869	0.689	0.657	0.657	0.572
SW-02A	36.00	0.162	0.140	0.126	0.220	0.601	0.587	0.443	0.295	0.234	0.223	0.223	0.194
SW-03	62.80	0.283	0.245	0.220	0.383	1.049	1.024	0.772	0.515	0.408	0.389	0.389	0.339
SW-06	41.40	0.186	0.161	0.145	0.253	0.691	0.675	0.509	0.339	0.269	0.257	0.257	0.224

Table 5-28: Lower and Upper Bounds of Normal Daily Mean Flows (m³/s)

Watercourse ID	Percentile	Percentile Daily Mean Flow (m³/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site Scale Watercourses													
B (SW-11)	Q_{75}	0.015	0.014	0.011	0.013	0.036	0.032	0.025	0.013	0.010	0.013	0.016	0.017
	Q_{25}	0.026	0.022	0.018	0.040	0.106	0.086	0.072	0.049	0.036	0.034	0.036	0.033
I	Q_{75}	0.003	0.003	0.002	0.002	0.007	0.006	0.005	0.002	0.002	0.002	0.003	0.003
	Q_{25}	0.005	0.004	0.003	0.007	0.020	0.016	0.013	0.009	0.007	0.006	0.007	0.006
J	Q_{75}	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	Q_{25}	0.001	0.001	0.001	0.002	0.006	0.005	0.004	0.003	0.002	0.002	0.002	0.002
K	Q_{75}	0.003	0.003	0.002	0.003	0.007	0.006	0.005	0.003	0.002	0.002	0.003	0.003
	Q_{25}	0.005	0.004	0.003	0.008	0.020	0.016	0.014	0.009	0.007	0.007	0.007	0.006
L	Q_{75}	0.002	0.002	0.002	0.002	0.006	0.005	0.004	0.002	0.001	0.002	0.003	0.003
	Q_{25}	0.004	0.003	0.003	0.006	0.016	0.013	0.011	0.008	0.005	0.005	0.006	0.005
Q	Q_{75}	0.009	0.008	0.007	0.008	0.021	0.019	0.015	0.008	0.006	0.008	0.010	0.010
	Q_{25}	0.016	0.013	0.010	0.024	0.063	0.051	0.043	0.029	0.021	0.020	0.022	0.019
R (SW-12)	Q_{75}	0.021	0.019	0.015	0.018	0.049	0.044	0.034	0.018	0.013	0.017	0.022	0.023
	Q_{25}	0.035	0.030	0.024	0.054	0.142	0.115	0.097	0.066	0.048	0.046	0.049	0.044
AB	Q_{75}	0.002	0.002	0.001	0.001	0.004	0.004	0.003	0.002	0.001	0.001	0.002	0.002
	Q_{25}	0.003	0.002	0.002	0.004	0.012	0.010	0.008	0.006	0.004	0.004	0.004	0.004
AD	Q_{75}	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
	Q_{25}	0.002	0.001	0.001	0.003	0.007	0.005	0.005	0.003	0.002	0.002	0.002	0.002

Table 5-28: Lower and Upper Bounds of Normal Daily Mean Flows (m³/s) (Continued)

Watercourse ID	Percentile	Percentile Daily Mean Flow (m³/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AF	Q_{75}	0.003	0.002	0.002	0.002	0.006	0.005	0.004	0.002	0.002	0.002	0.003	0.003
	Q_{25}	0.004	0.004	0.003	0.007	0.018	0.014	0.012	0.008	0.006	0.006	0.006	0.006
AH	Q_{75}	0.002	0.002	0.001	0.002	0.005	0.004	0.003	0.002	0.001	0.002	0.002	0.002
	Q_{25}	0.003	0.003	0.002	0.005	0.014	0.011	0.009	0.006	0.005	0.004	0.005	0.004
AI	Q_{75}	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Q_{25}	0.001	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Local Scale Watercourses													
SW-01	Q_{75}	0.351	0.322	0.259	0.300	0.835	0.744	0.577	0.309	0.225	0.294	0.378	0.395
	Q_{25}	0.605	0.508	0.407	0.915	2.428	1.964	1.650	1.128	0.815	0.788	0.837	0.756
SW-02A	Q_{75}	0.119	0.109	0.088	0.102	0.283	0.253	0.196	0.105	0.076	0.100	0.128	0.134
	Q_{25}	0.206	0.173	0.138	0.311	0.825	0.667	0.560	0.383	0.277	0.268	0.284	0.257
SW-03	Q_{75}	0.208	0.191	0.153	0.177	0.495	0.441	0.342	0.183	0.133	0.174	0.224	0.234
	Q_{25}	0.359	0.301	0.241	0.542	1.439	1.163	0.978	0.668	0.483	0.467	0.496	0.448
SW-06	Q_{75}	0.137	0.126	0.101	0.117	0.326	0.291	0.225	0.121	0.088	0.115	0.148	0.154
	Q_{25}	0.236	0.198	0.159	0.357	0.948	0.767	0.645	0.441	0.318	0.308	0.327	0.295

5.1.2.3.6 Flood Flows

Table 5-29 summarizes the instantaneous peak flows with return periods of 1.5, 10, 25 and 100 years for the watercourses of interest. These have been estimated using the linear relationship between the instantaneous peak flow with a 2-year return period and tributary drainage area in Figure 5-13 and the arithmetic mean of the frequency curves for Pipestone River and Eye River in Figure 5-14 (from the regional flow analysis).

Table 5-29: Instantaneous Peak Flows

Watercourse ID	Drainage Area (km²)	Instantaneous Peak Flows (m³/s)				
		Q2	**Q1.5**	**Q10**	**Q25**	**Q100**
Site Scale Watercourses						
B (SW-11)	4.62	0.117	0.091	0.201	0.585	2.33
I	0.852	0.022	0.017	0.037	0.108	0.43
J	0.256	0.007	0.005	0.011	0.032	0.13
K	0.890	0.023	0.017	0.039	0.113	0.45
L	0.705	0.018	0.014	0.031	0.089	0.36
Q	2.73	0.069	0.054	0.119	0.346	1.38
R (SW-12)	6.21	0.158	0.122	0.270	0.786	3.13
AB	0.520	0.013	0.010	0.023	0.066	0.26
AD	0.293	0.007	0.006	0.013	0.037	0.15
AF	0.775	0.020	0.015	0.034	0.098	0.39
AH	0.600	0.015	0.012	0.026	0.076	0.30
AI	0.103	0.003	0.002	0.004	0.013	0.05
Local Scale Watercourses						
SW-01	106	2.69	2.08	4.61	13.4	53.5
SW-02A	36.0	0.914	0.706	1.57	4.56	18.2
SW-03	62.8	1.60	1.23	2.73	7.95	31.7
SW-06	41.4	1.05	0.812	1.80	5.24	20.9

5.1.2.3.7 Low Flows

Table 5-30 shows the annual minimum 7-day mean flows with return periods of 2 and 20 years, and the annual minimum 30-day mean flow with a 2-year return period, for the watercourses. The flows have been estimated using the linear relationships in Figure 5-15 between flow and tributary drainage area, from the regional flow analysis.

Table 5-30: Low Flows

Watercourse ID	Drainage Area (km²)	Low Flows (m³/s)		
		7Q2	7Q20	30Q2
Site Scale Watercourses				
B (SW-11)	4.62	0.013	0.006	0.014
I	0.852	0.002	0.001	0.003
J	0.256	0.001	0.000	0.001
K	0.890	0.003	0.001	0.003
L	0.705	0.002	0.001	0.002
Q	2.73	0.008	0.004	0.008
R (SW-12)	6.21	0.018	0.009	0.019
AB	0.520	0.002	0.001	0.002
AD	0.293	0.001	0.000	0.001
AF	0.775	0.002	0.001	0.002
AH	0.600	0.002	0.001	0.002
AI	0.103	0.000	0.000	0.000
Local Scale Watercourses				
SW-01	106	0.307	0.148	0.329
SW-02A	36.0	0.104	0.050	0.112
SW-03	62.8	0.182	0.088	0.195
SW-06	41.4	0.120	0.058	0.128

According to Pyrce (2004), the annual minimum 30-day mean flow is considered to provide a reliable estimate of annual average base flow in any given year.

The monthly 90th exceedance percentile daily mean flows are shown in Table 5-31. These have been computed using the equations in Table 5-23 from the regional flow analysis.

Table 5-31: 90th Exceedance Percentile Daily Mean Flows (m³/s)

Watercourse ID	Drainage Area (km²)	Percentile Daily Mean Flows (m³/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site Scale Watercourses													
B (SW-11)	4.62	0.106	0.010	0.011	0.015	0.018	0.024	0.023	0.018	0.012	0.010	0.011	0.012
I	0.852	0.020	0.002	0.002	0.003	0.003	0.005	0.004	0.003	0.002	0.002	0.002	0.002
J	0.256	0.006	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
K	0.890	0.020	0.002	0.002	0.003	0.003	0.005	0.004	0.003	0.002	0.002	0.002	0.002
L	0.705	0.016	0.001	0.002	0.002	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002
Q	2.73	0.063	0.006	0.006	0.009	0.011	0.014	0.013	0.010	0.007	0.006	0.006	0.007
R (SW-12)	6.21	0.143	0.013	0.014	0.020	0.024	0.033	0.030	0.024	0.016	0.014	0.014	0.016
AB	0.520	0.012	0.001	0.001	0.002	0.002	0.003	0.003	0.002	0.001	0.001	0.001	0.001
AD	0.293	0.007	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
AF	0.775	0.018	0.002	0.002	0.002	0.003	0.004	0.004	0.003	0.002	0.002	0.002	0.002
AH	0.600	0.014	0.001	0.001	0.002	0.002	0.003	0.003	0.002	0.002	0.001	0.001	0.002
AI	0.103	0.002	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Local Scale Watercourses													
SW-01	106	2.438	0.223	0.244	0.339	0.413	0.562	0.519	0.403	0.265	0.233	0.244	0.265
SW-02A	36.00	0.828	0.076	0.083	0.115	0.140	0.191	0.176	0.137	0.090	0.079	0.083	0.090
SW-03	62.80	1.444	0.132	0.144	0.201	0.245	0.333	0.308	0.239	0.157	0.138	0.144	0.157
SW-06	41.40	0.952	0.087	0.095	0.132	0.161	0.219	0.203	0.157	0.104	0.091	0.095	0.104

5.2 Prediction of Potential Changes

5.2.1 Methods

5.2.1.1 Determination of Bounding Scenario

Changes to flows in site, local and regional scale watercourses from existing conditions are expected to occur in all four phases of the Project. The prediction of changes in flows in these watercourses has been based on a bounding (worst case) scenario: the Project phase when the combination of Project activities results in the greatest changes to flows.

The bounding scenario was selected by identifying the potential changes in flows as a result of Project activities in all phases of the Project. Table 5-32 summarizes the Project activities and the potential changes to flows from existing conditions associated with the various Project phases.

Table 5-32: Project Activities and Potential Changes in Flows from Existing Conditions

Project Activity	Potential Change
Construction Phase	
■ Site preparation (clearing, grubbing and stripping) ■ Removal and stockpiling of soil and overburden material ■ Removal and stockpiling of sediment from Mitta Lake when dewatering of the lake is completed ■ Transfer and stockpiling of waste rock from Mine development	■ Increase in flows in downstream watercourses due to increased runoff rates and volumes as a result of changes to land cover This change will be temporary, occurring prior to construction of the water collection system, and will be mitigated by the controlled release of runoff from temporary sediment control structures.
■ Temporary runoff diversion around construction works and Project facilities	■ Reduction and increase in flows due to the diversion of runoff from one watershed to another watershed
■ Runoff collection from areas within the Project footprint following construction of the water collection system (e.g. ditches, sumps, pump stations, ponds)	■ Reduction in flows in downstream watercourses due to the interception of runoff
■ Dewatering of Mitta Lake (API #12) with flows used to: ▪ Satisfy construction water requirements at the mine site and Tailings Management Facility (TMF), and ▪ Provide start-up water in the TMF reclaim pond	■ Reduction in flows in downstream watercourses due to water taking
■ Water taking from Sawbill Bay for potable and construction water supply at the accommodation camp	■ Reduction in flows in the Seine River downstream of Raft Lake Dam due to water taking
■ Discharge of treated sewage effluent from the accommodation camp into Sawbill Bay at the mouth of Sawbill Creek	■ Increase in flows in the Seine River downstream of Raft Lake Dam due to effluent discharge

Table 5-32: Project Activities and Potential Changes in Flows from Existing Conditions (Continued)

Project Activity	Potential Change
Operations Phase	
■ Runoff collection from areas within the Project footprint to meet, in part, the water requirements for ore processing	■ Reduction in flows due to the interception of runoff by the water collection system
■ Water taking from Sawbill Bay for ▪ Potable water supply to the accommodation camp, and ▪ Freshwater supply to the processing plant	■ Reduction in flows in Seine River downstream of Raft Lake Dam due to water taking
■ Discharge of the following into Sawbill Bay: ▪ Treated sewage effluent from the accommodation camp, and ▪ Treated wastewater effluent from the mine site	■ Increase in flows in the Seine River downstream of Raft Lake Dam due to treated effluent discharges
■ Discharge of runoff from the accommodation camp, emulsion plant and detonator storage area into Sawbill Bay Runoff from these areas will not be collected.	■ Increase in flows due to increased runoff rates and volumes, as a result of changes in land cover
■ Mine dewatering	■ Reduction in flows in downstream watercourses due to the interception of runoff from the Mine footprint ■ Reduction in flows in Seine River downstream of Raft Lake Dam due to the seepage of surface water from the Upper Marmion Reservoir into the open pits
Closure Phase	
■ Decommissioning of the accommodation camp, emulsion plant, detonator storage area, Ore Processing Facility, and administration offices These Project facilities will be demolished, the ground scarified and re-vegetated, and pre-development flow directions restored where possible	■ Increase in flows in downstream watercourses due to the change in land cover Reclaimed land may initially yield higher runoff rates and volumes due to less dense vegetation.
■ Runoff collection from the Waste Rock Management Facility (WRMF), low-grade ore stockpile, overburden stockpile and TMF Runoff will continue to be routed to the Mine Water Emergency Spill Pond and effluent treatment plant	■ Reduction in flows in downstream watercourses due to the interception of runoff

Table 5-32: Project Activities and Potential Changes in Flows from Existing Conditions (Continued)

Project Activity	Potential Change
■ Discharge of treated wastewater effluent from the mine site into Sawbill Bay The accommodation camp will be decommissioned and the discharge of treated sewage effluent into Sawbill Bay will cease.	■ Increase in flows in Seine River downstream of Raft Lake Dam due to the discharge of treated effluent
■ Back-flooding of the Mine At the end of mining, dewatering of the open pits will cease and the open pits will slowly fill with water.	■ Reduction in flows in downstream watercourses due to the interception of runoff in the Mine footprint ■ Reduction in flows in Seine River downstream of Raft Lake Dam due to the seepage of water from the Upper Marmion Reservoir into the open pits
Post-closure Phase	
■ Runoff collection from the WRMF, low-grade ore stockpile, overburden stockpile and TMF, until water quality is acceptable for direct discharge to the environment Runoff from these facilities will be routed to the open pits to accelerate back-flooding.	■ Reduction in flows in downstream watercourses due to the interception of runoff
■ Back-flooding of the Mine	■ Reduction in flows in the Seine River downstream of Raft Lake Dam due to the interception of runoff in the Mine footprint ■ Reduction in flows in downstream watercourses due to the seepage of water from the Upper Marmion Reservoir into the open pits
■ Discharge of runoff from the TMF into Sawbill Bay, when water quality is acceptable for direct discharge to the environment	■ Reduction and increase in flows in downstream watercourses due to runoff diversion from the Trap-Turtle-Lynxhead Bays watershed to the Sawbill Bay watershed
■ Discharge of runoff from the WRMF, low-grade ore stockpile and overburden stockpile into Sawbill Bay, Trap Bay and Lynxhead Bay, when water quality is acceptable for direct discharge to the environment The WRMF and low-grade ore stockpile will be graded to shed runoff and reduce infiltration, but will not be covered with soil or re-vegetated. The overburden stockpile will be graded to shed runoff and reduce infiltration and its surface will be directly re-vegetated.	■ Reduction and increase in flows in downstream watercourses as a result of the changes in land cover Lower runoff rates and volumes are expected from the WRMF and Low Grade Stockpile due to the larger grain size of the surface material. The overburden stockpile may initially yield higher runoff rates and volumes due to less dense vegetation.

Table 5-32: Project Activities and Potential Changes in Flows from Existing Conditions (Continued)

Project Activity	Potential Change
■ Overflow of water from the flooded open pits	■ Increase in flows in downstream watercourses due to changes in land cover Higher runoff rates and volumes are expected from the surface of the flooded open pits compared to natural ground

During the construction phase, flows in watercourses are expected to be altered from existing conditions by changes in land cover, runoff diversion, runoff interception, lake dewatering, water taking and effluent discharge. These changes are expected to occur during general construction works and the development of linear infrastructure, the accommodation camp, Mine, overburden stockpile, WRMF, TMF, and Support and Ancillary Infrastructure.

During the operations phase, flows in watercourses will continue to be influenced by changes in land cover, runoff interception, water taking and effluent discharge that commenced during the construction phase. In addition, further changes are expected as a result of:

- Increased runoff collection with the progressive expansion of the Mine, overburden stockpile, WRMF and TMF. The Project footprint and the quantity of runoff intercepted by the water collection system will increase over time.
- Increased water taking from Sawbill Bay to supply fresh water to the processing plant in addition to water taking to supply potable water to the accommodation camp.
- The discharge of treated wastewater effluent from the mine site, in excess of water requirements, in addition to the discharge of treated sewage effluent from the accommodation camp;
- Mine dewatering as the open pits are developed. Flows will increase as the mine is developed due to increased runoff rates and volumes from the expanding footprint, and increased seepage rates as a result of the growing hydraulic gradient between water in the reservoir and in the open pits.

During the closure phase, flows will continue to be altered by runoff collection and effluent discharge. However, the changes are expected to be smaller than during the operations phase. The accommodation camp, emulsion plant, detonator storage area, Ore Processing Facility and administration offices will be decommissioned and land occupied by these facilities will be reclaimed and pre-development drainage patterns restored where possible. In addition, water taking for potable water supply to the camp and freshwater supply to the processing plant, together with the discharge of treated sewage from the camp, will cease. At the end of mining, the dewatering system will be taken out of service and back-flooding of the open pits allowed to commence.

During the post-closure phase, flows will initially continue to be affected by the same Project activities as during the closure phase, with the exception that the discharge of treated wastewater from the mine site will cease. Runoff collected from the TMF, WRMF, Low Grade Ore Stockpile and overburden stockpile will be routed to the Mine to accelerate back-flooding. However, when water quality improves to an acceptable quality, runoff from these facilities will be allowed to discharge directly to the environment. In addition, 20 to 30 years after closure, the flooded open pits will begin to overflow and this overflow will be directed into Upper Marmion Reservoir.

Based on the above, it is concluded that the bounding (worst case) scenario for changes in flows from existing conditions will occur during the operations phase of the Project. Methods for the evaluation of expected changes to existing flows in site, local and regional scale watercourses during the operations phase are described in Sections 5.2.1.2 to 5.2.1.4 below.

5.2.1.2 Site Scale Watercourses

During the operations phase, changes in flows in site scale watercourses from existing conditions will occur as a result of the interception of runoff from areas within the Project footprint by the water collection system.

Regional analysis of natural (unregulated) flows indicated strong linear relationships between various flow statistics and tributary drainage area (Section 5.1.2.2.2). On this basis, the evaluation of changes to flows in site and local scale watercourses as a result of the Project was based on changes in tributary drainage areas. Expected changes to flows in site scale watercourses are described in Section 5.2.2.1 below.

5.2.1.3 Local Scale Watercourses

During the operations phase, changes in flows from existing conditions are expected in Lumby Creek in the Lynxhead-Trap-Turtle Bays watershed. Changes in flows in Lumby Creek will occur as a result of the interception of runoff from areas within the Project footprint by the water collection system.

Hydrologic modelling with HEC-HMS 3.5 software, developed for the United States Army Corps of Engineers, was completed in order to assess the changes in flows in this watercourse. Inputs to the model included:

- Climatic data for Atikokan (Section 4), including estimates of snowmelt and potential evapotranspiration.
- Drainage characteristics such as sub-basin areas, lengths of overland flow and channel lengths based on NRVIS 1:20,000 topographical data.
- Stage-storage-discharge relationships for Lizard Lake based on the rating curve developed for station SW-03 (Appendix 5.I) and bathymetric survey data (Golder 2012).

Two models were created: the first represented existing conditions (the base case) and the second represented conditions during the operations phase of the Project. The base case model was calibrated to flows recorded at stations SW-07, SW-02A, SW-02B, SW-12 and SW-03, and to water levels recorded at station SW-03 (Lizard Lake), between 2010 and 2012 (Appendix 5.I). The model representing the operations phase consisted of the base case model with changes to drainage characteristics consistent with the reduction in the surface area of the watershed. Flows in Lumby Creek were simulated over a 30-year period between 1982 and 2011 in both models. The expected changes in flows were assessed by comparing flows in the Creek from the base case model to flows from the model representing the operations phase of the Project.

The expected changes to flows in Lumby Creek are discussed in Section 5.2.2.2 below.

5.2.1.4 Regional Scale Watercourses

During the operations phase, outflows from Upper Marmion Reservoir which contribute to flows in the Seine River downstream of Raft Lake Dam could be influenced by:

- The interception of runoff from areas within the Project footprint by the water collection system.
- Water taking from Sawbill Bay in Upper Marmion Reservoir for potable water supply to the accommodation camp and for freshwater supply to the processing plant.
- Discharges of treated sewage effluent from the accommodation camp and of treated wastewater effluent from the mine site into Sawbill Bay in the Upper Marmion Reservoir.
- Increased runoff rates and volumes from areas within the Project footprint from which runoff is not collected, due to changes in land cover.
- Mine dewatering due to the interception of runoff in the Mine footprint and the seepage of water from Upper Marmion Reservoir into the open pits.

Potential changes in the outflows from the Upper Marmion Reservoir were assessed using spreadsheet monthly lake water balance models of existing conditions and of conditions during the operations phase of the Project. Two modelling approaches were employed:

- Single-year lake water balances representing average, as well as wet and dry annual flow conditions with return periods of 10, 25, 50 and 100 years, corresponding to estimates of water taking and effluent discharges obtained from site wide water balance modelling completed for the mine site (Site Water Quality TSD).
- Continuous lake water balance modelling over a 27-year period using historic time series of hydrologic data (i.e. rain, snowmelt, lake evaporation and flow). Simulations were run using estimates of Project water taking and effluent discharges obtained from site wide water balance modelling under:
  - Average hydrological conditions.
  - Wet hydrological conditions (annual total precipitation with a 1% probability of being equalled or exceeded).
  - Dry hydrological conditions (annual total precipitation with a 99% probability of being equalled or exceeded).

Lake water balance models were developed for Lac des Mille Lacs and Upper Marmion Reservoir. Regulated outflows from Lac des Mille Lacs make up a portion of the inflows to Upper Marmion Reservoir with runoff from the tributary drainage area between Lac des Mille Lacs Dam and Raft Lake Dam making up the balance of the inflow. The water balance for Lac des Mille Lacs took the form:

$$\mathbf{Q_{OUT} = Q_{IN} + R + SN - E_o + \Delta S}$$

Where:

Q_{OUT} represents outflows from the lake, Q_{IN} describes inflows to the lake from its tributary drainage area; R and SN are rainfall and snowmelt inputs to the lake surface; E_o is the evaporative loss from the lake surface; and ΔS is the change in the storage volume in the lake.

The water balance model for Upper Marmion Reservoir took the form:

$$Q_{OUT} = Q_{IN} + R + SN + ED - E_o - WT - SE + \Delta S$$

Where:

Q_{OUT} represents outflows from the reservoir, Q_{IN} describes inflows to the reservoir consisting of regulated outflows from Lac des Mille Lacs, unregulated inflows from its tributary drainage area downstream of Lac des Mille Lac Dam, and inflows from Lower Marmion Reservoir during the open-water season; R and SN are rainfall and snowmelt inputs to the reservoir surface; ED is the treated wastewater effluent discharge from the mine site; E_o is the evaporative loss from the reservoir surface area; WT represents the water taking for freshwater supply to the processing plant; SE is the seepage into the open pits; and ΔS is the change in the storage volume in the reservoir. Effluent discharge from the mine site, water taking for freshwater supply to the processing plant and seepage into the open pits were assigned zero values in the base case model.

The following assumptions were made in the lake water balances:

- Groundwater inflows to the reservoirs and groundwater outflows from the reservoirs are negligible.
- Water taking for potable water supply to the accommodation camp equals the discharge of treated sewage effluent from the camp. Since these flows effectively negate each other, they were not considered in the lake water balances.
- Changes due to increased runoff rates and volumes from areas within the Project footprint from which runoff is not collected (e.g. the accommodation camp, emulsion plant and detonator storage area) are negligible. These areas represent much less than 0.01% of the tributary drainage area to Upper Marmion Reservoir.
- Minimum monthly mean outflows from Lac des Mille Lacs and Upper Marmion Reservoir were 1.5 m^3/s and 10 m^3/s respectively in lake water balances representing existing conditions, in accordance with the operating rules for the Lac des Mille Lacs Dam and Raft Lake Dam specified in the 2004 to 2014 Seine River Water Management Plan (Boileau 2004).
- Changes in reservoir storage volumes were based on assumed target operating water levels developed for Lac des Mille Lacs and Upper Marmion Reservoir (Figures 5-17 and 5-18), provided minimum monthly mean outflows could be achieved. The assumed target operating water levels were developed for the monthly lake water balance model, based on objectives for reservoir operation, and minimum and maximum daily mean water levels specified in the operating rules for the Lac des Mille Lacs Dam and Raft Lake Dam, in the 2004 to 2014 Seine River Water Management Plan (Boileau 2004).
- Upper and Lower Marmion Reservoirs operate as a single water body from May to October (the open-water season). The tributary drainage area to Upper Marmion Reservoir and the reservoir surface area were correspondingly increased during these months.

- Reservoir surface areas did not change with rising and falling water levels (i.e. the slopes of reservoir banks were neglected).

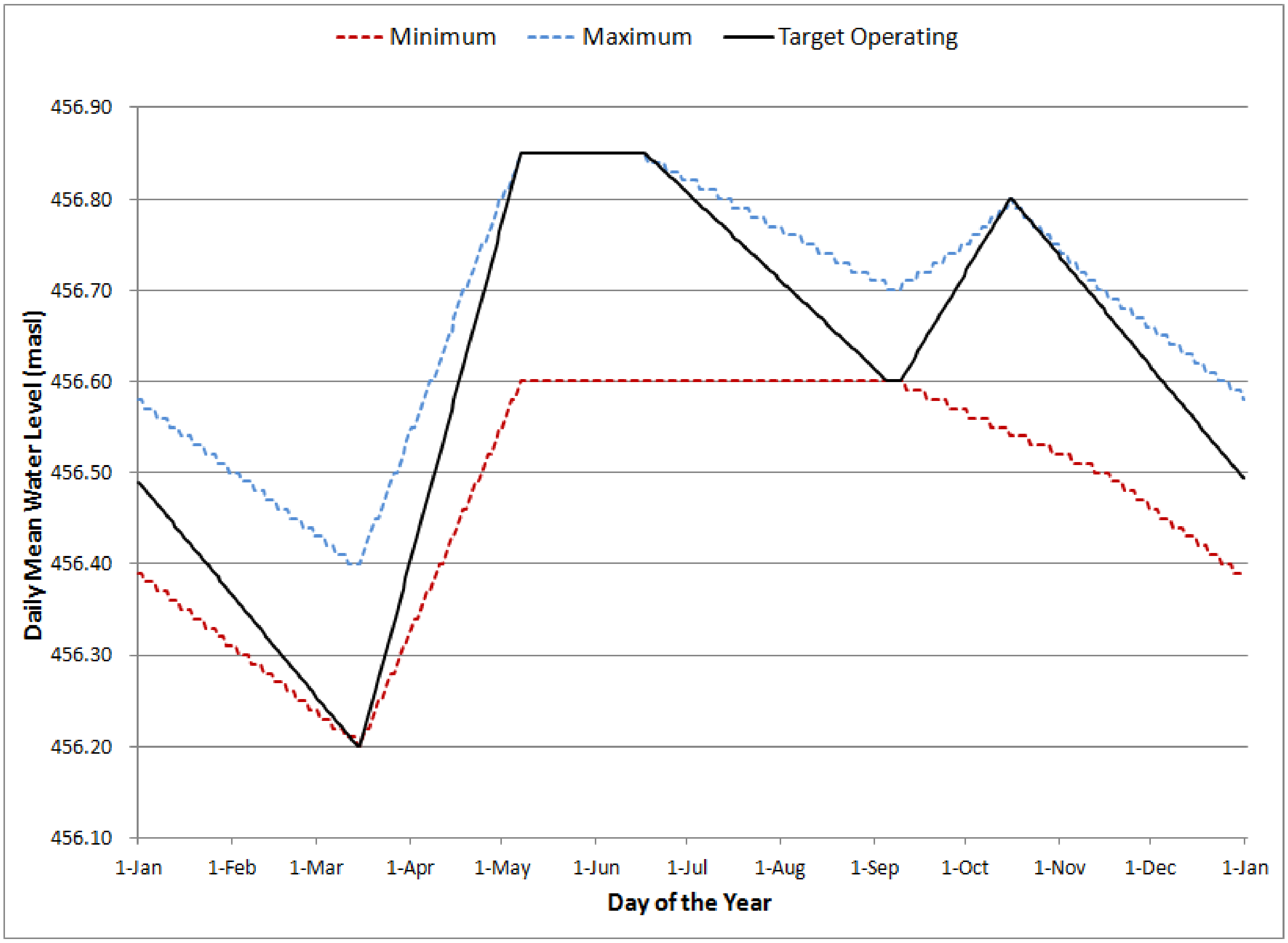


Figure 5-17: Assumed Target Operating Water Levels for Lac des Mille Lacs

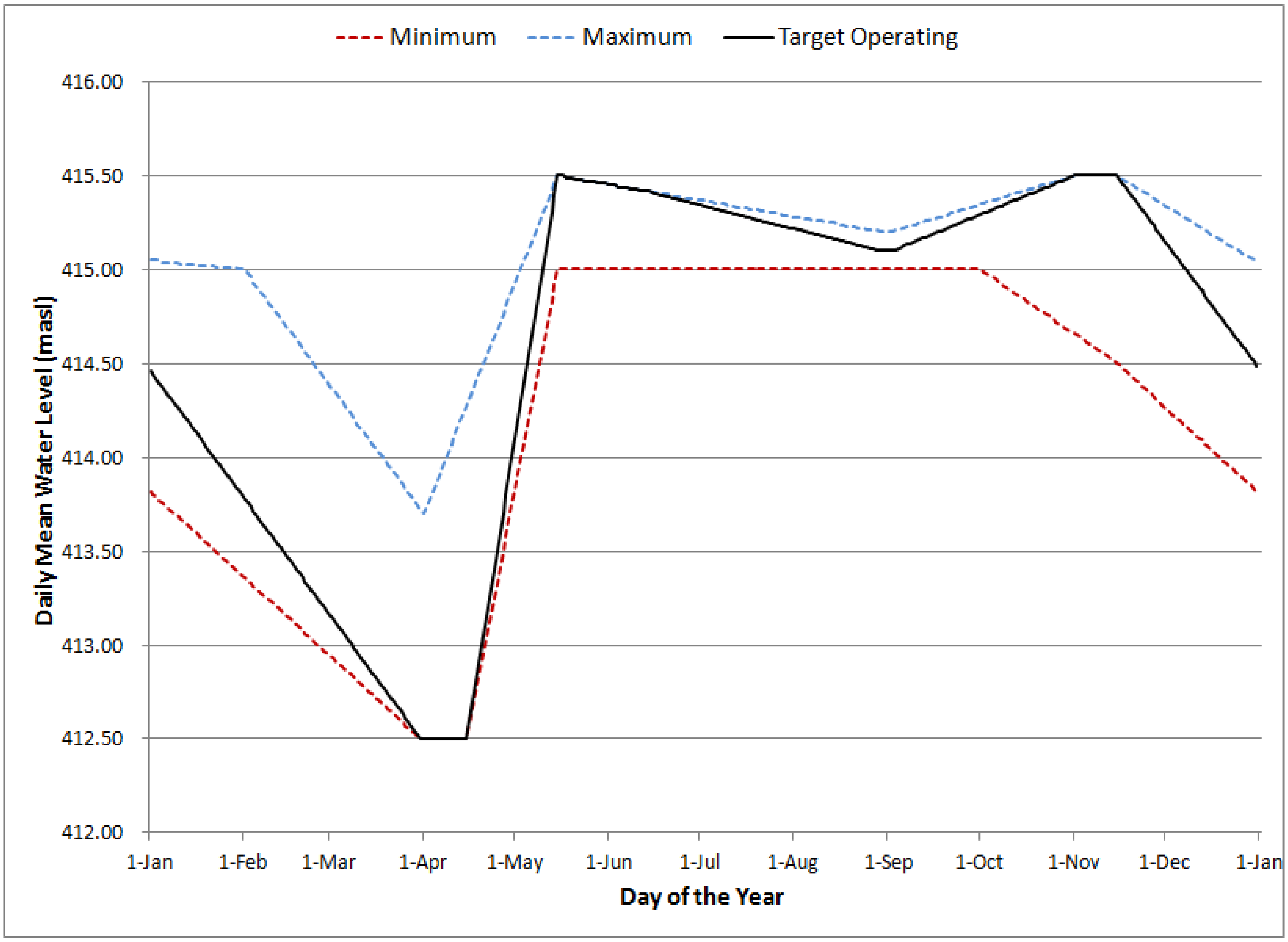


Figure 5-18: Assumed Target Operating Water Levels for the Upper Marmion Reservoir

Inputs to the single-year lake water balance models included:

- Monthly rain, snowmelt and lake evaporation for Upsala and Atikokan, which were input to the Lac des Mille Lacs and Upper Marmion Reservoir water balances respectively. Monthly data were developed by:
  - Completing frequency analysis of annual water losses for these stations (i.e. rain plus snowmelt minus lake evaporation) to:
    - Identify years representing average, wet and dry hydrologic conditions.
    - Evaluate the annual water loss in an average year, and wet and dry years with return periods of 10, 25, 50 and 100 years.
  - Distributing the annual water losses evaluated according to the average monthly distributions of annual water losses in years representing average, wet and dry hydrologic conditions.

- Monthly inflows to Lac des Mille Lacs, Upper Marmion Reservoir and Lower Marmion Reservoir under existing conditions and during the operations phase of the Project. Monthly inflows were developed by:
  - Using spatial interpolation and regionalization methods (Section 5.1.1.3.3) to develop synthetic daily inflows from January 1, 1984 to December 31, 2010 for:
    - The tributary drainage area to Lac des Mille Lacs, excluding the lake surface area.
    - The tributary drainage area to Upper Marmion Reservoir, excluding the reservoir surface area and the tributary drainage areas to Lac des Mille Lacs Dam and the Lower Marmion Sluiceway.
    - The tributary drainage area to Lower Marmion Reservoir, excluding the reservoir surface area.
  - Completing frequency analysis of annual inflows to:
    - Identify years representing average, wet and dry hydrologic conditions.
    - Evaluate the annual mean flow in an average year, and wet and dry years with return periods of 10, 25, 50 and 100 years.
  - Distributing the annual mean inflows evaluated according to the average monthly distributions of annual mean inflows in years representing average, wet and dry hydrologic conditions.
- Assumed target monthly mean operating water levels for Lac des Mille Lacs and Upper Marmion Reservoir (Figures 5-17 and 5-18).
- Monthly water taking for freshwater supply to the mine site and monthly discharges of treated wastewater from the mine site in an average year, and wet and dry years with return periods of 10, 25, 50 and 100 years, determined from site wide water balance modelling (Site Water Quality TSD).
- Steady state seepage from Upper Marmion Reservoir into the open pits determined from groundwater modelling (Hydrogeology TSD).

Inputs to the continuous lake water balance models included:

- Historic monthly climatic data (rain, snowmelt and lake evaporation) for Upsala and Atikokan from January 1984 to December 2010, which were input to the Lac des Mille Lacs and Upper Marmion Reservoir water balances respectively.
- Monthly mean inflows from January 1984 to December 2010 computed from synthetic daily data developed using spatial interpolation and regionalization methods for:
  - The tributary drainage area to Lac des Mille Lacs, excluding the reservoir surface area.
  - The tributary drainage area to Upper Marmion Reservoir, excluding its reservoir surface area and the tributary drainage areas to Lac des Mille Lacs Dam and Lower Marmion Sluiceway.
  - The tributary drainage area to Lower Marmion Reservoir, excluding its reservoir surface area.

Monthly mean inflows representing existing conditions and conditions during the operations phase of the Project were computed.

- Assumed target monthly mean operating water levels for Lac des Mille Lacs and Upper Marmion Reservoir (Figures 5-17 and 5-18).
- Monthly water taking for freshwater supply to the mine site and monthly discharges of treated wastewater effluent from the mine site in an average year, and wet and dry years with return periods of 100 years, determined from site wide water balance modelling (Site Water Quality TSD).
- Steady state seepage from Upper Marmion Reservoir into the open pits determined from groundwater modelling (Hydrogeology TSD).

5.2.2 Results

5.2.2.1 Site Scale Watercourses

Changes in the magnitude of flows in site scale watercourses under normal, dry and wet hydrologic conditions as a result of runoff diversion and runoff collection are expected to be roughly proportional to changes in their tributary drainage areas at any given location. A total of 29 site scale watersheds are located within the footprint of the base case Project. The expected changes in their tributary drainage areas, based on the Project components shown in Figure 1-2, are summarized in Table 5-33.

Table 5-33: Changes in Tributary Drainage Areas to Site Scale Watercourses

Watershed ID	Existing Watershed Area (ha)	Change due to Runoff Interception (ha)	New Watershed Area (ha)	Change as Percent of Existing Watershed Area (%)
AB	51.99	35.51	16.48	-68
AD	29.91	25.76	4.15	-86
AF	77.52	31.73	45.79	-41
AH	68.19	36.27	31.92	-53
AI	10.17	9.34	0.83	-92
AJ	12.64	0.00	12.64	0
AK	25.92	10.79	15.13	-42
AL	7.19	4.13	3.06	-57
AM	24.29	9.53	14.76	-39
AN	4.64	2.97	1.67	-64
AO	37.88	9.53	28.35	-25
AP	72.03	45.75	26.28	-64
AQ	6.86	2.96	3.90	-43
AR	12.87	9.45	3.42	-73
AS	71.97	43.12	28.84	-60
B	609.82	520.62	89.20	-85
C	134.96	0.00	134.96	0
E	122.80	0.00	122.80	0

Table 5-33: Changes in Tributary Drainage Areas to Site Scale Watercourses (Continued)

Watershed ID	Existing Watershed Area (ha)	Change due to Runoff Interception (ha)	New Watershed Area (ha)	Change as Percent of Existing Watershed Area (%)
F	78.00	1.25	76.75	-2
G	30.53	0.04	30.49	0
H	27.27	0.71	26.56	-3
I	85.24	85.24	0.00	-100
J	25.56	25.14	0.42	-98
K	89.03	88.27	0.75	-99
L	70.53	68.76	1.76	-98
N	158.55	0.00	158.55	0
P	124.90	2.72	122.18	-2
Q	272.96	259.90	13.06	-95
R	623.45	150.01	473.43	-24

Of the 29 watersheds in Table 5-33 above:

- Five are not affected by the Project footprint (0% change in tributary drainage area).
- Three are reduced in size by less than 10 % (runoff is intercepted by the Project water collection system).
- Six are reduced in size by less than 50% (greater than 10%).
- Nine are reduced in size by less than 90% (greater than 50%).
- Six are reduced in size by more than 90% (one by 100%).

The following can be expected as a result of changes in the tributary drainage areas of watercourses under average, wet and dry hydrologic conditions:

- Changes in the magnitudes of flows in watercourses, which are roughly proportional to the changes in drainage area.
- The percent changes listed in Table 5-33 apply strictly to the lower reach of the stream draining the watershed (the percent change in flow may be slightly greater in the reach immediately downstream of the point of runoff interception, and no change to flow is expected upstream of the point of runoff interception.
- Shorter durations of flows of a given magnitude where there is a reduction in tributary drainage area.
- Lower frequencies of occurrence (return periods) of flows of a given magnitude where there is a reduction in tributary drainage area.
- Where streams are intermittent/ephemeral, there may be longer periods when these are dry (the change may be expected to be roughly proportional to the reduction in tributary drainage area).

Changes to the general timing of seasonal flows are not anticipated.

The sum of the changes in the tributary drainage areas of these site scale watersheds is -1,480 ha, which represents 0.33% of the total tributary drainage area to Upper Marmion Reservoir at Raft Lake Dam.

5.2.2.2 Local Scale Watercourses

A reduction in the magnitude of flows in Lumby Creek during normal, wet and dry hydrologic conditions as a result of runoff collection from areas within the Project footprint is expected. This change will affect inflows to Lizard Lake and the lower reach of Lumby Creek between Lizard Lake and Turtle Bay. The change in the magnitude of flows in Lumby Creek will be roughly proportional to the reduction in its tributary drainage area (Table 5-34).

Table 5-34: Change in the Tributary Drainage Area to Lumby Creek

Watercourse Name	Existing Watershed Area (ha)	Change due to Runoff Diversion (ha)	Change due to Runoff Interception (ha)	New Watershed Area (ha)	Total Change as Percent of Existing Watershed Area (%)
Lumby Creek	6,272	+9.67	-439	5,842	-6.9%

Similar to the site scale watercourses, shorter durations and lower frequencies of occurrence of flows of a given magnitude may be expected; however, changes in the general timing of seasonal flows are not anticipated.

Table 5-35 shows potential changes in monthly mean flows in Lumby Creek obtained using hydrologic modelling. Changes range from -7.7% to 0.0%, with the greatest changes generally occurring in the spring and the smallest changes occurring in the winter.

Table 5-35: Changes to Monthly Mean Flows in Lumby Creek

Month	Maximum Change in Flow (%)	Minimum Change in Flow (%)
January	-3.3	-0.6
February	-2.2	0.0
March	-6.8	0.0
April	-7.7	-4.4
May	-7.6	-6.2
June	-7.5	-5.8
July	-7.4	-3.8
August	-7.1	-2.8
September	-6.7	-2.1
October	-6.8	-2.3
November	-6.1	-2.3
December	-5.5	-1.1
Overall	-7.7	0.0

5.2.2.3 *Regional Scale Watercourses*

Changes in the inflows to Upper Marmion Reservoir due to Project activities during the operations phase may result in changes to the outflows from the reservoir and flows in the Seine River downstream of Raft Lake Dam. Inflows to the reservoir are expected to be influenced by:

- The interception of runoff from areas within the Project footprint by the water collection system. The expected change (net reduction) in tributary drainage area to Upper Marmion Reservoir as a result of runoff interception by the water collection system is -1,480 ha, or -0.33% of its tributary drainage area excluding the reservoir surface area.
- Water taking from Sawbill Bay in Upper Marmion Reservoir for potable water supply to the accommodation camp and for freshwater supply to the processing plant. Potable water supply to the accommodation camp is estimated to be 0.004 m^3/s (3.5 L/s) based on a resident population of 1,200 and a per capita domestic water demand of 250 L/d. Estimates of freshwater supply to the processing plant under average, wet and dry hydrologic conditions were obtained from site wide water balance modelling completed for the mine site (Site Water Quality TSD), and are shown in Table 5-36 below.
- Discharges of treated sewage effluent from the accommodation camp and of treated wastewater effluent from the mine site to Sawbill Bay. Discharges of treated sewage effluent from the accommodation camp are expected to be roughly equal to the estimates of water taking for potable water supply to the camp above. Estimates of discharges of treated wastewater effluent from the mine site under average, wet and dry hydrologic conditions were obtained from site wide water balance modelling completed for the mine site (Site Water Quality TSD), and are shown in Table 5-37 below.
- Increased runoff rates and volumes from areas within the Project footprint from which runoff is not collected (e.g., the accommodation camp, emulsion plant, detonation storage area), due to changes in land cover. These facilities occupy less than 0.01% of the tributary drainage area to Upper Marmion Reservoir, and changes in land cover will have a negligible influence on reservoir inflows.
- Mine dewatering due to the seepage of water from Upper Marmion Reservoir into the open pits as a result of establishing a hydraulic gradient between the reservoir and the open pits. Groundwater seepage into the open pits at the end of the operations phase under steady state conditions is estimated to be 740 m^3/d and about 70% of this inflow (523 m^3/d) is expected to be sourced from the Upper Marmion Reservoir (Hydrogeology TSD).

Table 5-36: Freshwater Supply to the Processing Plant

Month	Freshwater Supply (m^3/hr)								
	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
January	301.5	301.5	301.5	301.5	301.5	490.9	858.0	861.6	864.8
February	301.5	301.5	301.5	301.5	301.5	898.0	898.0	898.0	898.0
March	301.5	301.5	301.5	301.5	301.5	808.2	819.1	826.2	832.4
April	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5
May	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	349.9

Table 5-36: Freshwater Supply to the Processing Plant (Continued)

Month	Freshwater Supply (m^3/hr)								
	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
June	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5
July	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5
August	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5
September	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5
October	301.5	301.5	301.5	301.5	301.5	301.5	301.5	301.5	397.3
November	301.5	301.5	301.5	301.5	301.5	301.5	301.5	477.6	684.3
December	301.5	301.5	301.5	301.5	301.5	301.5	558.1	791.4	800.2
Year	**301.5**	**301.5**	**301.5**	**301.5**	**301.5**	**406.4**	**460.2**	**495.4**	**526.2**

Table 5-37: Discharges of Treated Wastewater Effluent

Month	Discharges of Treated Wastewater Effluent (m^3/hr)								
	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
January	46.9	202.0	259.2	255.4	228.5	0.0	0.0	0.0	0.0
February	46.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
March	46.9	139.9	32.9	3.2	0.4	0.0	0.0	0.0	0.0
April	46.9	236.7	328.6	394.9	442.9	0.0	0.0	0.0	0.0
May	46.9	235.6	326.4	391.8	439.3	0.0	0.0	0.0	0.0
June	46.9	236.7	328.6	394.9	442.9	0.0	0.0	0.0	0.0
July	46.9	235.6	326.4	391.8	439.3	0.0	0.0	0.0	0.0
August	46.9	235.6	322.6	389.8	452.8	0.0	0.0	0.0	0.0
September	46.9	230.5	339.6	386.4	467.2	0.0	0.0	0.0	0.0
October	46.9	250.9	309.6	349.1	384.1	0.0	0.0	0.0	0.0
November	46.9	202.0	259.2	297.7	331.8	0.0	0.0	0.0	0.0
December	46.9	202.0	259.2	297.7	331.8	0.0	0.0	0.0	0.0
Year	**46.9**	**202.0**	**259.2**	**297.7**	**331.8**	**0.0**	**0.0**	**0.0**	**0.0**

The potential combined influences of runoff interception, water taking, effluent discharge and mine dewatering on inflows to Upper Marmion Reservoir (net reduction) are summarized in Tables 5-38 and 5-39. The consequent changes in outflows from the reservoir were evaluated using the single-year and continuous lake water balance models described previously (Section 5.2.1.4).

Table 5-38: Combined Project Influences on Annual Mean Inflows to Upper Marmion Reservoir (Net Reduction)

Project Activity	Changes to Annual Mean Inflows (m^3/s)		
	Average Year	100 Year Dry	100 Year Wet
Runoff interception	0.115	0.035	0.218
Potable water supply to the camp	0.004	0.004	0.004
Process water supply to the mine site	0.084	0.147	0.084
Treated sewage effluent discharge from the camp	-0.004	-0.004	-0.004
Treated wastewater effluent from the mine site	-0.013	0.000	-0.092
Mine dewatering	0.006	0.006	0.006
Total net reduction	**0.192**	**0.188**	**0.216**

Table 5-39: Combined Project Influences on Monthly Mean Inflows to Upper Marmion Reservoir (Net Reduction)

Month	Net Reduction in Upper Marmion Inflows (m^3/s)								
	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
January	0.137	0.114	0.108	0.109	0.126	0.192	0.284	0.275	0.276
February	0.127	0.150	0.160	0.160	0.170	0.295	0.285	0.285	0.275
March	0.127	0.111	0.151	0.149	0.170	0.261	0.264	0.266	0.257
April	0.177	0.194	0.189	0.180	0.177	0.180	0.160	0.150	0.130
May	0.307	0.514	0.549	0.571	0.588	0.230	0.210	0.180	0.183
June	0.307	0.364	0.369	0.380	0.397	0.200	0.170	0.160	0.140
July	0.257	0.244	0.239	0.251	0.248	0.180	0.160	0.140	0.130
August	0.187	0.174	0.180	0.172	0.174	0.140	0.140	0.120	0.120
September	0.187	0.156	0.135	0.132	0.120	0.130	0.120	0.110	0.110
October	0.177	0.150	0.144	0.143	0.143	0.160	0.150	0.130	0.156
November	0.167	0.154	0.158	0.157	0.158	0.140	0.140	0.169	0.226
December	0.147	0.134	0.138	0.127	0.128	0.130	0.201	0.256	0.248
Annual	0.192	0.205	0.210	0.211	0.216	0.186	0.190	0.187	0.188

Table 5-38 shows a potential total net reduction of 0.192 m^3/s in the annual inflow to Upper Marmion Reservoir in an average year. Table 5-38 also shows that runoff interception will result in the greatest potential reduction in the average and wet years, whereas process water supply will result in the greatest potential reduction in dry years. Table 5-39 shows that the potential net reduction in monthly inflows to Upper Marmion Reservoir ranges from 0.110 m³/s (January in the wet year with a 25-year return period) to 0.590 m³/s (May in the wet year with a 100-year return period).

The higher magnitude of net reductions in wet years compared to an average year and dry years is due to the reduction in tributary drainage area to the reservoir. Relationships between various flow statistics and tributary drainage area were derived from regional flow analysis (Section 5.1.2.2.2). Higher coefficients of proportionality were obtained in wet periods than in dry periods, indicating that reductions in tributary drainage area have a greater influence on high flows. However, it should be noted that net reductions in inflows to the reservoir during the operations phase in high flow periods represent a smaller percentage of existing inflows.

Single Year Lake Water Balance Modelling

Existing outflows from Upper Marmion Reservoir under average, wet and dry hydrologic conditions were estimated by satisfying minimum outflows from Lac des Mille Lacs (1.5 m³/s) and Upper Marmion Reservoir (10 m³/s), and meeting assumed target operating water levels (Figures 5-17 and 5-18) where possible. As noted above, assumed target operating water levels were developed based on a review of the objectives of reservoir operation at Lac des Mille Lacs and Upper Marmion Reservoir and the operating rules for Lac des Mille Lacs Dam and Raft Lake Dam. For the base case (representing existing conditions), minimum outflows from Upper Marmion Reservoir occurred in one month in the average year, and four, seven, eight and nine months in dry years with return periods of 10, 25, 50 and 100 years, respectively. This is considered to be realistic, given the large number of recorded occurrences of minimum and below minimum outflows during the period from 2004 to 2011 (Table 5-15, Section 5.1.2.2.1).

Potential changes to outflows from Upper Marmion Reservoir during the operations phase of the Project were predicted for the case where reservoir water levels under existing conditions remained unchanged in order to directly assess the Project influences on outflows. Under this scenario, outflows were allowed to fall below the minimum requirement due to the net reduction in inflows to the reservoir as a result of the combined influences of the Project. Table 5-40 shows the potential changes in outflows from the reservoir as a result of Project activities in the operations phase.

Table 5-40: Predicted Changes in Upper Marmion Reservoir Outflows (Single-Year Lake Water Balances)

Month	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
	Percentage Change in Outflows								
January	-0.34	-0.26	-0.22	-0.21	-0.22	-0.49	-0.80	-0.86	-1.40
February	-0.29	-0.33	-0.34	-0.32	-0.33	-0.77	-0.81	-0.86	-0.88
March	-0.40	-0.30	-0.38	-0.36	-0.40	-0.82	-0.92	-1.03	-1.06
April	-0.93	-0.66	-0.53	-0.49	-0.43	-1.16	-1.35	-1.50	-1.30
May	-3.10	-1.54	-1.02	-0.84	-0.72	-2.30	-2.10	-1.80	-1.80
June	-0.63	-0.38	-0.35	-0.33	-0.32	-2.00	-1.70	-1.60	-1.40
July	-0.43	-0.31	-0.28	-0.27	-0.26	-1.80	-1.60	-1.40	-1.30
August	-0.38	-0.30	-0.28	-0.24	-0.23	-0.77	-1.40	-1.20	-1.20
September	-0.55	-0.36	-0.28	-0.24	-0.21	-0.87	-1.20	-1.10	-1.10

Table 5-40: Predicted Changes in Upper Marmion Reservoir Outflows (Single-Year Lake Water Balances) (Continued)

Month	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	25	50	100	10	25	50	100
	Percentage Change in Outflows								
October	-1.23	-0.65	-0.49	-0.44	-0.42	-1.60	-1.50	-1.30	-1.60
November	-0.50	-0.33	-0.32	-0.30	-0.27	-0.77	-1.40	-1.70	-2.30
December	-0.31	-0.26	-0.23	-0.22	-0.21	-0.35	-0.70	-1.90	-2.50

The results of the single year lake water balance modelling indicate that potential changes in outflows range from -3.10% (May) to -0.21% (January, September and December), occurring in the average year and wet years with return periods of 50 and 100 years, respectively. Outflow reductions did not exceed 1.25% during any month in the average year, except in May. Outflows fell below the minimum requirement in one month in the average year, and in four, seven, eight and nine months in dry years, respectively, with return periods of 10, 25, 50 and 100 years, which corresponded to the same months when minimum outflows occurred under existing conditions. There was no increase in the frequency of occurrence of minimum outflows as a result of the Project.

Continuous Lake Water Balance Modelling

As with the single year lake water balance modelling, existing outflows from Upper Marmion Reservoir were estimated with the continuous model by satisfying minimum outflows from Lac des Mille Lacs (1.5 m^3/s) and Upper Marmion Reservoir (10 m^3/s) as the primary objective. Minimum outflows occurred in 90 out of 324 months (28% of the time) over the 27 year period that was modelled. This is considered to be realistic, given the large number of recorded occurrences of minimum and below minimum outflows during the period from 2004 to 2011 (Table 5-15, Section 5.1.2.2.1).

Outflows during the operations phase of the Project were predicted using monthly net water takings (water taking less effluent discharge) from the reservoir for an average year, and wet and dry years with return periods of 100-years determined from site wide water balance modelling (Site Water Quality TSD). Similar to the single year lake water balance modelling, the existing reservoir water levels remained unchanged in order to directly assess the Project influences on outflows.

Table 5-41 shows the potential changes in outflows from Upper Marmion Reservoir as a result of combined Project influences during the operations phase if reservoir water levels remain unchanged from existing conditions.

Table 5-41: Predicted Changes in Upper Marmion Reservoir Outflows (Continuous Lake Water Balances)

Month	Water Taking Scenario					
	Average Year		100 Year Wet		100 Year Dry	
	Maximum Percent Change	Minimum Percent Change	Maximum Percent Change	Minimum Percent Change	Maximum Percent Change	Minimum Percent Change
January	-1.30	-0.32	-0.70	-0.15	-2.90	-0.66
February	-0.74	-0.26	-0.88	-0.32	-1.96	-0.69
March	-0.44	-0.27	-0.51	-0.31	-1.07	-0.62
April	-1.40	-0.68	-0.49	0.00	-1.50	-0.71
May	-4.70	-1.06	-3.60	-0.30	-4.90	-1.11
June	-3.00	-0.41	-1.90	-0.20	-3.20	-0.42
July	-2.60	-0.36	-1.50	0.00	-2.70	-0.37
August	-2.40	-0.34	-1.30	0.20	-2.60	-0.35
September	-1.80	-0.36	-0.60	0.30	-1.90	-0.37
October	-2.40	-0.50	-1.50	0.00	-2.80	-0.55
November	-1.40	-0.39	-0.70	-0.10	-2.60	-0.53
December	-4.70	-0.33	-0.60	-0.09	-2.90	-0.57
Overall	-4.70	-0.26	-3.60	0.30	-4.90	-0.35

The results of the continuous lake water balance modelling indicate that maximum potential changes in outflows range from -4.90% (May) to 0.30% (September) occurring in the water takings scenarios for the dry year and the wet year with return periods of 100 years, respectively. Outflows fell below the minimum requirement in 80 out of 324 months (25% of the time) and 90 out of 324 months (28% of the time) in simulations using the net water taking in a wet and a dry year, respectively, with return periods of 100 years. There was no increase in the frequency of occurrence of minimum outflows as a result of the Project.

5.2.3 Summary of Predicted Changes

The greatest changes in flows as a result of Project activities during the operations phase are expected to occur in site scale watercourses as a result of changes to their tributary drainage areas. Of the 29 watersheds evaluated, five are unaffected, three will be reduced in size by less than 10%, six will be reduced in size by less than 50%, nine will be reduced in size by less than 90%, and six will be reduced in size by more than 90% (one by 100%). Changes to tributary drainage areas will occur due to the interception of runoff from areas within the Project footprint by the water collection system. Changes in flows are expected to be roughly proportional to changes in tributary drainage area.

The expected changes in flows in local scale watercourses are as follows:

- A reduction in flows in Lumby Creek of approximately 7% to 8% as a result of the interception of runoff from the Project footprint by the water collection system.

Changes in inflows to Upper Marmion Reservoir due to the Project activities during the operations phase may result in changes to the outflows from the reservoir and flows in the Seine River downstream of the Raft Lake Dam. Inflows to the reservoir are expected to be influenced by runoff interception, water taking, effluent discharge and mine dewatering. The total net reduction in annual mean inflows to the reservoir is estimated to be 0.192 m^3/s in an average year. This represents less than 1% of the average annual outflow at Raft Lake Dam under the 2004 to 2014 Seine River Water Management Plan, which was estimated as 32.4 m^3/s. Changes in monthly mean outflows from Upper Marmion Reservoir are expected to be:

- In the range -3.10% (average year) to -0.21% (wet years with return periods of 50 and 100 years) based on single-year lake water balance modelling. The magnitude of the changes (outflow reduction) did not exceed 1.25% during any month in an average year, except in May. The frequency of occurrence of minimum outflows was not increased by the Project.
- In the range -4.90% (100 year dry water taking scenario) and 0.30% (100 year wet water taking scenario) based on continuous lake water balance modelling. The frequency of occurrence of minimum outflows was not increased by the Project.

It should be noted that the predicted changes in Upper Marmion Reservoir outflows above are well within the generally accepted accuracy limits (i.e., ± 10%) of flow measurements in natural rivers and streams. Thus, in reality, the effects of the Project on outflows from the reservoir could not be measured in the field. Similarly, no measurable changes in flows are predicted to occur in the Seine River downstream of the reservoir.

6.0 LAKE WATER LEVELS

6.1 Existing Conditions

6.1.1 Methods

6.1.1.1 Parameters

Water Level Regime

The existing water level regime was characterized in terms of the monthly and seasonal fluctuations in water levels and the year-to-year variability in water levels. Monthly and seasonal fluctuations in water levels are described in terms of:

- The long-term average monthly and seasonal mean water levels.

The year-to-year variability in water levels is described by:

- The long-term range in annual mean water levels (the difference between the maximum and minimum annual mean water levels).
- Annual mean water levels with different average recurrence intervals (return periods).

Annual ranges in daily mean water levels have also been included as a descriptor of the existing water level regime.

Normal Water Levels

The following statistics are used as descriptors of the range of normal water levels in water bodies:

- The 25th exceedance percentile (WL_{25}) or daily mean water level equaled or exceeded 25% of the time. The WL_{25} represents the upper bound of normal water level conditions.
- The 75th exceedance percentile (WL_{75}) or daily mean water level equaled or exceeded 75% of the time. The WL_{75} represents the lower bound of normal water level conditions.

High Water Levels

The following statistics are used as descriptors of the flood properties of water bodies:

- The 20th exceedance percentile (WL_{20}), or water level equaled or exceeded 20 percent of the time, for the month in which the highest annual water level occurs. The WL_{20} is the high water mark considered by Fisheries and Oceans Canada (Ontario Great Lakes Area) in the review of development projects in or near water as the minimum elevation that will be considered as a boundary for fish habitat (Fisheries and Oceans Canada 2005).
- The instantaneous peak water level with a return period of 100 years (WL100). The WL100 is often used as the design flood for the protection of property and infrastructure sited in and around water bodies.

Low Water Levels

The following statistic is used to describe the drought properties of water bodies:

- The 90th exceedance percentile (WL_{90}) or daily mean water level equalled or exceeded 90% of the time. This water level is commonly used as a threshold below which drier than normal conditions exist.

6.1.1.2 Field Studies

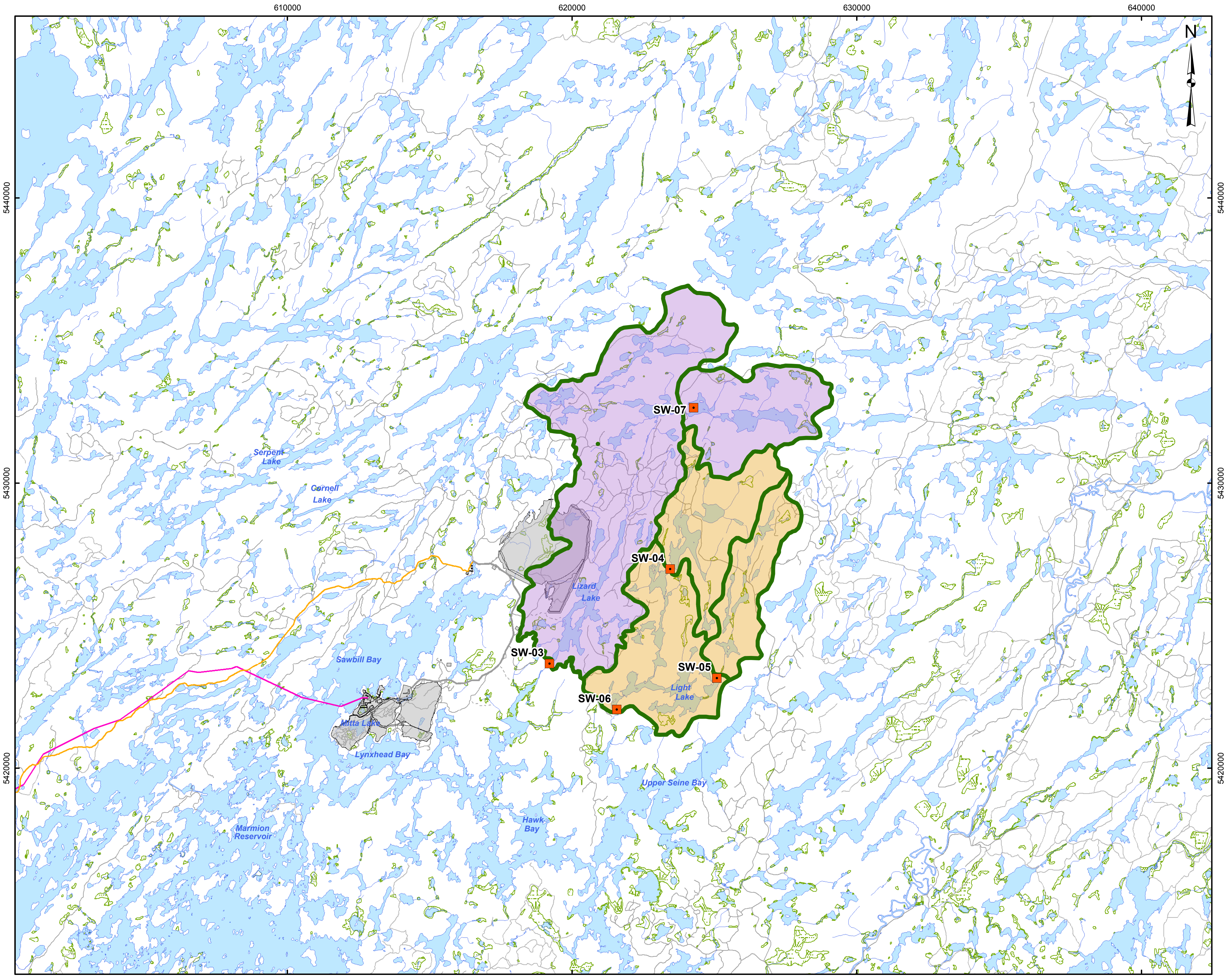
Field studies consisted of the installation and operation of five lake water level monitoring stations in local scale watersheds (Figure 6-1) for a period of two years from August 2010 to August 2012. The monitoring program was designed in the late spring/early summer of 2010 when definition of the Project was at an early stage. At that time, five alternative locations for the Tailings Management Facility were under consideration, which necessitated that the program be designed to cover a wide area. Since then, a preferred location and two alternative locations for the Tailings Management Facility have been selected.

All of the monitoring stations were continuous recording stations and automatically collected water level data at intervals of 15 minutes. Manual water level readings were collected at these stations during periodic site visits, and were used to correct the recorded data for logger drift. Table 6-1 provides summary information on the water level monitoring stations.

Table 6-1: Local Scale Water Level Monitoring Stations

Local Watershed	Station ID #	Station Name	Latitude/ Longitude	Distance from Project (km)[a]	Drainage Area (km^2)	Station Type	Final Data Product
Lynxhead-Trap-Turtle Bays	SW-07	Herontrack Lake near outlet	49.0342° N 91.2999° W	15	14.41	Recording	Daily mean water level
Lynxhead-Trap-Turtle Bays	SW-03	Lizard Lake near outlet	48.9545° N 91.3716° W	7	62.83	Recording	Daily mean water level
Light Bay	SW-04	Premier Lake near outlet	48.9835° N 91.3128° W	12	14.10	Recording	Daily mean water level
Light Bay	SW-05	Upper Light Lake near inlet	48.9487° N 91.2916° W	13	9.82	Recording	Daily mean water level
Light Bay	SW-06	Light Lake near outlet	48.9392° N 91.3397° W	9	41.36	Recording	Daily mean water level

Notes:
[a] Taken as the distance to the proposed location of the processing plant.



LEGEND

Surface Water Drainage Areas

- Contributing to SW-03
- Contributing to SW-06
- Road
- Trail
- River/Stream
- Lake
- Wetland
- Watershed Boundary
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

NOTES:

1. Lake Water Level Stations and Associated Drainage Areas:

Station ID	Station Name	Drainage Area (ha)
SW-03	LUMBY CREEK AT TURTLE BAY	4,841.91
SW-04	PREMIER LAKE-VISTA LAKE	1,409.88
SW-05	ST. PATRICK CREEK AT LIGHT LAKE	981.55
SW-06	LIGHT CREEK AT LIGHT LAKE	1,744.54
SW-07	LUMBY CREEK AT HERONTRACK LAKE	1,440.58

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000
SCALE 1:135,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

LOCAL SCALE LAKE WATER LEVEL MONITORING STATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 6-1	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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A total of 10 site visits were completed over the 2-year period that the stations were operating. During the site visits, manual water level readings were collected at all the monitoring stations, and water level data were downloaded from the continuous recording stations. Site visits were timed to observe as wide a range of water level conditions as possible. The first site visit was in August 2010 (summer low flows) to install the monitoring stations. Additional site visits were completed in:

- October 2010 (fall medium flows).
- January and March 2011 (winter low flows).
- April and May 2011 (spring high flows).
- August 2011 (summer low flows).
- February 2012 (winter low flows).
- May 2012 (spring high flows).
- August 2012 (summer low flows).

Water level monitoring is described in detail in Appendix 5.I which provides details of station locations, equipment installations, field and data processing methods, quality assurance-quality control activities, program limitations, as well as field observations and the final data product.

6.1.1.3 Secondary Data Review

6.1.1.3.1 Secondary Data

The water level monitoring completed for the Project was carried out on water bodies (lakes) draining local scale watersheds. At the regional scale, daily mean water levels in Upper Marmion Reservoir at Raft Lake Dam and in Lower Marmion Reservoir at Lower Marmion Sluiceway (Figure 3-1) on the Seine River are monitored by H2O Power LP and Valerie Falls Limited Partnership (Brookfield Renewable Energy Group) respectively, as part of compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. Charted data for both stations are published on the Seine River Watershed Information website, and charted data for Upper Marmion Reservoir at Raft Lake Dam are published on the Canadian Lake of the Woods Control Board's website. Discrete data records were sourced from Brookfield Renewable Energy Group and the Ontario Ministry of Natural Resources Atikokan in 2011, and the United States Army Corps of Engineers in 2012.

The water level monitoring completed for the Project provides short-term water level records representing only two years in hydrological time. Further, the water level records sourced for Upper and Lower Marmion Reservoir represent regulated water levels. In order to develop reliable statistics describing the natural (unregulated) water level regime and normal, flood and drought properties of water bodies, it was necessary to consider long-term water level records collected at three regional scale Water Survey of Canada (Environment Canada) hydrometric stations within 100 km of the Project (Figure 6-2). These data were used to place the short-term water level records in context, and to develop regional relationships that could be applied to the water bodies to determine summary water level statistics. Daily mean water levels for the three stations were downloaded from Water Survey of Canada's online database. The regional scale stations on the Upper and Lower Marmion Reservoirs, and the three regional scale stations operated by Water Survey of Canada are described in Table 6-2 and shown in Figure 6-2.

Table 6-2: Regional Scale Hydrometric Stations

Regional Watershed	Station ID	Station Name	Latitude/ Longitude	Distance from Project (km)[a]	Drainage Area (km²)	Record Type	Data Record
Rainy Lake	—[b]	Upper Marmion Reservoir at Raft Lake Dam	48.9176° N 91.5451° W[c]	7	4,426	Regulated	1-Jan-1982 to 31-Mar-2012[d]
Rainy Lake	—[b]	Lower Marmion Reservoir at Lower Marmion Sluiceway	48.9102° N 91.5413° W[c]	7	156	Regulated	1-Jan-2005 to 31-Aug-2010
Rainy Lake	05PB015	Little Turtle Lake near Mine Centre	48.7722°N 92.6083° W	88	4,870	Natural	1-Nov-1914 to 28-Feb-1967
Namakan Lake	05PA010	French Lake near Atikokan	48.6722° N 91.1350° W	37	494	Natural	1-May-1960 to 30-Jun-1998
Namakan Lake	05PA011	Lac La Croix at Campbell's Camp	48.3550°N 92.2172°W	86	13,400	Natural	1-Aug-1921 to 31-Dec-2008

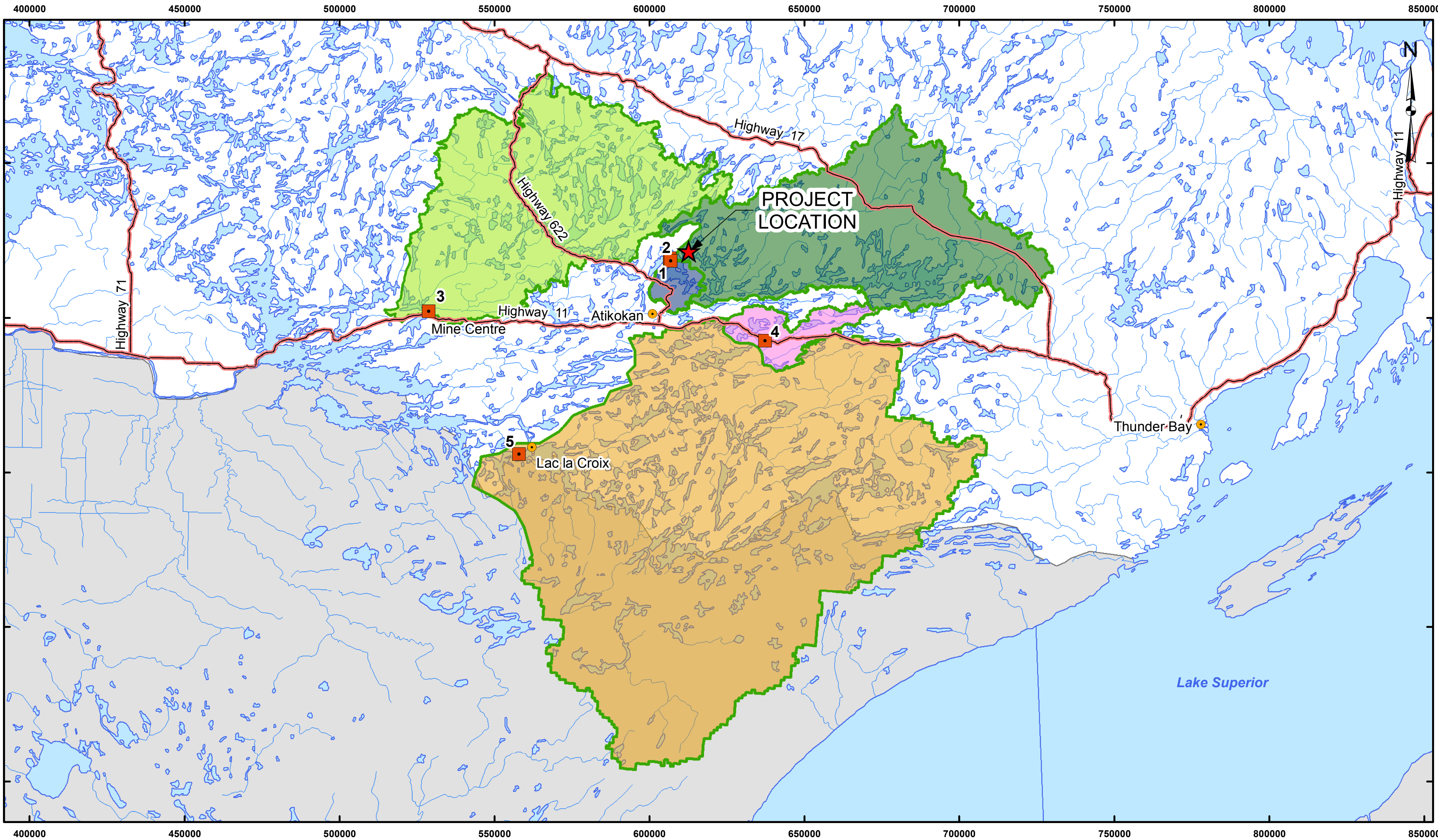
Notes:

(a) Taken as the distance to the proposed location of the processing plant.

(b) Not applicable.

(c) Estimated from Google Earth.

(d) Data prior to 2004 may not be representative of reservoir operation under the Plan.



LEGEND

- Project Location
- City/Town
- Lake Water Level Monitoring Station
- Provincial Highway
- River/Stream
- Lake
- Watershed Boundary

Water Level Stations

Station ID	Station Name	Latitude ° N	Longitude ° W	Watershed Area km^2
1	Upper Marmion Reservoir at Raft Lake Dam	48.9176	91.5451	4426
2	Lower Marmion Reservoir at Lower Marmion Sluiceway	48.9102	91.5413	156
3	Little Turtle Lake near Mine Centre	48.7722	92.6083	4870
4	French Lake near Atikokan	48.6722	91.135	494
5	Lac La Croix at Campbell's Camp	48.355	92.2172	13400

25 12.5 0 25 50 75

SCALE 1:1,800,000 Kilometres

REFERENCE

Base Data - Global Dataset, LAND INFO Worldwide Mapping, LLC, CANVEC

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

PROJECT

HAMMOND REEF GOLD PROJECT

ATIKOKAN, ONTARIO, CANADA

TITLE

REGIONAL SCALE LAKE WATER LEVEL MONITORING STATIONS

Golder Associates

Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	16 Mar. 2012	FIGURE: 6-2	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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6.1.1.3.2 Quality Assurance

The following quality assurance procedures were applied to the secondary data:

- Review of the percentage of missing and estimated data in the record for each station.
- Checks on the homogeneity of data using double mass analysis to compare annual mean water levels at each station to annual mean water levels at surrounding stations.
- Checks on the stationarity of the data collected at each station using scatter plots of annual mean water levels against time.

There are significant periods of missing data in the water level records for the Upper and Lower Marmion Reservoirs. As much as 42% of the record for the Upper Marmion Reservoir from January 1, 1982 to present is missing; water level observations prior to May 1998 appear to have been periodic. For the period that the 2004 to 2014 Seine River Water Management Plan has been in effect less than 0.5% of the record for the Upper Marmion Reservoir and 21% of the record for the Lower Marmion Reservoir are missing. Of the record for the Lower Marmion Reservoir, 35% was estimated based on the assumption that the reservoirs operate as a single water body during the open-water season (May to October).

Records for the Water Survey of Canada stations on Lac La Croix and Little Turtle Lake are the most complete; 4% or less of the records are missing. There is a high percentage (27%) of missing records for French Lake which is due in part to the seasonal operation of the station until 1982. At all three stations, 3% or less of the available water level record was estimated. Double mass analysis indicated consistency in annual mean water levels between Little Turtle Lake and Lac La Croix, and French Lake and Lac La Croix. Time series plots of annual mean water levels for the three stations indicated the data were stationary; trends and shifts in the data were not evident.

6.1.1.3.3 Data Analysis

Statistical analysis of the water level data for the regional scale monitoring stations was completed in order to:

- Characterize the water level regime and normal, flood and drought properties of the Upper and Lower Marmion Reservoirs, as operated prior to and under the 2004 to 2014 Seine River Water Management Plan.
- Place the short-term water level records for the local scale flow monitoring stations in context, and to identify regional patterns/relationships from which parameters describing the natural water level regime and normal, flood and drought properties of the water bodies of interest could be estimated.

Data analysis included development of the following:

- Long-term average monthly and seasonal mean water levels expressed as fluctuations about the long-term average annual mean water level, to describe the monthly and seasonal fluctuations in water levels.
- The long-term range in annual mean water levels expressed as fluctuations about the long-term average annual mean water level, to describe the year-to-year variability in water levels.

- Frequency curves relating the annual mean water levels for wet and dry years with different return periods to the annual mean water level with a return period of 2 years (an average year with an exceedance probability of 50%), to characterize the year-to-year variability in water levels.
- Monthly water level duration curves to describe the normal, flood and drought properties of the water bodies.
- A frequency curve relating the annual maximum daily mean water level during wet years with different return periods to the annual maximum daily mean water level with a return period of 2 years, to describe the flood properties of the water bodies.

6.1.2 Results

6.1.2.1 Field Studies Results

6.1.2.1.1 Local Scale Water Level Monitoring

Annual Mean Water Levels

Table 6-3 shows the annual mean water levels at the five continuous recording local scale monitoring stations for the period September 2010 to August 2012.

Table 6-3: Annual Mean Water Levels at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Annual Mean Water Level (masl)		
		September 2010 to August 2011	September 2011 to August 2012	Average
SW-07	Herontrack Lake at outlet	447.601	447.583	447.592
SW-03	Lizard Lake at outlet	426.605	426.696	426.650
SW-04	Premier Lake at outlet	432.951	432.966	432.959
SW-05	Upper Light Lake below St. Patrick Creek	431.699	431.735	431.717
SW-06	Light Lake at outlet	430.264	430.296	430.280

Annual mean water levels were higher in 2011 to 2012 at all the monitoring stations, with the exception of SW-07. This outcome is consistent with the results of frequency analysis of annual total precipitation (September to August) at Atikokan; 2011 to 2012 was a wet year regionally with a return period of 4.5 years (exceedance probability of 22%) whereas 2010 to 2011 was a near average year with a return period of 1.9 years (exceedance probability of 47%). Water levels at SW-07 were affected by beaver activity at the Lake outlet in the late summer and fall of 2010 which has likely resulted in the higher annual mean water level for 2010 to 2011.

Seasonal Mean Water Levels

Figure 6-3 shows average seasonal mean water levels expressed as fluctuations about the average annual mean water level at the local scale monitoring stations for the period September 2010 to August 2012.

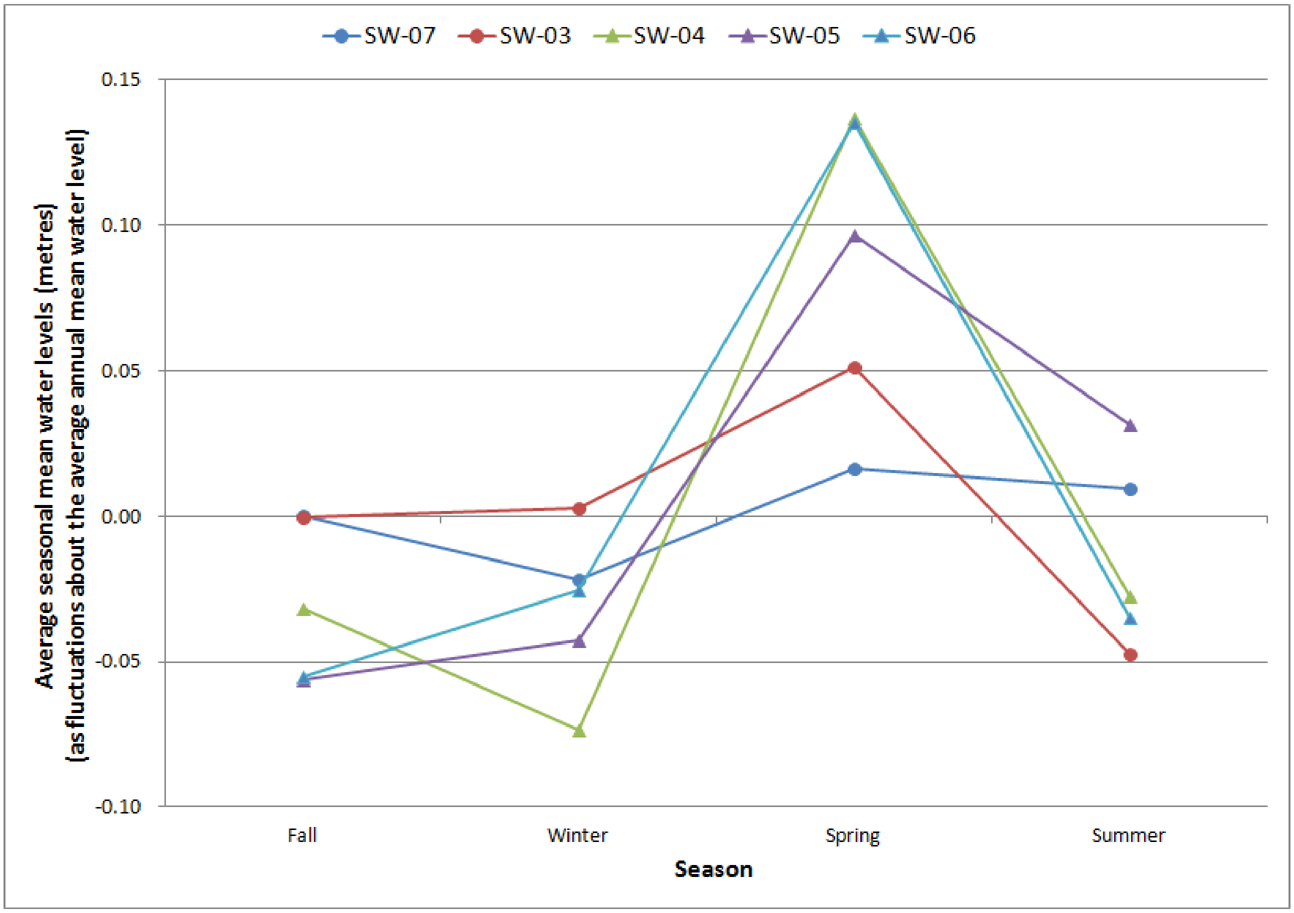

Figure 6-3: Average Seasonal Mean Water Levels at Local Scale Monitoring Stations

At all the monitoring stations, the highest average seasonal mean water levels occurred during the spring in response to the freshet and spring rains. The timing of the lowest average seasonal mean water levels varied between stations; the lowest water levels occurred in the fall at SW-05 and SW-06, in the winter at SW-04 and SW-07 and in the summer at SW-03. Water levels at the monitoring stations were affected by beaver activity, ice jams and debris buildup at the lake outlets, which may account for the inconsistency in the timing of the lowest seasonal mean water levels.

Figure 6-3 shows lower fluctuations in average seasonal mean water levels at SW-07 and SW-03 in the Lynxhead-Trap-Turtle Bays watershed than those at SW-04, SW-05 and SW-06 in the Light Bay watershed. This is likely due to physiographic differences between the watersheds.

Monthly Mean Water Levels

Figure 6-4 shows average monthly mean water levels expressed as fluctuations about the average annual mean water level at the local scale monitoring stations for the period September 2010 to August 2012.

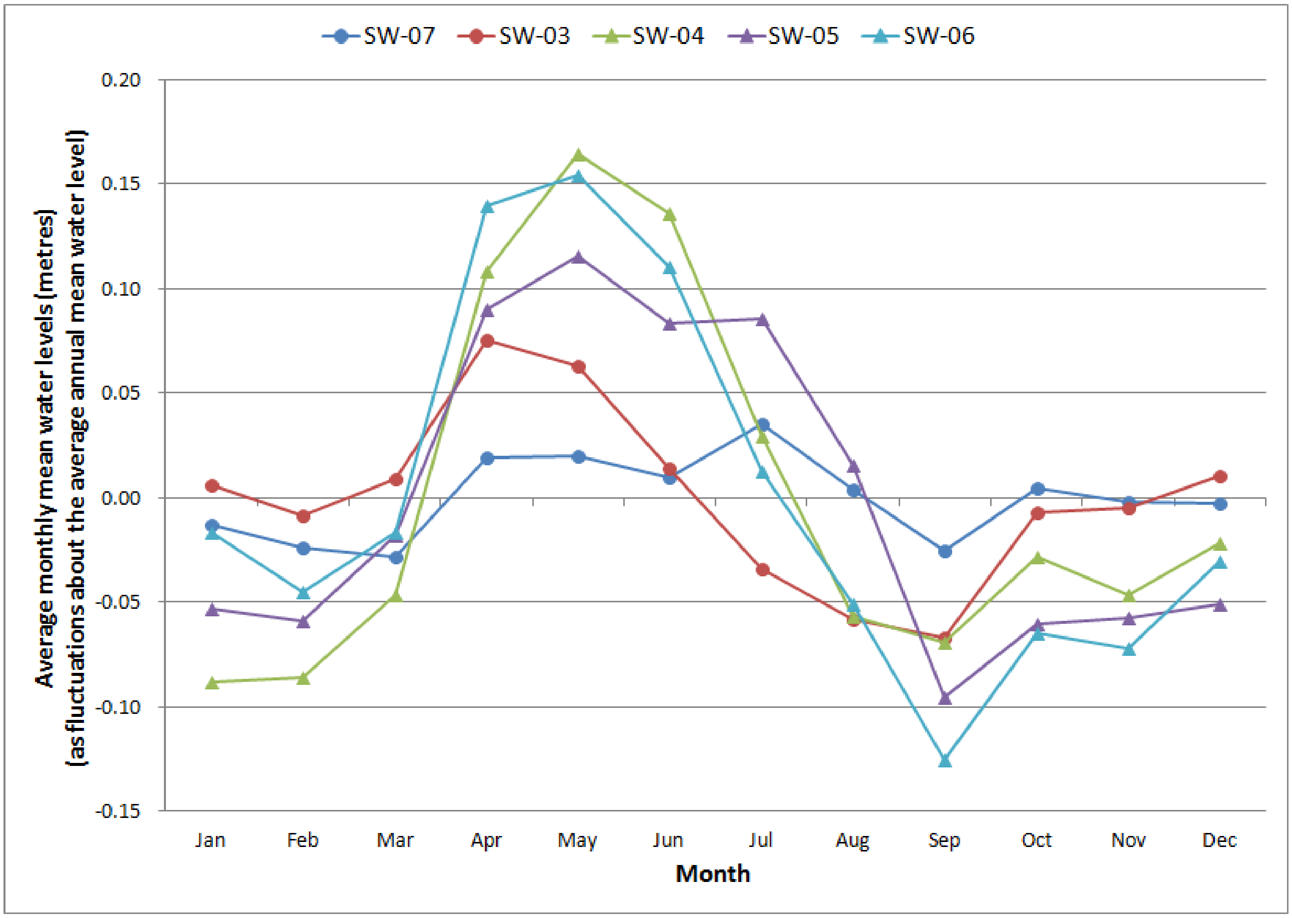

Figure 6-4: Average Monthly Mean Water Levels at Local Scale Monitoring Stations

The highest average monthly mean water levels occurred in April at SW-07 and SW-03 in the Lynxhead-Trap-Turtle Bays watershed, and in May at SW-04, SW-05 and SW-06 in the Light Bay watershed. The lowest average monthly mean water levels occurred in September at SW-03, SW-05 and SW-06, in March at SW-07 and in January at SW-04. Again, inconsistencies in the timing of the lowest water levels may be a result of beaver activity, ice jams and debris buildup at the lake outlets during the monitoring period.

Figure 6-4 shows lower fluctuations in average monthly mean water levels at SW-07 and SW-03 in the Lynxhead-Trap-Turtle Bays watershed than those at SW-04, SW-05 and SW-06 in the Light Bay watershed likely due to physiographic differences between the two watersheds.

Annual Maximum and Minimum Daily Mean Water Levels

Table 6-4 shows the annual maximum daily mean water levels at the local scale monitoring stations for the period September 2010 to August 2012.

Table 6-4: Annual Maximum Daily Mean Water Levels at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Annual Max. Daily Mean Water Levels in masl (in m above average annual mean water level)			
		2010 to 2011		2011 to 2012	
		Value	Day	Value	Day
SW-07	Herontrack Lake at outlet	447.691 (0.099)	May 2	447.813 (0.221)	May 30
SW-03	Lizard Lake at outlet	426.816 (0.166)	May 2	426.902 (0.252)	May 31
SW-04	Premier Lake at outlet	433.209 (0.250)	May 2	433.228 (0.269)	May 30
SW-05	Upper Light Lake below St. Patrick Creek	431.861 (0.144)	May 1	431.984 (0.267)	May 29
SW-06	Light Lake at outlet	430.530 (0.250)	May 2	430.609 (0.329)	May 31

Annual maximum daily mean water levels occurred in May during both years in response to the spring freshet (snowmelt) and spring rains. Values were higher in 2011 to 2012 corresponding to higher annual total precipitation in that year; 2011 to 2012 was a wet year receiving annual total precipitation with a return period of 4.5 years.

Table 6-5 shows the annual minimum daily mean water levels at the local scale monitoring stations for the period September 2010 to August 2012.

Table 6-5: Annual Minimum Daily Mean Water Levels at Local Scale Monitoring Stations, 2010 to 2012

Station ID	Station Name	Annual Min. Daily Mean Water Levels in masl (in m below average annual mean water level)			
		2010 to 2011		2011 to 2012	
		Value	Day	Value	Day
SW-07	Herontrack Lake at outlet	447.496 (0.096)	June 18	447.495 (0.097)	Mar 11
SW-03	Lizard Lake at outlet	426.495 (0.155)	Sep 1	426.569 (0.081)	Jul 28
SW-04	Premier Lake at outlet	432.821 (0.138)	Jan 27	432.814 (0.145)	Oct 7
SW-05	Upper Light Lake below St. Patrick Creek	431.553 (0.164)	Sep 1	431.563 (0.154)	Oct 7
SW-06	Light Lake at outlet	430.126 (0.154)	Aug 30	430.075 (0.205)	Oct 7

The timing of annual minimum daily mean water levels varied, except in 2011 to 2012 in the Light Bay watershed (where the annual minima occurred on October 7 at all three stations).

6.1.2.2 Secondary Data Review Results

Annual Mean Water Levels

Table 6-6 shows the long-term average and range of annual (September to August) mean water levels observed at the regional scale hydrometric stations.

Table 6-6: Average and Range of Annual Mean Water Levels at Regional Scale Hydrometric Stations

Station ID	Station Name	Period	Record Type	Average Annual Mean Water Level (m)	Range[a] in Annual Mean Water Levels (m)
—[c]	Upper Marmion Reservoir at Raft Lake Dam	1982-2003	Regulated	414.56	0.60
—[c]	Upper Marmion Reservoir at Raft Lake Dam	2004-2012	Regulated	414.73	0.81
—[c]	Lower Marmion Reservoir at Lower Marmion Sluiceway	2004-2012	Regulated	415.12	0.23
05PB015	Little Turtle Lake near Mine Centre	1914-1967	Natural	345.233	0.985
05PA010	French Lake near Atikokan	1960-1998	Natural	31.219[b]	1.547
05PA011	Lac La Croix at Campbell's Camp	1921-2008	Natural	360.919	1.148

Notes:

[a] The difference between the maximum and minimum annual mean water levels over the period of record.

[b] Relative to an arbitrary datum.

[c] Not applicable.

The ranges in annual mean water levels in the Upper and Lower Marmion Reservoirs are less than those in the unregulated lakes. Lower Marmion Reservoir exhibits the lowest year-to-year variability with a range of 0.23 m over the period of record. The range in water levels for the Upper Marmion Reservoir is higher for reservoir operation under the 2004 to 2014 Seine River Water Management Plan than prior to the Plan.

Of the unregulated lakes, Little Turtle Lake and Lac La Croix exhibit similar ranges in annual mean water levels. The range in water levels in French Lake is higher, indicating greater year-to-year variability.

Frequency analyses of annual mean water levels at the regional scale stations were completed. The Normal Probability Distribution best fit the data with coefficients of determination of ranging between 0.868 and 0.997. Figures 6-5 and 6-6 show the frequency curves for wet and dry years respectively, i.e. plots of annual mean water levels with different return periods, expressed as fluctuations about the annual mean water level with a 2-year return period (an average year).

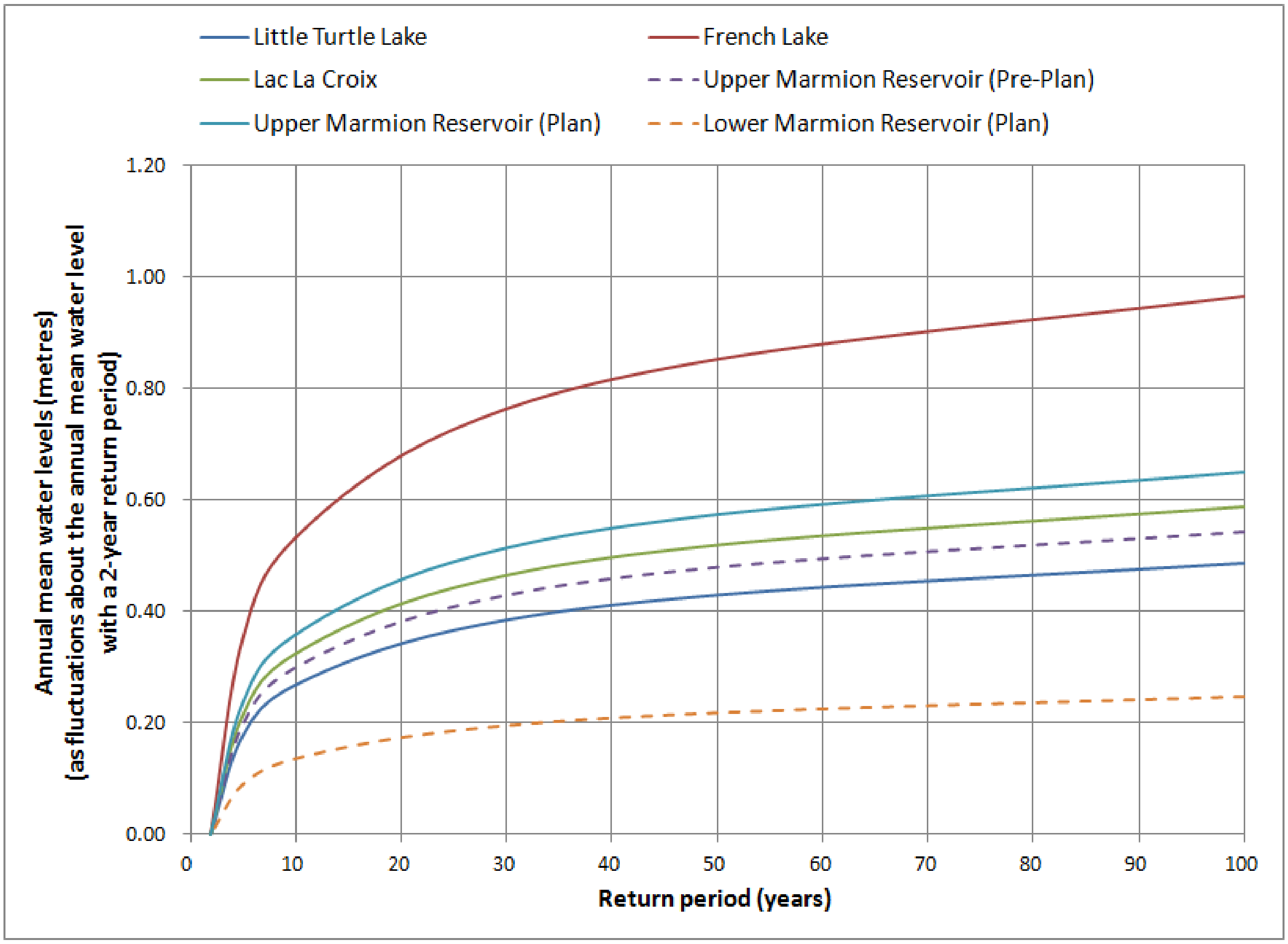

Figure 6-5: Frequency Curve for Wet Years at Regional Scale Monitoring Stations

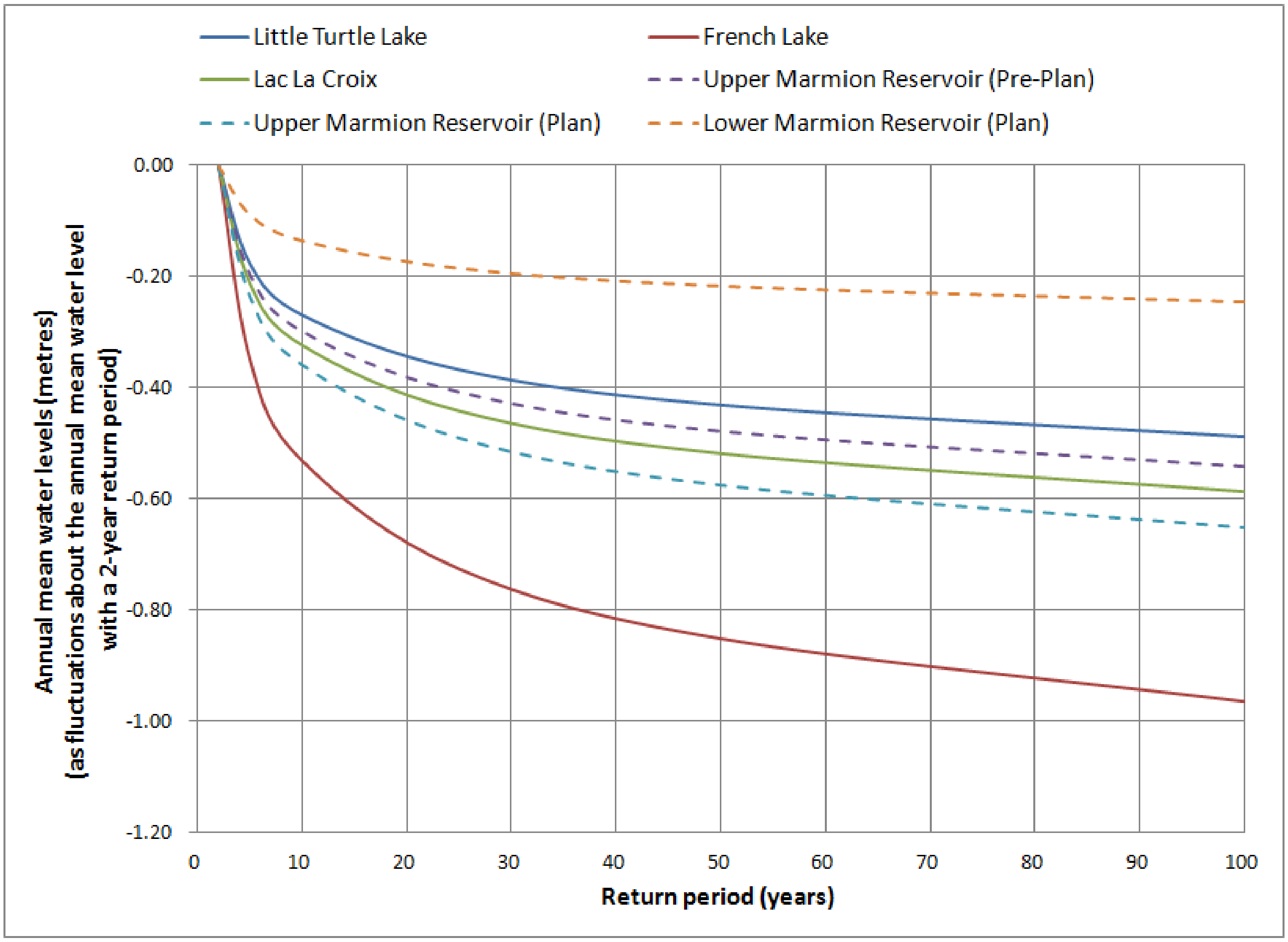

Figure 6-6: Frequency Curve for Dry Years at Regional Scale Monitoring Stations

Figures 6-5 and 6-6 show similar year-to-year variability in annual mean water levels in Little Turtle Lake, Lac La Croix and in Upper Marmion Reservoir under previous and present reservoir operations. French Lake exhibits greater year-to-year variability and Lower Marmion Reservoir lower year-to-year variability when compared to the other stations.

Seasonal Mean Water Levels

Figure 6-7 shows long-term average seasonal mean water levels expressed as fluctuations about the long-term average annual (September to August) mean water levels at the regional scale hydrometric stations.

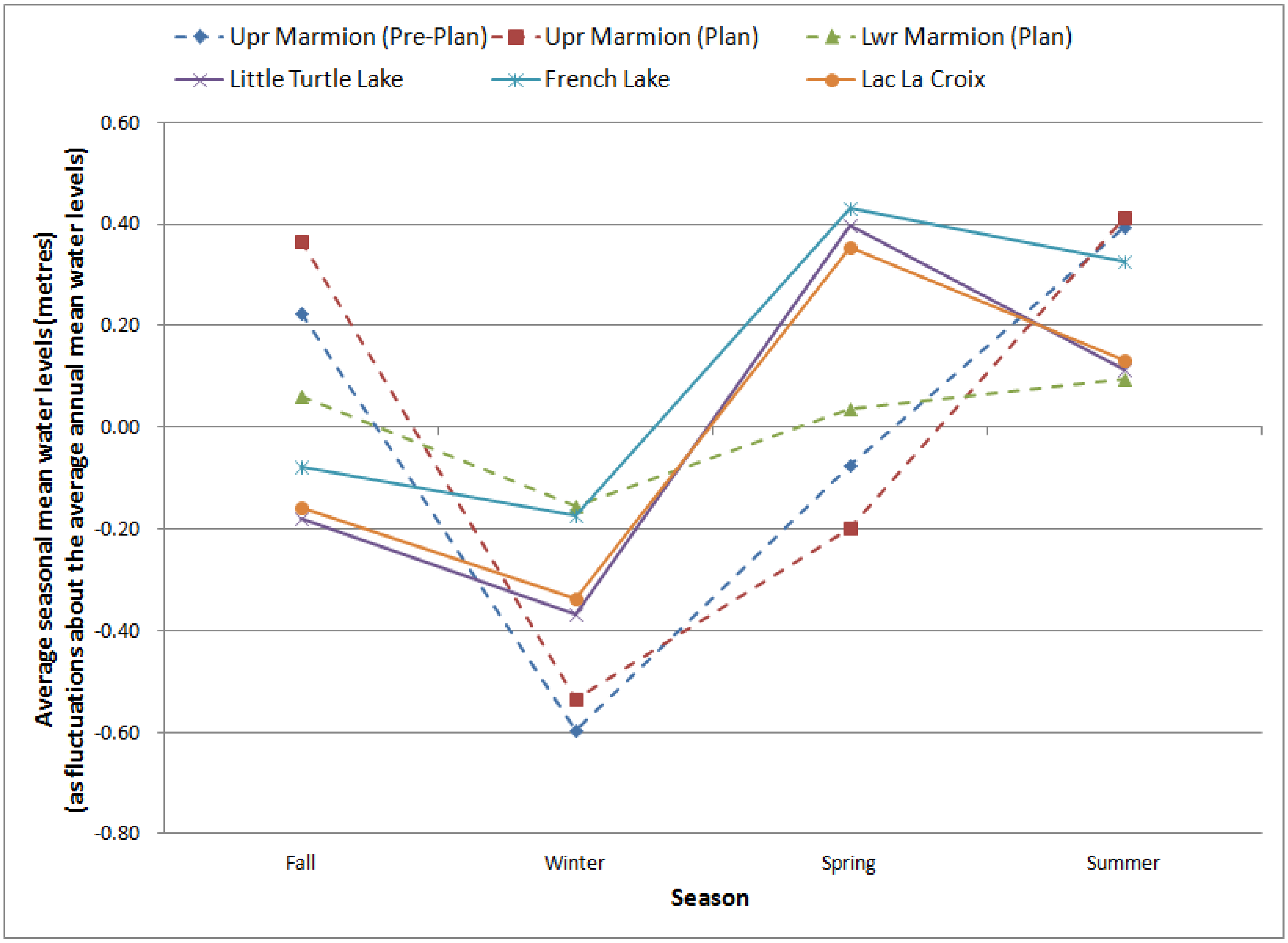

Figure 6-7: Long-term Average Seasonal Mean Water Levels at Regional Scale Monitoring Stations

Seasonal water level fluctuations at the three Water Survey of Canada stations with natural water level regimes exhibit a similar pattern with the highest water level occurring in the spring and the lowest in winter. Water level fluctuations in Little Turtle Lake and Lac La Croix are nearly identical; French Lake exhibits lower fluctuations in the fall and winter (indicating sustained water storage) and higher fluctuations in the summer (indicating a greater response to precipitation) than at the other two stations.

Water level fluctuations in the Upper and Lower Marmion Reservoirs with regulated water level regimes show the highest water level in the summer and the lowest in winter. The seasonal pattern reflects the management of water levels in the reservoirs: water is drawn down in the winter months to generate power and to provide storage capacity for the spring melt. Water level fluctuations in the Lower Marmion Reservoir are markedly lower than those in the Upper Marmion Reservoir: water levels in the former are maintained to provide suction head to cooling water pumps for the coal-fired Atikokan Generating Station. Water level fluctuations in the Upper Marmion Reservoir under the 2004 to 2014 Seine River Water Management Plan are similar to those prior to reservoir operation under the Plan.

Monthly Mean Water Levels

Figure 6-8 shows long-term average monthly mean water levels expressed as fluctuations about the long-term average annual (September to August) mean water levels at the regional scale hydrometric stations.

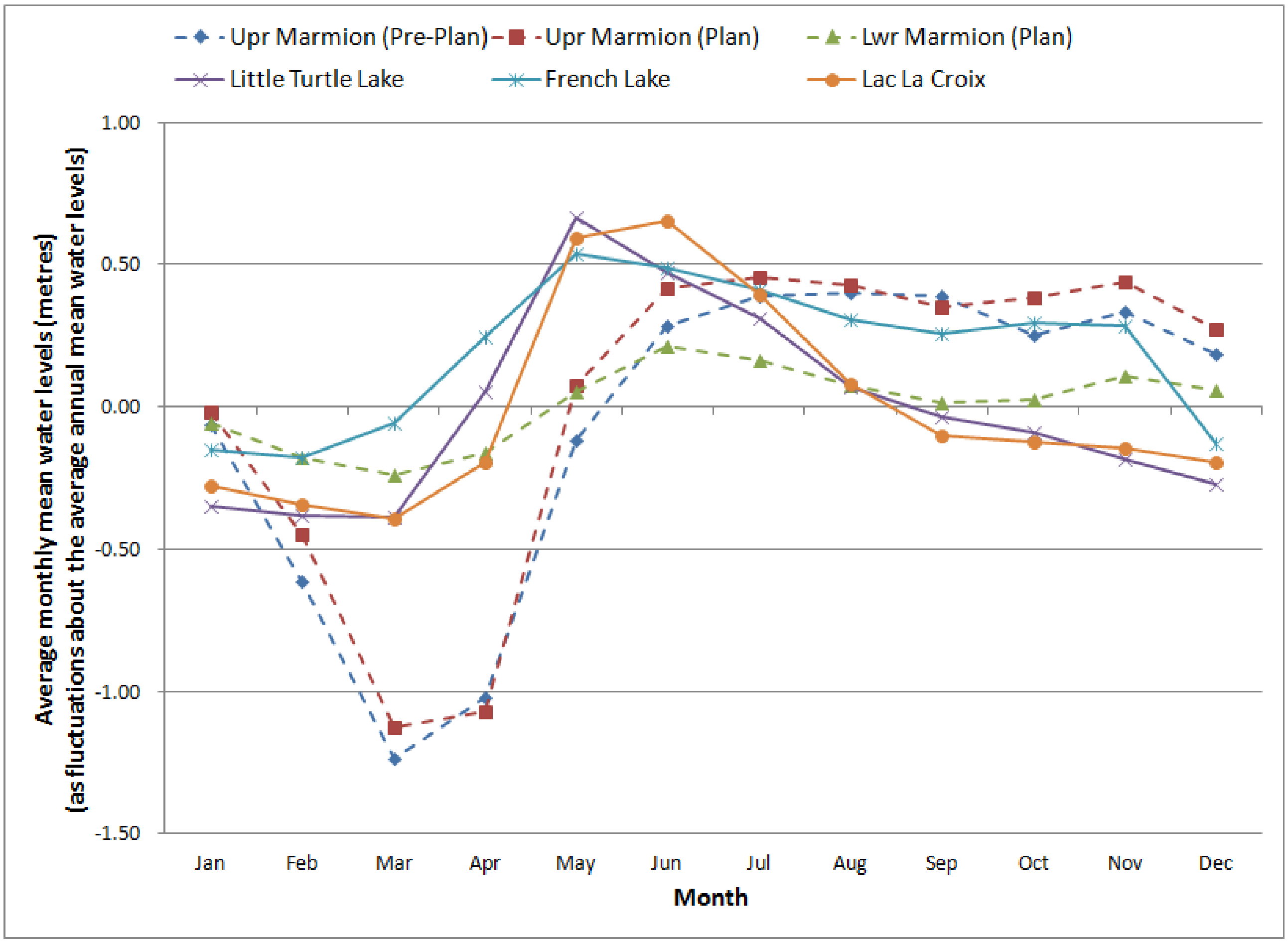

Figure 6-8: Long-term Average Monthly Mean Water Levels at Regional Scale Monitoring Stations

Monthly water level fluctuations at the three Water Survey of Canada stations with natural water level regimes exhibit a similar pattern with the highest water level occurring in May/June and the lowest in February/March. Water level fluctuations in Little Turtle Lake and Lac La Croix are nearly identical; French Lake exhibits lower fluctuations in January to April (indicating sustained water storage), and higher fluctuations in August to November (indicating a greater response to precipitation) than at the other two stations.

Under the 2004 to 2014 Seine River Water Management Plan, the highest water levels occur in July in the Upper Marmion Reservoir and in June in the Lower Marmion Reservoir. Under pre-Plan reservoir operation, the highest water levels in the Upper Marmion Reservoir occurred in August. The lowest water levels occur in March in both reservoirs under the present and past reservoir operation.

The monthly patterns reflect the management of water levels in the reservoirs: water is drawn down between November and March to generate power and to provide storage capacity for the spring melt. Water levels are rising from April to June/July in response to the spring runoff and to enhance walleye spawning opportunities and success. Water level fluctuations in the Lower Marmion Reservoir are lower than those in the Upper Marmion Reservoir: water levels in the former are maintained to provide suction head to cooling water pumps for the Atikokan Generating Station. In general, water level fluctuations in the Upper Marmion Reservoir under the 2004 to 2014 Seine River Water Management Plan are similar to those prior to reservoir operation under the Plan.

Annual Ranges in Daily Mean Lake Water Levels

Table 6-7 shows the average, maximum and minimum annual ranges in daily mean lake water levels at the regional scale stations, over their respective periods of record. There has been a reduction in the annual range in daily mean lake water levels in Upper Marmion Reservoir under the 2004 to 2014 Seine River Water Management Plan. Annual ranges varied from 2.00 to 2.72 m between 2004 and 2012. Prior to 2004, annual ranges in the reservoir varied from 1.94 to 3.87 m. Annual ranges in daily mean lake water levels in Lower Marmion Reservoir under present reservoir operations are much lower than in Upper Marmion Reservoir: values varied from 0.26 to 0.77 m between 2004 and 2012.

Table 6-7: Annual Ranges in Daily Mean Lake Water Levels

Station ID	Station Name	Period	Record Type	Annual Range (m)		
				Average	Maximum	Minimum
—[a]	Upper Marmion Reservoir at Raft Lake Dam	1982-2003	Regulated	2.66	3.87	1.94
—[a]	Upper Marmion Reservoir at Raft Lake Dam	2004-2012	Regulated	2.27	2.72	2.00
—[a]	Lower Marmion Reservoir at Lower Marmion Sluiceway	2004-2012	Regulated	0.55	0.77	0.26
05PB015	Little Turtle Lake near Mine Centre	1914-1967	Natural	1.600	3.283	0.701
05PA010	French Lake near Atikokan	1960-1998	Natural	0.761	1.702	0.220
05PA011	Lac La Croix at Campbell's Camp	1921-2008	Natural	1.555	3.018	0.289

Notes:
[a] Not applicable.

Of the unregulated lakes, Little Turtle Lake and Lac La Croix show similar average and maximum annual ranges in daily mean lake water levels, which are comparable to ranges observed in Upper Marmion Reservoir. The minimum annual range for Lac La Croix was similar to that for French Lake, and values were comparable to ranges observed in Lower Marmion Reservoir.

Normal Water Levels

Monthly water level duration curves were developed from daily mean water levels observed at the regional scale stations. Generally, the curves were flat reflecting the regulatory influence of lake storage; however, the curves for French Lake and Upper Marmion Reservoir under present reservoir operation were steeper above the 80th exceedance percentiles relative to the other stations during the winter months, indicating a more rapid draw down of water levels under low flow conditions. The curves for Upper Marmion Reservoir prior to the 2004 to 2014 Seine River Water Management Plan were steeper than under present reservoir operation.

Monthly 75th and 25th exceedance percentiles for the regional scale stations, representing the upper and lower bounds of normal water level conditions were derived from the water level duration curves. Percentiles for the Upper and Lower Marmion Reservoirs are shown in Figure 6-9, whereas values for the unregulated lakes are shown in Figure 6-10, expressed as fluctuations about the long-term average monthly mean water levels.

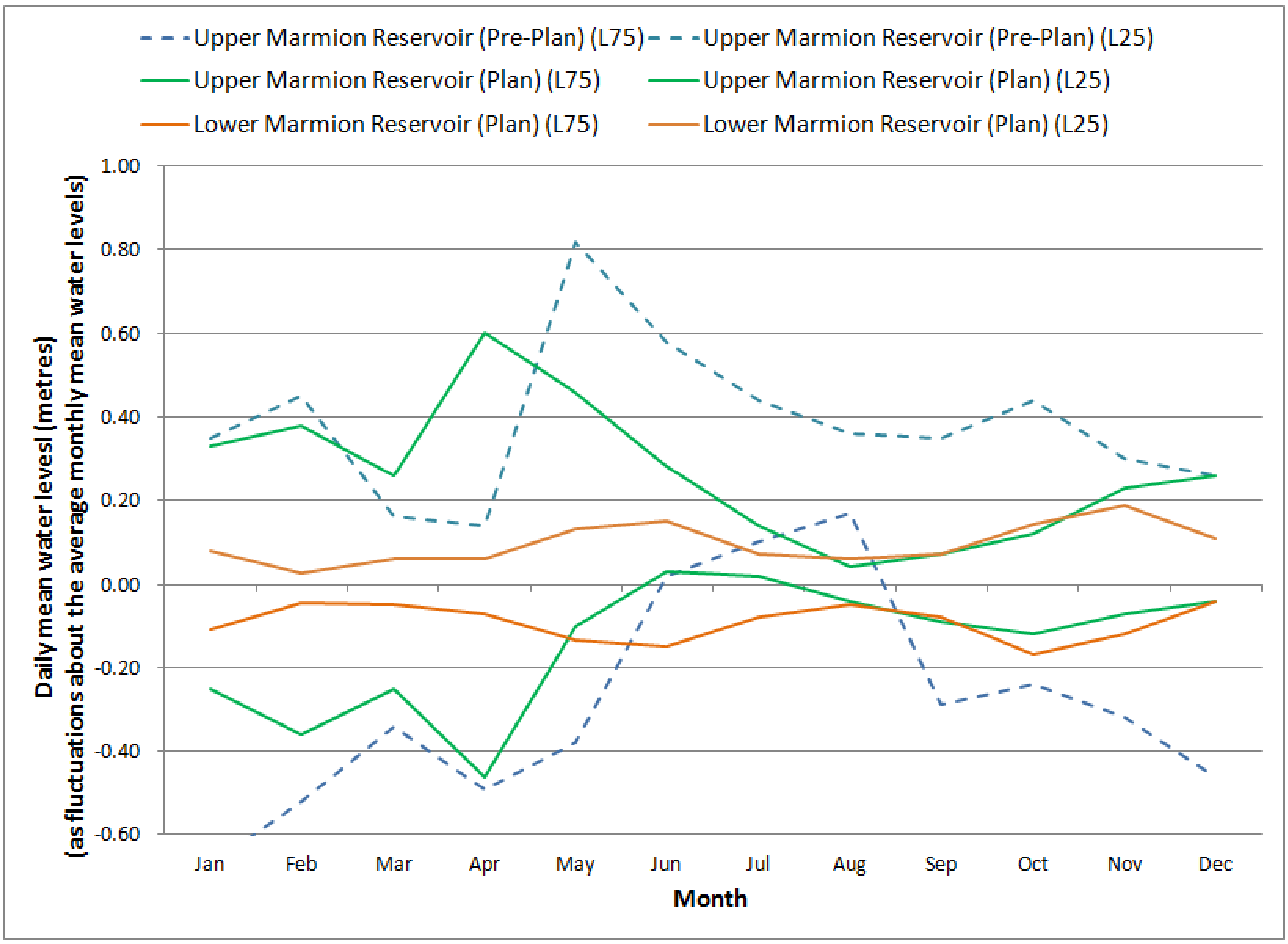

Figure 6-9: Upper and Lower Bounds of Normal Water Levels in the Marmion Reservoirs

Figure 6-9 shows that the range of normal water levels in the Upper Marmion Reservoir under present reservoir operation has changed from that prior to the 2004 to 2014 Seine River Water Management Plan; the range is markedly lower from June through to December. The range in normal water levels in the Lower Marmion Reservoir is lower than that for the Upper Marmion Reservoir from December through to May; the Lower Marmion Reservoir is managed independently of the Upper Marmion Reservoir during the winter months in order to maintain suction head for the cooling water pumps for the Atikokan Generating Station. The two reservoirs are operated as a single water body during the open-water season.

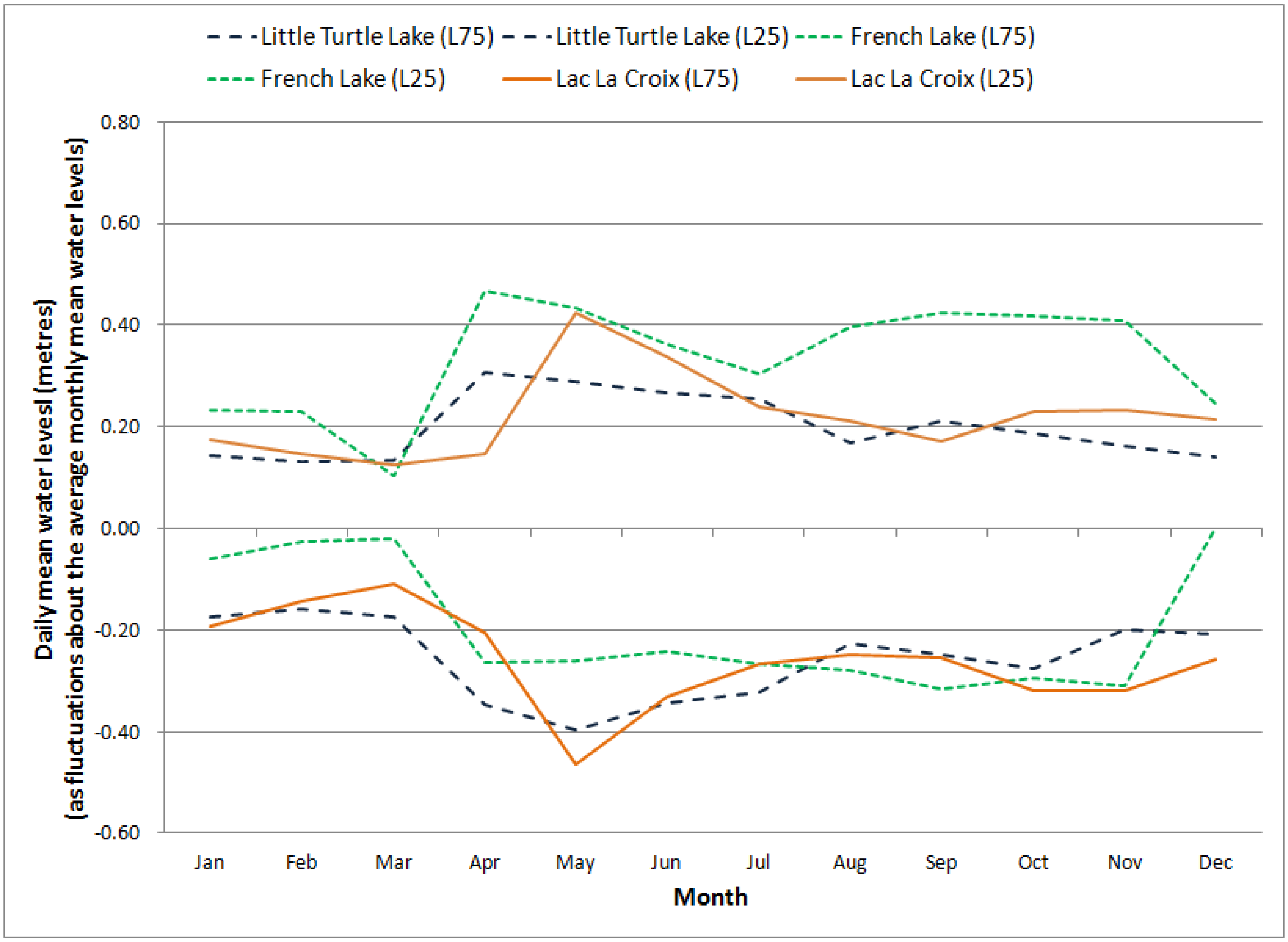

Figure 6-10: Upper and Lower Bounds of Normal Water Levels in Unregulated Lakes

Figure 6-10 shows similar ranges of normal water levels in the unregulated lakes.

High Water Levels

The 20th exceedance percentile daily mean water levels for months in which the highest annual water level occurs were derived from the water level duration curves developed for the regional scale stations. These exceedance percentiles are summarized in Table 6-8, expressed as fluctuations above the long-term average monthly mean water levels. The 20th exceedance percentile represents the high water mark considered by Fisheries and Oceans Canada (Ontario Great Lakes Area) as the minimum elevation for the boundary for fish habitat (Section 6.1.1.1).

Table 6-8: High Water Level 20th Exceedance Percentiles for Regional Scale Hydrometric Stations

Station ID	Station Name	Period	Record Type	Month[b]	Long-Term Average Monthly Mean Water Level[c] (m)	20th Exceedance Percentile Water Level[d] (m)
—[a]	Upper Marmion Reservoir at Raft Lake Dam	1982-2003	Regulated	June	414.85	0.61
—[a]	Upper Marmion Reservoir at Raft Lake Dam	2004-2012	Regulated	June	415.15	0.29
—[a]	Lower Marmion Reservoir at Lower Marmion Sluiceway	2004-2012	Regulated	June	415.33	0.18
05PB015	Little Turtle Lake near Mine Centre	1914-1967	Natural	May	345.896	0.451
05PA010	French Lake near Atikokan	1960-1998	Natural	May	31.760	0.497
05PA011	Lac La Croix at Campbell's Camp	1921-2008	Natural	May	361.510	0.525

Notes:

(a) Not applicable.

(b) Month in which the highest annual water level occurs; based on review of the daily mean water levels for the stations.

(c) Average of the monthly mean water levels for the month in which the highest annual water level occurs over the period.

(d) The 20th exceedance percentile daily mean water level expressed as a fluctuation above the long-term average monthly mean water level.

Frequency analyses of annual maximum daily mean water levels were completed for the regional scale stations. The Log-Normal Probability Distribution best fit the data with coefficients of determination ranging from 0.725 to 0.977. Figure 6-11 shows the resulting frequency curves (i.e., plots of annual maximum daily mean water levels with different return periods) expressed as fluctuations above the annual maxima with a 2-year return period (an average year).

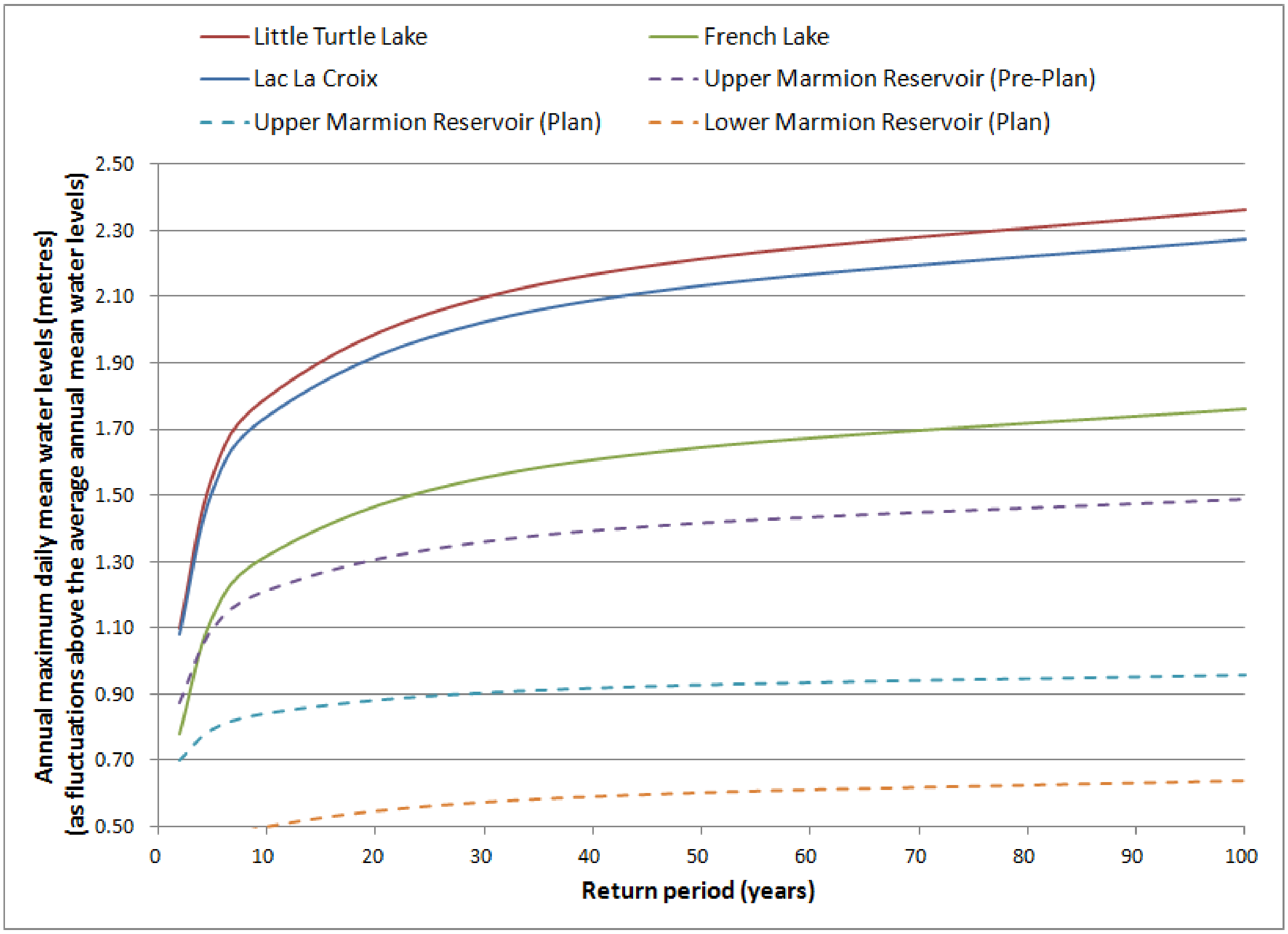

Figure 6-11: Frequency Curve of Annual Maximum Daily Mean Water Levels at Regional Scale Stations

The curves for the Upper and Lower Marmion Reservoirs under the 2004 to 2012 Seine River Water Management Plan are very flat, indicating marked attenuation of flood flows by present day reservoir operations. The curve for the Upper Marmion Reservoir prior to the Plan is steeper up to the 10-year return period.

Of the unregulated lakes, Little Turtle Lake and Lac La Croix have comparable frequency curves indicating similar water level responses to high precipitation events. The curve for French Lake indicates less of a response to precipitation and is likely due to physiographic differences in its tributary drainage area.

Low Water Levels

The 90th exceedance percentile daily mean water levels for each month were derived from the water level duration curves developed for the regional scale stations. The 90th exceedance percentile represents a threshold below which drought conditions may be considered to exist. Figure 6-12 shows the percentiles expressed as fluctuations below the long-term average monthly mean water levels.

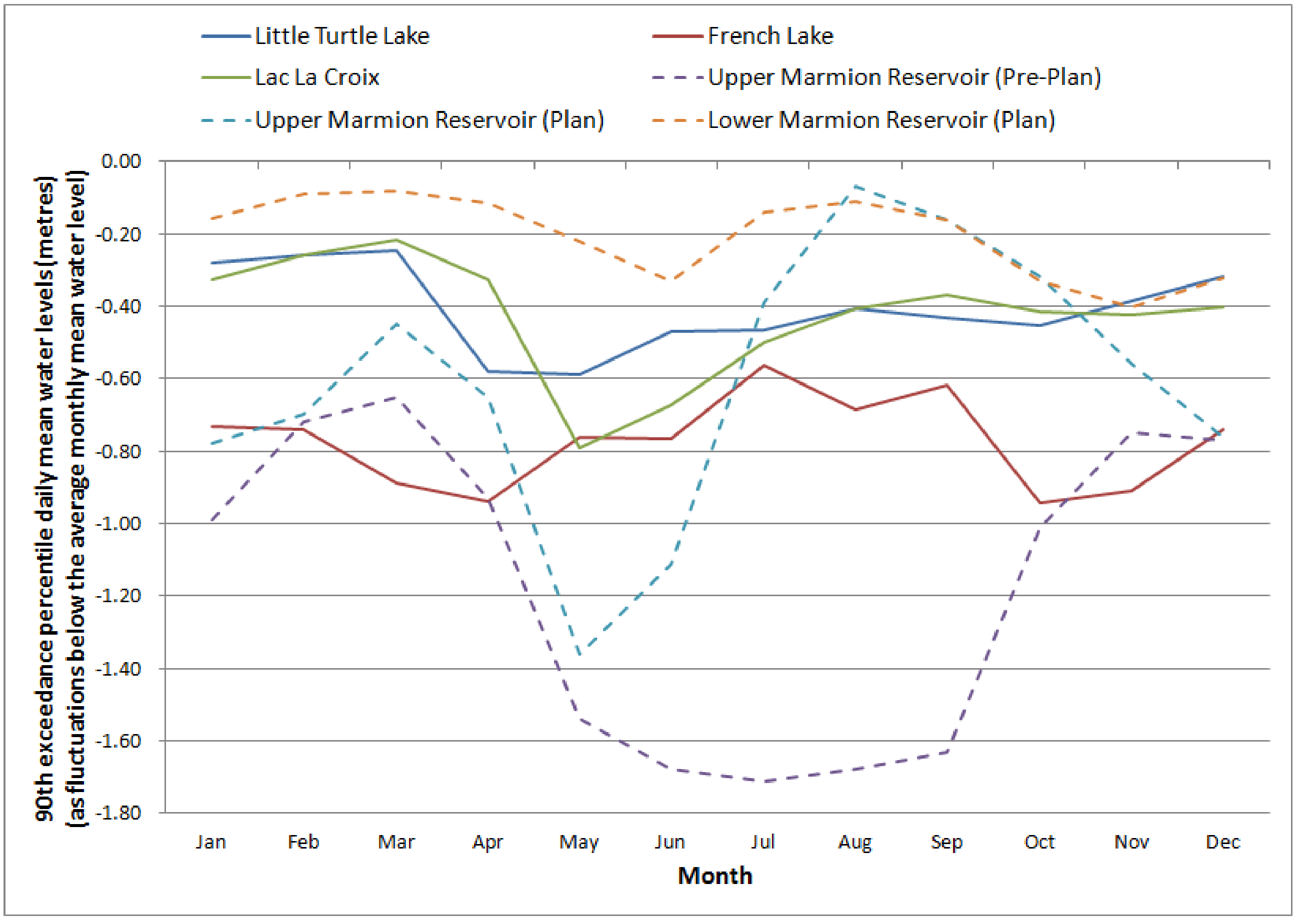

Figure 6-12: Low Water Levels at Regional Scale Stations

Figure 6-12 shows that the greatest fluctuations below the long-term average monthly mean water level occur in May and June in the Upper and Lower Marmion Reservoirs respectively under present reservoir operations. The lowest fluctuation occurs in July in the Upper Marmion Reservoir previous to the 2004 to 2014 Seine River Water Management Plan.

Little Turtle Lake and Lac La Croix show similar fluctuations in low water levels below the average monthly mean water levels. The curve for French Lake generally shows greater fluctuations below the average monthly mean water levels from August through to April, indicating a greater response to drier than normal conditions in these months compared to the other stations.

Lake Water Levels at Local and Regional Scale Stations

The water level monitoring completed for the Project at local scale stations provides short-term water level records representing only two years in hydrological time. In order to characterize the natural water level regime and normal, flood and drought properties at water bodies of interest to the Project, it is common practice to attempt to correlate the short-term records with concurrent long-term records available at regional scale stations.

However, the regional scale stations are either inactive or data concurrent with the water level monitoring completed for the Project are not available. Therefore, in order to put some context to water level data collected at the local stations, monthly mean water levels for 2011 were compared to water level data collected at the regional scale stations in a year with similar annual total precipitation.

Annual total precipitation at Atikokan in the calendar year 2011 was 611 mm (a dry year with a 6-year return period). The precipitation record for Atikokan was examined to identify a similar year for which water level data were available at all three regional scale stations. The calendar year 1963 was the only similar year identified with annual total precipitation of 639 mm. Comparison of the monthly distributions of total precipitation in 2011 and 1963 indicated differences in January through to March, May and October.

Figure 6-13 compares 2011 monthly mean water levels at the local scale stations and 1963 monthly mean water levels at the regional scale stations; monthly mean water levels are expressed as fluctuations about the annual mean water levels for these years.

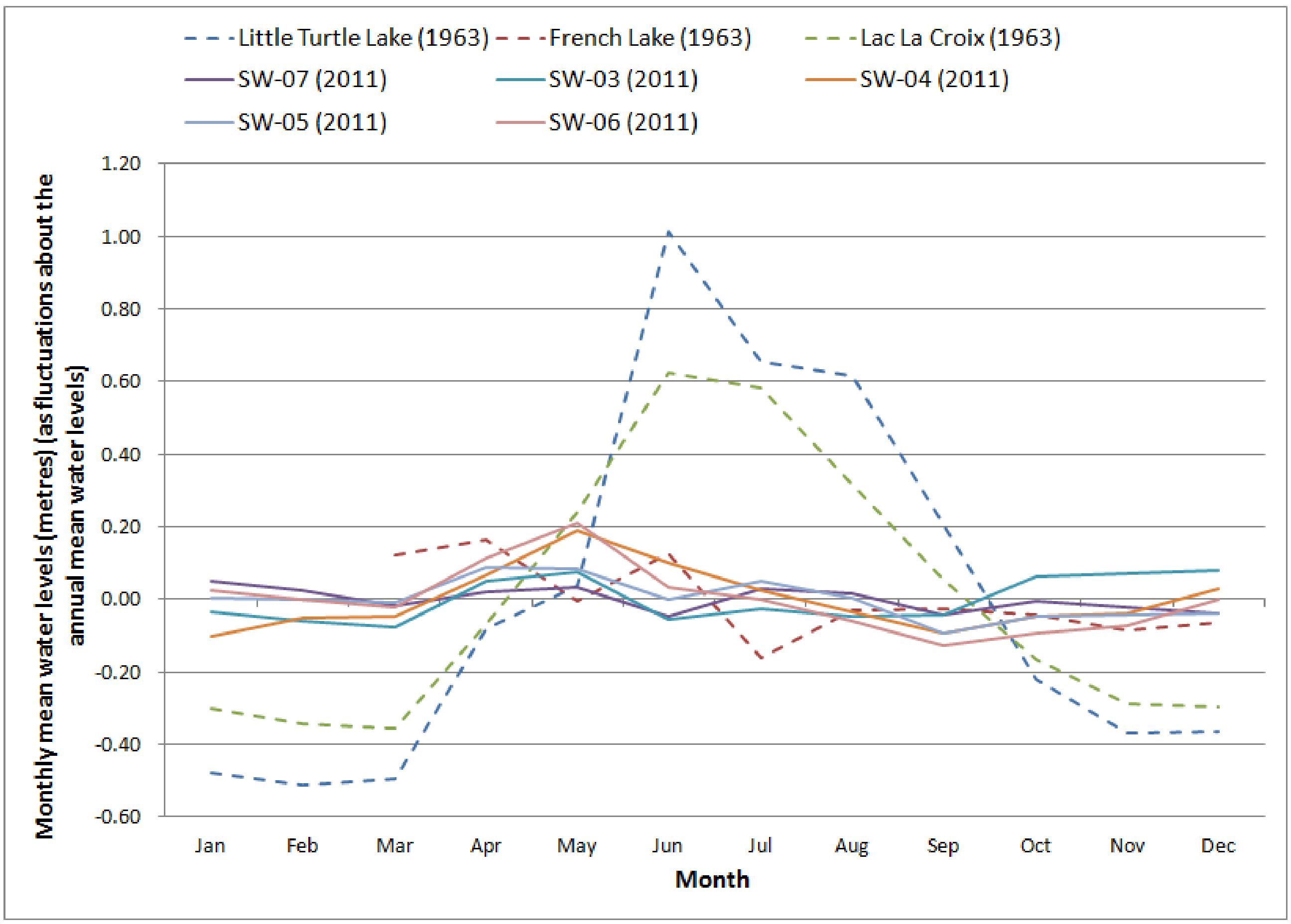

Figure 6-13: Monthly Mean Water Level Fluctuations at Local and Regional Scale Stations, 2011 and 1963

Figure 6-13 shows that monthly fluctuations in water levels at the local scale stations are similar to those at French Lake. Water levels at Little Turtle Lake and Lac La Croix are not representative of water levels at the local scale stations. This suggests that the various relationships between normal, low and high water levels that were determined for French Lake may be applied with caution to the local scale water bodies (lakes) of interest.

6.1.3 Summary of Existing Conditions

6.1.3.1 Water Bodies of Interest

A total of nine water bodies that may be affected by Project activities were identified following review of the Project Description prepared for and issued to the CEA Agency (April 2011) and of the Project components These water bodies of interest are shown in Figure 6-14.

At the site scale, these are:

- Mitta Lake (API[1] #12), located within the footprint of the west pit.
- Unnamed Lake 1 (API #13), which is to be used as the Mine Water Emergency Spill Pond.
- Unnamed Lake 3 (API #11), located within the footprint of the Waste Rock Stockpile.
- Unnamed Lake 4 (API #2), located within the footprints of the base case and Alternative #1 Tailings Management Facility.
- Unnamed Lake 5 (API #8), located to the east of the base case and Alternative #1 Tailings Management Facility.

At the local scale, water bodies of interest include:

- Lizard Lake, situated southeast of the base case and Alternative #1 Tailings Management Facility and northwest of the Alternative #2 Tailings Management Facility.
- Light Lake, situated east of the Alternative #2 Tailings Management Facility.

At the regional scale, the Project is bounded to the west and south by Upper Marmion Reservoir.

Mitta Lake and Unnamed Lakes 1, 3 and 4 will be contained within the Project footprint. However, Unnamed Lake 5, Lizard Lake, Light Lake and Upper Marmion Reservoir are possible sources of water supply and/or receivers of effluent discharges. The following sections focus on describing existing conditions in these latter water bodies where Project activities may result in changes to the water level regime, including their normal, flood and drought properties.

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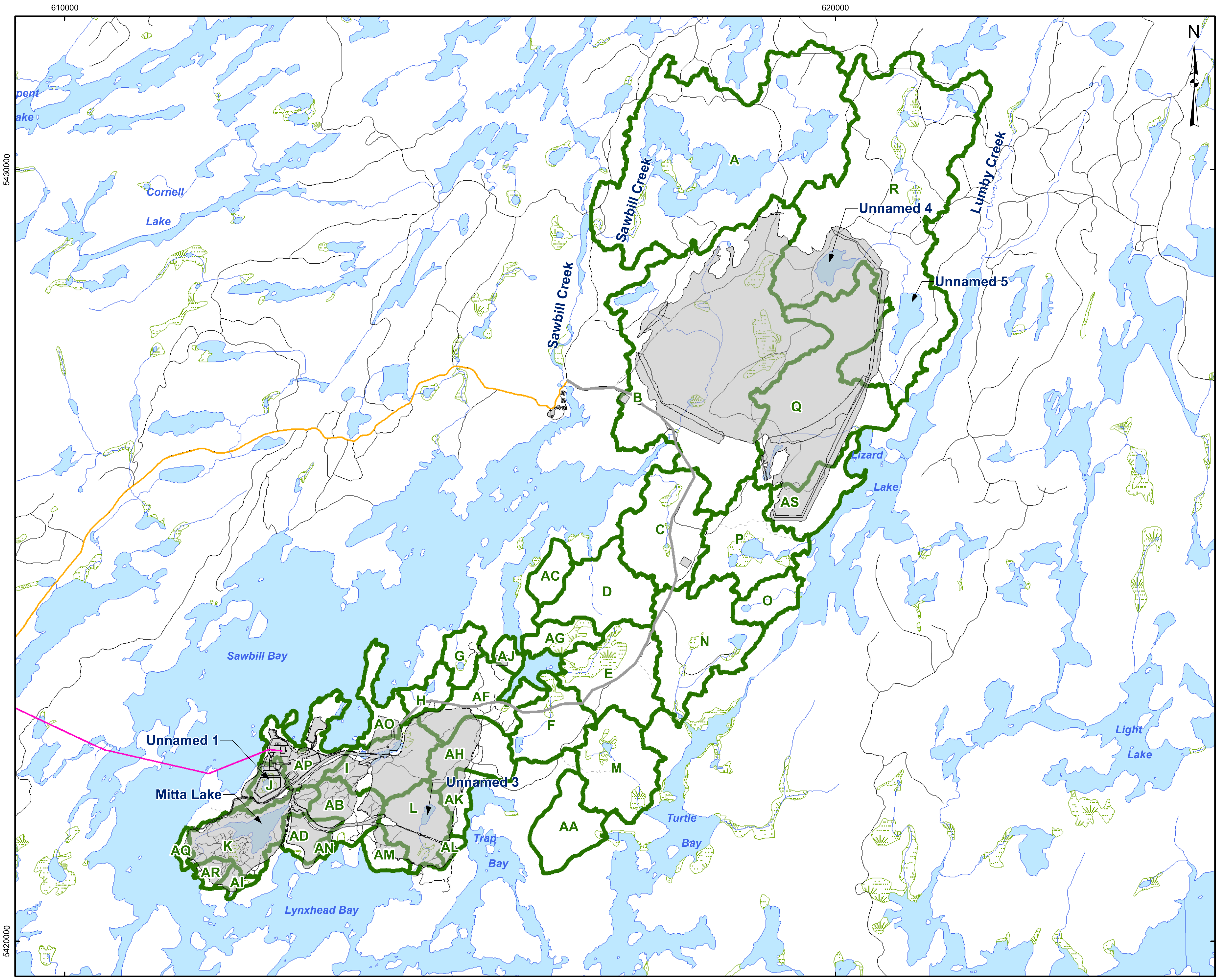
[1] Area of Potential Impact as identified in the Aquatic Environment TSD.



LEGEND

- Trail
- Road
- River/Stream
- Lake
- Wetland
- Watershed Boundary
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000

SCALE 1:50,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

WATER BODIES OF INTEREST

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

Golder Associates
Mississauga, Ontario

FIGURE: 6-14

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Hydrology\TSD\WaterbodiesofInterest.mxd

6.1.3.2 Annual Mean Water Levels

Table 6-9 shows the estimated long-term average and range of annual (September to August) mean water levels for the water bodies of interest.

The annual mean water levels for Mitta Lake, Unnamed Lake 1, Unnamed Lake 3, Unnamed Lake 4 and Unnamed Lake 5 were estimated from the shoreline elevation in GIS base data received from OHRG Ltd. in August 2010. The shoreline elevations represent a snapshot in time and are not likely to be representative of annual mean water levels. These were increased by an incremental value of 0.286 m, which was the difference between the shoreline elevation for Lizard Lake in the GIS base data and its long-term average annual mean water level estimated as described below.

The annual mean water levels for Lizard Lake and Light Lake were estimated using the value computed from observed water level data between September 2010 and August 2011. Annual total precipitation in this period had a return period of 1.9 years, representing fairly average conditions. The 2010 to 2011 annual mean water levels for Lizard Lake and Light Lake were adjusted to the 2-year annual mean water level using the frequency curve for French Lake in Figure 6-6. For the Upper and Lower Marmion Reservoirs, the annual mean water levels were computed from data collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. As stated in Section 6.1.2.2, the ranges in annual mean water levels in the Upper and Lower Marmion Reservoirs are less than those in the unregulated lakes.

Table 6-9: Long-Term Average and Range of Annual Mean Water Levels

Water Body	Average Annual Mean Water Levels (masl)	Range in Annual Mean Water Levels (masl)
Mitta Lake (API[a] #12)	431.299	1.547[b]
Unnamed Lake 1 (API[a] #13)	441.076	1.547[b]
Unnamed Lake 3 (API[a] #11)	431.726	1.547[b]
Unnamed Lake 4 (API[a] #2)	433.636	1.547[b]
Unnamed Lake 5 (API[a] #8)	428.946	1.547[b]
Lizard Lake	426.605	1.547[b]
Light Lake	430.264	1.547[b]
Upper Marmion Reservoir	414.73	0.81[c]
Lower Marmion Reservoir	415.12	0.23[c]

Notes:

(a) Area of Potential Impact identified by the Aquatic Environment team.

(b) The long-term range in annual mean water levels recorded at French Lake for the period September 1960 to August 1998.

(c) The range in annual mean water levels observed in the reservoirs between September 2004 and August 2012.

Tables 6-10 and 6-11 show the annual mean water levels in the same water bodies for wet and dry years with return periods of 2, 10, 25, 50 and 100 years. The annual mean water levels for the Upper and Lower Marmion Reservoirs are the results of frequency analysis of annual mean water level data observed in the reservoirs under the 2004 to 2014 Seine River Water Management Plan. For the smaller water bodies, the annual mean water levels were estimated using the frequency curves for French Lake in Figures 6-5 and 6-6 and the long-term average annual mean water levels for the water bodies in Table 6-9 above.

Table 6-10: Annual Mean Water Levels for Wet Years with Different Return Periods

Water Body	Annual Mean Water Levels (masl)				
	2-yr	10-yr	25-yr	50-yr	100-yr
Mitta Lake (API[a] #12)	431.299	431.830	432.025	432.151	432.264
Unnamed Lake 1 (API[a] #13)	441.076	441.607	441.802	441.928	442.041
Unnamed Lake 3 (API[a] #11)	431.726	432.257	432.452	432.578	432.691
Unnamed Lake 4 (API[a] #2)	433.636	434.167	434.362	434.488	434.601
Unnamed Lake 5 (API[a] #8)	428.946	429.477	429.672	429.798	429.911
Lizard Lake	426.640	427.172	427.366	427.492	427.605
Light Lake	430.299	430.831	431.025	431.151	431.264
Upper Marmion Reservoir	414.73	415.09	415.22	415.30	415.38
Lower Marmion Reservoir	415.12	415.26	415.31	415.34	415.37

Notes:
(a) Area of Potential Impact identified by the Aquatic Environment team.

Table 6-11: Annual Mean Water Levels for Dry Years with Different Return Periods

Water Body	Annual Mean Water Levels (masl)				
	2-yr	10-yr	25-yr	50-yr	100-yr
Mitta Lake (API[a] #12)	431.299	430.768	430.573	430.447	430.334
Unnamed Lake 1 (API[a] #13)	441.076	440.545	440.350	440.224	440.111
Unnamed Lake 3 (API[a] #11)	431.726	431.195	431.000	430.874	430.761
Unnamed Lake 4 (API[a] #2)	433.636	433.105	432.910	432.784	432.671
Unnamed Lake 5 (API[a] #8)	428.946	428.415	428.220	428.094	427.981
Lizard Lake	426.640	426.109	425.915	425.789	425.676
Light Lake	430.299	429.768	429.574	429.448	429.335
Upper Marmion Reservoir	414.73	414.37	414.24	414.16	414.08
Lower Marmion Reservoir	415.12	414.98	414.93	414.90	414.87

Notes:
(a) Area of Potential Impact identified by the Aquatic Environment team.

6.1.3.3 Seasonal Mean Water Levels

Table 6-12 shows the estimated long-term average seasonal mean water levels in the water bodies of interest. The average seasonal mean water levels for the Upper and Lower Marmion Reservoirs were computed from water level data collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. For the smaller water bodies, the long-term average seasonal mean water levels were estimated by applying the fluctuations of the seasonal mean water levels in French Lake about the long-term average annual mean water level in Figure 6-7 to the estimates of the long-term average annual mean water levels for the water bodies in Table 6-9.

Table 6-12: Long-Term Average Seasonal Mean Water Levels

Water Body	Seasonal Mean Water Levels (masl)			
	Fall (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Aug)
Mitta Lake (API[a] #12)	431.221	431.125	431.730	431.623
Unnamed Lake 1 (API[a] #13)	440.998	440.902	441.507	441.400
Unnamed Lake 3 (API[a] #11)	431.648	431.552	432.157	432.050
Unnamed Lake 4 (API[a] #2)	433.558	433.462	434.067	433.960
Unnamed Lake 5 (API[a] #8)	428.868	428.772	429.377	429.270
Lizard Lake	426.563	426.467	427.071	426.965
Light Lake	430.222	430.126	430.730	430.624
Upper Marmion Reservoir	415.10	414.20	414.53	415.14
Lower Marmion Reservoir	415.18	414.97	415.16	415.21

Notes:
(a) Area of Potential Impact identified by the Aquatic Environment team.

6.1.3.4 Monthly Mean Water Levels

Table 6-13 shows the estimated long-term average monthly mean water levels in the water bodies of interest. The average monthly mean water levels for the Upper and Lower Marmion Reservoirs were computed from water level data collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. For the smaller water bodies, the long-term average monthly mean water levels were estimated by applying the fluctuations of the monthly mean water levels in French Lake about the long-term average annual mean water level in Figure 6-8 to the estimates of the long-term average annual mean water levels for the water bodies in Table 6-9.

6.1.3.5 Normal Water Levels

Table 6-14 shows the estimated upper and lower bounds of normal daily mean water levels in the water bodies. These are the 75th (L_{75}) and 25th (L_{25}) exceedance percentile daily mean water levels (the daily mean water levels equaled or exceeded 75% and 25% of the time).

The L_{75} and L_{25} water levels for the Upper and Lower Marmion Reservoirs were read from monthly water duration curves constructed from water level data collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. For the smaller water bodies, the L_{75} and L_{25} water levels were estimated by applying the fluctuations of the L_{75} and L_{25} water levels in French Lake above the long-term average monthly mean water levels in Figure 6-9 to the estimates of the long-term average monthly mean water levels for the water bodies in Table 6-13.

6.1.3.6 High Water Marks

Table 6-15 shows the estimated 20th exceedance percentile daily mean water levels (L_{20}, the water level equaled or exceeded 20 percent of the time) in the water bodies for the month in which the highest annual water level occurs. The L_{20} is the high water mark considered by Fisheries and Oceans Canada (Ontario Great Lakes Area) in the review of development projects in or near water as the minimum elevation that will be considered as a boundary for fish habitat.

Review of water level data for the Upper and Lower Marmion Reservoirs collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan indicated that May is the month in which the highest annual water level typically occurs. The L_{20} high water marks in Table 6-15 were derived directly from monthly water level duration curves constructed from the data for these reservoirs.

For the smaller water bodies, it was assumed that the highest annual water level occurs in May (Table 6-13). The L_{20} high water marks for these water bodies were estimated by applying the fluctuation of the L_{20} high water mark in French Lake above the long-term average monthly mean level for May in Table 6-7 to the estimates of the long-term average monthly mean levels for May for the water bodies in Table 6-13.

Also shown in Table 6-15 are the estimated 100-year annual maximum water levels (L_{100}) in the water bodies, typically considered as the regional design flood level. The L_{100} high water marks for the Upper and Lower Marmion Reservoirs are based on frequency analysis of annual maximum water levels observed in the reservoirs since 2004. The L_{100} high water marks for the other water bodies were estimated using the frequency curve for French Lake in Figure 6-11 and estimates of long-term average annual mean water levels for the water bodies in Table 6-9.

Table 6-13: Long-Term Average Monthly Mean Water Levels

Water Body	Monthly Mean Water Levels (masl)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mitta Lake (API[a] #12)	431.148	431.121	431.243	431.546	431.840	431.789	431.713	431.605	431.555	431.593	431.586	431.170
Unnamed Lake 1 (API[a] #13)	440.925	440.898	441.020	441.323	441.617	441.566	441.490	441.382	441.332	441.370	441.363	440.947
Unnamed Lake 3 (API[a] #11)	431.575	431.548	431.670	431.973	432.267	432.216	432.140	432.032	431.982	432.020	432.013	431.597
Unnamed Lake 4 (API[a] #2)	433.485	433.458	433.580	433.883	434.177	434.126	434.050	433.942	433.892	433.930	433.923	433.507
Unnamed Lake 5 (API[a] #8)	428.795	428.768	428.890	429.193	429.487	429.436	429.360	429.252	429.202	429.240	429.233	428.817
Lizard Lake	426.489	426.462	426.585	426.887	427.181	427.131	427.054	426.947	426.897	426.934	426.928	426.512
Light Lake	430.148	430.121	430.244	430.546	430.840	430.790	430.713	430.606	430.556	430.593	430.587	430.171
Upper Marmion Reservoir	414.71	414.28	413.60	413.66	414.80	415.15	415.19	415.16	415.08	415.12	415.17	415.01
Lower Marmion Reservoir	415.07	414.94	414.88	414.96	415.17	415.33	415.29	415.19	415.13	415.14	415.23	415.18

Table 6-14: Normal Daily Mean Water Levels

Water Body	Percentile	Upper and Lower Bounds of Normal Daily Mean Water Levels (masl)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mitta Lake (API #12)	L_{75}	431.238	431.272	431.278	431.035	431.037	431.056	431.032	431.020	430.983	431.003	430.988	431.299
	L_{25}	431.533	431.528	431.401	431.767	431.732	431.660	431.603	431.695	431.723	431.717	431.708	431.543
Unnamed Lake 1 (API #13)	L_{75}	441.015	441.049	441.055	440.812	440.814	440.833	440.809	440.797	440.760	440.780	440.765	441.076
	L_{25}	441.310	441.305	441.178	441.544	441.509	441.437	441.380	441.472	441.500	441.494	441.485	441.320
Unnamed Lake 3 (API #11)	L_{75}	431.665	431.699	431.705	431.462	431.464	431.483	431.459	431.447	431.410	431.430	431.415	431.726
	L_{25}	431.960	431.955	431.828	432.194	432.159	432.087	432.030	432.122	432.150	432.144	432.135	431.970
Unnamed Lake 4 (API #2)	L_{75}	433.575	433.609	433.615	433.372	433.374	433.393	433.369	433.357	433.320	433.340	433.325	433.636
	L_{25}	433.870	433.865	433.738	434.104	434.069	433.997	433.940	434.032	434.060	434.054	434.045	433.880
Unnamed Lake 5 (API #8)	L_{75}	428.885	428.919	428.925	428.682	428.684	428.703	428.679	428.667	428.630	428.650	428.635	428.946
	L_{25}	429.180	429.175	429.048	429.414	429.379	429.307	429.250	429.342	429.370	429.364	429.355	429.190
Lizard Lake	L_{75}	426.579	426.613	426.619	426.376	426.378	426.397	426.373	426.361	426.324	426.344	426.329	426.640
	L_{25}	426.874	426.869	426.742	427.108	427.073	427.001	426.944	427.036	427.064	427.058	427.049	426.884
Light Lake	L_{75}	430.238	430.272	430.278	430.035	430.037	430.056	430.032	430.020	429.983	430.003	429.988	430.299
	L_{25}	430.533	430.528	430.401	430.767	430.732	430.660	430.603	430.695	430.723	430.717	430.708	430.543
Upper Marmion Reservoir	L_{75}	414.48	414.37	414.48	414.27	414.63	414.76	414.75	414.69	414.64	414.61	414.66	414.69
	L_{25}	415.06	415.11	414.99	415.33	415.19	415.01	414.87	414.77	414.80	414.85	414.96	414.99
Lower Marmion Reservoir	L_{75}	415.01	415.08	415.07	415.05	414.98	414.97	415.04	415.07	415.04	414.95	415.00	415.08
	L_{25}	415.20	415.15	415.18	415.18	415.25	415.27	415.19	415.18	415.19	415.26	415.31	415.23

Table 6-15: High Water Marks

Water Body	20th Perc. Daily Mean Water Level (masl)	100-Year Annual Maximum Daily Mean Water Level (masl)
Mitta Lake (API #12)	432.337	433.060
Unnamed Lake 1 (API #13)	442.114	442.837
Unnamed Lake 3 (API #11)	432.764	433.487
Unnamed Lake 4 (API #2)	434.674	435.397
Unnamed Lake 5 (API #8)	429.984	430.707
Lizard Lake	427.678	428.401
Light Lake	431.337	432.060
Upper Marmion Reservoir	415.51	415.69
Lower Marmion Reservoir	415.79	415.76

6.1.3.7 Low Water Levels

Table 6-16 shows the estimated 90th exceedance percentile daily mean water levels (L_{90}, or daily mean water level equaled or exceeded 90% of the time) in the water bodies for each month of the year. The L_{90} water level is commonly used as a threshold below which drier than normal conditions exist.

The L_{90} water levels for the Upper and Lower Marmion Reservoirs were read from monthly water duration curves constructed from water level data collected for compliance monitoring under the 2004 to 2014 Seine River Water Management Plan. For the smaller water bodies, the L_{90} water levels were estimated by applying the fluctuations of the L_{90} water levels in French Lake above the long-term average monthly mean water levels in Figure 6-12 to the estimates of the long-term average monthly mean water levels for the water bodies in Table 6-13.

Table 6-16: 90th Exceedance Percentile Daily Mean Water Levels

Water Body	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mitta Lake (API #12)	430.417	430.406	430.258	430.211	430.387	430.384	430.587	430.462	430.530	430.205	430.237	430.408
Unnamed Lake 1 (API #13)	440.194	440.183	440.035	439.988	440.164	440.161	440.364	440.239	440.307	439.982	440.014	440.185
Unnamed Lake 3 (API #11)	430.844	430.833	430.685	430.638	430.814	430.811	431.014	430.889	430.957	430.632	430.664	430.835
Unnamed Lake 4 (API #2)	432.754	432.743	432.595	432.548	432.724	432.721	432.924	432.799	432.867	432.542	432.574	432.745
Unnamed Lake 5 (API #8)	428.064	428.053	427.905	427.858	428.034	428.031	428.234	428.109	428.177	427.852	427.884	428.055
Lizard Lake	425.758	425.747	425.599	425.552	425.728	425.725	425.928	425.803	425.871	425.546	425.578	425.749
Light Lake	429.417	429.406	429.258	429.211	429.387	429.384	429.587	429.462	429.530	429.205	429.237	429.408
Upper Marmion Reservoir	413.799	413.879	414.129	413.929	413.219	413.469	414.189	414.509	414.419	414.259	414.019	413.819
Lower Marmion Reservoir	414.810	414.879	414.887	414.855	414.748	414.636	414.828	414.856	414.808	414.639	414.564	414.647

6.2 Prediction of Potential Changes

6.2.1 Methods

6.2.1.1 Determination of Bounding Scenario

Changes to lake water levels in site, local and regional scale water bodies from existing conditions are expected to occur in all four phases of the Project. The prediction of changes in lake water levels in these water bodies has been based on a bounding (worst case) scenario: the Project phase when the combination of Project activities results in the greatest changes to lake water levels.

The bounding scenario was selected by identifying the potential changes in flows as a result of Project activities in all phases of the Project. Table 6-17 summarizes the Project activities and the potential changes to lake water levels from existing conditions associated with the various Project phases.

Table 6-17: Project Activities and Potential Changes in Lake Water Levels from Existing Conditions

Project Activity	Potential Change
Construction Phase	
■ Site preparation (clearing, grubbing and stripping) ■ Removal and stockpiling of soil and overburden material ■ Removal and stockpiling of sediment from Mitta Lake when dewatering of the lake is completed ■ Transfer and stockpiling of waste rock from Mine development	■ Increase in lake water levels in downstream water bodies due to increased runoff rates and volumes as a result of changes to land cover This change will be temporary, occurring prior to construction of the water collection system, and will be mitigated by the controlled release of runoff from temporary sediment control structures.
■ Temporary runoff diversion around construction works and Project facilities	■ Reduction and increase in lake water levels in downstream water bodies due to the diversion of runoff from one watershed to another watershed
■ Runoff collection from areas within the Project footprint following construction of the water collection system (e.g. ditches, sumps, pump stations, ponds)	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff
■ Dewatering of Mitta Lake (API #12) with flows used to: ▪ Satisfy construction water requirements at the mine site and Tailings Management Facility (TMF), and ▪ Provide start-up water in the TMF reclaim pond	■ Reduction in lake water levels in Mitta Lake and downstream water bodies due to water taking
■ Water taking from Sawbill Bay for potable and construction water supply at the accommodation camp	■ Reduction in lake water levels in downstream water bodies due to water taking
■ Discharge of treated sewage effluent from the accommodation camps into Sawbill Bay at the mouth of Sawbill Creek	■ Increase in lake water levels in downstream water bodies due to effluent discharge

Table 6-17: Project Activities and Potential Changes in Lake Water Levels from Existing Conditions (Continued)

Project Activity	Potential Change
Operations Phase	
■ Stockpiling of waste rock from the Mine to fill in Unnamed Lake 3 (API #11) to create Waste Rock Management Facility (WRMF) ■ Deposition of tailings in Unnamed Lake 4 (API #2) in the TMF	■ Reduction in lake water levels due to the in-filling of lakes with mine waste
■ Runoff collection from areas within the Project footprint to meet, in part, the water requirements for ore processing	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff by the water collection system
■ Water taking from Sawbill Bay for ▪ Potable water supply to the accommodation camp, and ▪ Freshwater supply to the processing plant	■ Reduction in lake water levels in downstream water bodies due to water taking
■ Discharge of the following into Sawbill Bay: ▪ Treated sewage effluent from the accommodation camp, and ▪ Treated wastewater effluent from the mine site	■ Increase in lake water levels in downstream water bodies due to treated effluent discharges
■ Discharge of runoff from the accommodation camp, emulsion plant and detonator storage area into Sawbill Bay Runoff from these areas will not be collected.	■ Increase in lake water levels in downstream water bodies due to increased runoff rates and volumes, as a result of changes in land cover
■ Discharge of seepage from the TMF It is expected that a small amount of seepage from the TMF will not be intercepted by the seepage collection system.	■ Increase in lake water levels in downstream water bodies
■ Mine dewatering	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff from the Mine footprint ■ Reduction in lake water levels due to the seepage of surface water from the Upper Marmion Reservoir into the open pits

Table 6-17: Project Activities and Potential Changes in Lake Water Levels from Existing Conditions (Continued)

Project Activity	Potential Change
Closure Phase	
■ Decommissioning of the accommodation camp, emulsion plant, detonator storage area, and the Ore Processing Facility and administration offices These Project facilities will be demolished, the ground scarified and re-vegetated, and pre-development flow directions restored where possible	■ Increase in lake water levels in downstream water bodies due to the change in land cover Reclaimed land may initially yield higher runoff rates and volumes due to less dense vegetation.
■ Runoff collection from the WRMF, low-grade ore stockpile, overburden stockpile and TMF Runoff will continue to be routed to the Mine Water Emergency Spill Pond and effluent treatment plant	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff
■ Discharge of treated wastewater effluent from the mine site into Sawbill Bay The accommodation camp will be decommissioned and the discharge of treated sewage effluent to Sawbill Bay will cease.	■ Increase in lake water levels in downstream water bodies due to the discharge of treated effluent
■ Discharge of seepage from the TMF It is expected that a small amount of seepage from the TMF will not be intercepted by the seepage collection system.	■ Increase in lake water levels in downstream water bodies
■ Back-flooding of the Mine At the end of mining, dewatering of the open pits will cease and the open pits will slowly fill with water.	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff in the Mine footprint ■ Reduction in lake water levels to the seepage of water from the Upper Marmion Reservoir into the open pits
Post-closure Phase	
■ Runoff collection from the WRMF, low-grade ore stockpile, overburden stockpile and TMF, until water quality is acceptable for direct discharge to the environment Runoff from these facilities will be routed to the open pits to accelerate back-flooding.	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff

Table 6-17: Project Activities and Potential Changes in Lake Water Levels from Existing Conditions (Continued)

Project Activity	Potential Change
■ Discharge of seepage from the TMF It is expected that a small amount of seepage from the TMF will not be intercepted by the seepage collection system.	■ Increase in lake water levels in downstream water bodies
■ Back-flooding of the Mine	■ Reduction in lake water levels in downstream water bodies due to the interception of runoff in the Mine footprint ■ Reduction in lake water levels due to the seepage of water from the Upper Marmion Reservoir into the open pits
■ Discharge of runoff from the TMF into Sawbill Bay, when water quality is acceptable for direct discharge to the environment	■ Reduction and increase in lake water levels in downstream water bodies due to runoff diversion from the Trap-Turtle-Lynxhead Bays watershed to the Sawbill Bay watershed
■ Discharge of runoff from the WRMF, low-grade ore stockpile and overburden stockpile into Sawbill Bay, Trap Bay and Lynxhead Bay, when water quality is acceptable for direct discharge to the environment The WRMF and low-grade ore stockpile will be graded to shed runoff and reduce infiltration, but will not be covered with soil or re-vegetated. The overburden stockpile will be graded to shed runoff and reduce infiltration and its surface will be directly re-vegetated.	■ Reduction and increase in lake water levels in downstream water bodies as a result of the changes in land cover Lower runoff rates and volumes are expected from the WRMF and Low Grade Ore Stockpile due to the larger grain size of the surface material resulting in increased infiltration The overburden stockpile may initially yield higher runoff rates and volumes due to less dense vegetation. Runoff rates and volumes will decrease as vegetation matures.
■ Overflow of water from the flooded open pits into the Upper Marmion Reservoir	■ Increase in lake water levels in downstream water bodies due to changes in land cover Higher runoff rates and volumes are expected from the surface of the flooded open pits compared to natural ground

During the construction phase, lake water levels in water bodies are expected to be altered from existing conditions by changes in land cover, runoff diversion, runoff interception, lake dewatering, water taking and effluent discharge. These changes are expected to occur during general construction works and the development of linear infrastructure, the accommodation camp, Mine, overburden stockpile, WRMF, TMF, and Support and Ancillary Infrastructure.

During the operations phase, lake water levels in water bodies will continue to be influenced by changes in land cover, runoff diversion, runoff interception, water taking and effluent discharge that commenced during the construction phase. In addition, further changes are expected as a result of:

- The stockpiling of waste rock in Unnamed Lake 3 (API #11) in the WRMF and the deposition of tailings in Unnamed Lake 4 (API #2) in the TMF.
- Increased runoff collection with the progressive expansion of the Mine, overburden stockpile, WRMF and TMF. The Project footprint and the quantity of runoff intercepted by the water collection system will increase over time.
- Increased water taking from Sawbill Bay to supply fresh water to the processing plant in addition to water taking to supply potable water to the accommodation camp.
- The discharge of treated wastewater effluent from the mine site, in excess of water requirements, in addition to the discharge of treated sewage effluent from the accommodation camp.
- The discharge of seepage losses from the TMF that are not intercepted by the seepage collection system.
- Mine dewatering as the open pits are developed. There will be a reduction in lake water levels in the Upper Marmion Reservoir as the mine is developed due to increased seepage rates as a result of the growing hydraulic gradient between water in the reservoir and in the open pits.

During the closure phase, lake water levels will continue to be altered by runoff diversion, runoff collection and effluent discharge. However, the changes are expected to smaller than during the operations phase. The accommodation camp, emulsion plant, detonator storage area, Ore Processing Facility and administration offices will be decommissioned and land occupied by these facilities will be reclaimed and pre-development flow directions restored where possible. In addition, water taking for potable water supply to the camp and freshwater supply to the processing plant, together with the discharge of treated sewage from the camp, will cease. At the end of mining, the dewatering system will be taken out of service and back-flooding of the open pits allowed to commence.

During the post-closure phase, lake water levels will initially continue to be affected by the same Project activities as during the closure phase, with the exception that the discharge of treated wastewater from the mine site will cease. Runoff collected from the TMF, WRMF, low-grade ore stockpile and overburden stockpile will be routed to the Mine to accelerate back-flooding. However, when water quality improves to an acceptable quality, runoff from these facilities will be allowed to discharge directly to the environment. Between 20 and 30 years after closure, the flooded open pits will begin to overflow and this overflow will be directed into the Upper Marmion Reservoir.

Based on the above, it is concluded that the bounding (worst case) scenario for changes in lake water levels from existing conditions will occur during the operations phase of the Project. Methods for the evaluation of expected changes to existing lake water levels in site, local and regional scale water bodies during the operations phase are described in Sections 6.2.1.2 to 6.2.1.4 below.

6.2.1.2 Site Scale Water Bodies

During the operations phase, changes in lake water levels in site scale water bodies from existing conditions will occur as a result of:

- The in-filling of lakes in the footprints of the mine site, WRMF and TMF.
- The interception of runoff from areas within the Project footprint by the runoff collection system.
- The discharge of seepage losses from the TMF that are not intercepted by the seepage collection system.

With the exception of the in-filling of lakes in the mine site, WRMF and TMF footprints, changes to lake water levels will occur as a result of changes to inflows to and outflows from water bodies. Similar to the assessment of changes in streamflows (Section 5.2.1.2), changes to the inflows to and outflows from water bodies were evaluated based on changes in their tributary drainage areas.

Only one site scale water body, Unnamed Lake 5 (API #8), has been identified that will be affected by changes in inflows and outflows. This lake is located to the east of the TMF and is tributary to Lumby Creek located in the Lynxhead-Trap-Turtle Bays watershed. The expected changes in monthly mean water levels in the lake were assessed using hydraulic and hydrologic modelling.

Hydraulic modelling was undertaken using HEC-RAS V4.1.0 software, developed for the United States Army Corps of Engineers, in order to develop a rating curve for the outlet of the lake. Hydraulic characteristics for the lake outlet and downstream channel were inferred from field observations of the lake and channel depths and widths, channel obstructions, channel substrate, overbank slopes and surrounding vegetation that were collected during fish habitat mapping (Aquatic Environment TSD). The geometry of the flow measurement cross-section for the station SW-12, located on the downstream channel near its mouth at Lizard Lake, was also incorporated. The model was calibrated with the flows and water levels observed at station SW-12 (Table 5-9 and Appendix 5.I). Steady flow analysis was completed for a range of outflows from the lake in order to determine the corresponding lake water levels.

Hydrologic modelling was completed using HEC-HMS 3.5 software, also developed for the United States Army Corps of Engineers, in order to assess the changes in water levels in the lake. Two models were created: the first represented existing conditions (the base case) and the second represented hydrologic conditions during the operations phase of the Project. Inputs to both models included:

- Climatic data for Atikokan, including estimates of the snowmelt input and the evaporative loss from the surfaces of the water bodies.
- Drainage characteristics such as sub-basin areas, lengths of overland flow, channel lengths based on Ontario Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS) 1:20,000 topographical data.
- The rating equation developed for the lake outlet as described above (Section 5.2.2.1).
- An assumed stage-storage relationship for the lake based on the maximum depth observed during fish habitat mapping.

The base case model was calibrated to flows measured at station SW-12 between 2010 and 2012 (Appendix 5.I). The model representing conditions during the operations phase of the Project consisted of the base case model with changes to drainage characteristics consistent with the reduction in the surface area of the watershed. Water levels in the lake were simulated over a 30-year period between 1982 and 2011 in both models.

Assumptions in this approach are:

- The rating equation developed for the lake outlet will remain stable throughout the Project life.
- Unit runoff at SW-12 is representative of unit runoff across the entire catchment.

The expected changes to lake water levels in Unnamed Lake 5 (API #8) are described in Section 6.2.2.1 below.

6.2.1.3 Local Scale Water Bodies

During the operations phase, changes in lake water levels from existing conditions are expected in Lizard Lake. This lake is part of the Lumby Creek drainage system in the Lynxhead-Trap-Turtle Bays watershed. Changes in lake water levels will occur as a result of:

- The interception of runoff from areas within the Project footprint by the water collection system.
- The discharge of seepage losses from the TMF that are not intercepted by the seepage collection system.

Similar to Unnamed Lake 5 (API #8) above, hydrologic modelling with HEC-HMS 3.5 was used to assess the expected changes in monthly mean water levels in the Lizard Lake. Inputs to the model included:

- Climatic data for Atikokan, including estimates of the snowmelt input and evaporative loss from the lake water surface.
- Drainage characteristics such as sub-basin areas, lengths of overland flow, channel lengths based on NRVIS 1:20,000 topographical data.
- The rating curve for station SW-03 at the outlet of Lizard Lake, which was developed during flow monitoring between 2010 and 2012 (Appendix 5.I).
- A stage-storage relationship for Lizard Lake developed from bathymetric survey data collected in 2011 (Golder 2012).

Two models were created: the first represented existing conditions (the base case) and the second represented conditions during the operations phase of the Project. The base case model was calibrated to flows recorded at stations SW-07, SW-02A, SW-02B, SW-12 and SW-03 in the Lynxhead-Trap-Turtle Bays watershed between 2010 and 2012 (Appendix 5.I). The model representing conditions during the operations phase consisted of the base case model with changes to drainage characteristics consistent with the reduction in the surface area of the watershed. Water levels in the Lizard Lake were simulated over a 30-year period between 1982 and 2011 in both models.

The inherent assumptions in this approach are that:

- The rating equation developed for the SW-03 at the lake outlet will remain stable throughout the Project's life cycle.

The expected changes to water levels in Lizard Lake as a result of Project activities during the operations phase are discussed in Section 6.2.2.2 below.

6.2.1.4 Regional Scale Water Bodies

During the operations phase, lake water levels in the Upper Marmion Reservoir are expected to be influenced by:

- The interception of runoff from areas within the Project footprint by the water collection system.
- Water taking from Sawbill Bay in the Upper Marmion Reservoir for potable water supply to the accommodation camp and for freshwater supply to the processing plant.
- Discharges of treated sewage effluent from the accommodation camp of treated wastewater effluent from the mine site into Sawbill Bay in the Upper Marmion Reservoir.
- Direct discharge of runoff from the accommodation camp, the emulsion plant and the detonator storage area as a result of increased runoff rates and volumes due to changes in land cover.
- Discharge of seepage from the TMF. It is expected that a small amount of seepage will not be intercepted by the seepage collection system.
- Mine dewatering due to the interception of runoff in the Mine footprint and the seepage of water from the reservoir into the open pits.

Changes in lake water levels were assessed using the same spreadsheet monthly water balance models of existing conditions and of conditions during the operations phase of the Project that were developed for the evaluation of changes in outflows from the reservoir. Descriptions of the models, modelling assumptions and inputs are provided in Section 5.2.1.4.

Existing lake water levels in Upper Marmion Reservoir were determined by satisfying minimum outflows from Lac des Mille Lacs Dam (1.5 m^3/s) and Raft Lake Dam (10 m^3/s) as the primary objective, and meeting assumed target operating water levels (to the extent possible) developed for the reservoir, based on objectives and operating rules for Raft Lake Dam in the 2004 to 2014 Seine River Water Management Plan (Figures 5-17 and 5-18). Lake water levels during the operations phase of the Project were evaluated using both single year lake balance and continuous lake balance models.

6.2.2 Results

6.2.2.1 Site Scale Water Bodies

Four site scale water bodies will be completely in-filled and contained by the Project footprint and are not discussed further in this section. These are:

- Mitta Lake (API #12), located within the footprint of the west pit.
- Unnamed Lake 1 (API #13), which is to be used as the Mine Water Emergency Spill Pond.
- Unnamed Lake 3 (API #11), located within the footprint of the Waste Rock Stockpile.
- Unnamed Lake 4 (API #2), located within the footprint of the base case TMF.

Changes in lake water levels are expected to occur and have been assessed in one other site scale water body.

- Unnamed Lake 5 (API #8), which is located to the east of the base case TMF in site scale watershed R.

Reductions in the magnitude of water levels in Unnamed Lake 5 (API #8) as a result of runoff collection in the TMF are expected. Table 6-18 presents the results of hydraulic and hydrologic modelling to evaluate changes in lake water levels in this water body. Hydrologic modelling was completed using a 30-year climatic record that included normal, wet and dry conditions.

Table 6-18: Changes to Monthly Mean Water Levels in Unnamed Lake 5 (API #8)

Month	Maximum Change in Water Level (cm)	Minimum Change in Water Level (cm)
January	-0.6	-0.2
February	-0.3	-0.1
March	-1.0	-0.1
April	-1.7	-0.1
May	-2.1	-0.3
June	-1.6	-0.3
July	-1.5	-0.1
August	-1.7	0.0
September	-1.7	-0.1
October	-1.5	-0.2
November	-1.2	-0.3
December	-0.8	-0.2
Overall	-2.1	0.0

Table 6-18 indicates potential changes in monthly mean water levels in Unnamed Lake 5 (API #8) ranging from -2.1 cm (May) to 0.0 cm (August), with the greatest changes occurring in the spring and the smallest changes occurring in the late fall/winter. As a result of the reduction in tributary drainage area to the lake, shorter durations and lower frequencies of occurrence (return periods) of lake water levels of a given magnitude are also expected. Changes to the general timing of seasonal lake water levels are not anticipated.

6.2.2.2 Local Scale Water Bodies

Reductions in the magnitude of water levels in Lizard Lake under normal, wet and dry hydrologic conditions as a result of runoff collection in the TMF are expected. Table 6-19 presents the results of hydrologic modelling to evaluate changes in water levels in this water body.

Table 6-19: Changes in Monthly Mean Water Levels in Lizard Lake

Month	Maximum Change in Water Level (cm)	Minimum Change in Water Level (cm)
January	-0.3	0.0
February	-0.3	0.0
March	-1.0	0.0
April	-2.1	-0.2
May	-2.7	-0.5
June	-2.1	-0.5
July	-2.0	-0.2
August	-2.2	-0.3
September	-2.3	-0.1
October	-1.9	-0.2
November	-1.3	-0.2
December	-0.8	0.0
Overall	-2.7	0.0

Table 6-19 indicates potential changes in monthly mean water levels in Lizard Lake ranging from -2.7 cm (May) to 0.0 cm (December to March), with the greatest changes occurring during the spring and summer (April to September) and the smallest changes occurring during the late fall/winter (December to March). As a result of the reduction in tributary drainage area to the lake, shorter durations and lower frequencies of occurrence (return periods) of lake water levels of a given magnitude are also expected. Changes to the general timing of seasonal lake water levels are not anticipated.

6.2.2.3 Regional Scale Water Bodies

Water levels in the Upper Marmion Reservoir under normal, wet and dry hydrologic conditions may be affected by changes in inflows to the reservoir as a result of Project activities during the operations phase. Inflows to the reservoir are expected to be influenced by runoff interception, water taking, discharges of treated effluent, increased runoff due to changes in land cover, and mine dewatering. The possible combined influence of all these Project activities was evaluated using single-year and continuous lake water balance models as described in Section 6.2.1.4 above.

Single Year Lake Water Balance Modelling

For the single year lake water balance modelling, the potential changes to water levels in Upper Marmion Reservoir during the operations phase of the Project were predicted by maintaining the same outflows from the reservoir as under existing conditions (Section 6.2.1.4) in order to directly assess the full potential of Project influences on reservoir water levels.

Table 6-20 shows the number of months that monthly mean water levels in Upper Marmion Reservoir fell below the monthly averages of the minimum water levels stipulated in the operating plan in the average year and in dry years, under existing conditions and during the operations phase of the Project. Table 6-20 indicates that the frequency of occurrence of reservoir water levels falling below minimum requirements (Figures 5-17 and 5-18) during the operations phase of the Project remains similar to that under existing conditions. Water levels will fall below minimum requirements in one additional month (April) in the dry years with return periods of 10, 25 and 50 years as a result of the Project assuming existing reservoir outflows are maintained.

Table 6-20: Frequency of Below-Minimum Water Levels in Upper Marmion Reservoir

Year	Frequency	
	Existing Conditions	**Project Operations Phase**
Average	1 (May)	1 (May)
10-year dry	2 (May – June)	3 (April – June)
25-year dry	5 (May – September)	6 (April – September)
50-year dry	6 (May – October)	7 (April – October)
100-year dry	8 (April – November)	8 (April – November)

Table 6-21 shows the potential changes in the magnitude of water levels in Upper Marmion Reservoir as a result of Project activities in the operations phase if outflows under existing conditions remain unchanged. Potential changes in water levels range from -9.0 cm (May) during both wet and dry years with return periods of 100 years to -0.4 cm (June) occurring in dry years with return periods of 50 and 100 years. In an average year, the maximum reduction in water levels is 8.1 cm (May).

Table 6-21: Changes in Upper Marmion Reservoir Water Levels (Single Year Lake Water Balances)

Month	Average Year	Wet Year Return Period (years)				Dry Year Return Period (years)			
		10	**25**	**50**	**100**	**10**	**25**	**50**	**100**
	Change in Water Levels (cm)								
January	-5.3	-4.9	-4.9	-4.9	-5.0	-4.5	-5.1	-5.2	-5.4
February	-5.8	-5.6	-5.6	-5.6	-5.7	-5.8	-6.3	-6.5	-6.6
March	-6.4	-6.1	-6.3	-6.3	-6.5	-7.0	-7.6	-7.7	-7.9
April	-7.3	-7.1	-7.2	-7.1	-7.4	-7.9	-8.3	-8.4	-8.5
May	-8.1	-8.5	-8.8	-8.8	-9.0	-8.5	-8.9	-9.0	-9.0
June	-0.8	-1.0	-1.0	-1.0	-1.1	-0.5	-0.5	-0.4	-0.4
July	-1.6	-1.7	-1.7	-1.7	-1.8	-1.1	-0.9	-0.8	-0.7
August	-2.1	-2.2	-2.2	-2.2	-2.3	-1.4	-1.3	-1.2	-1.1
September	-2.6	-2.6	-2.6	-2.6	-2.6	-1.8	-1.6	-1.5	-1.4
October	-3.1	-3.0	-3.0	-3.0	-3.0	-2.3	-2.1	-1.8	-1.8
November	-3.9	-3.7	-3.7	-3.7	-3.7	-2.9	-2.7	-2.6	-2.9
December	-4.6	-4.4	-4.4	-4.4	-4.4	-3.5	-3.7	-3.9	-4.1

Continuous Lake Water Balance Modelling

Continuous lake water balance modelling allows potential changes to water levels in Upper Marmion Reservoir during the operations phase of the Project to be simulated over an extended period of time. For the limiting scenario where existing outflows are maintained (not adjusted to account for Project influences), initial model results indicated that a carryover effect from year to year would produce unacceptable changes in reservoir water levels by the end of the simulation period. To more realistically assess the effect of Project influences, reservoir water levels were predicted by incrementally adjusting outflows (versus those in the existing conditions model) to minimize changes in reservoir water levels while continuing to satisfy minimum outflow requirements. It should be pointed out that the reservoir need not be operated any differently than it currently is with respect to meeting the minimum and maximum daily mean water levels prescribed by the 2004-2014 Seine River Water Management Plan, as the Project influences are accounted for entirely by the predicted minor changes in water available for outflows as described in Section 5.2.2.3 (Table 5-40).

Under existing conditions, continuous lake water balance modelling predicted that monthly mean water levels in Upper Marmion Reservoir would fall below the monthly averages of the minimum water levels stipulated in the reservoir operating plan 65 out of 324 months (20% of the time). By comparison, the model simulations for the operations phase of the Project predicted monthly mean water levels in Upper Marmion Reservoir would fall below minimum requirements 66 out of 324 months under the average year and the 100 year dry water taking scenarios, and 65 out of 324 months under the 100 year wet water taking scenario. The model results showed that the frequency of occurrence of reservoir water levels falling below minimum requirements was not increased as a result of the Project.

Table 6-22 shows the potential changes in the magnitude of water levels in Upper Marmion Reservoir as a result of Project activities in the operations phase with incremental adjustments in existing reservoir outflows. Potential changes in water levels range from -6.8 cm (January) occurring in the 100-year dry water taking scenario to 0.0 cm (multiple months) occurring in the average year, 100-year dry and 100-year wet water taking scenarios. In an average year, the maximum reduction in water levels is 4.4 cm.

Table 6-22: Changes in Upper Marmion Reservoir Water Levels (Continuous Lake Water Balances)

Month	Water Taking Scenario					
	Average Year		100 Year Wet		100 Year Dry	
	Maximum Change (cm)	Minimum Change (cm)	Maximum Change (cm)	Minimum Change (cm)	Maximum Change (cm)	Minimum Change (cm)
January	-4.3	0.0	-1.0	0.0	-6.8	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0
April	-0.6	0.0	-0.1	0.0	-0.7	0.0
May	-1.3	0.0	-1.0	0.0	-1.4	0.0
June	-1.8	0.0	-1.2	0.0	-1.9	0.0
July	-2.3	0.0	-1.0	0.0	-2.5	0.0
August	-2.8	0.0	-1.1	0.0	-3.1	0.0
September	-3.2	0.0	-1.2	0.0	-3.5	0.0

Table 6-22: Changes in Upper Marmion Reservoir Water Levels (Continuous Lake Water Balances) (Continued)

Month	Water Taking Scenario					
	Average Year		100 Year Wet		100 Year Dry	
	Maximum Change (cm)	Minimum Change (cm)	Maximum Change (cm)	Minimum Change (cm)	Maximum Change (cm)	Minimum Change (cm)
October	-3.7	0.0	-1.4	0.0	-4.1	0.0
November	-3.8	0.0	-1.1	0.0	-4.8	0.0
December	-4.4	0.0	-1.3	0.0	-6.1	0.0
Overall	-4.4	0.0	-1.4	0.0	-6.8	0.0

6.2.3 Summary of Predicted Changes

Water levels in Unnamed Lake 5 (API #8) located to the east of the TMF in site scale watershed R are expected to be influenced by Project activities. Changes in the range of -2.1 cm to 0.0 cm are expected during the operations phase, with the greatest changes occurring during the spring and the smallest changes occurring during the late fall/winter.

Changes in water levels in Lizard Lake, ranging from -2.7 cm to 0.0 cm, are also expected as a result of Project activities during the operations phase. The greatest changes are expected to occur during the spring and summer months, and the smallest changes during the late fall/winter.

Changes in water levels in Upper Marmion Reservoir due to Project activities during the operations phase are expected to be:

- In the range -9.0 cm (100-yr wet and dry years) to -0.4 cm (50-yr and 100-yr dry years) based on single-year lake water balance modelling. In an average year, the predicted maximum reduction in water levels is 8.1 cm. The frequency of occurrence of reservoir water levels falling below the minimum requirements stipulated in the operating plan for Raft Lake Dam is expected to remain essentially unchanged from existing conditions.
- In the range -6.8 cm (100-yr dry water taking scenario) to 0.0 cm (all water taking scenarios) based on continuous lake water balance modelling. With the average year water taking scenario, the predicted maximum reduction in water levels is 4.4 cm. The frequency of occurrence of reservoir water levels falling below the minimum requirements stipulated in the operating plan for Raft Lake Dam is expected to remain unchanged from existing conditions.

The predicted changes in monthly water levels in Upper Marmion Reservoir represent less than 6% of the average annual range in monthly water levels (1.58 m) recorded in the reservoir since 2004.

Given the small percentage changes predicted in outflows from Upper Marmion Reservoir as a result of the Project (Section 5.2.2.3), no measurable changes in water levels are predicted to occur in water bodies downstream of the reservoir.

7.0 NAVIGABILITY

7.1 Navigable Water

The federal 1985 *Navigable Waters Protection Act* was established to protect the public right of navigation in Canadian waters by prohibiting the building, placing or maintaining of any works in, on, over, under, through or across any navigable water without the authorization of the Minister of Transport Canada. The expression 'navigable water' designates any waterway or water body that is capable of being navigated by any type of floating vessel for the purpose of transportation, recreation or commerce, and includes both inland and coastal waters as well as canals and any other waterway or water body created or altered for the benefit of the public.

The final authority to determine the navigability of a waterway or water body rests with the Minister of Transport Canada or his/her designated representative. In practice, the approval of works affecting navigable waters is carried out by Transport Canada under the Navigable Waters Protection Program (NWPP) and the navigability of the waterway or water body is determined during the application process. Factors considered in the determination include:

- The characteristics of the waterway or water body (e.g. depth, width, length, natural obstructions, and existing works).
- The history of the waterway or water body including all navigational use. However, the frequency of navigation may not be the determining factor in classifying navigable waters. If a waterway or water body has the potential to be navigated, it will be determined navigable.

A waterway or water body need not be navigable in entirety nor navigable year-round in order to be considered navigable water. Therefore, for the purposes of this TSD, it has been assumed that all waterways and water bodies that may be affected by the Project are navigable waters.

The *Navigable Waters Protection Act* was amended in 2009 to streamline the federal review process. The *Minor Works and Waters Order* established classes of works and waters that do not require application and approval through the NWPP. Transport Canada (2010) outlines a two-stage review process to assess if navigable water may be classified as minor. The initial review consists of measuring only the average depth and average width of the navigable water. The navigable water may be considered minor if:

- The average bankfull depth of the navigable water is less than 0.3 m.
- The average bankfull width of the navigable water is less than 1.2 m.

The secondary review consists of analyzing additional characteristics in combination with the average bankfull width of the section of navigable water that extends 100 m upstream and 100 m downstream of the proposed works. The navigable water may be considered minor if the average bankfull width is 1.2 m or greater but less than 3.0 m and one of the following four conditions is true:

- The average bankfull depth of the navigable water is 0.6 m or less.
- The slope of the navigable water is greater than 4%.

- The sinuosity ratio of the navigable water is greater than 2.
- There are three or more natural obstacles.

If navigable water is deemed to be minor, the works being considered are exempt from the NWPP process.

7.2 Existing Conditions

7.2.1 Methods

7.2.1.1 Parameters

The characterization of waterways and water bodies that will be directly and/or indirectly affected by components of the Project has been based on:

- The parameters identified in the EIS Guidelines prepared for the Project by the CEA Agency (2011) which are:
  - **Representative Width and Depth.** These corresponded to the average bankfull width and depth over a 200 m long section of the navigable water.
  - **Gradient**. This was calculated as the vertical fall divided by the total length of the navigable water.
  - **Flow.** The long-term average annual mean flow was used to describe flow conditions in navigable water.
- Additional parameters identified in Transport Canada (2010), required for the classification of minor navigable water, which are:
  - **Sinuosity Ratio.** The sinuosity ratio is a measure of how a watercourse meanders and was calculated as the ratio of the channel length to the down valley length.
  - **Frequency of Natural Obstacles.** This corresponded to the number of obstacles along a 200-m long section of the navigable water. According to Transport Canada (2010), a natural obstacle is a natural physical obstruction in the navigable water, such as a beaver dam, a deadfall, a steep drop or thick vegetation that prevents the passage of a vessel.
- The presence of existing works affecting watercourses.

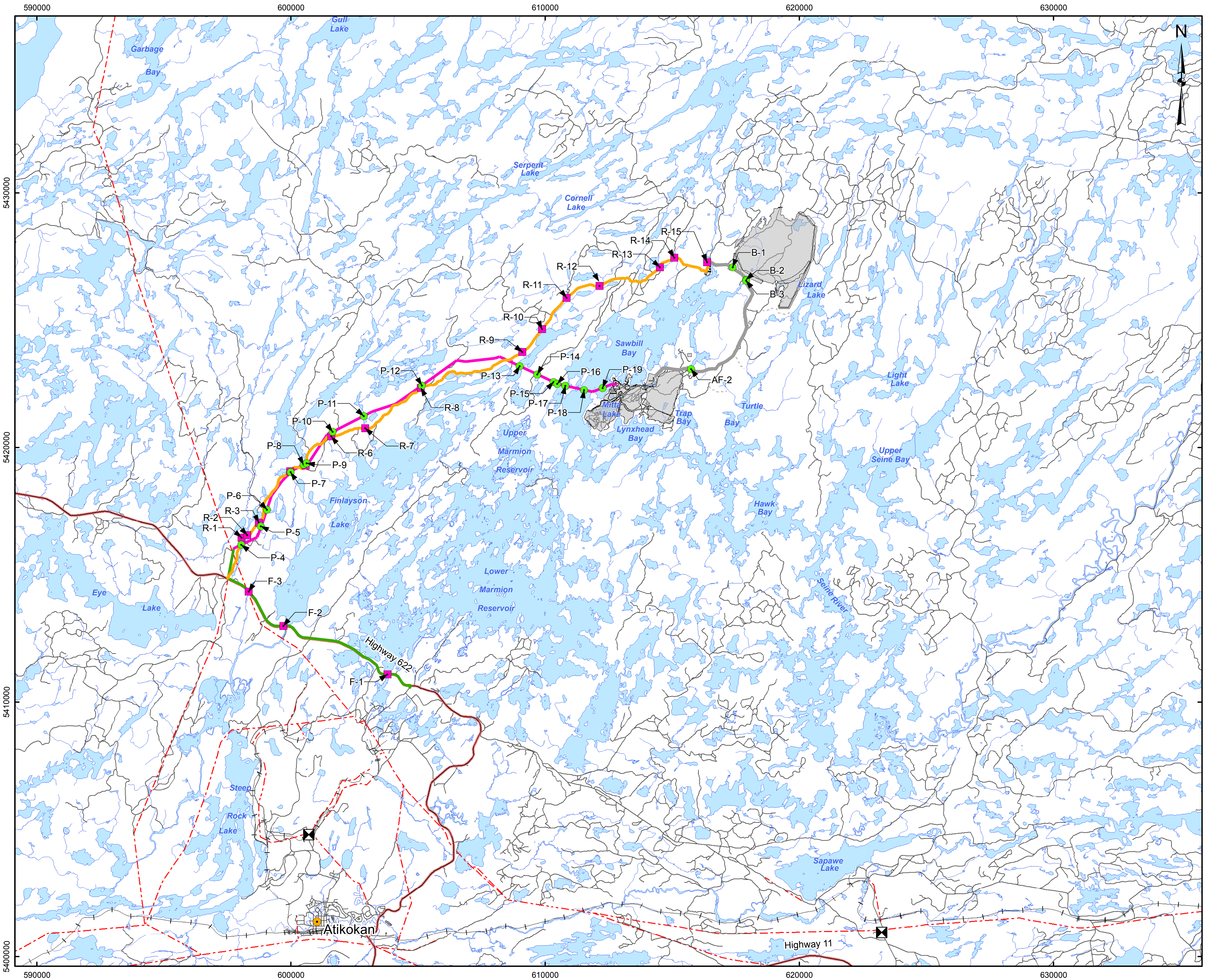
7.2.1.2 Field Studies

Field studies were completed in the Mine Study Area and consisted of:

- Surveys of the lower reaches of site scale watercourses draining the peninsulas where the Project is to be located (Figure 2-4). Surveys were completed in May and August 2012 and extended a distance 200 m upstream from the mouths of the watercourses.
- A survey of sections of site scale watercourses extending 100 m upstream and 100 m downstream of the sites of four new water crossings of the proposed mine site road (extending from the accommodation camp to the main access gate at the mine site) (Figure 7-1). Surveys were completed in August 2012.

The following field observations were collected during the above field surveys and are documented in Appendix 2.I:

- Bankfull width and depth. These were measured at the mouths and at sites 100 m and 200 m upstream of the mouths in the lower reaches of the site scale watercourses, and at the proposed sites of the watercourse crossings of the mine site road and 100 m upstream and 100 m downstream of the proposed sites.
- Frequency of natural obstacles. Natural obstacles were documented for watercourses with average bankfull widths of 1.2 m or greater (in some instances, natural obstacles in watercourses with average bankfull widths of less than 1.2 m were also documented).
- Direct flow measurements at suitable cross-sections in the lower reaches of the site scale watercourses and at the proposed sites for the watercourse crossings of the mine site road.



LEGEND

- City/Town
- Existing Water Crossing (R1)
- New Water Crossing (B1)
- Existing Power Transmission Station
- Provincial Highway
- Road
- Trail
- Existing Railway
- Power transmission line
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Fibre Optics Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000 6,000 8,000
SCALE 1:150,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
WATER CROSSINGS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 7-1	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Hydrology\TSD\WaterCrossings.mxd

7.2.1.3 Desktop Studies

Local Study Area

Desktop studies were used to supplement the findings of the field surveys in the Mine Study Area and to determine the characteristics of other navigable water in the Local Study Area. Desktop studies consisted of:

- Review of information collected on Areas of Potential Impact identified in the Aquatic Environment TSD to characterize site scale water bodies.
- Delineation of tributary drainage areas to the mouths of site scale watercourses and to the proposed sites of new water crossings of the mine site road. Tributary drainage areas were determined from Ontario Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS) 1:20,000 topographic data.
- Estimation of long-term average annual mean flows at the mouths of site scale watercourses and at the proposed sites of new water crossings of the mine site road. Flows were determined from the regional linear relationship between long-term average annual mean flow and tributary drainage area in Figure 5-7 (Section 5.1.2.2.2).
- Determination of the average gradient and sinuosity of the watercourses from NRVIS topographic data.
- Classification of minor navigable waters using Transport Canada's two-stage review process.
- Review of bathymetric survey data for Mitta Lake and Unnamed Lake 4 located within the Project footprint. Bathymetric surveys were completed in 2010 and 2011 (Golder 2012).

Linear Infrastructure Study Area

Desktop studies were used to characterize navigable waters along the proposed alignments of the access road (Hardtack/Sawbill Road), the project transmission line and the fibre optic line. These consisted of:

- Inventorying existing water crossings along the access road (Hardtack/Sawbill Road) (from Highway 622 to the junction with the mine site road (Reef Road) at the camps) based on NRVIS mapping.
- Inventorying new water crossings along proposed routes for the project transmission line and fibre optic line corridors based on NRVIS data.
- Delineation of tributary drainage areas to the water crossings from NRVIS data.
- Estimation of long-term average annual mean flows at the water crossings based on the regional linear relationship between long-term average annual mean flow and tributary drainage area in Figure 5-7 (Section 5.1.2.2.2).

7.2.2 Results

7.2.2.1 Local Study Area

Tables 7-1 to 7-4 summarize the relevant characteristics (with respect to navigability) of the water courses and water bodies (lakes and reservoirs) that were evaluated in the field and desktop studies.

The characteristics of the lower reaches of 34 site scale watercourses are presented in Table 7-1. Based on Transport Canada's screening process, 21 watercourses can be classified as minor navigable waters and

11 may be subject to the application process under the *Navigable Waters Protection Act*. Two sites were classified as wetland areas with no defined channel and are presumed not to be navigable. An additional 10 watersheds (AJ to AS in Figure 2-4) with possible watercourses were identified through desktop studies but were not visited in the field due to scheduling constraints. These sites may also be subject to the application process under the *Navigable Waters Protection Act*.

The characteristics of the site scale watercourses at new crossing sites along the proposed mine site road (Reef Road) are presented in Table 7-2. Based on the average bankfull width and depth and Transport Canada's screening process, watercourses B1, B2, B-3 and F-4 can be classified as minor navigable waters. Watercourse AF-5 may be subject to the application process under the *Navigable Waters Protection Act*.

The characteristics of the local scale watercourses are presented in Table 7-3. Based on the average bankfull width and depth and Transport Canada's screening process, neither Lumby Creek nor Sawbill Creek can be classified as minor navigable waters and these watercourses may be subject to the application process under the *Navigable Waters Protection Act*.

The characteristics of six site and local scale water bodies (lakes) are presented in Table 7-4. Based on Transport Canada's screening process, none of these water bodies can be classified as minor navigable waters and these water bodies may be subject to the application process under the *Navigable Waters Protection Act*.

Table 7-1: Characteristics of the Lower Reaches of Site Scale Watercourses

Water-course ID	NAD 83 UTM Zone 15N[(a)]	Tributary Drainage Area (km^2)	Long-Term Average Annual Mean Flow (m^3/s)	Perennial Stream	Average Bankfull Width (m)	Average Bankfull Depth (m)	Slope (m/m)	Sinuosity	Number of Obstacles	Minor Navigable Water
A	616953 E 5429178 N	5.90	0.077	Yes	3.2	0.6	1.0	1.7	16	No
B	617837 E 5426538 N	6.10	0.080	No	7.2	1.3	0.9	1.3	17	No
C	617657 E 5426048 N	1.35	0.018	No	7.0	0.7	1.4	1.4	18	No
D	616838 E 5424955 N	1.04	0.014	Yes	2.0	0.6	0.5	1.1	11	Yes
E	616502 E 5423489 N	1.23	0.016	Yes	9.0	0.6	0.5	1.2	13	No
F	616259 E 5423255 N	0.78	0.010	No	4.3	0.4	2.9	1.2	27	No
G	615083 E 5424006 N	0.31	0.004	No	—[(b)]	—[(b)]	5.8	1.1	—[(b)]	—[(b)]
H	614430 E 5423290 N	0.27	0.004	No	1.4	0.2	5.1	1.5	—[(c)]	Yes
I	613817 E 5422546 N	0.85	0.011	Yes	1.7	0.4	2.6	1.3	24	Yes
J	612538 E 5422318 N	0.26	0.003	No	6.1	0.6	4.7	1.1	24	No
K	611642 E 5421001 N	0.89	0.012	No	1.1	0.4	1.0	1.2	—[(c)]	Yes
L	614480 E 5420879 N	0.71	0.009	No	1.3	0.2	3.3	1.2	—[(c)]	Yes
M	617450 E 5421757 N	1.12	0.015	No	1.3	0.4	1.6	1.2	—[(c)]	Yes

Table 7-1: Characteristics of the Lower Reaches of Site Scale Watercourses (Continued)

Water-course ID	NAD 83 UTM Zone 15N[(a)]	Tributary Drainage Area (km^2)	Long-Term Average Annual Mean Flow (m^3/s)	Perennial Stream	Average Bankfull Width (m)	Average Bankfull Depth (m)	Slope (m/m)	Sinuosity	Number of Obstacles	Minor Navigable Water
N	618028 E 5422875 N	1.59	0.021	No	1.1	0.6	1.2	1.2	—[(c)]	Yes
O	619403 E 5424440 N	0.39	0.005	No	0.1	0.1	3.0	1.1	—[(c)]	Yes
P	619565 E 5425142 N	1.25	0.016	Yes	1.0	0.3	0.5	1.2	—[(c)]	Yes
Q	620234 E 5426671 N	2.73	0.036	No	4.8	0.6	0.8	1.2	10	No
R	620936 E 5427051 N	6.23	0.082	No	1.6	0.7	0.9	1.6	20	Yes
S	621005 E 5425285 N	2.31	0.030	Yes	6.0	0.9	0.8	2.2	13	No
T	618506 E 5421573 N	3.37	0.044	Yes	19.0	1.6	0.4	1.7	1	No
U	620932 E 5420684 N	2.01	0.026	No	4.7	0.6	0.9	1.3	17	No
V	622814 E 5423793 N	1.06	0.014	No	2.8	0.7	0.4	1.4	>30	Yes
W	620313 E 5423976 N	0.67	0.009	No	0.7	0.1	1.0	1.4	—[(c)]	Yes
X	620680 E 5420578 N	0.82	0.011	No	1.7	0.2	0.4	—[(c)]	—[(c)]	Yes
Y	619285 E 5420256 N	0.46	0.006	No	1.7	0.2	9.4	1.3	30	Yes
Z	618468 E 5422540 N	0.75	0.010	No	1.6	0.6	1.3	1.3	12	Yes

Table 7-1: Characteristics of the Lower Reaches of Site Scale Watercourses (Continued)

Water-course ID	NAD 83 UTM Zone 15N[(a)]	Tributary Drainage Area (km²)	Long-Term Average Annual Mean Flow (m³/s)	Perennial Stream	Average Bankfull Width (m)	Average Bankfull Depth (m)	Slope (m/m)	Sinuosity	Number of Obstacles	Minor Navigable Water
AA	616878 E 5421353 N	0.73	0.010	No	0.5	0.2	2.0	2.0	—[(c)]	Yes
AB	613579 E 5421293 N	0.52	0.007	No	1.3	0.2	1.7	1.5	—[(c)]	Yes
AC	616459 E 5425159 N	0.29	0.004	No	0.9	0.3	0.7	1.2	28	Yes
AD	612992 E 5421115 N	0.30	0.004	No	0.4	0.1	3.7	1.1	—[(c)]	Yes
AF	615619 E 5423121 N	0.78	0.010	Yes	4.1	0.3	3.8	2.0	28	No
AG	616332 E 5423726 N	0.34	0.004	No	—[(d)]	—[(d)]	—[(d)]	—[(d)]	—[(d)]	—[(d)]
AH	615549 E 5422139 N	0.68	0.009	No	0.1	0.1	—[(c)]	1.0	—[(c)]	Yes
AI	612133 E 5420545 N	0.10	0.001	No	1.7	0.2	12.7	1.1	—[(c)]	Yes

Notes:

(a) UTM coordinates at watershed outlet.

(b) Area dry and no defined channel identified.

(c) Not assessed.

(d) Wetland area, no defined channel identified.

Table 7-2: Characteristics of Site Scale Watercourses at New Water Crossings along the Proposed Mine Site Road (Reef Road)

Water Crossing ID	UTM NAD83 Zone 15	Drainage Area (km²)	Annual Mean Flow (m³/s)	Average Bankfull Width (m)	Average Bankfull Depth (m)	Mean Channel Slope (m/m)	Channel Sinuosity	Number of Natural Obstacles	Minor Navigable Water
B-1	617378 E 5427082 N	0.26	0.002	0.40	0.15	0.009	1.30	21	Yes
B-2	617898 E 5426581 N	5.04	0.041	7.17	1.28	0.009	1.30	17	Yes
B-3	617904 E 5426554 N	0.35	0.003	1.75	0.60	0.009	1.30	15	Yes
F-4[(a)]	616264 E 5423010 N	—[(b)]	—[(b)]	—[(b)]	—[(b)]	0.029	1.18	—[(b)]	Yes
AF-5[(a)]	615740 E 5423078 N	0.12	0.001	14.3	1.02	0.038	1.99	3	No

Notes:
(a) A crossing over a wetland area.
(b) Not assessed.

Table 7-3: Characteristics of the Lower Reaches of Local Scale Watercourses

Watercourse	Latitude/ Longitude	Tributary Drainage Area (km²)	Long-Term Average Annual Mean Flow (m³/s)	Perennial Stream	Average Bankfull Width (m)	Average Bankfull Depth (m)	Slope (m/m)	Minor Navigable Water
Lumby Creek	48.9541° N 91.3720° W	62.83	0.509	Yes	12.5	0.88	—[(a)]	No
Sawbill Creek	48.9867° N 91.4082° W	106.3	0.861	Yes	6.0	0.75	—[(a)]	No

Notes:
(a) Not assessed.

Table 7-4: Characteristics of Site and Local Scale Water Bodies (Lakes)

Water Body	API[a]	Water-shed	Drainage Area[c] (km²)	Long-Term Average Annual Mean Outflow[d] (m³/s)	Surface Area (km²)	Max. Length (m)	Max. Width (m)	Max. Depth (m)	Minor Navigable Water
Mitta Lake	12	K	0.68	0.009	0.17	980	390	16.0	No
Unnamed Lake 1	13	J	0.19	0.002	0.02	160	140	5.5	No
Unnamed Lake 3	11	L	0.13	0.002	0.03	280	125	5.5	No
Unnamed Lake 4	2	R	1.27	0.017	0.12	610	200	5.0	No
Unnamed Lake 5	8	R	5.73	0.075	0.18	865	345	7.0	No
Lizard Lake	—[b]	Lynxhead-Trap-Turtle-Bays	62.83	0.823	2.04	5,720	640	20	No

Notes:

(a) Area of Potential Impact identified in Aquatic Environment TSD.

(b) Not applicable.

(c) Tributary to lake outlet.

(d) Calculated from the drainage area using the relationship in Figure 5-7.

7.2.2.2 Access Road (Hardtack/Sawbill Road)

Figure 7-1 shows the locations of 15 existing water crossings (R-1 to R-15) along the access road (Hardtack/Sawbill Road) (from Highway 622 up to the junction with the mine site road (Reef Road)). This road will be upgraded under the Project; upgrading will include road widening and the lengthening of culverts and bridges at existing water crossings. These crossings were not included in the field surveys.

Table 7-5 provides information on tributary drainage areas and estimates of average annual mean flows (based on the regional relationship in Figure 5-7 in Section 5.1.2.2.2). Note that the watercourses at crossings R-8, R-10 and R-11 have previously been classified by Transport Canada as Non-Navigable Water (Golder 2011). An assessment for navigability of the remaining crossings will be carried out at the Project application stage, as required, to comply with Transport Canada's screening process.

Table 7-5: Watercourse/Water Body Characteristics at Existing Crossings along Hardtack/Sawbill Road

Water Crossing ID	UTM NAD83 Zone 15	Drainage Area (km^2)	Annual Mean Flow (m^3/s)
R-1	598051 E 5416455 N	1.39	0.011
R-2	617898 E 5426581 N	0.18	0.001
R-3	617904 E 5426554 N	0.57	0.005
R-4	615740 E 5423078 N	0.61	0.005
R-5	615740 E 5423078 N	0.25	0.002
R-6	615740 E 5423078 N	0.29	0.002
R-7	615740 E 5423078 N	38.16	0.309
R-8	615740 E 5423078 N	0.12	0.001
R-9	615740 E 5423078 N	10.24	0.083
R-10	615740 E 5423078 N	0.36	0.003
R-11	615740 E 5423078 N	4.18	0.034
R-12	615740 E 5423078 N	19.13	0.155
R-13	615740 E 5423078 N	1.79	0.014
R-14	615740 E 5423078 N	1.69	0.014
R-15	615740 E 5423078 N	106.34	0.861

7.2.2.3 Project Transmission and Fibre Optic Line Corridors

Figure 7-1 shows three possible new water crossings along the fibre optic line corridor, and 16 possible new water crossings along the project transmission line corridor. These crossings were not included in the field surveys.

Table 7-6 provides information characterizing the watercourses/water bodies at these locations, as determined from the desktop study. An assessment for navigability of the remaining crossings will be carried out at the Project application stage, as required, to comply with Transport Canada's screening process.

Table 7-6: Watercourse/Water Body Characteristics at New Water Crossings along the Proposed Fibre Optic Line and Project Transmission Line Corridors

Water Crossing ID	UTM NAD83 Zone 15	Drainage Area (km²)	Annual Mean Flow (m³/s)
F-1	603796 E 5411086 N	1.37	0.011
F-2	599697 E 5412983 N	4,526	36.7
F-3	598333 E 5414331 N	1.06	0.009
P-4	598039 E 5416175 N	1.39	0.011
P-5	598808 E 5416907 N	0.57	0.005
P-6	599047 E 5417555 N	0.13	0.001
P-7	599983 E 5419023 N	0.61	0.005
P-8	600492 E 5419321 N	0.28	0.002
P-9	600612 E 5419381 N	0.25	0.002
P-10	601634 E 5420612 N	0.29	0.002
P-11	602859 E 5421233 N	37.5	0.304
P-12	605149 E 5422431 N	0.10	0.001
P-13	608997 E 5423195 N	41.3	0.334
P-14	609689 E 5422871 N	0.07	0.001
P-15	610327 E 5422571 N	1.24	0.010
P-16	610477 E 5422500 N	0.04	0.000
P-17	610790 E 5422421 N	147	1.19
P-18	611530 E 5422254 N	147	1.19
P-19	612261 E 5422336 N	0.75	0.006

7.2.3 Summary of Existing Conditions

Table 7-7 presents a summary of the watercourses and water bodies that were included in field and desktop assessments to determine the navigability classification under existing conditions. A total of 91 sites were considered in the combined field and desktop assessment. Of these, 27 sites may be classified as minor navigable water based on Transport Canada's screening process, 20 may be subject to the Transport Canada application process and 41 sites could not be assessed due to insufficient information. For the unassessed sites, an assessment for navigability will be carried out at the Project application stage, as required, to comply with Transport Canada's screening process.

Table 7-7: Summary of Watercourses and Water Bodies in Field and Desktop Assessment

Project Component	Assessment Type	Watercourse Type	Total No. of Sites	Minor Navigable Water	Subject to Permit Process	Not Assessed
Mine Study Area	Field and Desktop	Site Scale Watercourses (Lower Reaches)	34	23	11	0
	Field and Desktop	Site Scale Watercourses (mine site road)	5	4	1	0
	Field and Desktop	Local Scale Watercourses	2	0	2	0
	Desktop	Site Scale Watercourses (Lower Reaches)	10	n/a	n/a	10
	Desktop	Lakes and Reservoirs	6	0	6	0
Access Road	Desktop	Watercourses	15	3	-	12
Project Transmission and Optic Lines	Desktop	Watercourses/ Lakes/Wetlands	19	-	-	19
Total			**91**	**30**	**20**	**41**

7.3 Prediction of Potential Changes

7.3.1 Determination of Bounding Scenario

Potential changes to navigable water from existing conditions have been identified as occurring in all four phases of the Project. The prediction of changes in navigable water has been based on a bounding (worst case) scenario: the Project phase when the combination of Project activities results in the greatest changes to navigable water.

The bounding scenario was selected by identifying the potential changes in navigable water as a result of Project activities in all phases of the Project. Table 7-8 summarizes the Project activities and the potential changes to navigable water from existing conditions associated with the various Project phases.

Table 7-8: Project Activities and Potential Changes to Navigable Waters

Project Activity	Potential Change
Construction Phase	
■ Upgrade of: ▪ Access road (Hardtack/Sawbill Road) ▪ Mine site road (Reef Road) ■ Construction of on-site roads	■ Obstructions (width, depth and height restrictions) in navigable water due to temporary works (e.g. cofferdams, detours, temporary bridges) ■ Obstructions (width, depth and height) in navigable water due to permanent works (e.g. culverts, bridges)

Table 7-8: Project Activities and Potential Changes to Navigable Waters (Continued)

Project Activity	Potential Change
■ Construction of: ▪ Fibre optic line ▪ Project transmission line	■ Obstructions (width, depth and height restrictions) in navigable water due to temporary works (e.g. cofferdams, detours, temporary bridges) required to facilitate construction access and activities
■ Construction of water intakes in Sawbill Bay for: ▪ Potable supply to the accommodation camp, and ▪ Freshwater supply to the processing plant	■ Obstructions (width and depth restrictions) in navigable water due to temporary works (e.g. cofferdams, temporary bridges/culverts) required to facilitate construction access and activities
■ Construction of effluent discharge outlet structures in Sawbill Bay for: ▪ Treated sewage from the accommodation camp, and ▪ Treated mine wastewater from the mine site	■ Obstructions (width and depth restrictions) in navigable water due to temporary works (e.g. cofferdams, temporary bridges/culverts) required to facilitate construction access and activities
■ Site preparation (clearing, grubbing and stripping) ■ Removal and stockpiling of soil and overburden material ■ Removal and stockpiling of sediment from Mitta Lake when dewatering of the lake is completed ■ Transfer and stockpiling of waste rock from Mine development	■ Increase in flows and water levels in downstream navigable water due to increased runoff rates and volumes as a result of changes to land cover ■ Loss of Mitta Lake as a navigable water due to dewatering activities
■ Temporary runoff diversion around construction works and Project facilities	■ Decrease and increase in flows and water levels in navigable water due to the diversion of runoff from one watershed to another watershed
■ Runoff collection from areas within the Project footprint following construction of the water collection system (e.g., ditches, sumps, pump stations, ponds)	■ Decrease in flows and water levels in downstream navigable water due to the interception of runoff
■ Dewatering of Mitta Lake with flows used to: ▪ Satisfy construction water requirements at the mine site and the Tailings Management Facility (TMF); and ▪ Provide start-up water in the TMF reclaim pond	■ Loss of Mitta Lake as a navigable water and decrease in flows and water levels in downstream navigable water due to water taking
■ Water taking from Sawbill Bay for potable and construction water supply at the accommodation camp	■ Reduction in flows and water levels in downstream navigable water due to water taking
■ Discharge of treated sewage effluent from the accommodation camp into Sawbill Bay	■ Increase in flows and water levels in downstream navigable water due to effluent discharge

Table 7-8: Project Activities and Potential Changes to Navigable Waters (Continued)

Project Activity	Potential Change
Operations Phase	
■ Progressive development of the Mine, Waste Rock Management Facility (WRMF), low-grade ore stockpile, overburden stockpile and TMF	■ Obstructions (width, depth and height restrictions) in navigable water due to the containment and/or removal of watercourses and water bodies by Project components
■ Transport of people and materials on: ▪ Access road (Hardtack/Sawbill Road) ▪ Mine site road (Reef Road) ▪ On-site roads	■ Obstructions (width, depth and height restrictions) in navigable water due to presence of the upgraded and newly constructed roads
■ Water taking from Sawbill Bay for: ▪ Potable water supply to the accommodation camp ▪ Freshwater supply to the processing plant	■ Decrease in flows and water levels in downstream navigable water due to water taking ■ Obstructions (width and depth restrictions) in navigable water due to presence of outlet structure in Sawbill Bay
■ Discharge of: ▪ Treated sewage effluent from the accommodation camp into Sawbill Bay ▪ Treated wastewater effluent from the mine site into Sawbill Bay	■ Increase in flows and water levels in downstream navigable water due to water taking ■ Obstructions (width and depth restrictions) in navigable water due to presence of outlet structures in Sawbill Bay
■ Runoff collection from areas within the Project footprint to meet, in part, the water requirements for ore processing	■ Decrease in flows and water levels in downstream navigable water due to the interception of runoff
■ Discharge of runoff from the accommodation camp, emulsion plant and detonator storage area into Sawbill Bay Runoff from these areas will not be collected	■ Increase in flows and water levels in downstream navigable water due to increased runoff rates and volumes, as a result of changes in land cover
■ Mine dewatering	■ Decrease in flows and water levels in downstream navigable water due to: ▪ The interception of runoff within the Mine footprint ▪ The seepage of surface water from the Upper Marmion Reservoir into the open pits
Closure	
■ Transport of people and materials on: ▪ Access road (Hardtack/Sawbill Road) ▪ Mine site road (Reef Road)	■ Obstructions (width, depth and height restrictions) in navigable water due to use of the roads

Table 7-8: Project Activities and Potential Changes to Navigable Waters (Continued)

Project Activity	Potential Change
■ Decommissioning of the accommodation camp, emulsion plant, detonator storage area, Ore Processing Facility, and administration offices These Project facilities will be demolished, the ground scarified and re-vegetated, and pre-development flow directions restored where possible	■ Increase in flows and water levels in downstream navigable water due to the change in land cover Reclaimed land may initially yield higher runoff rates and volumes due to less dense vegetation
■ Runoff collection from the Waste Rock Management Facility (WRMF), low-grade ore stockpile, overburden stockpile and TMF Runoff will continue to be routed to the Mine Water Emergency Spill Pond and effluent treatment plant	■ Decrease in flows and water levels in downstream navigable water due to the interception of runoff
■ Discharge of treated wastewater effluent from the mine site into Sawbill Bay The accommodation camp will be decommissioned and the discharge of treated effluent into Sawbill Bay will cease	■ Increase in flows and water levels in downstream navigable water due to effluent discharge
■ Back-flooding of the Mine At the end of mining, dewatering of the open pits will cease and the open pits will slowly fill with water	■ Decrease in flows and water levels in downstream navigable water due to: ▪ The interception of runoff within the Mine footprint ▪ The seepage of water from the Upper Marmion Reservoir into the open pits
Post-closure	
■ Transport of people and materials on: ▪ Access road (Hardtack/Sawbill Road) ▪ Mine site road (Reef Road)	■ Obstructions (width, depth and height restrictions) in navigable water due to presence of the roads
■ Runoff collection from the WRMF, low-grade ore stockpile, overburden stockpile and TMF, until water quality is acceptable for direct discharge to the environment Runoff from these facilities will be routed to the open pits to accelerate back-flooding	■ Decrease in flows and water levels in downstream navigable water due to the interception of runoff
■ Back-flooding of the Mine	■ Decrease in flows and water levels in downstream navigable water due to: ▪ The interception of runoff within the Mine footprint ▪ The seepage of water from the Upper Marmion Reservoir into the open pits
■ Discharge of runoff from the TMF into Sawbill Bay, when water quality is acceptable for direct discharge to the environment	■ Decrease and increase in flows and water levels in downstream navigable water due to runoff diversion from the Trap-Turtle-Lynxhead Bays watershed to the Sawbill Bay watershed

Table 7-8: Project Activities and Potential Changes to Navigable Waters (Continued)

Project Activity	Potential Change
■ Discharge of runoff from the WRMF, low-grade ore stockpile and overburden stockpile into Sawbill Bay, Trap Bay and Lynxhead Bay, when water quality is acceptable for direct discharge to the environment The WRMF and low-grade ore stockpile will be graded to shed runoff and reduce infiltration, but will not be covered with soil or re-vegetated The overburden stockpile will be graded to shed runoff and reduce infiltration and its surface will be directly re-vegetated	■ Decrease and increase in flows and water levels in navigable water as a result of changes in land cover ■ Lower runoff rates and volumes are expected from the WRMF and low-grade ore stockpile due to the larger grain size of the surface material ■ The overburden stockpile may initially yield higher runoff rates and volumes due to less dense vegetation but rates and volumes will gradually decrease as vegetation matures
■ Overflow of water from the flooded open pits	■ Decrease and increase in flows and water levels in downstream navigable water as a result of runoff diversion from one watershed to another ■ Increase in flows and water levels in downstream navigable water due to changes in land cover Higher runoff rates and volumes are expected from the surface of the flooded open pits compared to natural ground

During the construction phase, the navigability of waterways and water bodies is expected to be altered from existing conditions as a result of:

- Upgrades to the access road (Hardtack/Sawbill Road) and mine site road and construction of on-site roads. Upgrades to the access road may involve modifications to 15 existing water crossings. Realignment of the mine site road and the construction of on-site roads will require five or more new water crossings.
- Construction of the fibre optic line and the project transmission line. Construction will require 19 new water crossings. However, it is expected that the fibre optic line and project transmission line will be supported by structures built on or away from the banks of the watercourses/water bodies and that these structures will not enter the water nor will their construction require entry into the water.
- Construction of the water intake and effluent discharge structures;
- Changes in flows and water levels as a result of changes in land cover, runoff diversion, runoff interception, lake dewatering, water taking and effluent discharge.

The first two bullet points above have the potential to produce the greatest changes in navigable water since navigation will be aggravated by the operation of construction equipment, which typically creates a temporary interference that can extend beyond the footprint of the structure that is being built.

During the operations phase, the navigability of waterways and water bodies will continue to be influenced by the presence and use of the access road (Hardtack/Sawbill Road), mine site road (Reef Road) and on-site roads. In addition, the progressive expansion of the Mine, overburden stockpile, WRMF and TMF will consume Mitta Lake, four smaller unnamed lakes and several small watercourses in the Mine Study Area. The presence and use of the water intake and effluent discharge structures should be minimal as they will be constructed well below navigable water depth, however, changes in flows and water levels as a result of changes in land cover, runoff interception, lake dewatering, water taking and effluent discharge are all expected to be greater in the operations phase than in the construction phase

During the closure phase, changes to the flows and water levels in navigable waters are expected to be smaller than during the operations phase as a result of the following activities. The accommodation camp, emulsion plant, detonator storage area, Ore Processing Facility and administration offices will be decommissioned and land occupied by these facilities will be reclaimed and pre-development drainage patterns restored where possible. Water taking for potable water supply to the camp and freshwater supply to the mine site, and the discharge of treated sewage from the accommodation camp, will cease. In addition, the mine dewatering system will be taken out of service and back-flooding of the open pits will be allowed to commence, thus restoring navigability to the lakes and streams that were previously consumed by mine operations.

During the post-closure phase, changes in flows and water levels in navigable water are expected to be smaller than during the closure phase as vegetative cover in reclaimed areas continues to mature, thus reducing runoff rates and volumes. In addition, decommissioning of the mine site road will restore navigability to several site scale watercourses. Navigability will continue to be affected by the continued presence and use of the access road (Hardtack/Sawbill Road) (stream crossings).

Based on the above, it is concluded that the bounding (worst case) scenario for navigability occurs during the operations phase of the Project. Methods for the evaluation of expected changes to existing flows in site, local and regional scale watercourses during the operations phase are described below.

7.3.1.1 Prediction of Potential Changes

Potential changes to navigability during the operations phase (bounding scenario) can be broadly categorized as follows:

- Changes to flows and lake water levels affecting navigation.
- Physical obstructions (structures) affecting navigation.

Predicted changes to flows and lake water levels (potentially affecting water depths and widths) to site, local and regional scale watercourses and water bodies are evaluated in Section 5 and Section 6, respectively.

Physical obstructions potentially affecting navigability are expected to result from the presence and use of the following Project structures/components:

- Mine site road (Reef Road) stream crossing upgrades (site and local scales).
- On-site road (new) stream crossings (site scale).
- Water intake and effluent discharge structures in Sawbill Bay in the Upper Marmion Reservoir (regional scale).
- Access road (Hardtack/Sawbill Road) stream crossing upgrades (local and regional scales).

Upgrading of the existing stream crossings along the mine site road (Reef Road) and access road (Hardtack/Sawbill Road) is expected to involve widening of the roadways and replacement or extension of existing culverts. The potential change to navigability is to nominally increase the length of the portage around these existing obstructions.

The new stream crossings along the proposed on-site roads will create new obstructions to navigation, in addition to the numerous natural obstructions that currently exist on most of these streams. The potential change to navigability is to create a requirement to portage around these new obstructions.

The effluent discharge structure to Sawbill Creek will have a localized influence on the stream banks at the outfall location, but it can be constructed in a manner that minimizes the protrusion of the structure into the stream channel. Therefore the effect on navigability is likely to be minor.

Both the potable and mine process water supply intake structures and the treated wastewater discharge structure to Sawbill Bay are expected to be constructed in water depths that will provide adequate clearance (draught) for recreational boat traffic. In addition, signage warning boaters of potential underwater hazards can be installed to ensure that boaters stay clear of these locations Therefore, the change to navigability is likely to be minor.

7.3.2 Summary of Predicted Changes

Changes to Navigability due to Changes in Streamflows

Changes in streamflows were predicted in Section 5.2.

Changes in flows in site scale watercourses are expected to be roughly proportional to changes in their tributary drainage area. Of the 29 site scale watersheds assessed:

- Five are not affected by the Project footprint (0% change in tributary drainage area).
- Three are reduced in size by less than 10 % (runoff is intercepted by the Project water collection system).
- Six are reduced in size by less than 50% (greater than 10%).
- Nine are reduced in size by less than 90% (greater than 50%).
- Six are reduced in size by more than 90% (one by 100%).

Notable changes, with respect to navigability, are most likely to occur in cases where flows are reduced by 50% or more (i.e. 21 of 29 watersheds affected by the Project). Watercourses in the six site scale watersheds (AI, I, J, K, L and Q) where flows are expected to be reduced by 90% or more are essentially removed (taken over) by the Project footprint and would no longer retain any potential for navigation.

The predicted changes in the local scale watercourse, Lumby Creek, affected by the Project are described below. Notable changes with respect to navigability are not expected to occur.

- A reduction in flows in Lumby Creek of approximately 8% as a result of the interception of runoff from the Project footprint by the water collection system.

On a regional scale, the predicted changes in outflows from Upper Marmion Reservoir due to Project operations are less than 5% (reduced flows). Thus, the expected change in the navigability of the Seine River downstream of Raft Lake Dam is considered to be minor.

Changes to Navigability due to Changes in Lake Levels

Changes in lake water levels are predicted in Section 6.2.

At the site scale, four water bodies will be completely in-filled and consumed by the Project footprint. These are:

- Mitta Lake (API #12), located within the footprint of the West Pit.
- Unnamed Lake 1 (API #13), which is to be used as the Mine Water Emergency Spill Pond.
- Unnamed Lake 3 (API #11), located within the footprint of the Waste Rock Stockpile.
- Unnamed Lake 4 (API #2), located within the footprint of the base case TMF.

The above lakes would no longer retain any potential for navigation.

Also at the site scale, changes in the water levels in Unnamed Lake 5 (API #8) located to the east of the TMF in watershed R are expected to be in the range of -2.1 cm to 0.0 cm during the operations phase, with the greatest changes occurring during the spring and the smallest changes occurring during the late fall/winter.

On a local scale, changes in water levels in Lizard Lake, ranging from -2.7 cm to 0.0 cm, are predicted. The greatest changes are expected to occur during the spring and summer months, and the smallest changes during the late fall/winter.

Changes in the water levels in Upper Marmion Reservoir during the operations phase are expected to be:

- In the range -9.0 cm to -0.4 cm based on single-year lake water balance modelling; and
- In the range -6.8 cm to +0.0 cm based on continuous lake water balance modelling.

In the case of Unnamed Lake 5 (API #8), Lizard Lake and Upper Marmion Reservoir, the predicted maximum changes in water levels are minor (i.e., less than 10 cm). Relative to the depths of water in these lakes, these changes are unlikely to result in an appreciable change to navigation potential in these water bodies.

Changes to Navigability due to Stream Crossings along Roadways

Upgrading of the existing stream crossings along the access road (Hardtack/Sawbill Road) and mine site road (Reef Road) and the presence of the new crossings created along the proposed on-site roads may affect navigable waters by modestly increasing the length of the portage in the case of the former, and by creating the requirement to portage around new obstructions in the case of the latter.

Changes to Navigability due to Water Intake and Effluent Discharge Structures

The operation of the potable and mine process water intake structures in Sawbill Bay as well as the treated effluent discharge structures in Sawbill Bay are expected to be minimal in terms of their potential influences on navigable waters.

8.0 MONITORING PROGRAM

8.1 Program Objectives

The objectives of the Hydrology monitoring program are to:

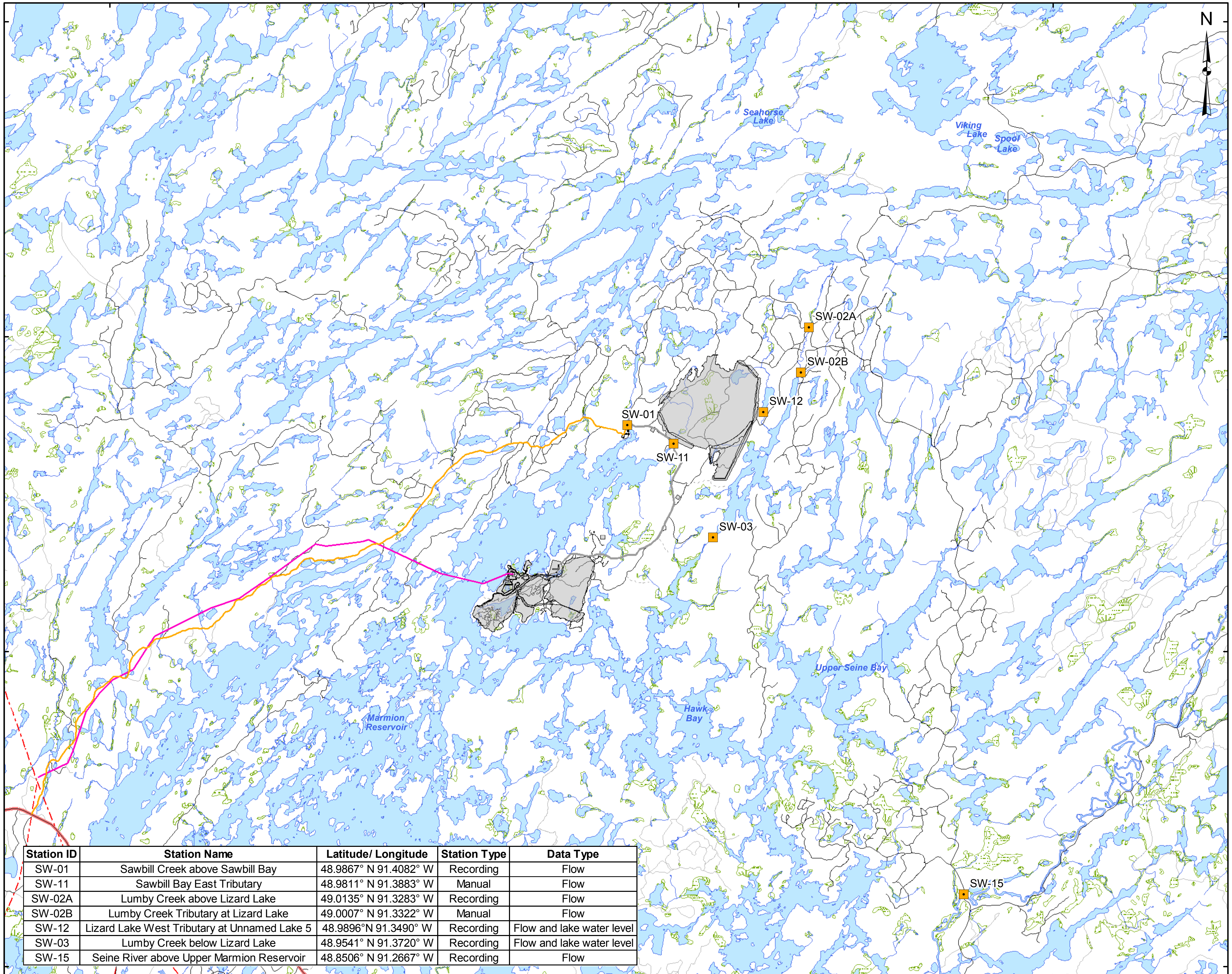
- Verify the accuracy of the predicted changes in flows and lake water levels in site, local and regional scale watercourses and water bodies.
- Confirm the assumptions underlying the predicted changes (e.g. water takings, effluent discharges, runoff rates).
- Support the implementation of adaptive management measures to address previously unanticipated changes.
- Satisfy compliance monitoring requirements included in Certificates of Approval and Permits to Take Water issued by the Ontario Ministry of the Environment pursuant to the *Ontario Water Resources Act* and in *Fisheries Act* Authorizations issued by Fisheries and Oceans Canada and authorizations issued pursuant to *the Navigable Waters Act* (if applicable).

8.2 Monitoring Activities

8.2.1 Field Studies

Field studies will consist of flow and water level monitoring in site, local and regional scale watercourses and water bodies identified as potentially being affected by Project activities and at key points in the Project's water management system to confirm and update estimates of water takings, effluent discharges and water recycling. Field monitoring activities for Hydrology will be coordinated with monitoring activities for other disciplines where appropriate, to reduce costs and increase efficiency.

It is proposed to operate a total of seven monitoring stations in site, local and regional scale watercourses as shown in Figure 8-1. The station locations and types, and the data to be collected are shown in Table 8-1.



Station ID	Station Name	Latitude/ Longitude	Station Type	Data Type
SW-01	Sawbill Creek above Sawbill Bay	48.9867° N 91.4082° W	Recording	Flow
SW-11	Sawbill Bay East Tributary	48.9811° N 91.3883° W	Manual	Flow
SW-02A	Lumby Creek above Lizard Lake	49.0135° N 91.3283° W	Recording	Flow
SW-02B	Lumby Creek Tributary at Lizard Lake	49.0007° N 91.3322° W	Manual	Flow
SW-12	Lizard Lake West Tributary at Unnamed Lake 5	48.9896°N 91.3490° W	Recording	Flow and lake water level
SW-03	Lumby Creek below Lizard Lake	48.9541° N 91.3720° W	Recording	Flow and lake water level
SW-15	Seine River above Upper Marmion Reservoir	48.8506° N 91.2667° W	Recording	Flow

LEGEND

- Proposed Follow-Up Monitoring Stations
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000 6,000
SCALE 1:125,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

PROPOSED FOLLOW-UP MONITORING STATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 8-1	
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

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Table 8-1: Monitoring Stations in Site Local and Regional Scale Watercourses and Water Bodies

Station ID	Station Name	Scale	Latitude/ Longitude	Station Type	Data Type
SW-01	Sawbill Creek above Sawbill Bay	Local	48.9867° N 91.4082° W	Recording	Daily mean flow
SW-11	Sawbill Bay East Tributary	Site	48.9811° N 91.3883° W	Manual	Instantaneous flows
SW-02A	Lumby Creek above Lizard Lake	Local	49.0135° N 91.3283° W	Recording	Daily mean flow
SW-02B	Lumby Creek Tributary at Lizard Lake	Local	49.0007° N 91.3322° W	Manual	Instantaneous flow
SW-12	Lizard Lake West Tributary at Unnamed Lake 5	Site	48.9896°N 91.3490° W	Recording	Daily mean flow Daily mean lake water level
SW-03	Lumby Creek below Lizard Lake	Local	48.9541° N 91.3720° W	Recording	Daily mean flow Daily mean lake water level
SW-15	Seine River above the Upper Marmion Reservoir	Regional	48.8506° N 91.2667° W	Recording	Daily mean flow

Stations SW-01, SW-11, SW-02A, SW-02B, SW-12 and SW-03 are existing monitoring stations. However, stations SW-01, SW-02A and SW-03 will require upgrading since the current installations are not suitable for long-term monitoring, and SW-12 will require relocation upstream to monitor lake water levels in and outflows from Unnamed Lake 5. SW-15 will be a new monitoring station.

It is proposed that recording stations consist of stilling well type installations on the banks of watercourses/water bodies, with intake pipes extending into the water. Data logging devices will be installed in the stilling wells to record water levels at half hourly intervals. Where applicable (i.e. at automatic recording stations), water level data will be converted to flow data using rating curves developed for the stations. Rating curves will be developed and maintained by collecting manual readings of water levels and direct flow measurements at the stations seasonally (i.e. four times per year in August, October, March and May) to broadly cover the range of hydrological conditions.

Existing monitoring stations are currently operating and will continue to be operated throughout the period prior to the construction phase and thereafter throughout the four phases of the Project. Monitoring at relocated and new stations will commence prior to the start of the construction phase, to establish existing conditions, and will continue throughout the four phases of the Project.

It is also proposed to install metering devices to record flow volumes at key locations in the Project's water management system. These locations and the data to be collected are shown in Table 8-2.

Table 8-2: Flow Metering Locations in Water Management System

Location	Data Type
Potable and fresh water intakes	Daily flow volumes
Treated sewage and mine wastewater effluent discharge outlets	Daily flow volumes
Mine dewatering pump stations	Weekly flow volumes
Mine water pump station	Weekly flow volumes
Tailings Management Facility (TMF) reclaim pond pump station	Weekly flow volumes
TMF seepage collection pump stations	Weekly flow volumes
Mine site water collection pump stations	Weekly flow volumes

In addition, daily mean water levels in the TMF reclaim pond and the Mine Water Emergency Spill Pond will be monitored: data logging devices will be installed to record water levels at hourly intervals.

Metering and data logging devices will be established in individual components of the water management system, prior to their commissioning and use, and data will be collected during the four phases of the Project as applicable.

8.2.2 Secondary Data Collection

In addition to carrying out field studies, the following secondary data in electronic format will be sourced on an annual basis throughout the four phases of the Project:

- On-site precipitation, temperature and evaporation data collected at the Project meteorological station (Atmospheric Environment TSD). It is recommended that the existing on-site meteorological station be expanded to include an evaporation pan that is operated between May and October.
- Precipitation and temperature data collected at Environment Canada's Atikokan (AUT) meteorological station.
- Flow and water level data for Lac des Mille Lacs, the Lower Marmion Reservoir and the Upper Marmion Reservoir collected by H2O Power Limited Partnership and Valerie Falls Limited Partnership (Brookfield Renewable Energy Group) as part of compliance monitoring under the Seine River Water Management Plan (Boileau 2004).

8.2.3 Desktop Methods

Appropriate desktop methods (analytical and modelling techniques) will be applied to the hydrological data collected in field studies and sourced externally in order to:

- Validate and update characterizations of existing flow and lake water level regimes, which were based on regional analyses. Existing monitoring stations will continue to be operated throughout the period prior to the construction phase and thereafter throughout the four phases of the Project. Monitoring at relocated and new stations will commence a minimum of one year prior to the start of the construction phase, to establish existing conditions, and will continue throughout the four phases of the Project.
- Update estimates of the predicted changes in flows and lake water levels during the four phases of the Project.

- Confirm estimates of the predicted changes in flows and lake water levels during each of the Project phases.
- Update estimates of water takings, effluent discharges and water recycling, which were based on a deterministic site wide water balance model of the mine site. It is proposed that a probabilistic site wide water balance model be developed to International Cyanide Management Code standards once the mine becomes operational.

8.2.4 Reporting

Compliance reporting requirements will be prescribed in provincial and federal approvals, permits and authorizations. It is anticipated that reporting will be on an annual basis in electronic and hard copy formats. Reporting with respect to Permits to Take Water will include daily volumes of water taken, but may also include conditions on storage of water and conducting water efficiency audits. Reporting with respect to Certificates of Approval will consist of monitoring data together with a compliance assessment summary of performance.

In addition to compliance reporting, it is proposed that annual monitoring reports be provided to key stakeholder members participating in the Seine River Water Management Plan, e.g., the Seine River Water Level Technical Committee, Ministry of Natural Resources (Thunder Bay and Fort Frances Districts), H2O Power Limited Partnership and Valerie Falls Limited Partnership. Reporting would be in electronic and hard copy format, but could also take the form of presentations at meetings of the Seine River Water Level Technical Committee. These reports would include full descriptions of monitoring activities completed in the previous year, rather than the focused scopes of compliance reports.

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10.0 GLOSSARY OF TERMS

Table 10-1: Glossary of Terms

Term	Definition
Actual Evapotranspiration	The actual amount of water that is evaporated or transpired from a vegetated surface depending on the availability of moisture in the soil for the use of vegetation.
Annual Minimum 30-Day Mean Flow	The lowest mean value for any 30 consecutive day period in a year.
Annual Minimum 7-Day Mean Flow	The lowest mean value for any seven consecutive day period in a year.
Bankfull Depth	The average vertical distance between the stream bed and the estimated water surface elevation required to completely fill the stream to a point above which water would enter the flood plain.
Bankfull Flow	The flow at the point of incipient flooding when the rising water level begins to flow out of the stream and over the flood plain.
Bankfull Width	The lateral extent of the water surface elevation at bankfull depth.
Base Flow	That part of streamflow that is not attributable to direct runoff from rainfall or snowmelt.
Base Flow Index	The ratio of the annual base flow in a stream to the total annual flow.
Boreal	Of or relating to the forest areas of the northern North Temperate Zone, dominated by coniferous trees.
Dendritic Drainage Pattern	A drainage pattern in which streams branch randomly in all directions and at almost any angle, resembling in plan the branching habit of trees.
Double Mass Analysis	A method of checking the consistency of a hydrological or meteorological record at a given location against records at a number of nearby locations. It is used to determine whether there is a need for corrections to data to account for changes in data collection procedures or other local conditions.
Entrenchment Ratio	A measure of the vertical confinement (bank height) of a stream; determined by dividing the width of the flood prone area by the bankfull width. The flood prone area is defined by measuring the width of the channel at twice bankfull depth.
Ephemeral Stream	A stream that flows only for hours or days during or immediately after a precipitation event (i.e. storm rainfall or snowmelt).
Exceedance Percentile	The magnitude of flow or lake water level above which a certain percent of observations fall.
Frequency Analysis	A method of statistical analysis to relate the magnitude of extreme events to their frequency of occurrence through the use of probability distributions.
Homogeneity	A hydrological time series is homogeneous if the statistical properties of any one part of the dataset are the same as any other part.
Interflow	The lateral movement of water that occurs in the upper part of the unsaturated zone of the underlying soil strata that directly enters a stream or other body of water.

Table 10-1: Glossary of Terms (Continued)

Term	Definition
Intermittent Stream	A seasonal stream that flows for part of the year; flow ceases for weeks or months each year.
Inter-Quartile Range	A measure of statistical dispersion, being equal to the difference between the 25th and 75th exceedance percentiles.
Lake Evaporation	The water loss from ponds and small reservoirs which have negligible heat storage capacities.
Linear Regression	An approach to modelling the relationship between a scalar dependent variable y on an explanatory variable x. The mathematical technique for finding the straight line that best fits the values of a linear function plotted on a scatter graph as data points.
Overland Flow	Water running over the surface of the land into a stream or body of water. May occur due to impermeable rock surfaces, saturated soils, rainfall intensity exceeding infiltration rate, snow/ice melt and compacted soils.
Pan Evaporation	The measured evaporative water loss from a standard container filled with water.
Parallel Drainage Pattern	A drainage pattern in which the streams and their tributaries are regularly spaced and flow parallel or sub-parallel to one another over a considerable area.
Perennial Stream	A stream that has continuous flow in parts of its stream bed all year round during years of normal rainfall.
Potential Evapotranspiration	The amount of water that would be evaporated or transpired from a vegetated surface if there is sufficient moisture in the soil at all times for the use of the vegetation.
Probability Distribution	A statistical function that describes all the possible values and likelihoods that a random variable can take within a given range.
Range	The difference between the maximum and the minimum flow or lake water level of a specified duration.
Rating Curve	A graph of flow versus water level at a particular point on a stream.
Rating Equation	An equation describing the graph of flow versus water level at a particular point on a stream.
Reference Crop Evapotranspiration	The evapotranspiration rate from a reference surface, a hypothetical grass reference crop with specific characteristics.
Return Period	The average time interval between actual occurrences of a hydrological event of a given or greater magnitude. The reciprocal of the annual probability of exceedance of a specific magnitude of flow, lake water level or precipitation total.
Riparian Flows	The high flows that access the flood plain on a fairly regular basis. These discharges form and sustain the complex environment adjacent to and overlapping the stream channel.

Table 10-1: Glossary of Terms (Continued)

Term	Definition
Runoff	That part of total precipitation which is not absorbed by deep strata, but finds its way into streams after meeting the persistent demands of evapotranspiration.
Runoff Coefficient	The ratio of the depth of runoff from the drainage basin to the depth of total precipitation.
Seepage	The slow movement of water through small openings and spaces in the surface of unsaturated soil, into or out of a body of surface or subsurface water.
Sinuosity Ratio	A measure of how a watercourse meanders; calculated as the ratio of the channel length to the down valley length.
Stationarity	A hydrological time series is stationary if it is free of trends, shifts, or periodicity (cyclicity).
Surficial Geology	The study of surface sediments, including soils. The term is sometimes applied to the study of bedrock at or near the earth's surface.
Thalweg	A line connecting the lowest points of successive cross-sections along the course of a stream.
Total Precipitation	The sum of rainfall and snowfall.
Trellis Drainage Pattern	A drainage pattern characterized by parallel main streams and secondary tributaries intersected at right angles by tributaries.
Tributary Drainage Area	The geographical area drained by a river and its tributaries; an area characterized by all runoff being conveyed to the same outlet. *Syn.:* Watershed.
Unit Runoff	The flow per unit drainage area, expressed either in L/s/km² or in mm (for a specified time period).
Valued Ecosystem Component	The environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance.
Watershed	An area or region drained by a river, river system, or other body of water.

11.0 ABBREVIATIONS, ACRONYMS AND INITIALISMS

Table 11-1: List of Abbreviations, Acronyms and Initialisms

Acronym	Definition
API	Area of Potential Impact, Aquatic Environment TSD
AUT	Automated
CEA	Canadian Environmental Assessment
DA	Drainage Area
EA	Environmental Assessment
EIS	Environmental Impact Statement
FDC	Flow Duration Curve
GIS	Geographic Information System
IJC	International Joint Commission
LISA	Linear Infrastructure Study Area
LP	Limited Partnership
LSA	Local Study Area
MOE	Ontario Ministry of the Environment
MSA	Mine Study Area
NAD	North American Datum
NRVIS	Natural Resources and Values Information System, Ontario Ministry of Natural Resources
NWPP	Navigable Waters Protection Program
OHRG	Osisko Hammond Reef Gold Ltd.
OMNR	Ontario Ministry of Natural Resources
ON	Ontario
O. Reg.	Ontario Regulation
PTTW	Permit to Take Water
TMF	Tailings Management Facility
ToR	Terms of Reference
TSD	Technical Support Document
WRMF	Waste Rock Management Facility
VEC	Valued Ecosystem Component
USA	United States of America

Table 11-1: List of Abbreviations, Acronyms and Initialisms (Continued)

Acronym	Definition
UTM	Universal Transverse Mercator geographic coordinate system

12.0 UNITS

Table 12-1: List of Units

Unit	Abbreviations
°C	degree Celsius
%	Percentage
cm	centimetre
cm/d	centimetres per day
ha	hectare
km	kilometre
km^2	square kilometre
L/d	litres per day
L/s	litres per second
$L/s/km^2$	litres per second per square kilometre
m	metre
m/km	metres per kilometre
m/m	metres per metre
m^3	cubic metre
m^3/d	cubic metres per day
m^3/hr	cubic metres per hour
m^3/s	cubic metres per second
$m^3/s/d$	cubic metres per second per day
masl	metres above sea level
min	minute
mm	millimetre
sm^{-1}	seconds per metre
yr	year

APPENDIX 2.I

Characterization of Site Scale Watercourses

Table of Contents

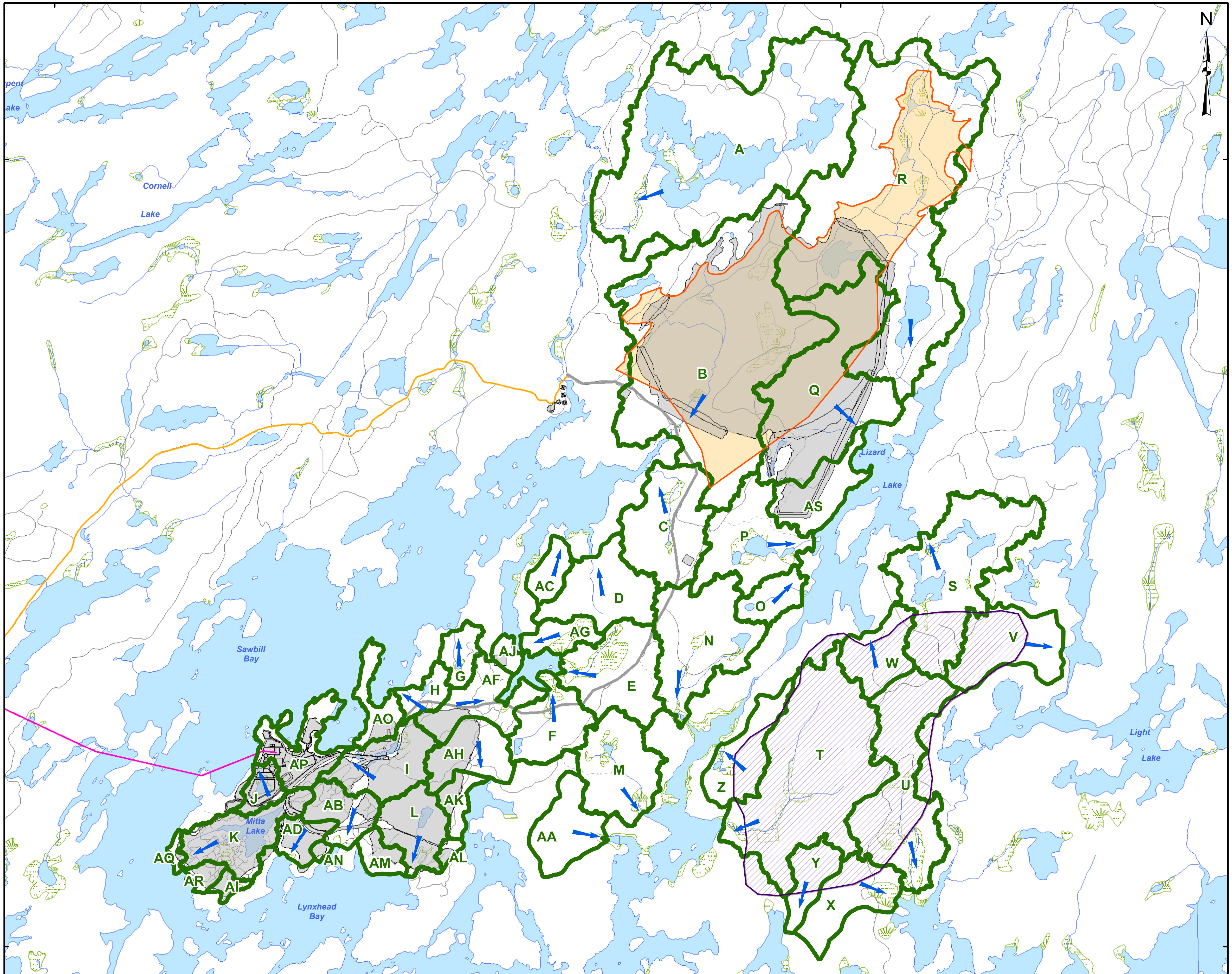
1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. (OHRG) is planning the development of a gold mine deposit in north-western Ontario. The mine is located approximately 170 km west of Thunder Bay and approximately 23 km northeast of the town of Atikokan. The project will involve the development of an open pit mining area, as well as waste rock and tailings management facilities. On-site infrastructure will include a processing plant, an explosives plant, offices and maintenance facilities. Off-site infrastructure will include the upgrading of site access and construction of a power transmission line and a fibre optics line.

The Project is located on the right bank of the Seine River on two peninsulas extending into the Upper Marmion Reservoir. The peninsulas are drained by numerous small watercourses as shown in Figure 1. These small watercourses have tributary drainage areas of 6.3 km² and less. Year-round monitoring of baseline flows in these watercourses was not considered practical given the number of streams and their small drainage areas. Instead, baseline conditions in these streams were characterized by completing two field surveys and using desktop methods. The data collected included:

- General watershed characteristics;
- Stream geomorphic characteristics;
- Direct flow measurements; and
- Selected water quality parameters.

This report describes the methods and limitations of data collection and summarizes the findings of this study.



LEGEND

- Flow Direction
- Trail
- Road
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Tailings Management Facility Alternative 1
- Tailings Management Facility Alternative 2
- Local Watershed Boundary

WATERSHED AREAS

SITE WATERSHEDS	
Watershed ID	*Watershed Area (ha)*
A	590.00
AA	73.34
AB	51.99
AC	29.24
AD	29.91
AF	77.52
AG	34.18
AH	68.19
AI	10.17
AJ	12.64
AK	25.92
AL	7.19
AM	24.29
AN	4.64
AO	37.88
AP	72.03
AQ	6.86
AR	12.87
AS	71.97
B	609.82
C	134.96
D	104.31
E	122.80
F	78.00
G	30.53
H	27.27
I	85.24
J	25.56
K	89.03
L	70.53
M	111.72
N	158.55
O	38.76
P	124.90
Q	272.96
R	623.45
S	230.85
T	336.68
U	200.68
V	106.27
W	66.90
X	82.32
Y	45.66
Z	74.75

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000

SCALE 1:50,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

SITE SCALE WATERSHEDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008		
GIS	JO	4 Feb. 2013		
CHECK	CC	4 Feb. 2013		
REVIEW	THW	4 Feb. 2013		

FIGURE: 1

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Hydrology\TSD\SiteWatershedMap_Appendix.mxd

2.0 DESKTOP METHODS

Based on reviews of the Project footprint and the Ontario Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS) 1:20,000 topographic data, 44 site scale watersheds were identified within the Project footprint. These watersheds and their tributary drainage areas are shown in Figure 1 and are listed in Table 1 below.

Table 1: Site Scale Watercourses

Watershed ID	Coordinates at Watershed Outlet NAD 83 UTM Zone 15N	Drainage Area (km^2)	Draining to
A	616953 E; 5429178 N	5.90	Sawbill Creek
B	617837 E; 5426538 N	6.10	Sawbill Bay in Upper Marmion Reservoir
C	617657 E; 5426048 N	1.35	Sawbill Bay in Upper Marmion Reservoir
D	616838 E; 5424955 N	1.04	Sawbill Bay in Upper Marmion Reservoir
E	616502 E; 5423489 N	1.23	Sawbill Bay in Upper Marmion Reservoir
F	616259 E; 5423255 N	0.78	Sawbill Bay in Upper Marmion Reservoir
G	615083 E; 5424006 N	0.31	Sawbill Bay in Upper Marmion Reservoir
H	614430 E; 5423290 N	0.27	Sawbill Bay in Upper Marmion Reservoir
I	613817 E; 5422546 N	0.85	Sawbill Bay in Upper Marmion Reservoir
J	612538 E; 5422318 N	0.26	Sawbill Bay in Upper Marmion Reservoir
K	611642 E; 5421001 N	0.89	Upper Marmion Reservoir
L	614480 E; 5420879 N	0.71	Lynxhead Bay in Upper Marmion Reservoir
M	617450 E; 5421757 N	1.12	Turtle Bay in Upper Marmion Reservoir
N	618028 E; 5422875 N	1.59	Turtle Bay in Upper Marmion Reservoir
O	619403 E; 5424440 N	0.39	Lizard Lake
P	619565 E; 5425142 N	1.25	Lizard Lake
Q	620234 E; 5426671 N	2.73	Lizard Lake
R	620936 E; 5427051 N	6.23	Lizard Lake
S	621005 E; 5425285 N	2.31	Lizard Lake
T	618506 E; 5421573 N	3.37	Turtle Bay in Upper Marmion Reservoir
U	620932 E; 5420684 N	2.01	Light Bay in Upper Marmion Reservoir
V	622814 E; 5423793 N	1.06	Vista Lake/Light Lake
W	620313 E; 5423976 N	0.67	Lizard Lake
X	620680 E; 5420578 N	0.82	Light Bay in Upper Marmion Reservoir
Y	619285 E; 5420256 N	0.46	Dunnet Lake
Z	618468 E; 5422540 N	0.75	Turtle Bay in Upper Marmion Reservoir
AA	616878 E; 5421353 N	0.73	Turtle Bay in Upper Marmion Reservoir

Watershed ID	Coordinates at Watershed Outlet NAD 83 UTM Zone 15N	Drainage Area (km^2)	Draining to
AB	613579 E; 5421293 N	0.52	Lynxhead Bay in Upper Marmion Reservoir
AC	616459 E; 5425159 N	0.29	Sawbill Bay in Upper Marmion Reservoir
AD	612992 E; 5421115 N	0.30	Lynxhead Bay in Upper Marmion Reservoir
AF	615619 E; 5423121 N	0.78	Sawbill Bay in Upper Marmion Reservoir
AG	616332 E; 5423726 N	0.34	Sawbill Bay in Upper Marmion Reservoir
AH	615549 E; 5422139 N	0.68	Trap Bay in Upper Marmion Reservoir
AI	612133 E; 5420545 N	0.10	Lynxhead Bay in Upper Marmion Reservoir
AJ	--[(a)]	0.13	Sawbill Bay in Upper Marmion Reservoir
AK	--[(a)]	0.26	Trap Bay in Upper Marmion Reservoir
AL	615164 E; 5421314 N	0.07	Trap Bay in Upper Marmion Reservoir
AM	--[(a)]	0.24	Lynxhead Bay in Upper Marmion Reservoir
AN	--[(a)]	0.05	Lynxhead Bay in Upper Marmion Reservoir
AO	--[(a)]	0.38	Sawbill Bay in Upper Marmion Reservoir
AP	--[(a)]	0.72	Sawbill Bay in Upper Marmion Reservoir
AQ	611482 E; 5421191 N	0.07	Upper Marmion Reservoir
AR	--[(a)]	0.13	Upper Marmion Reservoir
AS	--[(a)]	0.72	Lizard Lake

(a) No defined outlet or more than one outlet

Watercourses associated with 34 of these watersheds were characterized (A to AI). Watercourses in the remaining 10 watersheds (AJ to AS) were not assessed; these watersheds were identified as being affected following revisions to the Project footprint which were received after completion of the baseline study. However, no defined watercourses are indicated in these watersheds by NRVIS topographic data.

Watershed and stream geomorphic characteristics were determined for each of the watercourses assessed from the NRVIS topographic data. These are documented in a series of watercourse survey sheets (Attachment 2.I.1). Note that each watercourse survey sheet is identified by the site scale watershed ID (e.g. SS-A) which corresponds to that watercourse. The characteristics included the:

- Tributary drainage area;
- Watershed perimeter;
- Lake and wetland storage areas;
- Length of main channel;
- Mean channel gradient; and
- Channel sinuosity.

The channel entrenchment ratio was calculated from field observations of bankfull width and depth collected at the watercourses (Section 3.0).

The surface geology in each of the site scale watersheds was determined from mapping of the surficial geology of the Hammond Reef property completed by Stea Surficial Geology Services (2009) that was provided by OHRG.

3.0 FIELD SURVEYS

Two field surveys were completed in 2012 for the purpose of characterizing the site scale watercourses; the first took place in May and the second in August. The observations and measurements obtained during the two field surveys are documented in the watercourse survey sheets (Attachment 2.I.1).

It should be noted that manual flow monitoring stations were installed and operated between August 2010 and August 2012 on watercourses A, B and R as part of the Flow and Lake Water Level Monitoring Program for the Project (Appendix 5.I). These are the local scale flow monitoring stations SW-10, SW-11 and SW12 respectively.

Geomorphic characteristics

As part of the first survey, field reconnaissance of the lower reaches of the watercourses for a distance of approximately 200 m upstream from the watershed outlet was completed. The following information on the geomorphic characteristics of the streams was collected:

- Descriptions of the reach and the channel thalweg;
- Channel bankfull width, bankfull depth and substrate;
- The vegetative cover/root zone and width of the floodplain; and
- Photographs of the channel and its left and right bank looking upstream and downstream.

For each watercourse, field observations were collected in a section of the reach that was considered representative of the overall conditions. Bankfull depth and bankfull width were calculated as the averages of three measurements: at the watershed outlet, 100 m upstream of the outlet and 200 m upstream of the outlet.

Natural obstructions

The frequency of natural obstructions in the lower reaches of the watercourses was recorded. This information was collected for the assessment of minor navigable waters as described in Transport Canada (2010). Transport Canada's definition of a natural obstruction was adopted; a natural obstruction is a natural physical obstacle that prevents the passage of a vessel on navigable water and requires portaging in order to continue along the navigable water. Natural obstructions may include, but are not limited to, beaver dams, deadfalls, large steep drops or thick vegetation growing in the channel. The type and location of each natural obstacle encountered along the lower reaches of the watercourses were documented.

Discharge measurements

The May survey was completed under high flow conditions (spring freshet) and the August survey under low flow conditions (summer low flows). Direct flow measurements were collected during both the surveys at each of the

34 small watercourses using standard procedures described in WSC (1999), Terzi (1981) and Rantz *et al* (1982a). In summary:

- A measurement cross-section was identified that was fairly uniform in depth, with parallel flow lines and fairly uniform in velocity throughout the cross-section.
- Flow measurements were collected by wading using the Velocity-Area Method, with incremental widths selected to contain approximately 10% of the estimated total discharge, when possible;
- As open-water conditions were present, the Six-Tenths Method was employed for velocity measurements in water depths less than 0.75 m and the Two-Point Method in water depths of 0.75 m or greater;
- Flows were computed using the Mid-Point Method.

Table 2 lists the current meters that were used for velocity measurements; the current meters are calibrated annually.

Table 2: Current Meters

Current Meter	Velocity Range	Minimum Flow Depth
Valeport Electromagnetic Flow Meter Model 801	≤ 5 m/s	0.050 m
Marsh-McBirney, INC, Flow-Mate Model 2000	-0.15 to +6 m/s	0.050 m
USGS Pygmy Current Meter Model 6205	0.025 to 1.5 m/s	0.075 m

The direct flow measurements collected during the surveys were supplemented with direct flow measurements collected:

- At the manual local scale flow monitoring stations SW-10, SW-11 and SW-12; and
- By the Aquatic Environment team during fish habitat field studies of the watercourses in October 2010, May 2011 and August 2011 (Golder, 2012).

Water quality testing

Field measurements of water temperature, pH, electrical conductivity and dissolved oxygen were collected in each of the 34 small watercourses during both surveys. Field tests were performed as far from the bank as safely possible, carefully wading out to avoid disturbing the bottom sediment, and facing upstream. Measurements of water temperature, pH and electrical conductivity were collected using Hanna pH and conductivity pens while measurements of dissolved oxygen (DO) were collected using a YSI 550A DO meter.

Field studies limitations

Limitations to the field studies include:

- Field surveys were completed during May and August 2012, representing spring high flow and summer low flow conditions in the watercourses. Additional site visits would have permitted better inter-seasonal characterization of the flows in the watercourses.

- At watercourses B, C, D, F, M, N, P, R, S, U and AC the terrain was flat and swampy and/or channels were ill-defined. Flows at these locations are likely underestimated.
- The accuracy of direct flow measurements in some of the watercourses was affected by the small sizes of the streams. The flows in some of the panels were greater than 10% of the total flow in the cross-section, even though incremental panel widths of 10 cm were used in all cases.
- Field reconnaissance was only completed in the lower reaches of the watercourses (200 m from the watershed outlet).

4.0 SUMMARY OF FINDINGS

The following sections provide summary information on the site scale watercourses. Detailed information can be found on the watercourse survey sheets (Attachment 2.I.1).

Watershed characteristics

- The median of the tributary drainage areas to the site scale watercourses is 0.84 km²; the 75th and 25th exceedance percentiles are 0.47 km² and 1.32 km² respectively.
- The median percentage of the tributary drainage areas covered by lakes and wetlands is 7%; the 75th and 25th exceedance percentiles are 2% and 14% respectively.
- The predominant surficial geology of the site scale watersheds was a discontinuous till veneer, i.e. 10-80% bedrock outcrop interspersed with deposits of till (unsorted deposits of boulders/gravel/mud).
- The floodplains associated with the watercourses were generally of two types: (1) an extensive flat floodplain thickly vegetated with long grass and shrubs, and (2) a narrow floodplain (extending less than 3 m on either side of the channel or no identifiable floodplain, surrounded by dense forest with soil in between trees covered by moss.

Stream geomorphic characteristics

- The median mean channel gradient is 1%; the 75th and 25th exceedance percentiles are 0.8% and 3% respectively.
- Bankfull depths average 0.4 m and are all, with the exception of watercourse T, less than 0.9 m in depth. Bankfull widths average 3.0 m and range between 0.10 m and 9 m, with the exception of watercourse T which has a width of 19.3 m.
- Based on the Rosgen Classification of Natural Rivers (Rosgen, 1996), the lower reaches of the watercourses are entrenched, with the exception of watercourse B which is moderately entrenched, and channel sinuosity ranges between low and moderate.

Flows

- During both field surveys, no defined stream channels were located for watercourses G and AG.
- Based on the direct flow measurements collected, the 75th and 25th exceedance percentiles unit runoff from the tributary drainage areas 3.6 and 7.7 L/s/km² in May and 0.0 and 5.5 L/s/km² in August.

- Table 3 shows the classification of the watercourses as perennial and intermittent/ephemeral[1]. Classification was based on the following criteria:
  - Watercourses in which flows were observed during the open-water season, and with average bankfull depths greater than 25 cm, were classified as perennial.
  - Watercourses in which zero flows were observed or with average bankfull depths less than 25 cm were classified as intermittent/ephemeral. These streams are expected to freeze entirely during the winter season; the expected maximum ice thickness in the watercourses was estimated to be 25 cm based on Atikokan meteorological data and Stefan's equation (MOE, 2003).

Table 3: Watercourse classification as perennial, intermittent/ephemeral streams

Watercourse Classification	Watercourse ID	Watercourse Classification	Watercourse ID
Perennial	A	Intermittent/Ephemeral	M
Perennial	D	Intermittent/Ephemeral	N
Perennial	E	Intermittent/Ephemeral	R
Perennial	I	Intermittent/Ephemeral	V
Perennial	P	Intermittent/Ephemeral	Y
Perennial	Q	Intermittent/Ephemeral	Z
Perennial	S	Intermittent/Ephemeral	AC
Perennial	T	Intermittent/Ephemeral	AI
Perennial	AF	Intermittent/Ephemeral	O
Intermittent/Ephemeral	B	Intermittent/Ephemeral	U
Intermittent/Ephemeral	C	Intermittent/Ephemeral	W
Intermittent/Ephemeral	F	Intermittent/Ephemeral	X
Intermittent/Ephemeral	H	Intermittent/Ephemeral	AA
Intermittent/Ephemeral	J	Intermittent/Ephemeral	AB
Intermittent/Ephemeral	K	Intermittent/Ephemeral	AD
Intermittent/Ephemeral	L	Intermittent/Ephemeral	AH

Note: No defined streams were found at watersheds G and AG

Water quality

- Conductivity was found to be predominantly low with a median value of 40 µS/cm. The 75th and 25th exceedance percentiles are 0 and 93 µS/cm.
- Flows were found to be near-neutral to slightly acid with pH values ranging from 4.3 to 8.4.

[1] A perennial stream is a stream (channel) that has continuous flow in parts of its stream bed all year round during years of normal rainfall. "Perennial" streams are contrasted with "intermittent" streams which normally cease flowing for weeks or months each year, and with "ephemeral" channels that flow only for hours or days following rainfall.

- Dissolved oxygen ranged between 4.1 and 8.9 mg/L. The 75th and 25th exceedance percentiles are 5.5 and 8.3 mg/L.

Minor Navigable Waters

Transport Canada (2010) proposes a two-tiered screening process to identify minor navigable waters. Under the initial review, a watercourse may be considered a minor navigable water if the average bankfull depth is less than 0.3 m or the average bankfull width is less than 1.2 m. Under the secondary review, watercourses may be classified as minor navigable waters if one of the following four conditions is true:

- Average depth less than or equal to 0.6m or;
- Slope greater than 4% or;
- Sinuosity ratio greater than 2 or;
- There are 3 or more natural obstacles.

Twenty three of the thirty four watercourses were classified as minor navigable waters (MNW) based on screening criteria in the Minor Waters User Guide (Transport Canada, 2010) and field observations collected during the May field survey. Table 4 summarizes all relevant information for the classification and shows the results.

Table 4: Classification of Watercourses as Minor Navigable Waters (MNW)

Water-course ID	Watershed Outlet NAD 83 UTM Zone 15N	Mean Width (W) / Depth (D) (m)		MNW under Initial Review (Yes/No)	Mean Channel Slope m/m	Channel Sinuosity	Natural obstacles	MNW under Secondary Review (Yes/No)
A	616953	W	3.17	n	0.010	1.73	16	n
	5429178	D	0.55					
B	617837	W	7.17	n	0.009	1.30	17	n
	5426538	D	1.28					
C	617657	W	7.00	n	0.014	1.37	18	n
	5426048	D	0.73					
D	616838	W	2.03	n	0.005	1.10	11	y
	5424955	D	0.60					
E	616502	W	9.00	n	0.005	1.18	13	n
	5423489	D	0.58					
F	616259	W	4.33	n	0.029	1.18	27	n
	5423255	D	0.40					
G	615083	W	-	y	0.058	1.05	-	y
	5424006	D	-					
H	614430	W	1.40	y	0.051	1.52	-	y
	5423290	D	0.17					
I	613817	W	1.67	n	0.026	1.34	24	y
	5422546	D	0.35					
J	612538	W	6.07	n	0.047	1.05	24	n
	5422318	D	0.55					
K	611642	W	1.07	y	0.010	1.20	-	y
	5421001	D	0.35					
L	614480	W	1.33	y	0.033	1.18	-	y
	5420879	D	0.23					

Water-course ID	Watershed Outlet NAD 83 UTM Zone 15N	Mean Width (W) / Depth (D) (m)		MNW under Initial Review (Yes/No)	Mean Channel Slope m/m	Channel Sinuosity	Natural obstacles	MNW under Secondary Review (Yes/No)
M	617450	W	1.27	n	0.016	1.23	-	y
	5421757	D	0.38					
N	618028	W	1.10	y	0.012	1.23	-	y
	5422875	D	0.62					
O	619403	W	0.13	y	0.030	1.09	-	y
	5424440	D	0.07					
P	619565	W	1.03	y	0.005	1.17	-	y
	5425142	D	0.27					
Q	620234	W	4.83	n	0.008	1.21	10	n
	5426671	D	0.62					
R	620936	W	1.60	n	0.009	1.59	20	y
	5427051	D	0.72					
S	621005	W	6.00	n	0.008	2.17	13	n
	5425285	D	0.85					
T	618506	W	19.33	n	0.004	1.73	1	n
	5421573	D	1.57					
U	620932	W	4.67	n	0.009	1.34	17	n
	5420684	D	0.62					
V	622814	W	2.83	n	0.004	1.39	>30	y
	5423793	D	0.70					
W	620313	W	0.67	y	0.010	1.36	-	y
	5423976	D	0.08					
X	620680	W	1.73	y	0.004	--	-	y
	5420578	D	0.17					
Y	619285	W	1.67	y	0.004	1.28	30	y

Water-course ID	Watershed Outlet NAD 83 UTM Zone 15N	Mean Width (W) / Depth (D) (m)		MNW under Initial Review (Yes/No)	Mean Channel Slope m/m	Channel Sinuosity	Natural obstacles	MNW under Secondary Review (Yes/No)
	5420256	D	0.22					
Z	618468	W	1.60	n	0.013	1.26	12	y
	5422540	D	0.58					
AA	616878	W	0.47	y	0.020	1.95	-	y
	5421353	D	0.18					
AB	613579	W	1.30	y	0.017	1.51	-	y
	5421293	D	0.23					
AC	616459	W	0.87	y	0.007	1.15	28	y
	5425159	D	0.28					
AD	612992	W	0.40	y	0.037	1.07	-	y
	5421115	D	0.05					
AF	615619	W	4.10	n	0.038	1.99	28	n
	5423121	D	0.30					
AG	616332	W	-	y	--	--	-	y
	5423726	D	-					
AH	615549	W	0.13	y	--	1.00	-	y
	5422139	D	0.05					
AI	612133	W	1.67	y	0.127	1.10	-	y
	5420545	D	0.15					

(a) Wet areas evident, but no defined channel identified
(b) Area dry, no defined channel identified
(c) Wetland area, no defined channel identified

5.0 REFERENCES

Golder Associates Ltd. (2012); Osisko Hammond Reef Gold Project, Fish and Fish Habitat Baseline Studies Interim Report; Report No. 10-1118-0020 (5200), Doc. No. 2012-027 (RevD); July 3.

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Transport Canada (2010). Minor Waters User Guide. TP 14838.

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ATTACHMENT 2.I.1

Watercourse Survey Sheets

Watershed Characteristics	Watershed ID:	SS-A	Drainage Area: 580.69 ha; Perimeter: 18.95 km; Lake and Wetland Area[1]: 132.70 ha
	Surface Geology[5]	90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 10% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed outlet:	15N 616856 E 5429337 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel goes through woodland with bedrock outcropping about 200m upstream the stream outlet.	
	Thalweg Description (straight, bend, off-center):	Meandering thalweg through boulders.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, shrubs and tall trees (4"-5" diameter) / 5 cm to 50 cm	
	Bankfull Depth:	0.55 m	
	Bankfull Width:	3.17 m	
	Length of main channel[1]:	5.27 km	
	Mean channel slope[1]:	0.010	
	Sinuosity[1,2]:	1.73 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.35 (entrenched)	
	Floodplain Observations:	Narrow wooded floodplain, 4m to the right and 2m to the left.	
	General Observations:	-	
Substrate: (L & R looking downstream)	Left Bank:	Vegetated, organic	
	Bed:	Organic, boulders	
	Right Bank:	Vegetated, organic	

Additional Comments:
–

Field Observations

Survey at:		Date	05/18/12	08/29/12		
		Time	4:55 PM	10:17 AM		
		East/North	616953 / 5429178	616953 / 5429178		
Weather Conditions:			Overcast			
In-Situ Water Chemistry						
Temperature:		°C	22.20	17.50		
Conductivity:		mS/cm	0.00	0.00		
pH:			6.89	6.60		
DO:		mg/L	7.52	-		
		%	-	7.82%		
Flow Measurements[3]						
Q:		L/s	26.50	19.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-A

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 1

Watershed Characteristics	Watershed ID:	SS-B	Drainage Area: 609.82 ha Perimeter: 20.02 km Lake and Wetland Area[4]: 75.25 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table), 40% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 45% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed outlet:	15N 617837 E 5426538 N	
Channel Section at Watershed Outlet:	General Section Description:	Meandering small channel through flat field.	
	Thalweg Description (straight, bend, off-center):	Off-centered to the right (meandering thalweg).	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, dog wood and many standing dead trees / 5cm	
	Bankfull Depth:	1.30 m	
	Bankfull Width:	7.20 m	
	Length of main channel[1]:	3.50 km	
	Mean channel slope[1]:	0.009	
	Sinuosity[1,2]:	1.30 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.40 (entrenched)	
	Floodplain Observations:	Flat grassy floodplain with some dead standing trees. It looks like an old dried out swamp.	
	General Observations:	–	
Substrate: (L & R looking downstream)	Left Bank:	Vegetated (long grass)	
	Bed:	Sand, organic and long grass	
	Right Bank:	Vegetated (long grass)	

Additional Comments:

–

Field Observations

Survey at:	Date	05/12/10	10/16/10	05/18/12	08/29/12
	Time	-	-	10:30 AM	8:29 AM
	East/North	617925 / 5426595	617955 / 5426709	617930 / 5426603	617930 / 5426603
Weather Conditions:		-	-	Sunny, partially cloudy	-
In-Situ Water Chemistry					
Temperature:	°C	-	-	12.30	13.70
Conductivity:	mS/cm	-	-	0.00	0.00
pH:		-	-	6.77	6.65
DO:	mg/L	-	-	8.80	-
	%	-	-	-	3.24%
Flow Measurements[3]					
Q:	L/s	136.00	9.00	42.00	143.0

Notes:

1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-B

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 2

Watershed Characteristics	Watershed ID:	SS-C	Drainage Area:	134.96 ha
			Perimeter:	7.78 km
			Lake and Wetland Area[1]:	5.10 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).		
	UTM Coordinates at watershed	15N	617567 E	5426049 N
Channel Section at Watershed Outlet:	General Section Description:	Channel goes through flat grassy field with some rock outcropping.		
	Thalweg Description (straight, bend, off-center):	Meandering through channel.		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass and some shrubs		
	Bankfull Depth:	0.73 m		
	Bankfull Width:	7.00 m		
	Length of main channel[1]:	1.34 km		
	Mean channel slope[1]:	0.014		
	Sinuosity[1,2]:	1.37 (moderate sinuosity)		
	Entrenchment ratio[2]:	0.21 (entrenched)		
	Floodplain Observations:	Narrow flat grassy floodplain. It extends 6m to the right and 4m to the left.		
	General Observations:	Channel dries out 25m upstream, it flows underground for 20m until rises to surface.		
Substrate: (L & R looking downstream)	Left Bank:	Vegetated (long grass)		
	Bed:	Organic with boulders		
	Right Bank:	Vegetated (long grass)		

Additional Comments:
–

Field Observations

Survey at:	Date	05/20/12	08/25/12		
	Time	9:00 AM	9:38 AM		
	East/North	617794 / 5425949	617794 / 5425949		
Weather Conditions:		Light rain (heavy rain last night)			
In-Situ Water Chemistry					
Temperature:	°C	14.40	15.20		
Conductivity:	mS/cm	0.01	0.00		
pH:		6.48	8.40		
DO:	mg/L	4.78	-		
	%	-	7.30%		
Flow Measurements[3]					
Q:	L/s	5.00	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-C

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 3

Watershed Characteristics	Watershed ID:	SS-D	Drainage Area: 104.31 ha Perimeter: 7.29 km Lake and Wetland Area[1]: 0.00 ha
	Surface Geology[5]	20% Organic terrain (deposits of peat in areas of high water table), 60% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 20% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 616838 E	5424955 N
Channel Section at Watershed Outlet:	General Section Description:	Incised channel through marshy area.	
	Thalweg Description (straight, bend, off-center):	Straight stream section and centered thalweg.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grasses and shrubs. Root depth is 5cm.	
	Bankfull Depth:	0.60 m	
	Bankfull Width:	2.03 m	
	Length of main channel[1]:	0.80 km	
	Mean channel slope[1]:	0.005	
	Sinuosity[1,2]:	1.10 (low sinuosity)	
	Entrenchment ratio[2]:	0.59 (entrenched)	
	Floodplain Observations:	Flat and dense vegetated floodplain with some ponded water in land depressions.	
	General Observations:	General area has lots of vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Vegetated; organic	
	Bed:	Organic	
	Right Bank:	Vegetated; organic	

Additional Comments:
-

Field Observations

Survey at:	Date	05/12/11	08/31/11	05/20/12	08/25/12
	Time	-	4:45 PM	11:50 AM	10:43 AM
	East/North	616833 / 5424868	616811 / 5424813	616818 / 5424764	616818 / 5424764
Weather Conditions:		-	Overcast	Light rain (heavy rain last night)	
In-Situ Water Chemistry					
Temperature:	°C	-	15.00	15.10	18.10
Conductivity:	mS/cm	-	0.01	0.08	0.00
pH:		-	7.02	6.35	6.39
DO:	mg/L	-	-	4.09	-
	%	-	-	-	2.50%
Flow Measurements[3]					
Q:	L/s	26.00	estimated < 1 L/s	6.00	7.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-D

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 4

Watershed Characteristics	Watershed ID:	SS-E	Drainage Area: 116.69 ha Perimeter: 7.42 km Lake and Wetland Area[4]: 16.32 ha
	Surface Geology[5]	90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 10% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 616502 E 5423489 N	
Channel Section at Watershed Outlet:	General Section Description:	Meandering channel through dense vegetation.	
	Thalweg Description (straight, bend, off-center):	Meandering.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, moss, shrubs and tall trees (5 to 20 cm).	
	Bankfull Depth:	0.58 m	
	Bankfull Width:	9.00 m	
	Length of main channel[1]:	0.99 km	
	Mean channel slope[1]:	0.005	
	Sinuosity[1,2]:	1.18	
	Entrenchment ratio[2]:	0.13 (entrenched)	
	Floodplain Observations:	The flood plain is narrow and extends 2m to the right and 4m to the left until the tree line.	
	General Observations:	Water level of the stream and lake remained constant from the outlet to 60m upstream.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Organic	
	Right Bank:	Grass	

Additional Comments:
-

Field Observations

Survey at:	Date	05/09/11	05/23/12	08/28/12	
	Time	-	9:00 AM	9:46 AM	
	East/North	616578 / 5423477	616693 / 5423488	616693 / 5423488	
Weather Conditions:		-	Overcast		

In-Situ Water Chemistry

Temperature:	°C	-	8.70	15.40	
Conductivity:	mS/cm	-	-	0.00	
pH:		-	5.89	6.20	
DO:	mg/L	-	8.38	-	
	%	-	-	1.40%	

Flow Measurements[3]

Q:	L/s	36.00	11.00	6.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-E

PROJECT #: 10-1118-0020 (6100) | DATE: December 13, 2012 | Hammond Reef Gold Project | SHEET 5

Watershed Characteristics	Watershed ID:	SS-F	Drainage Area: 74.26 ha Perimeter: 5.29 km Lake and Wetland Area[1,4]: 5.82 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 616259 E	5423255 N
Channel Section at Watershed Outlet:	General Section Description:	Marshy area.	
	Thalweg Description (straight, bend, off-center):	Not defined.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grasses, moss, shrubs and trees. Root depth ranging between 0.3 m and 0.4 m	
	Bankfull Depth:	0.40 m	
	Bankfull Width:	4.33 m	
	Length of main channel[1]:	1.06 km	
	Mean channel slope[1]:	0.029	
	Sinuosity[1,2]:	1.18 (low sinuosity)	
	Entrenchment ratio[2]:	0.18 (entrenched)	
	Floodplain Observations:	Marsh, flat and vegetated.	
	General Observations:	Current section corresponds to a marsh with lots of vegetation. Stream dries up upstream and has cattails downstream.	
Substrate: (L & R looking downstream)	Left Bank:	Vegetated; organic	
	Bed:	Organic	
	Right Bank:	Vegetated; organic	

Additional Comments:
- Aug 2011 visit: The stream was disconnected from the upstream section; the wet areas in the current section were backed up from Sawbill Bay. There was no running flow, just ponded water.
- 2012 visit: Water level of the channel through wetland and lake were similar up to 115m upstream from the outlet to the lake.

Field Observations

Survey at:	Date	10/16/10	05/09/11	08/31/11	05/23/12	08/28/12
	Time	-	-	3:10 PM	11:00 AM	10:29 AM
	East / North	616290 / 5423116	616300 / 5423151	-	616289 / 5423107	616289 / 5423107
Weather Conditions:		-	-	Overcast , light drizzle	Overcast	
In-Situ Water Chemistry						
Temperature:	°C	-	-	15.80	10.30	14.40
Conductivity:	mS/cm	-	-	0.00	-	0.00
pH:		-	-	7.71	5.81	5.93
DO:	mg/L	-	-	-	7.67	-
	%	-	-	-	-	0.39%
Flow Measurements[3]						
Q:	L/s	0.00	4.00	0.00	5.00	19.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-F

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 6

Watershed Characteristics	Watershed ID:	SS-G	Drainage Area: 30.53 ha Perimeter: 3.38 km Lake and Wetland Area[1,4]: 2.01 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 615083 E 5424006 N	
Channel Section at Watershed Outlet:	General Section Description:	Dry area, no stream found.	
	Thalweg Description (straight, bend, off-center):	No defined channel, several potential runoff paths.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Thick vegetation and tall trees	
	Bankfull Depth:	- m	
	Bankfull Width:	- m	
	Length of main channel[1]:	0.50 km	
	Mean channel slope[1]:	0.058	
	Sinuosity[1,2]:	1.05	
	Entrenchment ratio[2]:	-	
	Floodplain Observations:	-	
	General Observations:	-	
Substrate: (L & R looking downstream)	Left Bank:	-	
	Bed:	-	
	Right Bank:	-	

Additional Comments:
No defined channel and dry area on all site visits (2011 and 2012).

Field Observations

Survey at:	Date	09/01/11	05/20/12	08/25/12	
	Time	-	3:30 PM	11:59 AM	
	East / North	-	615097 / 5423978	615097 / 5423978	
Weather Conditions:		Overcast	Overcast		
In-Situ Water Chemistry					
Temperature:	°C	-	-	-	
Conductivity:	mS/cm	-	-	-	
pH:		-	-	-	
DO:	mg/L	-	-	-	
	%	-	-	-	
Flow Measurements[3]					
Q:	L/s	-	-	-	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-G

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 7

Watershed Characteristics	Watershed ID:	SS-H	Drainage Area: 27.27 ha Perimeter: 3.72 km Lake and Wetland Area[4]: 1.43 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 614430 E 5423290 N	
Channel Section at Watershed Outlet:	General Section Description:	Thick bush; fairly steep and incised channel. The channel was dry during the 2011 visit and little flow found was at channel outlet during the 2012 visit.	
	Thalweg Description (straight, bend, off-center):	Straight; Channel is the thalweg.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, shrubs and grasses. Root depth ranging between 0.3 m and 0.4 m	
	Bankfull Depth:	0.17 m	
	Bankfull Width:	1.40 m	
	Length of main channel[1]:	0.57 km	
	Mean channel slope[1]:	0.051	
	Sinuosity[1,2]:	1.52 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.24 (entrenched)	
	Floodplain Observations:	Steep floodplain with little storage and very vegetated	
	General Observations:	Several runoff pathways.	
Substrate: (L & R looking downstream)	Left Bank:	Vegetated; organic	
	Bed:	Organic (also rocks at upstream steeper section)	
	Right Bank:	Vegetated; organic	

Additional Comments:
2011 visit: Dry channel
May 2012 visit: Little flow found out
Aug 2012 visit: Dry channel

Field Observations

Survey at:	Date	09/01/11	05/20/12	08/25/12	
	Time	11:30 AM	4:30 PM	12:40 PM	
	East / North	-	614442 / 5423279	614442 / 5423279	
Weather Conditions:		Partly cloudy/sunny and breezy	Overcast (heavy rain last night)		
In-Situ Water Chemistry					
Temperature:	°C	-	9.80	-	
Conductivity:	mS/cm	-	0.06	-	
pH:		-	6.31	-	
DO:	mg/L	-	6.70	-	
	%	-	-	-	
Flow Measurements[3]					
Q:	L/s	0.00	3.00	0.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-H

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 8

Watershed Characteristics	Watershed ID:	SS-I	Drainage Area: 85.24 ha Perimeter: 6.51 km Lake and Wetland Area[4]: 4.29 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 613817 E 5422546 N	
Channel Section at Watershed Outlet:	General Section Description:	Pools and short steep riffles.	
	Thalweg Description (straight, bend, off-center):	Off-centre through boulders.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Thick cover of grasses and shrubs. Root depth varies from 0.3 m to 0.6 m.	
	Bankfull Depth:	0.35 m	
	Bankfull Width:	1.67 m	
	Length of main channel[1]:	0.76 km	
	Mean channel slope[1]:	0.026	
	Sinuosity[1,2]:	1.34 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.42 (entrenched)	
	Floodplain Observations:	Minimal floodplain and thick vegetative cover (grasses and shrubs).	
	General Observations:	Water course is incised, which shows steep banks and thick vegetative cover. Right bank is noticeably higher than left. The upstream section is all bedrock base and has a steep grade.	
Substrate: (L & R looking downstream)	Left Bank:	Bedrock with vegetative cover	
	Bed:	Coarse material; boulders, rocks and bedrock base	
	Right Bank:	Variable; bedrock, vegetative cover and rocks	

Additional Comments:
-Orange deposition on bed and vegetation.

Field Observations

Survey at:		Date	10/16/10	05/08/11	08/31/11	05/20/12	08/25/12
		Time	-	-	9:20 AM	5:30 PM	1:09 PM
		East/North	613849 / 5422487	613828 / 5422524	613830 / 5422530	613878 / 5422430	613831 / 5422527
Weather Conditions:			-	-	Light rain (heavy rain previous evening)	Overcast (heavy rain previous evening)	
In-Situ Water Chemistry							
Temperature:		°C	-	-	14.50	-	17.90
Conductivity:		mS/cm	-	-	0.29	-	0.00
pH:			-	-	8.00	-	6.34
DO:		mg/L	-	-	-	-	-
		%	-	-	-	-	59.40%
Flow Measurements[3]							
Q:		L/s	2.00	17.00	1.90	3.00	1.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-I

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 9

Watershed Characteristics	Watershed ID:	SS-J	Drainage Area: 25.56 ha Perimeter: 3.38 km Lake and Wetland Area[4]: 3.59 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table), 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 5% Scoured Bedrock (devoid of sediment cover).	
	UTM Coordinates at watershed	15N 612538 E 5422318 N	
Channel Section at Watershed Outlet:	General Section Description:	The section shows pools and drops and with a very steep stream grade.	
	Thalweg Description (straight, bend, off-center):	Centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees and moss. Root depth at 0.3 m	
	Bankfull Depth:	0.55 m	
	Bankfull Width:	6.07 m	
	Length of main channel[1]:	0.40 km	
	Mean channel slope[1]:	0.047	
	Sinuosity[1,2]:	1.05 (low sinuosity)	
	Entrenchment ratio[2]:	0.18 (entrenched)	
	Floodplain Observations:	Exposed soil, trees and organic deposition is observed; steep floodplain.	
	General Observations:	Series of pools and waterfalls.	
Substrate: (L & R looking downstream)	Left Bank:	Organic, boulders and some bedrock	
	Bed:	Rocks and organics	
	Right Bank:	Organic, boulders and some bedrock	

Additional Comments:
-

Field Observations

Survey at:	Date	10/15/10	05/08/11	08/31/11	05/21/12	08/25/12
	Time	-	-	10:30 AM	9:00 AM	1:38 PM
	East/North	612568 / 5422291	612549 / 5422326	612550 / 5422320	612550 / 5422320	612550 / 5422320
Weather Conditions:		-	-	Overcast and no rain (light rain 1.0 hrs ago and heavy rain previous evening)	Sunny, no clouds	
In-Situ Water Chemistry						
Temperature:	°C	-	-	15.50	11.50	18.50
Conductivity:	mS/cm	-	-	0.04	0.04	0.00
pH:		-	-	7.25	7.04	6.72
DO:	mg/L	-	-	-	8.33	-
	%	-	-	-	-	1.20%
Flow Measurements[3]						
Q:	L/s	3.00	2.00	1.75	3.00	0.10

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-J

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 10

Watershed Characteristics	Watershed ID:	SS-K	Drainage Area: 89.03 ha Perimeter: 7.35 km Lake and Wetland Area[4]: 27.65 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 611642 E 5421001 N	
Channel Section at Watershed Outlet:	General Section Description:	The section consists of one long riffle with small pools and a moderate steep stream slope.	
	Thalweg Description (straight, bend, off-center):	Not defined. Toward banks in small pools.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass along banks and weed farther out. Root depth is not visible	
	Bankfull Depth:	0.35 m	
	Bankfull Width:	1.07 m	
	Length of main channel[1]:	1.78 km	
	Mean channel slope[1]:	0.010	
	Sinuosity[1,2]:	1.20 (low sinuosity)	
	Entrenchment ratio[2]:	0.66 (entrenched)	
	Floodplain Observations:	The floodplain is flat near the mouth of the water course (downstream current metering section) and steeper at upstream section. Floodplain has long grasses and also cobbles.	
	General Observations:	Presence of some pooled water in floodplain.	
Substrate: (L & R looking downstream)	Left Bank:	Cobbles and rock	
	Bed:	Stones and organic material	
	Right Bank:	Cobbles and rock	

Additional Comments:
-

Field Observations

Survey at:	Date	10/16/10	05/08/11	08/31/11	05/21/12	08/25/12
	Time	-	-	10:50 AM	10:30 AM	2:50 PM
	East / North	611689 / 5421067	611659 / 5421016	611653 / 5421 013	611642 / 5421001	611642 / 5421001
Weather Conditions:		-	-	Overcast and no rain (light rain 1.5 hrs ago and heavy rain previous evening)	Sunny	
In-Situ Water Chemistry						
Temperature:	°C	-	-	14.90	13.50	20.80
Conductivity:	mS/cm	-	-	0.23	0.07	0.00
pH:		-	-	7.14	6.73	6.82
DO:	mg/L	-	-	-	7.46	-
	%	-	-	-	-	33.10%
Flow Measurements[3]						
Q:	L/s	2.00	5.00	0.33	3.00	0.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-K

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 11

Watershed Characteristics	Watershed ID:	SS-L	Drainage Area: 70.53 ha Perimeter: 5.49 km Lake and Wetland Area[4]: 4.62 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 614480 E 5420879 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel through dense forest.	
	Thalweg Description (straight, bend, off-center):	Meandering through rocks.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Moss, tall trees and shrubs / 0.3 to 0.5 m	
	Bankfull Depth:	0.23 m	
	Bankfull Width:	1.33 m	
	Length of main channel[1]:	1.11 km	
	Mean channel slope[1]:	0.033	
	Sinuosity[1,2]:	1.18 (low sinuosity)	
	Entrenchment ratio[2]:	0.35 (entrenched)	
	Floodplain Observations:	Not identified. No trace of high water marks and very incised channel.	
	General Observations:	Lots of logs and rock blocks along the channel.	
Substrate: (L & R looking downstream)	Left Bank:	Rocks covered by moss	
	Bed:	Organic and rocks	
	Right Bank:	Rocks covered by moss	

Additional Comments:
-

Field Observations

Survey at:	Date	10/15/10	05/21/12	08/26/12	
	Time	-	3:30 PM	12:00 PM	
	East/North	612568 / 5422291	614480 / 5420879	614480 / 5420879	
Weather Conditions:		-	Sunny		
In-Situ Water Chemistry					
Temperature:	°C	-	13.80	15.50	
Conductivity:	mS/cm	-	0.00	0.00	
pH:		-	7.16	7.02	
DO:	mg/L	-	8.54	-	
	%	-	-	21.50%	
Flow Measurements[3]					
Q:	L/s	1.00	5.00	0.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-L

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 12

Watershed Characteristics	Watershed ID:	SS-M	Drainage Area: 111.72 ha Perimeter: 6.67 km Lake and Wetland Area[1,4]: 9.53 ha
	Surface Geology[5]	35% Organic terrain (deposits of peat in areas of high water table) and 65% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 617450 E 5421757 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel goes through flat and dense vegetated areas.	
	Thalweg Description (straight, bend, off-center):	Straight and centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, lots of shrubs and some trees	
	Bankfull Depth:	0.38 m	
	Bankfull Width:	1.27 m	
	Length of main channel[1]:	1.18 km	
	Mean channel slope[1]:	0.016	
	Sinuosity[1,2]:	1.23 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.61 (entrenched)	
	Floodplain Observations:	Flat grassy flood plain. It extends 20m each side from the channel banks.	
	General Observations:	Channel extends about 250m from the outlet to the lake. Influenced by lake water level for about 160m. Upstream channel spreads out into 4 small pathways and then disappears into thick vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Organic	
	Right Bank:	Grass	

Additional Comments:
-

Field Observations

			10/14/10	05/11/11	05/22/12	08/26/12
Survey at:		Date	10/14/10	05/11/11	05/22/12	08/26/12
		Time	-	-	11:00 AM	3:03 PM
		East/North	617444 / 5421946	617436 / 5421897	617450 / 5421980	617420 / 5421819
Weather Conditions:			-	-	Overcast	
In-Situ Water Chemistry						
Temperature:	°C		-	-	11.10	-
Conductivity:	mS/cm		-	-	0.00	-
pH:			-	-	6.51	-
DO:	mg/L		-	-	4.25	-
	%		-	-	-	-
Flow Measurements[3]						
Q:	L/s		1.00	32.00	4.00	0.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-M

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 13

Watershed Characteristics	Watershed ID:	SS-N	Drainage Area: 158.55 ha Perimeter: 9.77 km Lake and Wetland Area[1]: 9.10 ha
	Surface Geology[5]	20% Organic terrain (deposits of peat in areas of high water table) and 80% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 618028 E 5422875 N	
Channel Section at Watershed Outlet:	General Section Description:	Meandering channel through grassy flat area.	
	Thalweg Description (straight, bend, off-center):	Meandering.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass and some shrubs / 5 cm	
	Bankfull Depth:	0.62 m	
	Bankfull Width:	1.10 m	
	Length of main channel[1]:	1.67 km	
	Mean channel slope[1]:	0.012	
	Sinuosity[1,2]:	1.23 (moderate sinuosity)	
	Entrenchment ratio[2]:	1.12 (entrenched)	
	Floodplain Observations:	Grassy flat plain. It extends 20m to the right and 10m to the left.	
	General Observations:	Meandering channel through flat area with many obstacles across (lots of logs and grass covered berms).	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Silty organic	
	Right Bank:	Grass	

Additional Comments:
-

Field Observations

Survey at:	Date	05/12/11	05/22/12	08/26/12	
	Time	-	12:00 PM	3:42 PM	
	East/North	618009 / 5422895	617926 / 5422995	617926 / 5422995	
Weather Conditions:		-	Overcast		
In-Situ Water Chemistry					
Temperature:	°C	-	11.90	16.30	
Conductivity:	mS/cm	-	0.00	0.00	
pH:		-	6.44	6.70	
DO:	mg/L	-	5.51	-	
	%	-	-	9.00%	
Flow Measurements[3]					
Q:	L/s	42.00	8.00	0.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N
2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)
3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-N

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 14

Watershed Characteristics	Watershed ID:	SS-O	Drainage Area: 38.76 ha Perimeter: 3.88 km Lake and Wetland Area[1]: 1.30 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 619523 E 5424508 N	
Channel Section at Watershed Outlet:	General Section Description:	Dry small channel from stream outlet to the Lizard Lake.	
	Thalweg Description (straight, bend, off-center):	Straight.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, shrubs and trees	
	Bankfull Depth:	0.07 m	
	Bankfull Width:	0.13 m	
	Length of main channel[1]:	0.85 km	
	Mean channel slope[1]:	0.030	
	Sinuosity[1,2]:	1.09 (low sinuosity)	
	Entrenchment ratio[2]:	1.00 (entrenched)	
	Floodplain Observations:	No trace of watermarks.	
	General Observations:	Dry area.	
Substrate: (L & R looking downstream)	Left Bank:	Vegetative	
	Bed:	Vegetative	
	Right Bank:	Vegetative	

Additional Comments:
- Dry channel on both visits

Field Observations

Survey at:	Date	05/17/12	08/28/12		
	Time	11:15 AM	5:25 PM		
	East/North	619484 / 5424463	619484 / 5424463		
Weather Conditions:		Partially cloudy			
In-Situ Water Chemistry					
Temperature:	°C	-	-		
Conductivity:	mS/cm	-	-		
pH:		-	-		
DO:	mg/L	-	-		
	%	-	-		
Flow Measurements[3]					
Q:	L/s	0.00	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N
2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)
3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-O

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 15

Watershed Characteristics	Watershed ID:	SS-P	Drainage Area: 124.90 ha Perimeter: 9.30 km Lake and Wetland Area[1]: 18.30 ha
	Surface Geology[5]	20% Organic terrain (deposits of peat in areas of high water table) and 80% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 619669 E 5425149 N	
Channel Section at Watershed Outlet:	General Section Description:	Incised small channel over grassy plain with some rock outcropping. Section located 5m downstream of a ponded area (dammed by an old vegetated beaver dam) at stream outlet to Lizard Lake.	
	Thalweg Description (straight, bend, off-center):	Straight and centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, cat tails and some shrubs / 5 cm to 20 cm	
	Bankfull Depth:	0.27 m	
	Bankfull Width:	1.03 m	
	Length of main channel[1]:	1.27 km	
	Mean channel slope[1]:	0.005	
	Sinuosity[1,2]:	1.17 (low sinuosity)	
	Entrenchment ratio[2]:	0.52 (entrenched)	
	Floodplain Observations:	Flat grassy floodplain with some rock outcropping. Floodplain extends 7m to the right and 30m to the left until tree line.	
	General Observations:	Channel at surveyed location comes from a beaver pond (20m long x 30m width). Beaver pond is receipt of two small tributary channels.	
Substrate: (L & R looking downstream)	Left Bank:	Organic	
	Bed:	Organic	
	Right Bank:	Organic	

Additional Comments:
-

Field Observations

Survey at:	Date	05/17/12	08/28/12		
	Time	1:00 PM	5:54 PM		
	East/North	619565 / 5425142	619604 / 5425167		
Weather Conditions:		Sunny			
In-Situ Water Chemistry					
Temperature:	°C	17.80	24.60		
Conductivity:	mS/cm	0.00	0.00		
pH:		6.52	6.40		
DO:	mg/L	8.87	-		
	%	-	5.57%		
Flow Measurements[3]					
Q:	L/s	4.30	10.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-P

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 16

Watershed Characteristics	Watershed ID:	SS-Q	Drainage Area: 272.96 ha Perimeter: 14.46 km Lake and Wetland Area[4]: 100.67 ha
	Surface Geology[5]	45% Organic terrain (deposits of peat in areas of high water table), 15% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 40% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 620322 E	5426634 N
Channel Section at Watershed Outlet:	General Section Description:	Well defined channel at marshy area. Section located at about 100m upstream the outlet to the lake.	
	Thalweg Description (straight, bend, off-center):	Straight and off-centered to both sides.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, shrubs and some trees	
	Bankfull Depth:	0.62 m	
	Bankfull Width:	4.83 m	
	Length of main channel[1]:	1.70 km	
	Mean channel slope[1]:	0.008	
	Sinuosity[1,2]:	1.21 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.26 (entrenched)	
	Floodplain Observations:	Grassy narrow floodplain. It extends 10m to the right and 15m to the left.	
	General Observations:	-	
Substrate: (L & R looking downstream)	Left Bank:	Vegetative	
	Bed:	Organic (soft)	
	Right Bank:	Vegetative	

Additional Comments:
-

Field Observations

Survey at:	Date	10/19/10	05/19/12	08/28/12	
	Time	-	11:15 AM	6:33 PM	
	East/North	620194 / 5426644	620169 / 5426638	620169 / 5426638	
Weather Conditions:		-	Overcast		

In-Situ Water Chemistry

Temperature:	°C	-	19.50	19.40	
Conductivity:	mS/cm	-	0.00	0.00	
pH:		-	6.07	6.01	
DO:	mg/L	-	4.75	-	
	%	-	-	0.15%	

Flow Measurements[3]

Q:	L/s	5.00	27.10	48.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-Q

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 17

Watershed Characteristics	Watershed ID:	SS-R	Drainage Area: 632.96 ha Perimeter: 25.57 km Lake and Wetland Area[1,4]: 74.84 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table), 50% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 40% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 620967 E 5427032 N	
Channel Section at Watershed Outlet:	General Section Description:	Small channel through dense vegetation	
	Thalweg Description (straight, bend, off-center):	Straight.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, cedar trees and lots of dead fallen trees (5 cm to 20 cm).	
	Bankfull Depth:	0.72 m	
	Bankfull Width:	1.60 m	
	Length of main channel[1]:	6.05 km	
	Mean channel slope[1]:	0.01	
	Sinuosity[1,2]:	1.59 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.90 (entrenched)	
	Floodplain Observations:	Grassy floodplain. 4m to the right and >100m to the left (runs along the lake shoreline)	
	General Observations:	Many small feeder tributaries along the main channel	
Substrate: (L & R looking downstream)	Left Bank:	Vegetative	
	Bed:	Organic	
	Right Bank:	Vegetative	

Additional Comments:

-

Field Observations

Survey at:	Date	10/14/10	05/17/12	08/31/12	
	Time	-	3:30 PM	3:11 PM	
	East/North	620942 / 5427052	620936 / 5427060	620936 / 5427060	
Weather Conditions:		-	Sunny		
In-Situ Water Chemistry					
Temperature:	°C	-	16.90	-	
Conductivity:	mS/cm	-	0.00	-	
pH:		-	7.17	-	
DO:	mg/L	-	7.47	-	
	%	-	-	-	
Flow Measurements[3]					
Q:	L/s	7.10	26.10	0.00	

Notes:

1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-R

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 18

Watershed Characteristics	Watershed ID:	SS-S	Drainage Area:	230.85 ha
			Perimeter:	13.33 km
			Lake and Wetland Area[1,4]:	31.20 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table) and 95% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).		
	UTM Coordinates at watershed	15N	621005 E	5425285 N
Channel Section at Watershed Outlet:	General Section Description:	Small channel coming out from small pond feed by two smaller tributaries.		
	Thalweg Description (straight, bend, off-center):	Meandering through rocks.		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass and some shrubs (5cm to 20cm).		
	Bankfull Depth:	0.85 m		
	Bankfull Width:	6.00 m		
	Length of main channel[1]:	1.83 km		
	Mean channel slope[1]:	0.01		
	Sinuosity[1,2]:	2.17 (moderate sinuosity)		
	Entrenchment ratio[2]:	0.28 (entrenched)		
	Floodplain Observations:	Grassy narrow flood plain with rock outcropping. It extends 10m to the right until rock outcropping and 2.5m to the left until hill side.		
	General Observations:	-		
Substrate: (L & R looking downstream)	Left Bank:	Vegetative		
	Bed:	Corse sand and boulders		
	Right Bank:	Vegetative		

Additional Comments:
-

Field Observations

Survey at:	Date	05/19/12	08/28/12		
	Time	9:30 AM	4:20 PM		
	East/North	621088 / 5425097	621088 / 5425097		
Weather Conditions:		Overcast			
In-Situ Water Chemistry					
Temperature:	°C	18.70	22.30		
Conductivity:	mS/cm	0.40	0.00		
pH:		6.67	6.41		
DO:	mg/L	7.52	-		
	%	-	6.15%		
Flow Measurements[3]					
Q:	L/s	23.10	10.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-S

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 19

Watershed Characteristics	Watershed ID:	SS-T	Drainage Area:	336.68 ha
			Perimeter:	15.06 km
			Lake and Wetland Area[4]:	18.10 ha
	Surface Geology[5]	30% Organic terrain (deposits of peat in areas of high water table) and 70% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).		
	UTM Coordinates at watershed	15N	618506 E	5421573 N
Channel Section at Watershed Outlet:	General Section Description:	Wide stream through flat grassy area.		
	Thalweg Description (straight, bend, off-center):	-		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, shrubs and some dead standing trees		
	Bankfull Depth:	1.57 m		
	Bankfull Width:	19.33 m		
	Length of main channel[1]:	3.41 km		
	Mean channel slope[1]:	0.00		
	Sinuosity[1,2]:	1.73 (moderate sinuosity)		
	Entrenchment ratio[2]:	0.16 (entrenched)		
	Floodplain Observations:	Channel centered on the floodplain. Flat and grassy plain. It extends 10m to each side.		
	General Observations:	Wide stream blocked at the outlet to the lake by many of floating logs.		
Substrate: (L & R looking downstream)	Left Bank:	Grass		
	Bed:	Silty organic		
	Right Bank:	Grass		

Additional Comments:
- May 2012 visit: Not possible to measure flowwith the available equipment because of not safe conditions.

Field Observations

Survey at:		Date	10/14/10	05/11/11	05/22/12	08/27/12
		Time	-	-	2:30 PM	9:39 AM
		East / North	618685/ 5421469	618685/ 5421469	618639 / 5421525	618681 / 5421471
Weather Conditions:			-	-	Sunny and partially cloudy	
In-Situ Water Chemistry						
Temperature:		°C	-	-	15.10	18.60
Conductivity:		mS/cm	-	-	-	0.00
pH:			-	-	6.49	7.22
DO:		mg/L	-	-	8.66	-
		%	-	-	-	15.60%
Flow Measurements[3]						
Q:		L/s	9.00	66.00	-	64.00

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-T

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 20

Watershed Characteristics	Watershed ID:	SS-U	Drainage Area: 200.68 ha Perimeter: 10.96 km Lake and Wetland Area[4]: 22.04 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table) and 85% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 620932 E 5420684 N	
Channel Section at Watershed Outlet:	General Section Description:	Well defined channel through grassy flat area.	
	Thalweg Description (straight, bend, off-center):	Straight and centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, shrubs and some trees	
	Bankfull Depth:	0.62 m	
	Bankfull Width:	4.67 m	
	Length of main channel[1]:	1.90 km	
	Mean channel slope[1]:	0.009	
	Sinuosity[1,2]:	1.34 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.26 (entrenched)	
	Floodplain Observations:	Channel centered on the floodplain. Flat and grassy plain that extends 10m to each side.	
	General Observations:	Channel interrupted by two large ponds (dammed by beaver dams). Channel splits into two between the two ponds.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Silty, organic	
	Right Bank:	Grass	

Additional Comments:
-2012 visit: Flow measured at the two channels located downstream a ponded area by beaver dams.

Field Observations

Survey at:	Date	05/22/12	08/27/12		
	Time	5:00 PM	12:08 PM		
	East/North	620936 / 5420847	620936 / 5420847		
Weather Conditions:		Sunny and partially cloudy			
In-Situ Water Chemistry					
Temperature:	°C	14.30	18.00		
Conductivity:	mS/cm	-	0.00		
pH:		5.64	6.36		
DO:	mg/L	6.80	-		
	%	-	0.40%		
Flow Measurements[3]					
Q:	L/s	10.00	0.30		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-U

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 21

Looking upstream

Looking downstream

Watershed Characteristics	Watershed ID:	SS-V	Drainage Area: 101.65 ha Perimeter: 5.79 km Lake and Wetland Area[1]: 0.00 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 622814 E 5423793 N	
Channel Section at Watershed Outlet:	General Section Description:	Meandering channel through thick vegetation.	
	Thalweg Description (straight, bend, off-center):	Meandering.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, moss, shrubs and small trees	
	Bankfull Depth:	0.70 m	
	Bankfull Width:	2.83 m	
	Length of main channel[1]:	1.32 km	
	Mean channel slope[1]:	0.004	
	Sinuosity[1,2]:	1.39 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.49 (entrenched)	
	Floodplain Observations:	Flat, vegetated and narrow floodplain. It extends 4m to the right and 8m to the left until the tree line.	
	General Observations:	Defined channel up to 200m upstream from the outlet to the lake. Channel upstream disappears into thick vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Organic	
	Right Bank:	Moss and shrubs	

Additional Comments:
- Not possible to flow measure. EM flow meter failed and too little flow to use the pigmy.

Field Observations

Survey at:	Date	05/24/12	08/30/12		
	Time	10:30 AM	2:40 PM		
	East /North	622656 / 5423818	622727 / 5423810		
Weather Conditions		Ligth rain (heavy rain previous nigth)			
In-Situ Water Chemistry					
Temperature:	°C	9.20	-		
Conductivity:	mS/cm	0.00	-		
pH:		4.87	-		
DO:	mg/L	4.52	-		
	%	-	-		
Flow Measurements[3]					
Q:	L/s	-	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied river morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland evaluation screening conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-V

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 22

Watershed Characteristics	Watershed ID:	SS-W	Drainage Area: 66.90 ha Perimeter: 7.31 km Lake and Wetland Area[1,4]: 24.60 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table) and 85% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 620310 E 5423981 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel at the stream outlet to the Lizard Lake. No flow, stagnant water.	
	Thalweg Description (straight, bend, off-center):	Meandering through boulders.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Moss, shrubs and trees	
	Bankfull Depth:	0.08 m	
	Bankfull Width:	0.67 m	
	Length of main channel[1]:	1.24 km	
	Mean channel slope[1]:	0.010	
	Sinuosity[1,2]:	1.36 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.25 (entrenched)	
	Floodplain Observations:	Not identified. Very narrow valley.	
	General Observations:	Channel disappears and dries out 30m upstream into thick vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Moss and boulders	
	Bed:	Silt and boulders	
	Right Bank:	Moss and boulders	

Additional Comments:
Channel dries out 30m upstream the outlet.

Field Observations

Survey at:	Date	05/17/12	08/28/12		
	Time	11:45 AM	4:57 PM		
	East/North	620313 / 5423941	620313 / 5423941		
Weather Conditions:		Overcast			
In-Situ Water Chemistry					
Temperature:	°C	-	-		
Conductivity:	mS/cm	-	-		
pH:		-	-		
DO:	mg/L	-	-		
	%	-	-		
Flow Measurements[3]					
Q:	L/s	0.00	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-W

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 23

Looking upstream

Watershed Characteristics	Watershed ID:	SS-X	Drainage Area:	82.32 ha
			Perimeter:	5.10 km
			Lake and Wetland Area[4]:	8.70 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table) and 85% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).		
	UTM Coordinates at watershed	15N	620680 E	5420578 N
Channel Section at Watershed Outlet:	General Section Description:	Short channel (<200m length) through wetland.		
	Thalweg Description (straight, bend, off-center):	-		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass, moss, shrubs and some tall trees		
	Bankfull Depth:	0.17 m		
	Bankfull Width:	1.73 m		
	Length of main channel[1]:	0.17 km		
	Mean channel slope[1]:	0.004		
	Sinuosity[1,2]:	-		
	Entrenchment ratio[2]:	0.19 (entrenched)		
	Floodplain Observations:	Wetland area		
	General Observations:	-		
Substrate: (L & R looking downstream)	Left Bank:	Grass		
	Bed:	Organic		
	Right Bank:	Grass		

Additional Comments:
-Visit May 2012: No channel found
-Visit Aug 2012: Short channel found at north side of the wetland. Channel starts 170m upstream the lake and ends 20m upstream from the edge wetland/lake.

Field Observations

Survey at:	Date	05/22/12	08/27/12		
	Time	4:20 PM	8:55 AM		
	East / North	620486 / 5420638	620690 / 5420733		
Weather Conditions:		Sunny and partially cloudy			

In-Situ Water Chemistry

Temperature:	°C	-	18.00		
Conductivity:	mS/cm	-	0.00		
pH:		-	6.29		
DO:	mg/L	-	-		
	%	-	0.41%		

Flow Measurements[3]

Q:	L/s	-	22.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-X

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 24

Watershed Characteristics	Watershed ID:	SS-Y	Drainage Area: 45.66 ha Perimeter: 4.20 km Lake and Wetland Area[4]: 0.00 ha
	Surface Geology[5]	20% Organic terrain (deposits of peat in areas of high water table) and 80% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 619285 E 5420256 N	
Channel Section at Watershed Outlet:	General Section Description:	Small channel through thick vegetation.	
	Thalweg Description (straight, bend, off-center):	Straight and centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grassy shrubs and some trees	
	Bankfull Depth:	0.22 m	
	Bankfull Width:	1.67 m	
	Length of main channel[1]:	1.34 km	
	Mean channel slope[1]:	0.004	
	Sinuosity[1,2]:	1.28 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.26 (entrenched)	
	Floodplain Observations:	Flat vegetated plain and wetland.	
	General Observations:	Channel through wetland for 40m from the outlet to the lake. Upstream channel gets narrow and goes into thick vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Organic	
	Right Bank:	Grass	

Additional Comments:
-Visit aug 2012: Dry channel at flow measurement location

Field Observations

Survey at:	Date	05/23/12	08/31/12		
	Time	6:00 PM	9:09 AM		
	East / North	619343 / 5420275	619343 / 5420275		
Weather Conditions:		Rain			
In-Situ Water Chemistry					
Temperature:	°C	11.00	-		
Conductivity:	mS/cm	-	-		
pH:		4.30	-		
DO:	mg/L	6.41	-		
	%	-	-		
Flow Measurements[3]					
Q:	L/s	6.00	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

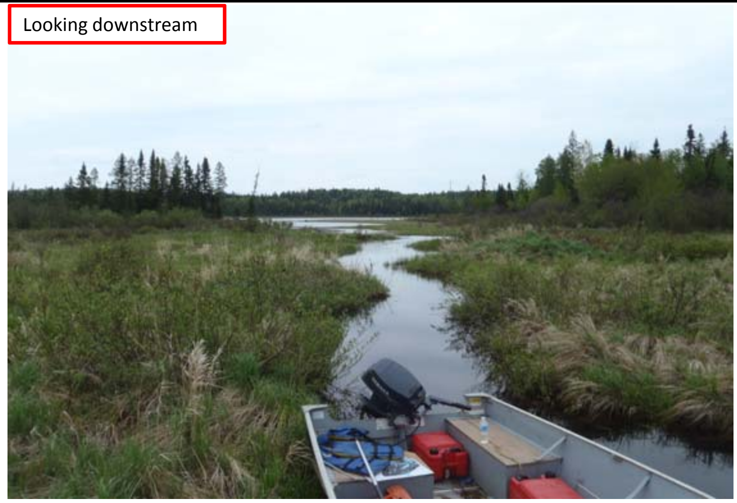
4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-Y

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 25



Watershed Characteristics	Watershed ID:	SS-Z	Drainage Area: 74.75 ha Perimeter: 5.50 km Lake and Wetland Area[1,4]: 0.97 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 618468 E 5422540 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel through grassy flat area.	
	Thalweg Description (straight, bend, off-center):	Straight and centered.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass and shrubs	
	Bankfull Depth:	0.58 m	
	Bankfull Width:	1.60 m	
	Length of main channel[1]:	0.38 km	
	Mean channel slope[1]:	0.013	
	Sinuosity[1,2]:	1.26 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.73 (entrenched)	
	Floodplain Observations:	Flat grassy plain. It extends 15m to the right and 8m to the left.	
	General Observations:	Channel is influenced by lake water level up to about 100m upstream from the lake outlet.	
Substrate: (L & R looking downstream)	Left Bank:	Grass	
	Bed:	Organic	
	Right Bank:	Grass	

Additional Comments:
- 2012 visit: Flow measured downstream of a pond (dammed by old beaver dam) at the two pond outlets (two small channels).
- It was possible to canoe up to about 100m from outlet to the lake.

Field Observations

Survey at:	Date	05/11/11	05/22/12	08/26/12	
	Time	-	1:10 PM	4:09 PM	
	East/North	618484 / 5422491	618451 / 5421468	618451 / 5421468	
Weather Conditions:		-	Light rain		
In-Situ Water Chemistry					
Temperature:	°C	-	13.90	21.10	
Conductivity:	mS/cm	-	-	0.00	
pH:		-	6.32	6.61	
DO:	mg/L	-	6.45	-	
	%	-	-	9.30%	
Flow Measurements[3]					
Q:	L/s	10.00	4.00	0.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N
2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)
3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-Z

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 26

Watershed Characteristics	Watershed ID:	SS-AA	Drainage Area: 73.34 ha Perimeter: 4.40 km Lake and Wetland Area[1]: 1.20 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table) and 85% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 616964 E 5421374 N	
Channel Section at Watershed Outlet:	General Section Description:	Channel goes through a flat and very vegetated area with stagnant water.	
	Thalweg Description (straight, bend, off-center):	Meandering through dense vegetation (3cm to 20cm).	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Moss covering the ground and lots of shrubs	
	Bankfull Depth:	0.18 m	
	Bankfull Width:	0.47 m	
	Length of main channel[1]:	1.13 km	
	Mean channel slope[1]:	0.020	
	Sinuosity[1,2]:	1.95 (moderate sinuosity)	
	Entrenchment ratio[2]:	0.79 (entrenched)	
	Floodplain Observations:	Flat and extensive flood plain, ponded water around.	
	General Observations:	Upstream channel disappears into vegetation. Downstream channel goes into wetland for about 100m until channel outlet reaches the lake.	
Substrate: (L & R looking downstream)	Left Bank:	Moss	
	Bed:	Organic	
	Right Bank:	Moss	

Additional Comments:
- Channel extension is about 120m long from the outlet to the lake. Not defined channel upstream, it disappears into thick vegetation.
- No flow, influenced by lake water level.

Field Observations

Survey at:	Date	05/22/12	08/26/12		
	Time	10:00 AM	2:03 PM		
	East / North	616866 / 5421421	616866 / 5421421		
Weather Conditions:		Overcast			
In-Situ Water Chemistry					
Temperature:	°C	-	17.50		
Conductivity:	mS/cm	-	0.00		
pH:		-	6.84		
DO:	mg/L	-	-		
	%	-	3.60%		
Flow Measurements[3]					
Q:	L/s	0.00	0.20		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method
4. Based on wetland mapping conducted by Golder
5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AA

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 27

Watershed Characteristics	Watershed ID:	SS-AB	Drainage Area:	51.99 ha
			Perimeter:	4.20 km
			Lake and Wetland Area[1]:	1.10 ha
	Surface Geology[5]	10% Organic terrain (deposits of peat in areas of high water table) and 90% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).		
	UTM Coordinates at watershed	15N	613579 E	5421293 N
Channel Section at Watershed Outlet:	General Section Description:	Incised and high grade channel through dense forest.		
	Thalweg Description (straight, bend, off-center):	Straight.		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Moss, shrubs and tall trees		
	Bankfull Depth:	0.23 m		
	Bankfull Width:	1.30 m		
	Length of main channel[1]:	1.03 km		
	Mean channel slope[1]:	0.017		
	Sinuosity[1,2]:	1.51 (moderate sinuosity)		
	Entrenchment ratio[2]:	0.36 (entrenched)		
	Floodplain Observations:	Not identified. No trace of high water marks.		
	General Observations:	Channel through narrow depression (3 m to the right and 1 m to the left).		
Substrate: (L & R looking downstream)	Left Bank:	Organic soil and moss		
	Bed:	Organic		
	Right Bank:	Organic soil and moss		

Additional Comments:
-

Field Observations

Survey at:		Date	05/21/12	08/26/12		
		Time	2:10 PM	11:14 AM		
		East/North	613611 / 5421468	613611 / 5421468		
Weather Conditions:			Sunny			
In-Situ Water Chemistry						
Temperature:		°C	11.10	16.70		
Conductivity:		mS/cm	0.19	0.00		
pH:			6.89	6.90		
DO:		mg/L	8.54	-		
		%	-	25.10%		
Flow Measurements[3]						
Q:		L/s	2.00	0.30		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AB

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 28

Watershed Characteristics	Watershed ID:	SS-AC; Drainage Area: 29.24 ha; Perimeter: 2.60 km; Lake and Wetland Area[1]: 0.00 ha
	Surface Geology[5]	35% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 65% Outwash Deltas and Meltwater Channels (deposits of sand and gravel)
	UTM Coordinates at watershed	15N 616459 E 5425159 N
Channel Section at Watershed Outlet:	General Section Description:	Incised channel through marshy area.
	Thalweg Description (straight, bend, off-center):	Channel is thalweg.
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grasses and shrubs. Root depth 5cm
	Bankfull Depth:	0.28 m
	Bankfull Width:	0.87 m
	Length of main channel[1]:	0.41 km
	Mean channel slope[1]:	0.007
	Sinuosity[1,2]:	1.15 (low sinuosity)
	Entrenchment ratio[2]:	0.65 (entrenched)
	Floodplain Observations:	The floodplain is flat and has lots of storage water. There no trace of water marks, when high flows occurs the water spreads.
	General Observations:	There is little flow and the upstream channel goes into thicker shrubs and disappears under vegetation.
Substrate: (L & R looking downstream)	Left Bank:	Vegetated; organic
	Bed:	Organic
	Right Bank:	Vegetated; organic

Additional Comments:

Field Observations

Survey at:	Date	08/31/11	05/20/12	08/25/12	
	Time	4:10 PM	1:30 PM	11:36 AM	
	East / North	616409 / 5425141	616408 / 5425146	616440 / 5425137	
Weather Conditions:		Overcast	Light rain (heavy rain last night)		
In-Situ Water Chemistry					
Temperature:	°C	14.30	12.90	21.10	
Conductivity:	mS/cm	0.09	0.43	0.00	
pH:		7.03	6.28	6.22	
DO:	mg/L	-	5.10	-	
	%	-	-	4.50%	
Flow Measurements[3]					
Q:	L/s	0.00	2.00	0.00	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AC

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 29

Watershed Characteristics	Watershed ID:	SS-AD	Drainage Area: 29.32 ha Perimeter: 2.67 km Lake and Wetland Area[4]: 0.87 ha
	Surface Geology[5]	100% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud).	
	UTM Coordinates at watershed	15N 612992 E 5421115 N	
Channel Section at Watershed Outlet:	General Section Description:	Marshy area with no defined channel.	
	Thalweg Description (straight, bend, off-center):	Not visible.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, grasses and shrubs. The root depth is not visible	
	Bankfull Depth:	0.05 m	
	Bankfull Width:	0.40 m	
	Length of main channel[1]:	0.29 km	
	Mean channel slope[1]:	0.037	
	Sinuosity[1,2]:	1.07 (low sinuosity)	
	Entrenchment ratio[2]:	0.25 (entrenched)	
	Floodplain Observations:	Floodplain is flat and very vegetated	
	General Observations:	The upstream section consists in a thick tree area with marsh and trees with several pathways. During the 2011 site visit, water flowed through a road culvert and immediately upstream was being disturbed by drilling work conducted at that time.	
Substrate: (L & R looking downstream)	Left Bank:	-	
	Bed:	-	
	Right Bank:	-	

Additional Comments:
- 2011 visit: The flow was measured through the road culvert and could be partially discharging from drilling works conducted upstream.
- May 2012 visit: Not defined channel upstream or downstream. Culvert could not be found, very disturbed area by old drilling works and not possible to measure flow, although some water can be heard flowing under ground.
- Aug 2012 visit: Culvert could not be found, very disturbed area by old drilling works. A short and low flow channel was found. Water seepage below the ground downstream this channel section.

Field Observations

Survey at:	Date	08/31/11	05/21/12	08/26/12	
	Time	11:50 AM	1:15 PM	9:00 AM	
	East/North	613050 / 5421167	613050 / 5421167	613067/ 5421195	
Weather Conditions:		Overcast	Sunny		
In-Situ Water Chemistry					
Temperature:	°C	14.60	-	15.40	
Conductivity:	mS/cm	0.09	-	0.00	
pH:		7.48	-	7.07	
DO:	mg/L	-	-	-	
	%	-	-	7.50%	
Flow Measurements[3]					
Q:	L/s	1.28	no measurable	0.50	

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AD

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 30

Watershed Characteristics	Watershed ID:	SS-AF	Drainage Area:	77.50 ha
			Perimeter:	2.80 km
			Lake and Wetland Area[1,4]:	0.70 ha
	Surface Geology[5]	60% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 40% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).		
	UTM Coordinates at watershed	15N	615618 E	5423133 N
Channel Section at Watershed Outlet:	General Section Description:	Meandering channel through dense vegetation.		
	Thalweg Description (straight, bend, off-center):	Meandering.		
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Pine forest, lots of shrubs and moss		
	Bankfull Depth:	0.30 m		
	Bankfull Width:	4.10 m		
	Length of main channel[1]:	0.65 km		
	Mean channel slope[1]:	0.038		
	Sinuosity[1,2]:	1.99 (moderate sinuosity)		
	Entrenchment ratio[2]:	0.15 (entrenched)		
	Floodplain Observations:	Not identified. No trace of high water marks.		
	General Observations:	Lots of obstacles along the channel.		
Substrate: (L & R looking downstream)	Left Bank:	Moss		
	Bed:	Organic		
	Right Bank:	Moss		

Additional Comments:

-

Field Observations

Survey at:	Date	05/23/12	08/28/12		
	Time	12:00pm	11:25 AM		
	East / North	615550 / 5423162	615592 / 5423126		
Weather Conditions:		Overcast			
In-Situ Water Chemistry					
Temperature:	°C	9.40	13.80		
Conductivity:	mS/cm	-	0.00		
pH:		6.27	6.14		
OD:	mg/L	8.29	-		
	%	-	18.20%		
Flow Measurements[3]					
Q:	L/s	3.00	9.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AF

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 31

Watershed Characteristics	Watershed ID:	SS-AG	Drainage Area: 34.20 ha Perimeter: 3.00 km Lake and Wetland Area[1,4]: 8.80 ha
	Surface Geology[5]	15% Organic terrain (deposits of peat in areas of high water table), 40% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 45% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 616332 E	5423726 N
Channel Section at Watershed Outlet:	General Section Description:	Wetland.	
	Thalweg Description (straight, bend, off-center):	-	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Long grass, moss and some shrubs / 5 cm	
	Bankfull Depth:	- m	
	Bankfull Width:	- m	
	Length of main channel[1]:	- km	
	Mean channel slope[1]:	-	
	Sinuosity[1,2]:	-	
	Entrenchment ratio[2]:	-	
	Floodplain Observations:	Wetland area is the floodplain.	
	General Observations:	Wetland extends for about 650m from the lake.	
Substrate: (L & R looking downstream)	Left Bank:	-	
	Bed:	-	
	Right Bank:	-	

Additional Comments:
- No channel found, but the area was an extensive wetland area. There was no flow, just stagnant water.

Field Observations

Survey at:	Date	05/23/12	08/28/12		
	Time	9:00 AM	8:45 AM		
	East / North	616332 / 5423726	616332 / 5423726		
Weather Conditions:		Overcast			
In-Situ Water Chemistry					
Temperature:	°C	-	-		
Conductivity:	mS/cm	-	-		
pH:		-	-		
OD:	mg/L	-	-		
	%	-	-		
Flow Measurements[3]					
Q:	L/s	-	-		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AG

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 32

Watershed Characteristics	Watershed ID:	SS-AH	Drainage Area: 60.00 ha Perimeter: 2.80 km Lake and Wetland Area[1,4]: 0.00 ha
	Surface Geology[5]	5% Organic terrain (deposits of peat in areas of high water table), 50% Till Veneer-Discontinuous (bedrock outcrop interspersed with unsorted deposits of boulders/gravel/mud) and 45% Outwash Deltas and Meltwater Channels (deposits of sand and gravel).	
	UTM Coordinates at watershed	15N 615549 E	5422139 N
Channel Section at Watershed Outlet:	General Section Description:	Small and short channel through dense vegetation.	
	Thalweg Description (straight, bend, off-center):	Straight.	
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Moss, shrubs and trees	
	Bankfull Depth:	0.13 m	
	Bankfull Width:	0.05 m	
	Length of main channel[1]:	0.05 km	
	Mean channel slope[1]:	-	
	Sinuosity[1,2]:	1.00 (low sinuosity)	
	Entrenchment ratio[2]:	0.77 (entrenched)	
	Floodplain Observations:	Not identified. No trace of high water marks.	
	General Observations:	Total stream length is 50m. The upstream channel disappears into thick vegetation.	
Substrate: (L & R looking downstream)	Left Bank:	Moss	
	Bed:	Organic	
	Right Bank:	Moss	

Additional Comments:
-There was no flow and there was a blockage from outlet to the lake.

Field Observations

Survey at:	Date	05/22/12	08/26/12		
	Time	9:00 AM	12:55 PM		
	East / North	615568 / 5422172	615568 / 5422172		
Weather Conditions:		Light rain			

In-Situ Water Chemistry

Temperature:	°C	-	-		
Conductivity:	mS/cm	-	-		
pH:		-	-		
OD:	mg/L	-	-		
	%	-	-		

Flow Measurements[3]

Q:	L/s	0.00	0.00		

Notes:
1. This is an approximate value based on limited topographical information. Base data from MNR NRVIS (obtained 2004, CANMAP v2006.4, CanVec) and contours every 1 m - Provided by OSISKO Hammond Reef Gold Project Ltd (April, 2010). Datum: NAD 83 Coordinate System: UTM Zone 15N

2. Ranking determined from the Rosgen Classification Tables (Rosgen, D. (1996). Applied River Morphology. Wildlife Hydrology, Pagosa Springs, CO.)

3. Calculated using the mid-section method

4. Based on wetland mapping conducted by Golder

5. Source: Stea Surficial Geology Services 2009, Surficial Geology of the Hammond Reef Property, West-Central Ontario (provided by Osisko)

Golder Associates

Site Scale Watercourse Surveys SS-AH

PROJECT #:	10-1118-0020 (6100)	DATE:	December 13, 2012	Hammond Reef Gold Project	SHEET 33

APPENDIX 5.I

Flow and Lake Water Level Monitoring

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TABLES

FIGURES

ATTACHMENTS

1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. (OHRG) proposes the development of an open pit gold mine, the Hammond Reef Gold Project (Project), near the town of Atikokan in north-western Ontario. The Project will involve the development of an open pit mining area, as well as waste rock and tailings management facilities. On-site infrastructure will include a processing plant, an explosives plant, offices and maintenance facilities. Off-site infrastructure will include the upgrading of site access and the construction of a power transmission line and a fibre optics line.

A flow and lake water level monitoring program was established in August 2010 to collect hydrometric data in the Project locality. The data collected was correlated with longer-term records for nearby regional Water Survey of Canada (WSC) flow monitoring stations to permit the characterization of baseline conditions at the site and local scales.

This report is organized in two parts:

- The first part (in the sections to follow) provides a summary of the rationale for siting the gauging stations, the equipment installations, the methods of measurement and computation, considerations in the timing of the site visits, quality assurance/quality control measures and the limitations of the program.
- The second part (Attachments 5.I.1 to 5.I.13) consists of detailed descriptions of the gauging stations, the rating curves developed, and the records of daily mean discharges and lake water levels for each monitoring station.

2.0 GAUGING STATION LOCATIONS

A total of 13 gauging stations were established for the flow and lake water level monitoring program to collect systematic records of stage (water level) and flow. The locations of the gauging stations were first selected based on a desk study which included review of an early revision of the Project Description (Golder, 2011), the Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS) 1:20,000 topographic data, and other background literature (Boileau, 2004).

Gauging stations were generally sited with consideration given to:

- The Project footprint and the locations of open pit mining areas, waste rock and tailings management facilities;
- The anticipated locations of Project water intakes and effluent discharges;
- Topographical information including drainage patterns, flow paths, catchment sizes and water bodies;
- Station accessibility via the existing network of roads and navigable waterways;
- The locations of existing water control structures.

The specific locations of gauging stations were determined during ground reconnaissance, conducted as part of the first site visit in August, 2010. Rantz *et al* (1982a) lists the following key criteria for an ideal gauge site, and these were used as guidelines in the specific siting of gauging stations:

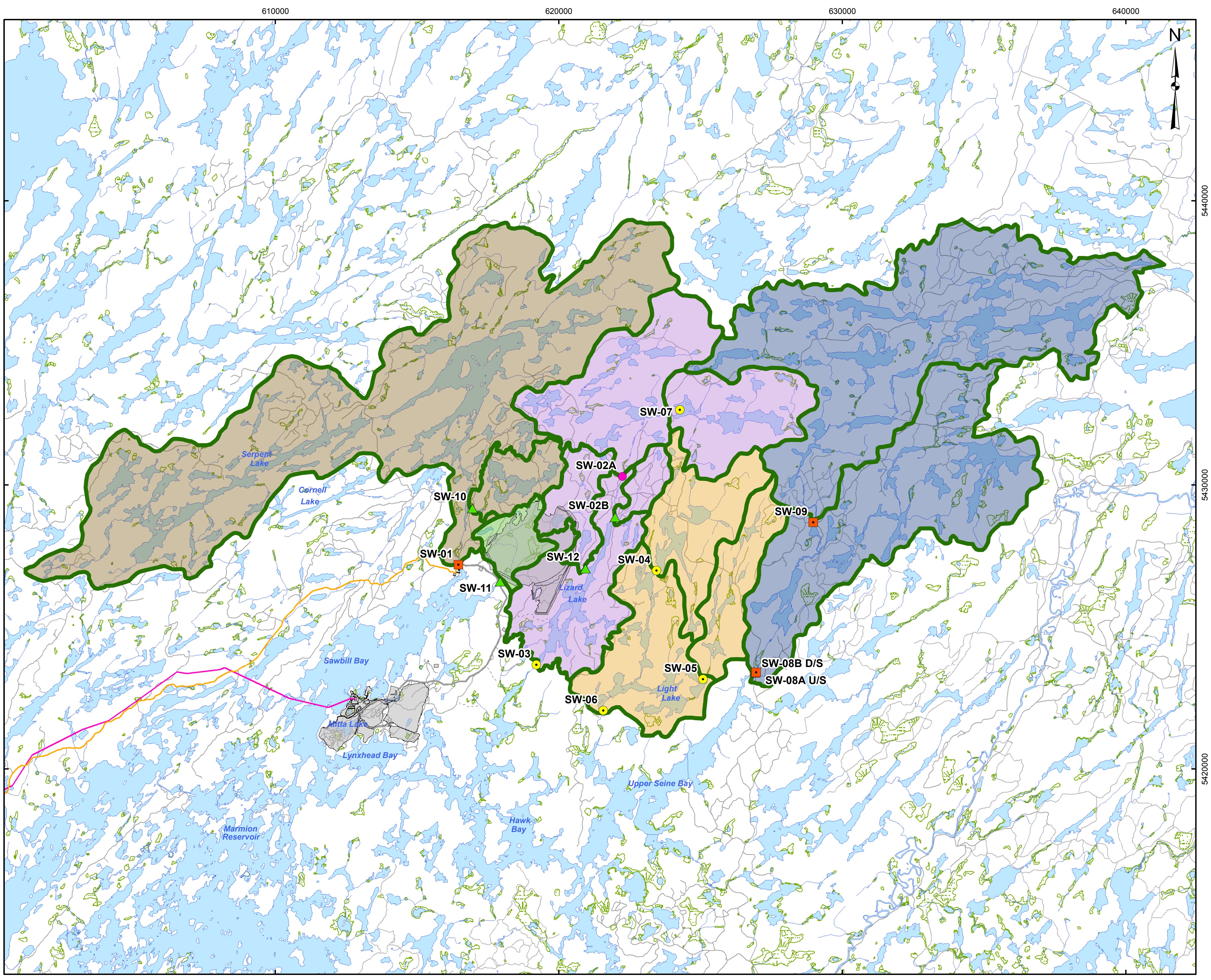
- The general course of the stream is straight for about 100 m upstream and downstream of the site;
- The total flow is confined to one channel at all stages, and no flow bypasses the site as subsurface flow;
- The streambed is not subject to scour and fill, and is free of aquatic growth;
- Banks are permanent, high enough to contain floods, and are free of brush;
- Unchanging natural controls are present in the form of a bedrock outcrop or other stable riffle for low flow, and a channel constriction for high flow; or a falls or cascade that is unsubmerged at all stages;
- A pool is present upstream from the control at extremely low stages;
- A satisfactory reach for measuring discharge at all stages is available within reasonable proximity of the gauge site.

Gauging stations are shown on Figure 1, and are listed in Table 1 together with the rationale for their selection.

Table 1: Gauging Stations for Streamflow and Lake Level Monitoring

Station ID	Station Name	NAD 83 UTM Zone 15N Coordinates	Data Collected	Rationale for Selection
SW-01	Sawbill Creek at Sawbill Bay	616461 E 5427196 N	Flow	Main inflow to Sawbill Bay – the bay is the proposed location for the water intakes and a potential receiver of non-point source pollution in stormwater runoff
SW-02A	Lumby Creek above Lizard Lake	622241 E 5430299 N	Flow	Main inflow to Lizard Lake – the lake is located between Tailings Management Alternatives (TMA) #1 and #2 and it is a potential receiver of non-point source pollution in stormwater runoff and seepage flows
SW-02B	Lumby Creek East Tributary above Lizard Lake	621983 E 5428872 N	Flow	Tributary to main inflow to Lizard Lake – see above
SW-03	Lumby Creek below Lizard Lake/ Lizard Lake	610183 E 5423635 N/ 619212 E 5423678 N	Flow/ Water Level	Outlet from Lizard Lake – see above
SW-04	Premier Lake-Vista Lake/ Premier Lake	623404 E 5426952 N/ 625085 E 5423163 N	Flow/ Water Level	Outlet from Premier Lake – the lake is located mid-catchment on the main tributary to Light Lake
SW-05	St. Patrick Creek above Light Lake/ Upper Light Lake	625325 E 5423669 N/ 625085 E 5423163 N	Flow Water Level	Significant tributary to Light Lake – the lake is located downstream of TMA #2 and is a potential receiver of non-point source pollution stormwater runoff and

Station ID	Station Name	NAD 83 UTM Zone 15N Coordinates	Data Collected	Rationale for Selection
				seepage flows
SW-06	Light Creek below Light Lake/ Light Lake	621569 E 5421997 N/ 621581 E 5422023 N	Flow Water Level	Outlet from Light Lake – as above
SW-07	Lumby Creek below Herontrack Lake/ Herontrack Lake	623987 E 5432453 N/ 624266 E 5432648 N	Flow Water Level	Outlet from Herontrack Lake – the lake is located in the upper reaches of the main tributary to Light Lake
SW-08 Upstream	Caribou River at Upper Seine Bay	626937 E 5423385 N	Flow	Tributary to Seine River upstream of project – data may be used in hydrodynamic modelling of Upper Marmion Reservoir
SW-08 Downstream	Caribou River at Upper Seine Bay	626958 E 5423402 N	Flow	Tributary to Seine River upstream of project – data may be used in hydrodynamic modelling of Upper Marmion Reservoir
SW-09	Bar Creek above Caribou River	628979 E 5428689 N	Flow	Tributary located in the upper reaches of the Caribou River catchment – as above
SW-10	Sawbill Creek below Long Hike Lake	616953 E 5429177 N	Flow	Tributary to main inflow to Sawbill Bay – as above
SW-11	Sawbill Bay Tributary at Reef Road	617930 E 5426603 N	Flow	Inflow to Sawbill Bay – as above
SW-12	Lizard Lake West Tributary	620937 E 5427060 N	Flow	Inflow to Lizard Lake – as above



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LEGEND

- Barologger and Stream Gauging Station
- Spot Flow Measurement Location
- Stream Gauging Station
- Stream Gauging and Water Level Monitoring Station
- Road
- Trail
- River/Stream
- Lake
- Wetland
- Local Watershed Boundary
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

Surface Water Drainage Areas

- Contributing to SW-01
- Contributing to SW-03
- Contributing to SW-06
- Contributing to SW-08
- Contributing to SW-11

NOTES:

1. Stream Gauging Stations and Associated Drainage Area:

Station ID	Station Name	Drainage Area (ha)
SW-01	SAWBILL CREEK AT SAWBILL BAY	10,634.14
SW-02A	LUMBY CREEK ABOVE LIZARD LAKE	3,597.52
SW-03	LUMBY CREEK AT TURTLE BAY	6,282.83
SW-04	PREMIER LAKE-VISTA LAKE	1,409.88
SW-05	ST. PATRICK CREEK AT LIGHT LAKE	981.55
SW-06	LIGHT CREEK AT LIGHT LAKE	4,135.96
SW-07	LUMBY CREEK AT HERONTRACK LAKE	1,440.58
SW-08DS/US	CARIBOU RIVER AT UPPER SEINE BAY	11,264.36
SW-09	BAR CREEK NEAR CARIBOU RIVER	6,872.60

2. Spot Flow Measurement Stations:

Station ID	Station Name	Drainage Area (ha)
SW-02B	LUMBY CREEK TRIBUTARY AT LIZARD LAKE	285.81
SW-10	SAWBILL CREEK AT LONG HIKE LAKE	587.07
SW-11	SAWBILL BAY TRIBUTARY AT REEF ROAD	461.80
SW-12	LIZARD LAKE TRIBUTARY	620.95

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

2,000 0 2,000 4,000
SCALE 1:135,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
LOCAL SCALE FLOW AND WATER LEVEL MONITORING STATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 1	
GIS	JO	9 Oct. 2012		
CHECK	CC	9 Oct. 2012		
REVIEW	THW	9 Oct. 2012		

3.0 EQUIPMENT INSTALLATIONS

Of the 13 gauging stations established for the project, nine were recording (automatic) gauging stations and four were non-recording (manual) stations. Decisions on the types of gauging stations installed were based on the:

- Anticipated use of the record;
- Size of the watercourse/water body and its catchment;
- Potential for correlation of data collected at ungauged locations to that collected at gauged locations.

3.1 Recording Stations

Recording stations were equipped with Solinst Leveloggers and Direct Read Cables for the measurement of water levels. Recorded water level data were converted to flow data using rating curves (stage-discharge relationships) developed for each gauging station (Section 5). The option of Direct Read Cables was selected to avoid pulling the Levelogger for data download, in particular during periods of ice cover in the winter and spring seasons. Leveloggers were installed using one of the following two configurations depending on the channel substrate:

- Fastened inside concrete cinder blocks which were placed on the streambed and held in place using large rocks;
- Tied onto T-bars which were driven into the stream bed.

In either case, Direct Read Cables were run through flexible PVC piping from the Levelogger to PVC housing on the stream bank at an elevation above the high water mark. Leveloggers were installed where possible in water depths of one metre or greater to avoid damage due to freezing during the winter.

Leveloggers record total pressure head (barometric pressure and water pressure) and the recorded data must be corrected for barometric pressure. For this purpose, a Solinst Barologger was installed at Station SW-02A to sample barometric pressure for the adjustment of Levelogger data at each installation. The Barologger was hung inside PVC plastic tubing fastened to a birch tree, approximately 1.5 m up the left bank, downstream of the culvert crossing.

The Leveloggers record water temperature in addition to total pressure head and the Barologger records air temperature together with barometric pressure. The Leveloggers and the Barologger were programmed to sample at 15-min intervals.

In addition to the data logging equipment, staff gauges were installed at all the recording stations to permit periodic manual checks of the recorded water level data. Staff gauges were fixed to T-posts which were driven into the streambed in the vicinity of the Leveloggers

3.2 Non-Recording Stations

At non-recording stations, water level data were collected manually at irregular intervals, dependent on the timing of site visits (Section 5). Staff gauges were installed using the same configuration as for recording stations (Section 3.1).

3.3 Surveying

A local benchmark was established at each gauging station, which was later referenced to a geodetic datum by others. Field surveys were completed immediately following station installation August 2010 and in October 2010 to determine the elevations of the following relative to the benchmark:

- Levelogger;
- Top of staff gauge;
- Gauge height of zero flow at the hydraulic control;
- Channel cross-sections up- and downstream of the station;
- Longitudinal profile of the channel in the vicinity of the station.

This information was used to:

- Tie water levels recorded by the Levelogger to manual readings from the staff gauge;
- Relate the observed water levels to the hydraulic control;
- Provide geometric data to support rating curve development, where necessary (Section 6); and
- Provide information on the fluvial geomorphology.

The stations were re-surveyed in May 2012 to check for and correct changes in the elevations of the Levelogger and the top of the staff gauge due to natural processes (e.g. freeze-thaw, settlement).

4.0 DISCHARGE MEASUREMENTS

Direct discharge measurements were collected during 12 site visits (Section 5) together with manual readings of stage (from the staff gauges), in order to develop rating curves for the gauging stations. Measurement cross-sections suitable for low and high flow conditions, and for measurements from an ice cover, were identified at the time of station installation. The following guidelines in Rantz *et al* (1982a) were used in the selection of measurement cross-sections:

- The measurement cross-section should be in reasonable proximity to the gauge to avoid the need for adjusting the measured discharges;
- The measurement cross-section should be of fairly uniform depth;
- Flow lines should be parallel and fairly uniform in velocity through the cross-section.

Discharge measurements were conducted by wading and from ice cover during the winter season using standard procedures described in WSC (1999), Terzi (1981) and Rantz *et al* (1982a). In summary:

- Discharge measurements were collected using the Velocity-Area Method, with incremental widths selected to contain approximately 10% of the estimated total discharge;
- Under open-water conditions, the Six-Tenths Method was employed for velocity measurements in water depths less than 0.75 m and the Two-Point Method in water depths of 0.75 m or greater;
- When conducting discharge measurements from ice cover, the 0.5 Method for velocity measurements was employed in effective water depths less than 0.75 m, and the Two-Point Method in effective depths of 0.75 m or greater. A coefficient of 0.88 was applied to velocity measurements collected using the 0.5 Method;
- Stream discharge was computed using the Mid-Point Method;
- Manual readings of the staff gauge were taken at the start and/or end of each discharge measurement.

Table 2 lists the current meters that were used for velocity measurements:

Table 2: Current Meters

Current Meter	Velocity Range	Minimum Flow Depth
Valeport Electromagnetic Flow Meter Model 801	≤ 5 m/s	0.050 m
USGS Type AA Current Meter Model 6200	0.025 to 7.5 m/s	0.15 m
USGS Pygmy Current Meter Model 6205	0.025 to 1.5 m/s	0.075 m
USGS Type AA-Ice (Polymer) Meter Model 6245	0.025 to 7.5 m/s	0.15 m

The current meters are calibrated annually, with the exception of the USGS Type AA-Ice Meter which is calibrated every three years.

5.0 SITE VISITS

A total of 10 site visits were carried out between 2010 and 2012 for the purpose of:

- Downloading the recorded water level data;
- Collecting discharge measurements and manual readings of water levels;
- Completing station maintenance.

The timing of site visits was selected with a view to collecting discharge measurements across the full range of flow conditions (high, medium and low flows) for the purpose of rating curve development. In selecting the timing of site visits, the following regional data were reviewed:

- Discharge hydrographs for WSC hydrometric stations;
- Climate records for Environment Canada meteorological stations.

Site visits were conducted in:

- August 2010, to install the gauging stations under low flow conditions;
- October 2010, when medium flows occurred in response to fall rainfall;
- January 2011, at the start of winter when ice conditions were considered to be safe;
- March 2011, at the end of the winter season before ice break-up, when flows were lowest;
- April and May 2011, when the spring freshet was underway and high flow conditions existed;
- August 2011, to retrieve recorded data to complete one year of monitoring;
- February 2012, in the middle of winter;
- May 2012, during the spring freshet;
- August 2012; to retrieve recorded data to complete two years of monitoring.

6.0 RATING CURVE DEVELOPMENT

The manual readings of stage and discharge measurements, together with field observations, collected during the site visits were used to develop open-water rating curves for the gauging stations. The rating curves were used to determine daily mean discharge records from water level data collected at the recording stations under ice-free conditions. A curve was fitted to the stage-discharge data of the form:

$$Q = A * (y - y_o) ^ B$$

Where: Q = Discharge, m^3/s

A, B = Dimensionless coefficients

y_o = Gauge height at zero flow, masl

y = Stage, masl

Gauge height at zero flow was estimated either from the survey data for the gauging station's hydraulic control, or using standard techniques described in Rantz *et al* (1982b) and WSC (1999).

7.0 DAILY MEAN DISCHARGE COMPUTATIONS

The water levels recorded at 15 min intervals were corrected for logger drift using the manual readings of stage collected during the site visits. The rating equation derived for each recording station was then applied to the water levels to obtain the corresponding discharges. Shift corrections were applied where rated discharges differed from measured discharges collected at the time of the site visits. Daily mean discharges were computed as the average of the 15-min interval discharges over a 24-hour period.

Daily mean discharges determined directly from daily mean water levels may be in error for the following reasons (WSC, 1999):

- The rate of change in stage;
- The relative condition of the river (high or low);
- The shape of the stage hydrograph for the day and the proportion of time during which the stage is relatively high or low;
- The relative curvature of the stage-discharge curve in the range of recorded stage during the day.

The hydrographic and comparison method described in Melcher and Walker (1990) was used to estimate daily mean discharges during the winter season.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

The following Quality Assurance/Quality Control measures were implemented during data collection and computation:

- Testing and maintenance of the current meters were routinely carried out according to manufacturer instructions, and the guidelines described in WSC (1999) and Rantz *et al* (1982a);
- Equipment installations at gauging stations were inspected and maintenance performed where required during the site visits;
- Each gauging station, in particular the hydraulic control, was periodically inspected and changes in channel cross-section and profile due to deposition, erosion, debris accumulation, beaver activity or ice cover were documented.
- Discharge measurements were computed in the field and compared to previous measurements at the same gauging station;
- Data computations and rating curve development were independently checked;
- Recorded water level data were compared with manual staff gauge readings taken during the site visits and corrected for logger drift;
- The magnitudes of the changes in recorded water levels between successive 15-min intervals were reviewed and large changes were flagged and checked;
- Daily mean water level data were plotted with daily total precipitation, and daily mean air and water temperature data to check for consistency;
- Daily mean discharges at a gauging station were plotted with values for upstream, downstream and adjacent gauging stations for the purpose of comparison;
- Missing and estimated data, and daily mean discharges under ice, were flagged in the record.

9.0 PROGRAM LIMITATIONS

Limitations to the flow and lake water level monitoring program for the Project include:

- The stations were sited to collect flow and water level data over one to two years at strategic locations in support of the Project's environmental assessment, as opposed to collecting longer-term hydrometric data for multiple uses as carried out by WSC.
- The conditions at some of the gauging stations are not ideal for stream gauging. Generally, the streams consisted of short reaches between two lakes. This factor, together with accessibility issues presented by the thick vegetation and limited road/trail network, restricted the siting of the gauging stations.
- The substrate at SW-04 was comprised of cobbles and boulders and subsurface flow was observed to occur beneath the measuring cross-section. Discharges at this station are likely underestimated.
- Five gauging stations (SW-03, SW-12, SW-04, SW-05 and SW-06) were only accessible over water. Poor ice conditions prevented visits to these stations (SW-03, SW-05 and SW-06) by snowmobile during the winter seasons.
- Beaver activity affected the hydraulic controls at five of the gauging stations (SW-07, SW-03, SW-06, SW-08 and SW-09), and the quality of the rating curves developed. Appropriate shift corrections were applied to gauge heights recorded at these stations in order to compute daily mean discharges.

10.0 REFERENCES

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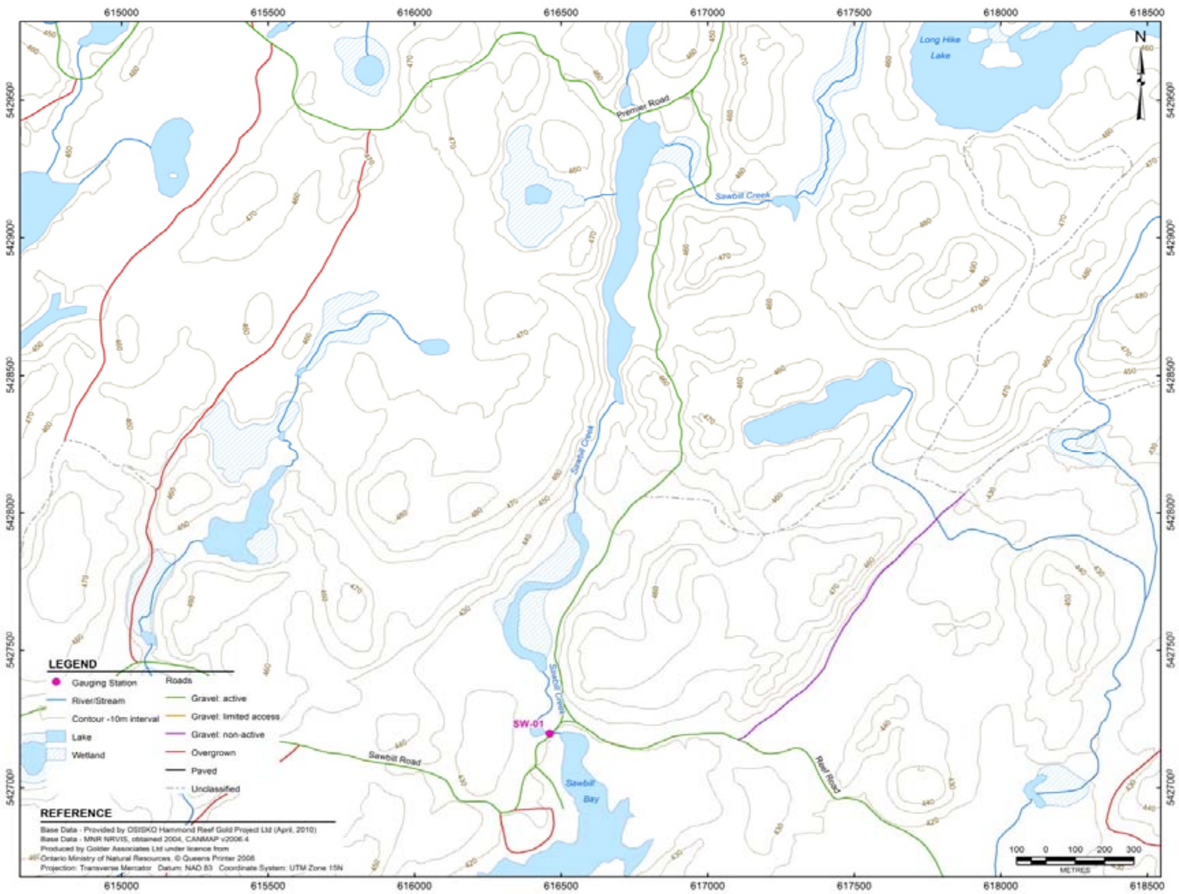
ATTACHMENT 5.I.1

Local Scale Monitoring Station SW-01; Sawbill Creek at Sawbill Bay



Station ID:	SW-01	**Installation Date:**	18-Aug-2010
Watercourse Name:	Sawbill Creek at Sawbill Bay	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 616461 N 5427196	**Logger Serial No.:**	1053622
Location Description:	The station is located at a culvert crossing on Sawbill Road ~150 m north of the camp and just south of the intersection with Reef Road. It is located in the lower catchment draining to Sawbill Bay, ~20 m upstream of the bay.	**Installation Type:**	Logger installed in concrete block near left bank in deepest part of pool upstream of culvert, and weighed down with rocks. Cable run to pipe housing on left bank in flexible pipe also weighed down with rocks. Staff gauge installed on T-post in stream channel near right bank opposite logger.
Elevation:	The benchmark is a nail in tree on right bank upstream of culvert/road, flagged with tape. Benchmark surveyed as 417.365 masl.	**Instal. Problems/Risks:**	Difficulty driving T-posts due to shallow depth to bedrock; staff gauge could be ripped out in high flows, by debris and during ice breakup.

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

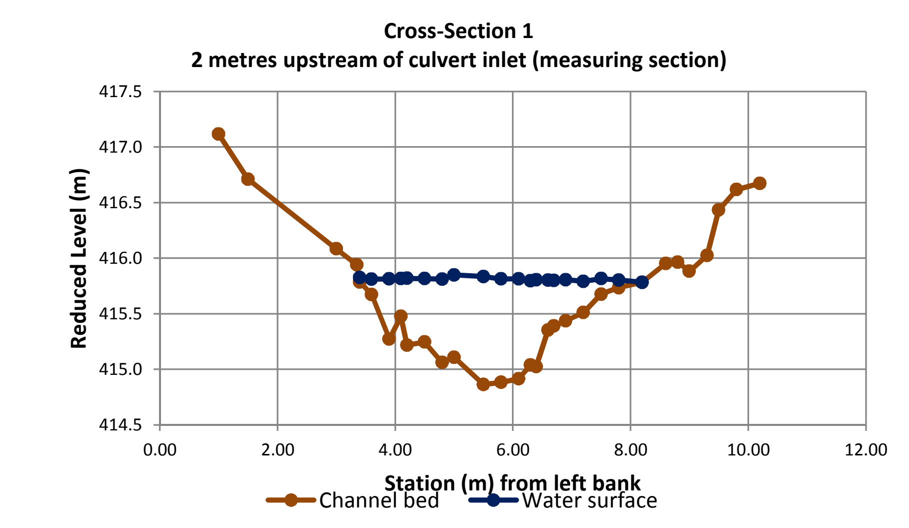
Gauge:	Hydraulic Control:	The logger and staff gauge are installed in a pool upstream of the road crossing. Hydraulic control is provided by a smooth-walled 2300 mm diameter steel pipe culvert with projecting ends and the road embankment. The culvert is 10.5 m long with a barrel slope of 4.3%.
Current Metering Section:	General Section Description:	The measuring cross-section is located 1-2 metres upstream of the culvert crossing and ~10 m downstream of a bend. The channel bed slope steepens downstream of the culvert.
	Thalweg (straight, bend, off-center):	Off-centre; to the left of the culvert inlet
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/Root Zone Depth:	Trees, brush, ferns and moss; shallow root zone
	Bankfull Depth (m):	0.50 - 1.00
	Bankfull Width (m):	5.25 -7.00
	Floodplain Observations:	Deposition on the left bank in the bend upstream of station; here the slope is flatter and the vegetation thins
	General Observations:	Young fluvial channel; wide shallow cross-section; straight; high bed load
Substrate:	Left Bank:	Bedrock outcrop, boulders
	Bed:	Boulders
	Right Bank:	Bedrock outcrop

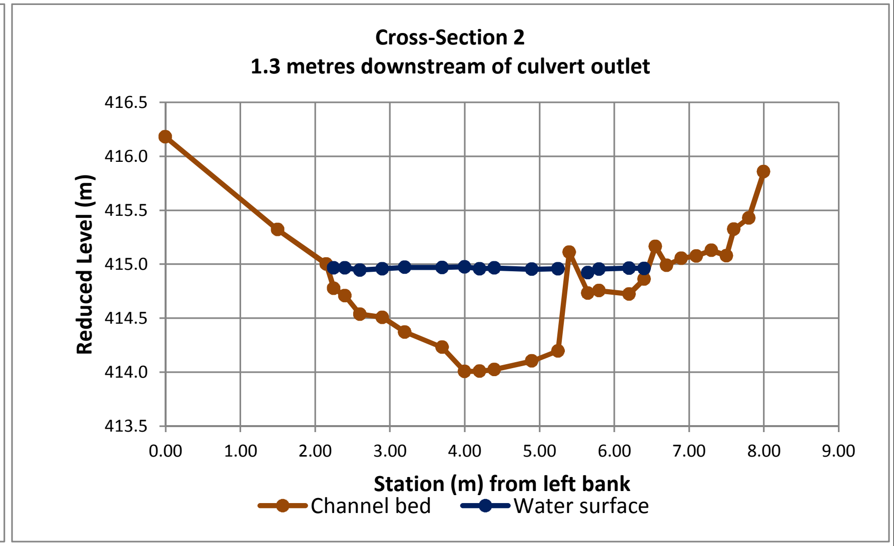
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

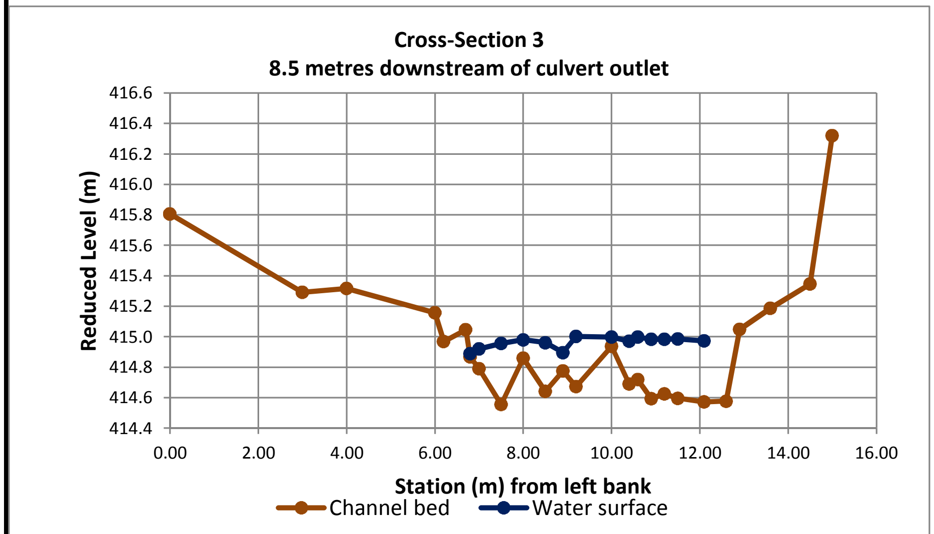
Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2





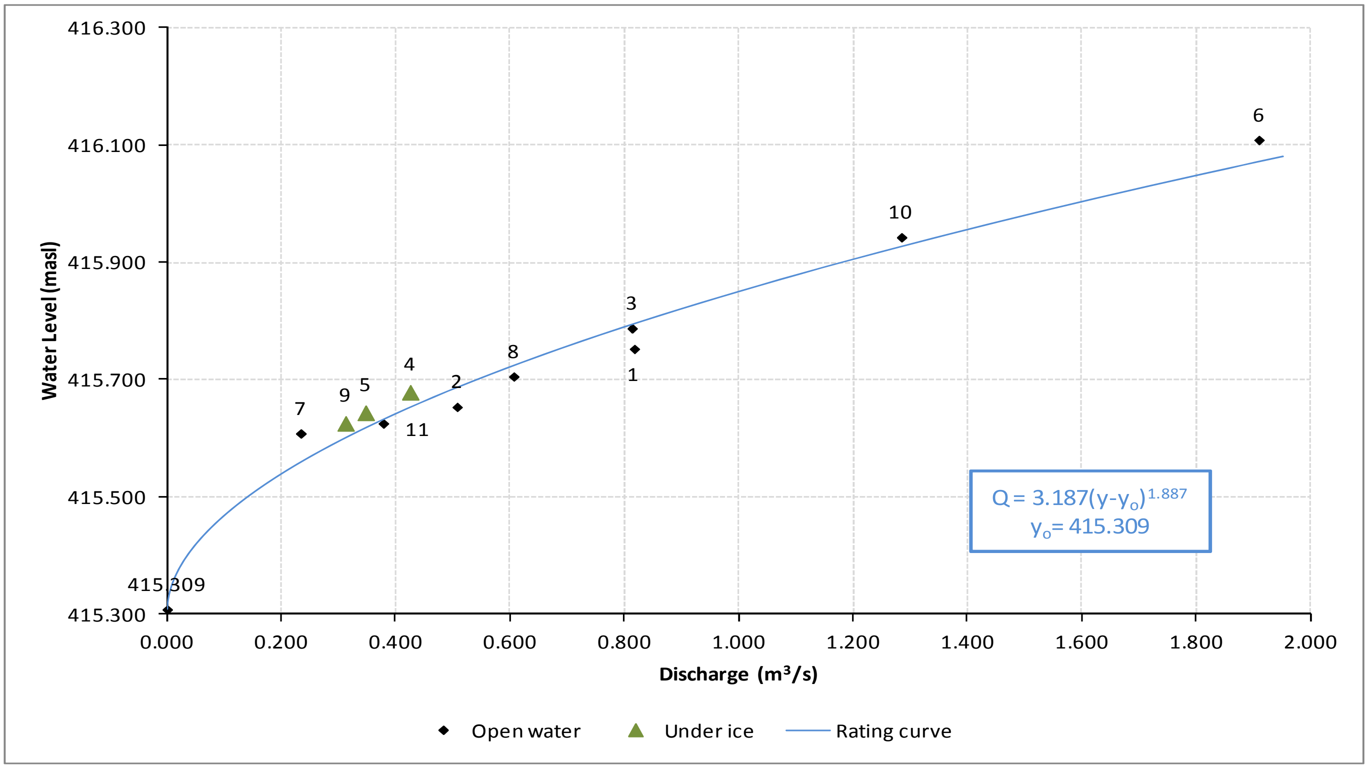


Note: Survey completed in October 2010.

Golder Associates				Flow Monitoring Station SW-01	
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	18-Aug-2010	0.817	415.753
2	28-Aug-2010	0.507	415.654
3	13-Oct-2010	0.813	415.788
4	20-Jan-2011	0.425	415.679
5	04-Mar-2011	0.347	415.644
6	20-May-2011	1.909	416.109
7	28-Aug-2011	0.234	415.609
8	28-Oct-2011	0.606	415.706
9	10-Feb-2012	0.312	415.626
10	18-May-2012	1.284	415.943
11	29-Aug-2012	0.378	415.626
—	G.H. at zero flow	0.000	415.309



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
18-Aug-2010	0.03	6.91	21.05	-
04-Mar-2011	0.02	7.22	0.30	-
20-May-2011	0.01	8.48	15.40	-
28-Aug-2011	0.01	7.27	22.10	-
18-May-2012	0.05	6.80	14.60	8.26
29-Aug-2012	0.03	6.60	23.60	7.24

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	Hammond Reef Gold Project	SHEET 4
DATE:	September 18, 2012		

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Sawbill Creek at Sawbill Bay

Station ID: SW-01

UTM coordinates: 15U E 616461 N 5427196

Drainage area: 10,634.14 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.402B	0.389B	0.320B	0.220B	3.885E	1.306	0.495	0.366			0.572B	0.399B	1
2	0.395B	0.383B	0.343B	0.222B	3.945E	1.267	0.497	0.434			0.569B	0.370B	2
3	0.387B	0.350B	0.313B	0.226B	3.937E	1.206	0.479	0.464			0.557B	0.368B	3
4	0.380B	0.347B	0.335B	0.244B	3.855E	1.177	0.472	0.433			0.529B	0.389B	4
5	0.373B	0.373B	0.365B	0.243B	3.804E	1.134	0.550	0.416			0.503B	0.381B	5
6	0.366B	0.379B	0.344B	0.242B	3.811E	1.098	0.531	0.408			0.495B	0.359B	6
7	0.359B	0.411B	0.329B	0.238B	3.699E	1.069	0.539	0.394			0.517B	0.356B	7
8	0.353B	0.414B	0.326B	0.245B	3.533E	1.040	0.585	0.381			0.486B	0.367B	8
9	0.346B	0.392B	0.319B	0.263B	3.367E	0.975	0.596	0.403			0.471B	0.373B	9
10	0.340B	0.393B	0.327B	0.308B	3.242E	0.888	0.619	0.405			0.482B	0.377B	10
11	0.354B	0.356B	0.313B	0.556B	3.188E	0.823	0.595	0.400			0.460B	0.343B	11
12	0.384B	0.348B	0.292B	0.677B	2.926E	0.766	0.575	0.403			0.446B	0.323B	12
13	0.387B	0.365B	0.302B	0.935B	2.749E	0.713	0.548	0.386			0.455B	0.312B	13
14	0.388B	0.385B	0.291B	1.200B	2.525E	0.668	0.515	0.373			0.449B	0.311B	14
15	0.401B	0.370B	0.279B	1.430B	2.375E	0.634	0.498	0.353			0.448B	0.358B	15
16	0.389B	0.362B	0.274B	1.721B	2.252E	0.616	0.486	0.344			0.454B	0.370B	16
17	0.349B	0.356B	0.279B	1.923E	2.128E	0.587	0.466	0.355			0.445B	0.367B	17
18	0.382B	0.389B	0.290B	1.876B	2.020E	0.554	0.453	0.334			0.430B	0.353B	18
19	0.383B	0.383B	0.277B	1.962E	1.945E	0.557	0.434	0.323			0.445B	0.358B	19
20	0.412B	0.370B	0.268B	2.073E	1.923E	0.535	0.441	0.312			0.445B	0.318B	20
21	0.432B	0.372B	0.274B	2.189E	1.897	0.501	0.535	0.300			0.424B	0.336B	21
22	0.395B	0.350B	0.275B	2.225E	1.890	0.489	0.490	0.284			0.392B	0.341B	22
23	0.370B	0.341B	0.280B	2.310E	1.853	0.498	0.475	0.267			0.384B	0.323B	23
24	0.345B	0.367B	0.279B	2.410E	1.782	0.473	0.460	0.274			0.377B	0.317B	24
25	0.352B	0.383B	0.272B	2.479E	1.698	0.449	0.455	0.281			0.386B	0.346B	25
26	0.346B	0.377B	0.267B	2.697E	1.627	0.426	0.437	0.268			0.389B	0.320B	26
27	0.376B	0.341B	0.261B	2.932E	1.557	0.510	0.438	0.259			0.411B	0.318B	27
28	0.386B	0.333B	0.251B	3.149E	1.484	0.586	0.437	0.252		0.620B	0.401B	0.317B	28
29	0.391B		0.241B	3.363E	1.450	0.541	0.421			0.610B	0.394B	0.315B	29
30	0.431B		0.234B	3.560E	1.399	0.506	0.402			0.595B	0.401B	0.313B	30
31	0.408B		0.227B		1.331		0.387			0.578B		0.311B	31
MEAN	0.379	0.371	0.292	1.471	2.551	0.753	0.494	0.353			0.454	0.345	
MAX	0.432	0.414	0.365	3.560	3.945	1.306	0.619	0.464			0.572	0.399	
MIN	0.340	0.333	0.227	0.220	1.331	0.426	0.387	0.252			0.377	0.311	
L/s/km²	3.57	3.49	2.74	13.83	23.99	7.08	4.64	3.32			4.27	3.25	

ANNUAL MEAN 0.750 MAX 3.945 MIN 0.220 L/s/km² 7.06

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Sawbill Creek at Sawbill Bay

Station ID: SW-01

UTM coordinates: 15U E 616461 N 5427196

Drainage area: 10,634.14 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.331B	0.264B	0.236B	4.222E	2.110E	3.754E	2.344E	0.691					1
2	0.354B	0.264B	0.216B	4.224E	2.103E	3.597E	2.244E	0.709					2
3	0.339B	0.263B	0.239B	4.354E	2.071E	3.404E	2.452E	0.692					3
4	0.346B	0.263B	0.249B	4.295E	1.999E	3.212E	2.261E	0.687					4
5	0.295B	0.262B	0.239B	4.173E	1.918E	3.055E	2.221E	0.697					5
6	0.313B	0.283B	0.208B	3.987E	1.880	2.884E	2.142E	0.656					6
7	0.326B	0.280B	0.231B	3.824E	1.983E	2.714E	2.053E	0.646					7
8	0.302B	0.260B	0.239B	3.772E	2.028E	2.640E	1.968E	0.629					8
9	0.303B	0.255B	0.237B	3.634E	1.978E	2.697E	1.838	0.682					9
10	0.292B	0.284B	0.210B	3.456E	1.880	2.584E	1.696	0.624					10
11	0.306B	0.275B	0.221B	3.240E	1.877	2.477E	1.567	0.587					11
12	0.321B	0.256B	0.215B	3.060E	1.830	2.446E	1.431	0.563					12
13	0.309B	0.275B	0.261B	2.872E	1.731	2.247E	1.344	0.547					13
14	0.297B	0.262B	0.255B	2.827E	1.636	2.225E	1.268	0.528					14
15	0.257B	0.250B	0.262B	2.743E	1.633	2.313E	1.219	0.506					15
16	0.284B	0.244B	0.261B	2.867E	1.536	2.222E	1.248	0.554					16
17	0.284B	0.240B	0.299B	2.710E	1.386	2.370E	1.231	0.522					17
18	0.271B	0.236B	0.349B	2.729E	1.309	2.436E	1.139	0.504					18
19	0.270B	0.228B	0.434B	2.752E	1.300	2.634E	1.036	0.488					19
20	0.270B	0.212B	0.603B	2.703E	1.333	2.768E	0.925	0.470					20
21	0.269B	0.207B	0.864B	2.646E	1.284	3.216E	0.851	0.450					21
22	0.269B	0.235B	1.088B	2.624E	1.235	3.369E	0.768	0.436					22
23	0.268B	0.245B	1.551B	2.563E	1.230	3.386E	0.735	0.417					23
24	0.268B	0.244B	2.239E	2.532E	1.460	3.334E	0.692	0.407					24
25	0.267B	0.256B	2.663E	2.526E	1.682	3.193E	0.658	0.413					25
26	0.267B	0.242B	2.818E	2.533E	1.668	3.012E	0.646	0.417					26
27	0.266B	0.261B	3.351E	2.397E	1.816	2.896E	0.595	0.409					27
28	0.266B	0.241B	3.872E	2.276E	2.603E	2.792E	0.547	0.391					28
29	0.266B	0.225B	3.990E	2.192E	3.304E	2.623E	0.588	0.380					29
30	0.265B		4.124E	2.146E	3.832E	2.491E	0.828						30
31	0.265B		4.169E		3.882E		0.742						31
MEAN	0.291	0.252	1.167	3.096	1.920	2.833	1.332	0.541					
MAX	0.354	0.284	4.169	4.354	3.882	3.754	2.452	0.709					
MIN	0.257	0.207	0.208	2.146	1.230	2.222	0.547	0.380					
L/s/km²	2.73	2.37	10.98	29.11	18.05	26.64	12.52	5.09					

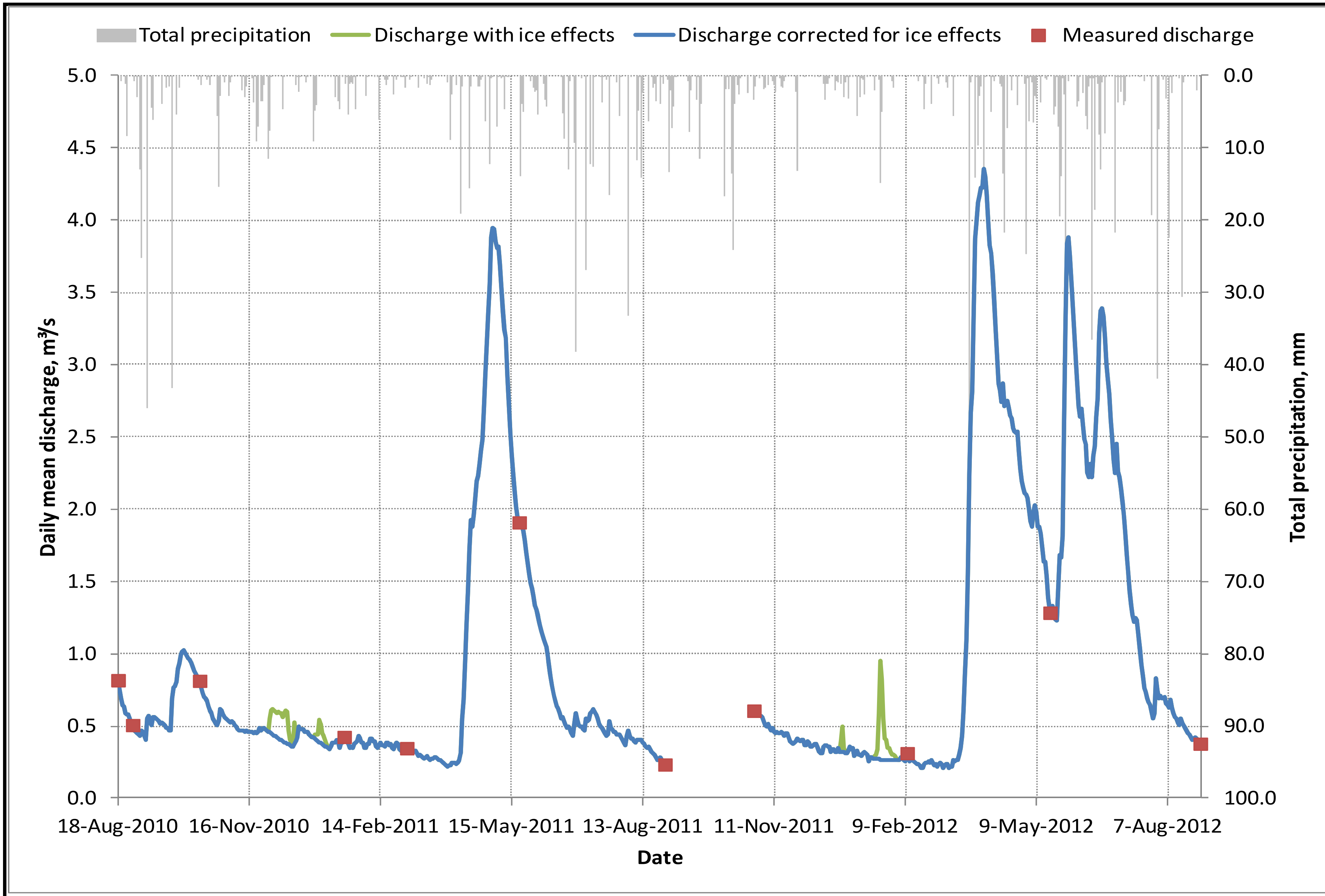
ANNUAL MEAN 1.433 MAX 4.354 MIN 0.207 L/s/km² 13.48

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7



Golder Associates	Flow Monitoring Station SW-01				
PROJECT	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 8

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Sawbill Creek at Sawbill Bay

Station ID: SW-01

UTM coordinates: U15 E 616461 N 5427196

Drainage area: 10,634.14 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									21.6	10.5	3.7	-0.2	1
2									19.8	9.4	4.1	-0.3	2
3									17.2	9.2	5.2	-0.3	3
4									15.0	9.8	4.3	-0.3	4
5									15.1	10.6	2.7	-0.3	5
6									15.5	11.7	2.9	-0.4	6
7									13.4	11.4	3.0	-0.4	7
8									12.8	12.0	3.7	-0.5	8
9									12.9	12.4	4.3	-0.5	9
10									13.3	12.5	5.1	-0.5	10
11									14.1	12.2	5.4	-0.5	11
12									14.3	11.2	3.5	-0.5	12
13									13.8	10.3	2.5	-0.5	13
14									13.1	10.1	1.8	-0.5	14
15									12.2	9.9	1.4	-0.5	15
16									11.7	9.6	1.5	-0.5	16
17									13.1	8.6	1.6	-0.5	17
18								19.5	12.1	7.5	0.8	-0.5	18
19								18.8	11.6	7.4	0.5	-0.5	19
20								18.7	11.6	7.5	-0.3	-0.5	20
21								20.4	12.1	6.2	-0.1	-0.4	21
22								21.1	12.2	6.6	0.0	-0.4	22
23								22.7	11.6	6.7	-0.4	-0.4	23
24								22.0	10.3	6.4	-0.3	-0.4	24
25								19.5	10.0	7.1	-0.3	-0.4	25
26								19.2	10.3	8.3	-0.4	-0.4	26
27								20.5	10.7	7.3	-0.2	-0.4	27
28								22.0	10.7	5.4	-0.1	-0.4	28
29								23.0	11.0	4.0	0.2	-0.4	29
30								23.9	11.4	4.2	0.1	-0.4	30
31								23.7		3.7		-0.5	31
MEAN (°C)									13.1	8.7	1.9	-0.4	
MAX (°C)									21.6	12.5	5.4	-0.2	
MIN (°C)									10.0	3.7	-0.4	-0.5	

ANNUAL MEAN (°C) 5.8 MAX (°C) 21.6 MIN (°C) -0.5

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 9

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Sawbill Creek at Sawbill Bay

Station ID: SW-01

UTM coordinates: U15 E 616461 N 5427196

Drainage area: 10,634.14 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.5	-0.5	-0.5	0.3	3.6	14.3	21.9	23.9			5.2	-0.3	1
2	-0.5	-0.5	-0.5	0.7	3.6	14.2	23.0	25.0			4.8	-0.4	2
3	-0.5	-0.5	-0.5	0.2	4.9	15.4	22.6	23.9			3.7	-0.2	3
4	-0.5	-0.5	-0.5	0.6	5.6	16.4	22.5	24.4			3.3	-0.4	4
5	-0.5	-0.5	-0.5	0.7	5.4	16.5	23.1	24.6			3.6	-0.5	5
6	-0.5	-0.5	-0.5	1.1	5.6	18.3	23.3	24.1			4.6	-0.6	6
7	-0.5	-0.5	-0.5	1.1	5.8	17.5	23.1	23.5			3.5	-0.5	7
8	-0.5	-0.5	-0.5	1.4	6.2	15.9	23.3	22.8			2.8	-0.5	8
9	-0.5	-0.5	-0.5	1.7	6.6	14.9	22.0	20.9			2.3	-0.6	9
10	-0.5	-0.5	-0.5	1.2	7.5	15.7	22.4	19.9			2.1	-0.6	10
11	-0.5	-0.5	-0.5	1.6	9.1	16.1	23.6	21.5			1.6	-0.6	11
12	-0.5	-0.5	-0.5	1.9	9.6	17.4	21.6	22.2			2.3	-0.5	12
13	-0.5	-0.5	-0.5	1.4	8.7	18.8	20.4	23.0			2.3	-0.5	13
14	-0.5	-0.5	-0.5	1.3	8.3	19.8	21.5	22.5			2.2	-0.5	14
15	-0.5	-0.5	-0.5	1.6	9.2	19.5	21.3	23.2			2.1	-0.5	15
16	-0.5	-0.5	-0.5	0.9	10.0	19.4	22.6	23.2			1.2	-0.6	16
17	-0.5	-0.5	-0.5	0.9	11.2	20.4	25.7	22.1			0.2	-0.6	17
18	-0.5	-0.5	-0.5	1.5	11.8	20.2	27.1	21.8			0.0	-0.5	18
19	-0.5	-0.5	-0.5	1.9	13.1	18.0	26.6	21.9			0.1	-0.5	19
20	-0.5	-0.5	-0.5	2.3	14.0	17.0	25.3	20.0			-0.4	-0.5	20
21	-0.5	-0.5	-0.4	2.7	14.0	17.3	24.2	19.8			-0.3	-0.5	21
22	-0.5	-0.5	-0.3	2.9	13.8	16.4	24.3	19.4			0.0	-0.5	22
23	-0.5	-0.5	-0.4	3.0	14.1	15.8	20.8	21.2			0.7	-0.5	23
24	-0.5	-0.5	-0.3	3.3	13.6	17.7	19.9	20.4			0.8	-0.5	24
25	-0.5	-0.5	-0.3	4.2	13.9	20.1	21.0	19.6			1.1	-0.5	25
26	-0.5	-0.5	-0.3	4.0	13.7	20.2	21.2	21.0			0.4	-0.4	26
27	-0.5	-0.5	-0.3	2.7	13.9	19.0	21.2	20.3			0.2	-0.6	27
28	-0.5	-0.5	-0.2	3.7	13.6	17.6	21.9	19.0		4.1	0.2	-0.6	28
29	-0.5		-0.1	4.6	14.6	18.7	23.0			4.4	-0.2	-0.6	29
30	-0.5		0.1	4.2	14.5	20.3	22.8			4.1	-0.2	-0.6	30
31	-0.5		0.3		15.1		23.2			4.4		-0.5	31
MEAN (°C)	-0.5	-0.5	-0.4	2.0	10.1	17.6	22.8	22.0			1.7	-0.5	
MAX (°C)	-0.5	-0.5	0.3	4.6	15.1	20.4	27.1	25.0			5.2	-0.2	
MIN (°C)	-0.5	-0.5	-0.5	0.2	3.6	14.2	19.9	19.0			-0.4	-0.6	

ANNUAL MEAN (°C) 7.4 MAX (°C) 27.1 MIN (°C) -0.6

Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Sawbill Creek at Sawbill Bay | Station ID: SW-01

UTM coordinates: U15 E 616461 N 5427196 | Drainage area: 10,634.14 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.5	-0.6	-0.6	3.8	9.2	15.1	23.6	23.7					1
2	-0.6	-0.6	-0.6	3.9	10.8	15.9	24.5	23.6					2
3	-0.6	-0.6	-0.6	4.4	11.3	17.0	25.0	23.0					3
4	-0.6	-0.6	-0.6	4.6	10.9	18.1	25.0	22.3					4
5	-0.6	-0.6	-0.6	4.7	10.4	18.5	25.1	21.0					5
6	-0.6	-0.6	-0.6	4.9	9.8	19.2	24.0	22.1					6
7	-0.6	-0.6	-0.6	5.0	10.0	20.0	23.9	21.7					7
8	-0.6	-0.6	-0.6	4.9	10.2	19.9	24.4	21.6					8
9	-0.5	-0.6	-0.6	4.5	10.7	21.0	24.1	21.4					9
10	-0.5	-0.6	-0.6	4.2	12.2	22.0	24.1	20.9					10
11	-0.5	-0.6	-0.6	4.8	12.2	21.4	24.9	21.6					11
12	-0.6	-0.6	-0.6	5.7	12.2	19.1	25.7	21.7					12
13	-0.6	-0.6	-0.4	6.3	13.0	18.7	26.2	22.1					13
14	-0.6	-0.6	-0.2	6.2	14.1	18.1	26.5	21.8					14
15	-0.6	-0.6	0.1	5.4	13.8	18.5	25.7	21.2					15
16	-0.6	-0.6	0.6	2.3	13.1	19.6	24.2	19.9					16
17	-0.6	-0.6	1.3	2.9	14.3	19.5	23.8	17.9					17
18	-0.6	-0.6	2.0	4.0	15.9	19.9	23.8	18.7					18
19	-0.6	-0.6	2.4	4.5	17.1	19.3	24.3	17.8					19
20	-0.6	-0.6	2.8	5.1	15.8	18.5	24.8	18.7					20
21	-0.6	-0.6	2.7	5.6	15.3	18.5	25.0	19.5					21
22	-0.6	-0.6	3.0	6.3	15.4	19.1	24.8	21.3					22
23	-0.6	-0.6	3.4	6.7	15.4	19.9	24.5	22.2					23
24	-0.6	-0.6	3.1	7.4	15.1	20.4	23.8	22.7					24
25	-0.6	-0.6	2.4	7.4	14.3	20.7	24.1	22.7					25
26	-0.6	-0.6	2.6	6.6	13.9	21.1	22.9	21.6					26
27	-0.6	-0.6	3.1	7.3	13.0	22.2	22.2	20.7					27
28	-0.6	-0.6	3.2	7.9	12.3	23.1	23.0	20.5					28
29	-0.6	-0.6	2.9	8.4	13.0	22.9	22.4	19.7					29
30	-0.6		2.2	8.8	12.5	22.8	21.8						30
31	-0.6		2.7		13.6	23.6	22.2						31
MEAN (°C)	-0.6	-0.6	1.1	5.5	12.9	19.8	24.2	21.2					
MAX (°C)	-0.5	-0.6	3.4	8.8	17.1	23.6	26.5	23.7					
MIN (°C)	-0.6	-0.6	-0.6	2.3	9.2	15.1	21.8	17.8					

ANNUAL — MEAN (°C): 10.4 — MAX (°C): 26.5 — MIN (°C): -0.6

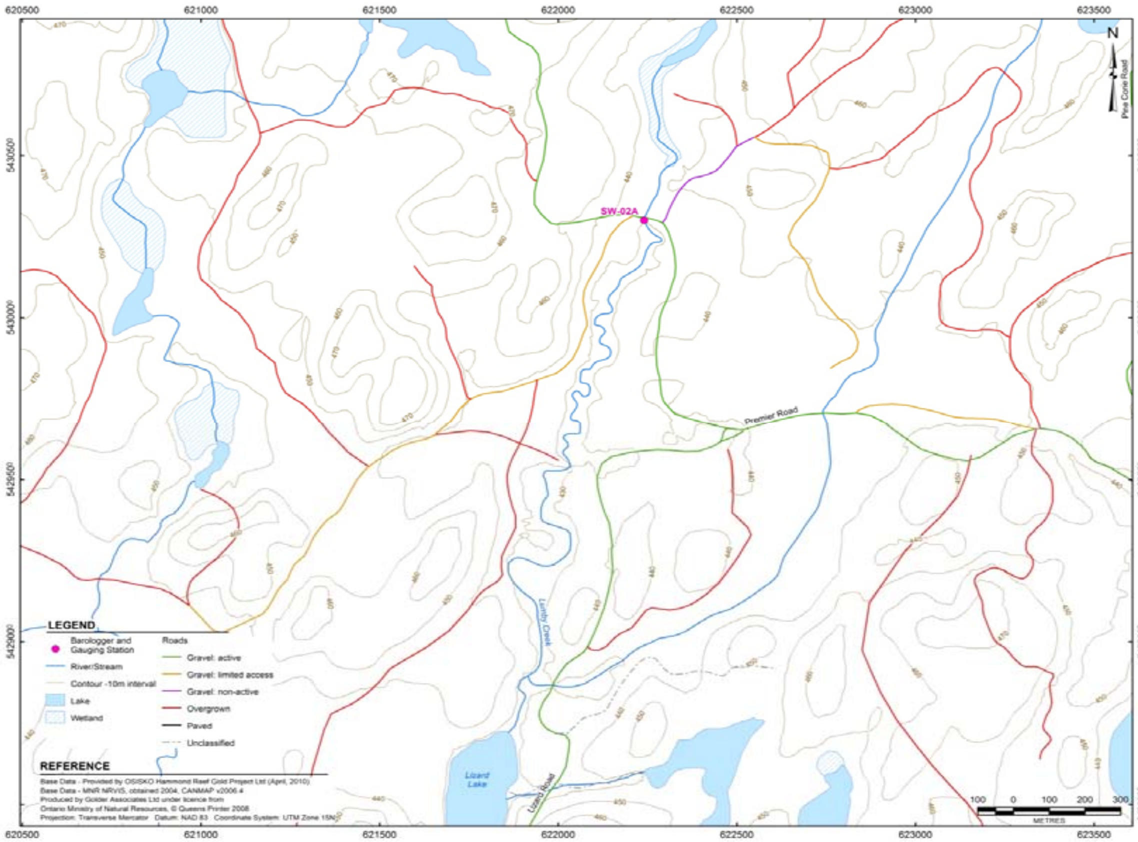
Golder Associates

Flow Monitoring Station SW-01

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11

ATTACHMENT 5.I.2

Local Scale Monitoring Station SW-02A; Lumby Creek above Lizard Lake



Station ID:	SW-02A	**Installation Date:**	26-Aug-2010
Watercourse Name:	Lumby Creek above Lizard Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 622241 N 5430299	**Logger Serial Nos.:**	Levelogger 1053623; Barologger 0011053513
Location Description:	The station is located at the twin culvert crossing on Premier Road between KM36 and KM37. It is located in the middle of the catchment draining to Turtle Bay ~1.8 km upstream of Lizard Lake.	**Installation Type:**	Levelogger installed in concrete block on stream bed downstream of east culvert. Cable run in flexible pipe buried in shallow trench on stream bed, but exposed on shore, to pipe housing (painted yellow) ~1.5 m from left bank and ~5 m downstream of culverts. Staff gauge installed on T-post in stream channel downstream of logger and east culvert outlet. Barologger installed on birch tree next to cable housing.
Elevation:	The benchmark is centre of painted "X" on high point of rock next to east culvert outlet. Benchmark surveyed at 430.055 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out in high flows, by debris and ice breakup

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

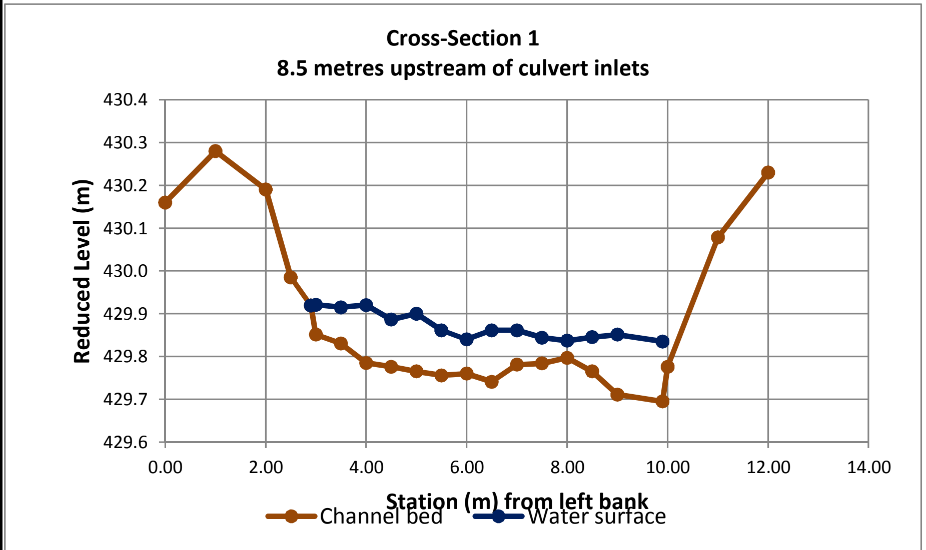
Gauge:	Hydraulic Control:	Levelogger and staff gauge installed in pool downstream of culvert outlets. Hydraulic control is provided by downstream riffle.
Current Metering Section:	General Section Description:	Discharge measurements are collected at the culvert inlets. The culverts consist of two 1830 mm diameter CSP with projecting ends. The culverts are 15.60 m long with barrel slopes of 3.16% (LB culvert) and 2.53% (RB culvert).
	Thalweg (straight, bend, off-center):	Off-centre; to the left of culvert outlets
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush and grass; shallow root zone
	Bankfull Depth (m):	0.50
	Bankfull Width (m):	5.00 - 11.25
	Floodplain Observations:	Deposition on left bank downstream of culverts; grassed; wetlands ~180 m upstream
	General Observations:	Young fluvial channel; wide shallow cross-section, straight with steep gradient (sinuousity increases downstream); high bed load
Substrate:	Left Bank:	Cobbles and boulders
	Bed :	Sand with cobbles and boulders; sand deposit downstream of culvert
	Right Bank:	Cobbles and boulders

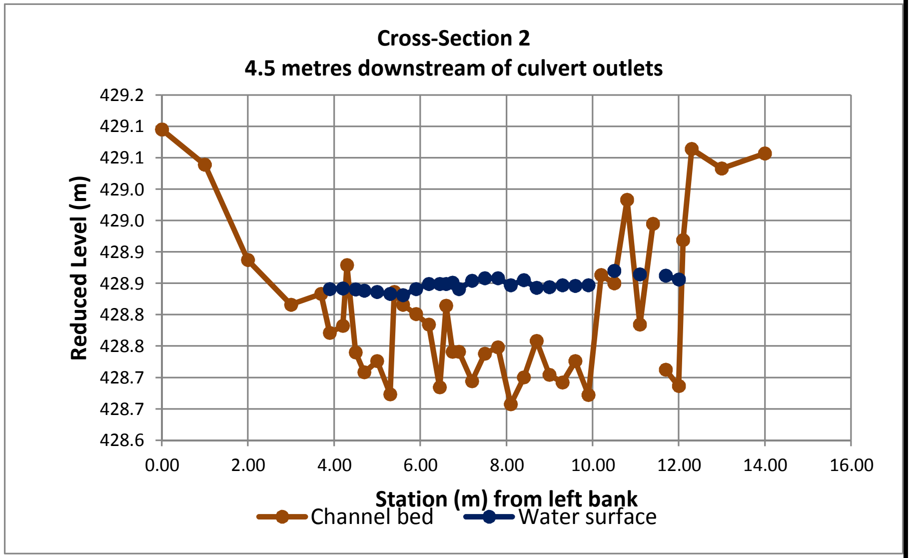
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

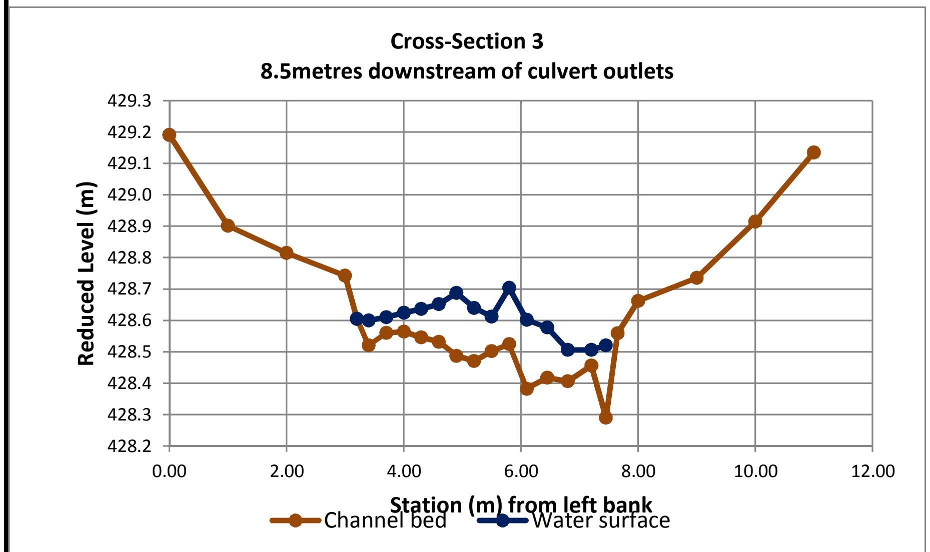
Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2





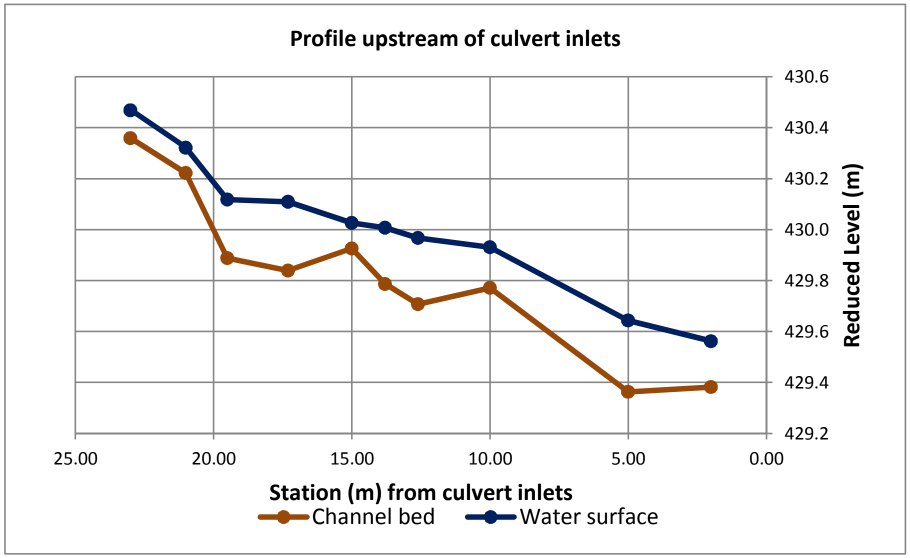


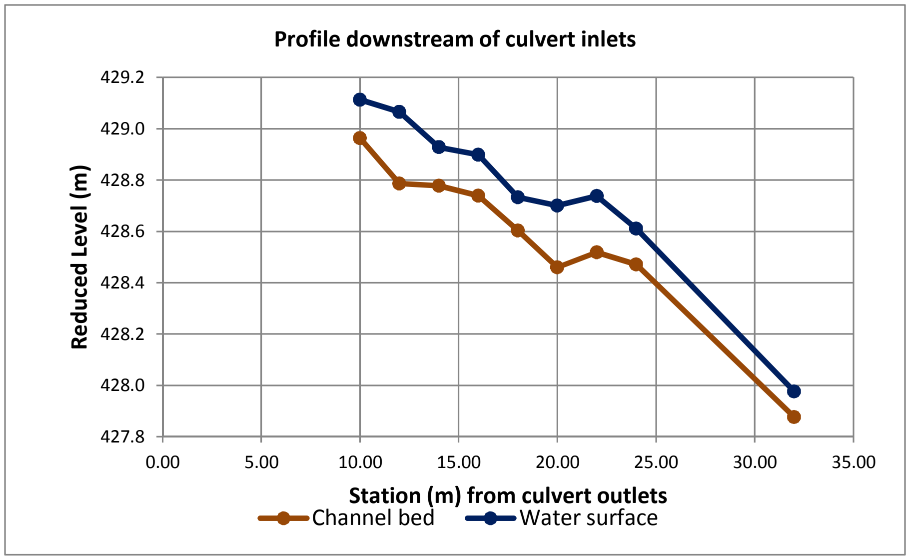
Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3



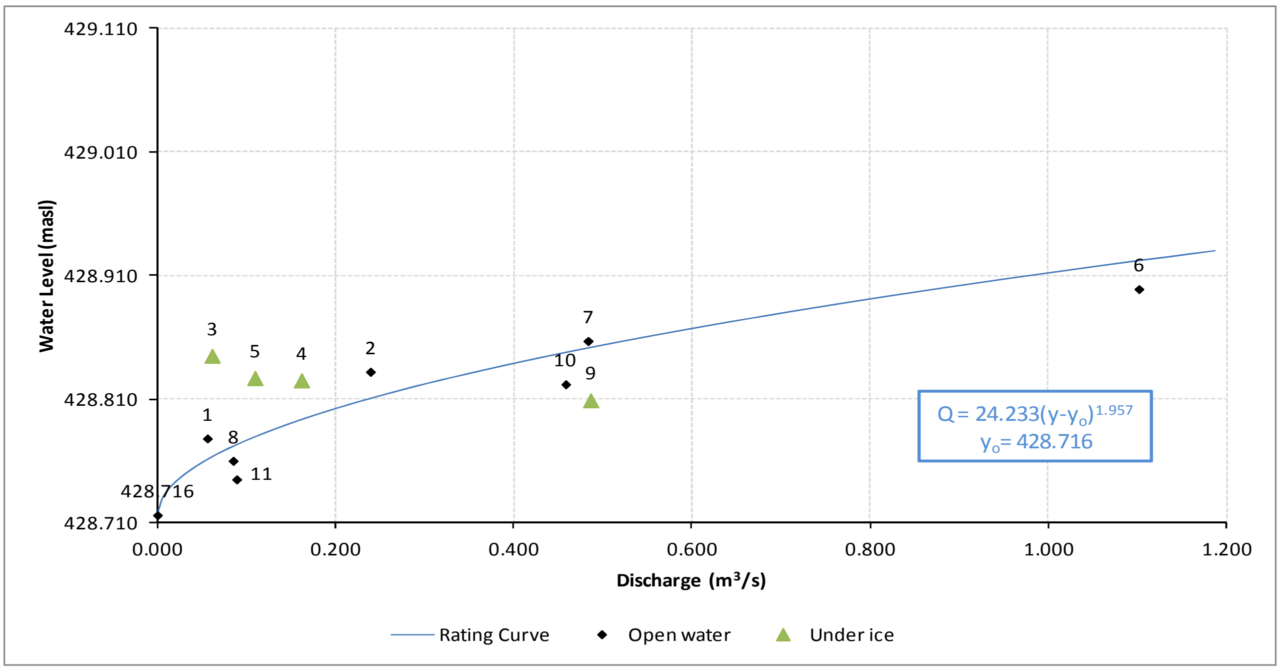


Note: Survey completed in October 2010.

Golder Associates				Flow Monitoring Station SW-02A
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project — SHEET 4

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	26-Aug-2010	0.056	428.778
2	13-Oct-2010	0.239	428.832
3	20-Jan-2011	0.061	428.845
4	24-Jan-2011	0.162	428.825
5	05-Mar-2011	0.109	428.827
6	27-Apr-2011	1.101	428.899
7	23-May-2011	0.483	428.857
8	29-Aug-2011	0.085	428.760
9	08-Feb-2012	0.486	428.809
10	18-May-2012	0.458	428.822
11	29-Aug-2012	0.089	428.745
—	G.H. at zero flow	0.000	428.716



NOTES:
1) Water level was fluctuating for measurement no. 2 , the lowest reading was used.
2) Gauge height was underestimated for measurement no. 3; the staff gauge was in the culvert wake.

In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
18-Aug-2010	0.09	7.66	15.65	-
05-Mar-2011	0.02	6.57	0.30	-
27-Apr-2011	0.04	7.68	3.30	-
23-May-2011	0.08	8.11	16.10	-
29-Aug-2011	0.08	7.49	20.60	-
18-May-2012	0.03	6.98	18.50	8.87
29-Aug-2012	0.07	6.64	19.80	7.38

Golder Associates

Flow Monitoring Station SW-02A

PROJECT: 10-1118-0020 (6700)
DATE: September 18, 2012

Hammond Reef Gold Project

SHEET 5

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Lumby Creek above Lizard Lake

Station ID: SW-02A

UTM coordinates: 15U E 622241 N 5430299

Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.048	0.664	0.184B	0.337B	1
2									0.055	0.629	0.176B	0.332B	2
3									0.071	0.582	0.171B	0.326B	3
4									0.063	0.534	0.181B	0.321B	4
5									0.061	0.482	0.186B	0.316B	5
6									0.059	0.418	0.175B	0.311B	6
7									0.186	0.392	0.180B	0.306B	7
8									0.230	0.357	0.175B	0.301B	8
9									0.204	0.328	0.178B	0.297B	9
10									0.188	0.313	0.172B	0.292B	10
11									0.256	0.301	0.176B	0.287B	11
12									0.265	0.287	0.186B	0.283B	12
13									0.237	0.269	0.183B	0.278B	13
14									0.223	0.249	0.182B	0.274B	14
15									0.213	0.218	0.185B	0.270B	15
16									0.194	0.199	0.190B	0.266B	16
17									0.187	0.189	0.187B	0.261B	17
18									0.174	0.178	0.203B	0.257B	18
19									0.163	0.164	0.192B	0.253B	19
20									0.148	0.153	0.217B	0.249B	20
21									0.132	0.151	0.203B	0.245B	21
22									0.122	0.133	0.222B	0.241B	22
23									0.129	0.133	0.296B	0.238B	23
24									0.359	0.135	0.311B	0.234B	24
25									0.409	0.125	0.318B	0.249B	25
26								0.058	0.451	0.158	0.357B	0.274B	26
27								0.055	0.495	0.218	0.369B	0.245B	27
28								0.045	0.587	0.213	0.369B	0.222B	28
29								0.044	0.616	0.196B	0.348B	0.206B	29
30								0.042	0.638	0.191B	0.342B	0.198B	30
31								0.045		0.186B		0.196B	31
MEAN									0.239	0.282	0.227	0.270	
MAX									0.638	0.664	0.369	0.337	
MIN									0.048	0.125	0.171	0.196	
L/s/km²									6.64	7.84	6.31	7.50	

ANNUAL MEAN 0.245 MAX 0.664 MIN 0.042 L/s/km² 6.81

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Lumby Creek above Lizard Lake | Station ID: SW-02A

UTM coordinates: 15U E 622241 N 5430299 | Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.194B	0.149B	0.113B	0.119B	1.596E	0.328	0.177	0.231	0.095	0.060	0.415B	0.343B	1
2	0.193B	0.148B	0.112B	0.122B	1.715E	0.296	0.191	0.355	0.115	0.049	0.416B	0.340B	2
3	0.191B	0.146B	0.111B	0.131B	1.721E	0.278	0.190	0.434	0.127	0.052	0.405B	0.337B	3
4	0.190B	0.145B	0.110B	0.151B	1.630E	0.274	0.193	0.387	0.126	0.048	0.373B	0.334B	4
5	0.188B	0.144B	0.109B	0.160B	1.565E	0.274	0.252	0.343	0.121	0.056	0.333B	0.331B	5
6	0.187B	0.142B	0.112B	0.165B	1.538E	0.250	0.261	0.331	0.113	0.051	0.326B	0.328B	6
7	0.185B	0.141B	0.115B	0.161B	1.451E	0.253	0.286	0.302	0.104	0.051	0.324B	0.324B	7
8	0.184B	0.139B	0.119B	0.166B	1.373E	0.240	0.356	0.290	0.104	0.096	0.313B	0.321B	8
9	0.182B	0.138B	0.122B	0.184B	1.239E	0.244	0.403	0.291	0.102	0.108	0.308B	0.318B	9
10	0.181B	0.137B	0.125B	0.227B	1.161E	0.230	0.436	0.272	0.100	0.092	0.294B	0.315B	10
11	0.179B	0.135B	0.129B	0.475B	1.152E	0.211	0.424	0.253	0.091	0.082	0.284B	0.313B	11
12	0.178B	0.134B	0.119B	0.574B	1.088	0.210	0.414	0.255	0.084	0.100	0.277B	0.310B	12
13	0.177B	0.133B	0.143B	0.700B	0.989	0.188	0.406	0.237	0.068	0.294	0.286B	0.307B	13
14	0.175B	0.131B	0.145B	0.752B	0.880	0.162	0.376	0.224	0.055	0.532	0.278B	0.304B	14
15	0.174B	0.130B	0.135B	0.806B	0.845	0.151	0.366	0.205	0.042	0.553	0.283B	0.321B	15
16	0.172B	0.129B	0.137B	0.861B	0.783	0.138	0.358	0.192	0.038	0.536	0.290B	0.394B	16
17	0.171B	0.128B	0.137B	0.915B	0.719	0.126	0.354	0.204	0.032	0.505	0.302B	0.377B	17
18	0.170B	0.126B	0.162B	0.969B	0.643	0.114	0.349	0.182	0.024	0.512	0.301B	0.311B	18
19	0.168B	0.125B	0.153B	1.024B	0.572	0.113	0.342	0.171	0.026	0.511	0.304B	0.330B	19
20	0.167B	0.124B	0.142B	1.078B	0.521	0.103	0.351	0.154	0.034	0.523	0.342B	0.321B	20
21	0.166B	0.123B	0.140B	1.064B	0.485	0.092	0.418	0.140	0.053	0.532	0.368B	0.308B	21
22	0.164B	0.121B	0.138B	1.079B	0.492	0.092	0.394	0.123	0.059	0.514	0.290B	0.342B	22
23	0.163B	0.120B	0.136B	1.096B	0.508	0.098	0.392	0.103	0.056	0.515	0.274B	0.332B	23
24	0.162B	0.119B	0.134B	1.117E	0.482	0.092	0.357	0.113	0.059	0.527	0.294B	0.322B	24
25	0.160B	0.118B	0.132B	1.164E	0.466	0.089	0.345	0.121	0.061	0.527	0.297B	0.311B	25
26	0.158B	0.117B	0.130B	1.203E	0.453	0.082	0.324	0.117	0.062	0.505	0.314B	0.303B	26
27	0.157B	0.116B	0.128B	1.283E	0.418	0.143	0.314	0.113	0.067	0.494	0.353B	0.378B	27
28	0.155B	0.115B	0.126B	1.274E	0.392	0.199	0.299	0.102	0.069	0.491B	0.353B	0.398B	28
29	0.154B		0.124B	1.299E	0.364	0.189	0.289	0.093	0.074	0.482B	0.350B	0.322B	29
30	0.152B		0.122B	1.377E	0.364	0.174	0.276	0.096	0.068	0.469B	0.346B	0.314B	30
31	0.151B		0.121B		0.328		0.250	0.090		0.450B		0.321B	31
MEAN	0.173	0.131	0.128	0.723	0.901	0.181	0.327	0.210	0.074	0.333	0.323	0.330	
MAX	0.194	0.149	0.162	1.377	1.721	0.328	0.436	0.434	0.127	0.553	0.416	0.398	
MIN	0.151	0.115	0.109	0.119	0.328	0.082	0.177	0.090	0.024	0.048	0.274	0.303	
L/s/km²	4.80	3.65	3.57	20.10	25.04	5.03	9.10	5.85	2.07	9.25	8.98	9.17	

ANNUAL MEAN 0.321 MAX 1.721 MIN 0.024 L/s/km² 8.93

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Lumby Creek above Lizard Lake | Station ID: SW-02A

UTM coordinates: 15U E 622241 N 5430299 | Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.323B	0.387B	0.289B	1.731E	0.748	2.928E	0.776	0.326					1
2	0.388B	0.372B	0.270B	1.568E	0.724	2.314E	0.708	0.349					2
3	0.398B	0.366B	0.301B	1.596E	0.722	1.727E	0.859	0.331					3
4	0.341B	0.362B	0.339B	1.538E	0.691	1.379E	0.848	0.301					4
5	0.304B	0.373B	0.323B	1.426E	0.661	1.197E	0.815	0.300					5
6	0.283B	0.390B	0.237B	1.282E	0.639	1.014	0.790	0.284					6
7	0.314B	0.433B	0.233B	1.211E	0.703	0.928	0.787	0.290					7
8	0.314B	0.444B	0.244B	1.149E	0.763	0.951	0.745	0.276					8
9	0.280B	0.393B	0.261B	1.072B	0.749	1.157E	0.705	0.283					9
10	0.272B	0.428B	0.216B	1.037B	0.722	1.150E	0.656	0.278					10
11	0.291B	0.406B	0.210B	0.955B	0.715	1.169E	0.621	0.269					11
12	0.354B	0.386B	0.206B	0.922B	0.720	1.203E	0.569	0.251					12
13	0.354B	0.432B	0.235B	0.861B	0.665	1.081	0.550	0.232					13
14	0.332B	0.395B	0.248B	0.817B	0.623	1.077	0.537	0.224					14
15	0.285B	0.391B	0.256B	0.801B	0.593	1.190E	0.535	0.221					15
16	0.279B	0.357B	0.262B	0.942B	0.560	1.198E	0.562	0.223					16
17	0.327B	0.356B	0.299B	0.997B	0.506	1.290E	0.571	0.203					17
18	0.355B	0.350B	0.360B	0.937B	0.463	1.379E	0.525	0.194					18
19	0.389B	0.348B	0.425B	0.947	0.443	1.667E	0.487	0.200					19
20	0.398B	0.305B	0.497B	0.933	0.458	1.864E	0.443	0.177					20
21	0.351B	0.281B	0.516B	0.913	0.425	2.412E	0.416	0.166					21
22	0.216B	0.298B	0.531B	0.886	0.436	2.347E	0.379	0.150					22
23	0.271B	0.301B	0.695B	0.872	0.415	2.092E	0.335	0.141					23
24	0.330B	0.298B	0.939B	0.830	0.493	1.775E	0.332	0.114					24
25	0.351B	0.333B	1.113E	0.805	0.611	1.499E	0.292	0.117					25
26	0.338B	0.325B	1.335E	0.849	0.659	1.319E	0.272	0.118					26
27	0.388B	0.337B	1.713E	0.859	0.734	1.140E	0.260	0.108					27
28	0.402B	0.324B	1.996E	0.831	1.318E	1.032	0.241	0.107					28
29	0.452B	0.281B	2.074E	0.790	2.956E	0.901	0.270	0.115					29
30	0.438B		2.001E	0.748	4.214E	0.815	0.423						30
31	0.378B		1.885E		3.802E		0.384						31
MEAN	0.339	0.360	0.662	1.037	0.933	1.440	0.539	0.219					
MAX	0.452	0.444	2.074	1.731	4.214	2.928	0.859	0.349					
MIN	0.216	0.281	0.206	0.748	0.415	0.815	0.241	0.107					
L/s/km²	9.41	10.02	18.39	28.82	25.94	40.02	14.97	6.08					

ANNUAL — MEAN: 0.693 — MAX: 4.214 — MIN: 0.107 — L/s/km²: 19.27

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 8

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Lumby Creek above Lizard Lake | Station ID: SW-02A

UTM coordinates: U15 E 622241 N 5430299 | Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									20.7	10.2	3.8	-0.2	1
2									18.6	9.4	3.9	-0.2	2
3									15.7	9.2	5.3	-0.2	3
4									14.4	9.7	4.2	-0.2	4
5									14.2	10.4	2.5	-0.3	5
6									14.2	11.3	2.6	-0.3	6
7									12.4	10.6	3.1	-0.4	7
8									12.0	11.0	3.7	-0.4	8
9									11.8	11.7	4.3	-0.4	9
10									12.3	11.9	4.9	-0.4	10
11									13.6	11.3	5.0	-0.4	11
12									13.9	10.2	3.3	-0.4	12
13									13.3	9.3	2.2	-0.4	13
14									12.8	9.0	2.0	-0.4	14
15									11.1	9.3	1.9	-0.4	15
16									10.9	9.0	1.8	-0.4	16
17									12.3	8.0	1.5	-0.4	17
18									11.3	6.6	0.7	-0.4	18
19									10.7	6.5	0.2	-0.4	19
20									10.4	6.9	-0.1	-0.4	20
21									11.3	5.8	-0.2	-0.4	21
22									11.8	6.2	-0.1	-0.3	22
23									11.1	6.3	-0.3	-0.3	23
24									9.9	6.1	-0.4	-0.4	24
25									9.8	6.7	-0.3	-0.4	25
26								20.2	10.0	8.4	-0.3	-0.4	26
27								19.3	10.6	7.0	-0.2	-0.4	27
28								21.7	10.8	5.0	-0.1	-0.4	28
29								22.5	11.1	3.9	0.1	-0.4	29
30								23.7	11.2	4.0	0.0	-0.4	30
31								23.4		3.9		-0.4	31
MEAN (°C)									12.5	8.2	1.8	-0.4	
MAX (°C)									20.7	11.9	5.3	-0.2	
MIN (°C)									9.8	3.9	-0.4	-0.4	

ANNUAL MEAN (°C) 5.5 MAX (°C) 20.7 MIN (°C) -0.4

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Lumby Creek above Lizard Lake | Station ID: SW-02A

UTM coordinates: U15 E 622241 N 5430299 | Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.4	-0.4	-0.4	-0.1	4.0	14.3	21.7	22.9	19.7	9.0	5.8	-0.3	1
2	-0.4	-0.4	-0.4	0.3	4.4	13.9	22.4	23.9	20.9	10.2	5.3	-0.4	2
3	-0.4	-0.4	-0.4	0.0	5.3	15.5	21.7	22.6	19.0	11.9	3.7	-0.3	3
4	-0.4	-0.4	-0.4	0.3	5.4	16.4	21.5	23.0	16.5	12.5	3.1	-0.3	4
5	-0.4	-0.4	-0.4	0.5	4.9	16.2	22.4	23.7	14.9	13.1	3.9	-0.5	5
6	-0.4	-0.4	-0.4	0.8	5.6	18.4	22.0	23.2	15.6	13.4	5.1	-0.5	6
7	-0.4	-0.4	-0.4	0.9	5.8	17.3	21.7	23.0	17.1	13.6	4.0	-0.5	7
8	-0.4	-0.4	-0.4	1.2	6.3	15.4	22.2	22.0	18.5	15.6	3.4	-0.5	8
9	-0.4	-0.4	-0.4	1.7	7.3	14.5	21.0	20.7	19.5	13.7	2.4	-0.5	9
10	-0.4	-0.4	-0.4	1.0	8.2	15.1	21.9	20.0	20.0	13.5	2.4	-0.5	10
11	-0.4	-0.4	-0.4	1.4	9.4	16.0	23.1	21.2	19.5	14.2	2.0	-0.5	11
12	-0.4	-0.4	-0.4	1.6	9.6	17.3	21.2	22.1	17.7	12.4	2.9	-0.5	12
13	-0.4	-0.4	-0.4	1.2	9.1	18.7	20.2	22.8	14.3	12.4	2.7	-0.5	13
14	-0.4	-0.4	-0.4	1.3	9.1	20.2	21.2	22.1	10.9	10.6	2.8	-0.4	14
15	-0.4	-0.4	-0.4	1.8	9.6	19.4	20.6	22.4	9.9	9.0	2.4	-0.4	15
16	-0.4	-0.4	-0.4	1.1	10.6	19.5	22.4	22.2	10.2	8.0	1.7	-0.5	16
17	-0.4	-0.4	-0.4	1.5	12.1	20.5	25.2	21.8	10.1	7.3	0.5	-0.5	17
18	-0.4	-0.4	-0.4	2.0	12.9	19.4	26.3	21.4	11.0	7.2	0.2	-0.5	18
19	-0.4	-0.4	-0.4	2.1	14.7	17.3	25.8	20.9	12.6	7.3	0.2	-0.4	19
20	-0.4	-0.4	-0.4	2.5	15.8	16.5	24.6	19.4	12.0	7.3	-0.3	-0.4	20
21	-0.4	-0.4	-0.4	2.9	15.7	16.9	23.8	18.8	11.1	6.3	-0.4	-0.4	21
22	-0.4	-0.4	-0.3	3.0	15.8	16.0	23.6	18.6	9.2	6.7	-0.4	-0.4	22
23	-0.4	-0.4	-0.3	3.1	15.5	15.7	20.4	20.8	11.0	7.4	0.0	-0.5	23
24	-0.4	-0.4	-0.3	3.5	14.3	18.1	19.9	19.6	9.9	6.8	0.4	-0.4	24
25	-0.4	-0.4	-0.3	4.2	13.9	19.8	20.6	19.6	10.7	5.6	0.7	-0.4	25
26	-0.4	-0.4	-0.3	3.7	14.0	19.4	20.7	20.5	11.6	5.8	0.3	-0.4	26
27	-0.4	-0.4	-0.3	2.7	14.2	18.2	20.3	19.5	12.6	5.3	0.0	-0.4	27
28	-0.4	-0.4	-0.3	4.2	14.2	16.9	21.6	18.8	13.0	4.8	0.1	-0.5	28
29	-0.4		-0.2	4.8	15.2	18.0	22.2	19.4	12.6	5.3	-0.2	-0.5	29
30	-0.4		-0.2	4.2	14.8	19.7	21.9	19.3	10.5	4.9	-0.3	-0.5	30
31	-0.4		-0.1		15.6		22.3	18.7		5.0		-0.5	31
MEAN (°C)	-0.4	-0.4	-0.4	2.0	10.8	17.3	22.1	21.1	14.1	9.2	1.8	-0.4	
MAX (°C)	-0.4	-0.4	-0.1	4.8	15.8	20.5	26.3	23.9	20.9	15.6	5.8	-0.3	
MIN (°C)	-0.4	-0.4	-0.4	-0.1	4.0	13.9	19.9	18.6	9.2	4.8	-0.4	-0.5	

ANNUAL MEAN (°C) 8.1 MAX (°C) 26.3 MIN (°C) -0.5

Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Lumby Creek above Lizard Lake

Station ID: SW-02A

UTM coordinates: U15 E 622241 N 5430299

Drainage area: 3,597.52 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.5	-0.5	-0.5	4.4	9.5	15.3	23.4	23.1					1
2	-0.5	-0.5	-0.5	4.0	11.2	16.3	24.8	23.1					2
3	-0.5	-0.5	-0.5	4.5	11.5	17.1	24.9	22.2					3
4	-0.5	-0.5	-0.5	4.2	11.3	19.0	24.6	21.8					4
5	-0.5	-0.5	-0.5	4.6	10.9	18.6	25.0	20.8					5
6	-0.5	-0.5	-0.5	5.0	10.6	19.6	23.5	21.4					6
7	-0.5	-0.5	-0.5	5.3	10.7	20.6	23.5	20.8					7
8	-0.5	-0.5	-0.5	5.4	10.7	20.7	24.3	20.6					8
9	-0.5	-0.5	-0.5	4.8	10.7	20.9	23.8	20.6					9
10	-0.5	-0.5	-0.5	4.4	12.3	22.3	23.9	20.1					10
11	-0.5	-0.5	-0.5	5.2	12.2	21.5	24.8	20.5					11
12	-0.5	-0.5	-0.5	6.2	12.2	19.1	25.8	20.9					12
13	-0.5	-0.5	-0.5	6.7	12.8	18.6	26.0	21.7					13
14	-0.5	-0.5	-0.4	6.7	13.7	18.1	26.2	21.1					14
15	-0.5	-0.5	-0.3	6.0	13.5	18.6	25.3	20.2					15
16	-0.5	-0.5	0.0	2.5	12.8	19.6	23.8	19.4					16
17	-0.5	-0.5	0.8	3.5	14.5	19.3	23.7	18.0					17
18	-0.5	-0.5	1.9	4.7	15.9	19.7	23.8	18.5					18
19	-0.5	-0.5	2.5	5.0	17.4	19.0	24.0	17.6					19
20	-0.5	-0.5	2.8	5.6	16.0	18.8	24.6	18.4					20
21	-0.5	-0.5	2.5	5.7	15.2	18.9	24.8	19.1					21
22	-0.5	-0.5	3.2	6.3	15.6	19.2	24.2	20.1					22
23	-0.5	-0.5	3.7	6.9	15.5	19.9	24.3	21.2					23
24	-0.5	-0.5	3.2	8.1	15.4	20.4	23.4	22.4					24
25	-0.5	-0.5	2.9	7.7	14.4	20.9	23.6	21.9					25
26	-0.5	-0.5	3.5	7.1	14.1	21.7	22.6	20.7					26
27	-0.5	-0.5	4.1	7.4	13.3	22.5	21.9	19.8					27
28	-0.5	-0.5	4.1	8.1	12.7	23.7	22.6	20.2					28
29	-0.5	-0.5	3.9	8.4	13.1	22.7	21.5	18.0					29
30	-0.5		3.5	8.9	13.1	22.3	21.1						30
31	-0.5		3.8		14.1	23.4	21.6						31
MEAN (°C)	-0.5	-0.5	1.3	5.8	13.1	19.9	23.9	20.5					
MAX (°C)	-0.5	-0.5	4.1	8.9	17.4	23.7	26.2	23.1					
MIN (°C)	-0.5	-0.5	-0.5	2.5	9.5	15.3	21.1	17.6					

ANNUAL MEAN (°C) 10.4 MAX (°C) 26.2 MIN (°C) -0.5

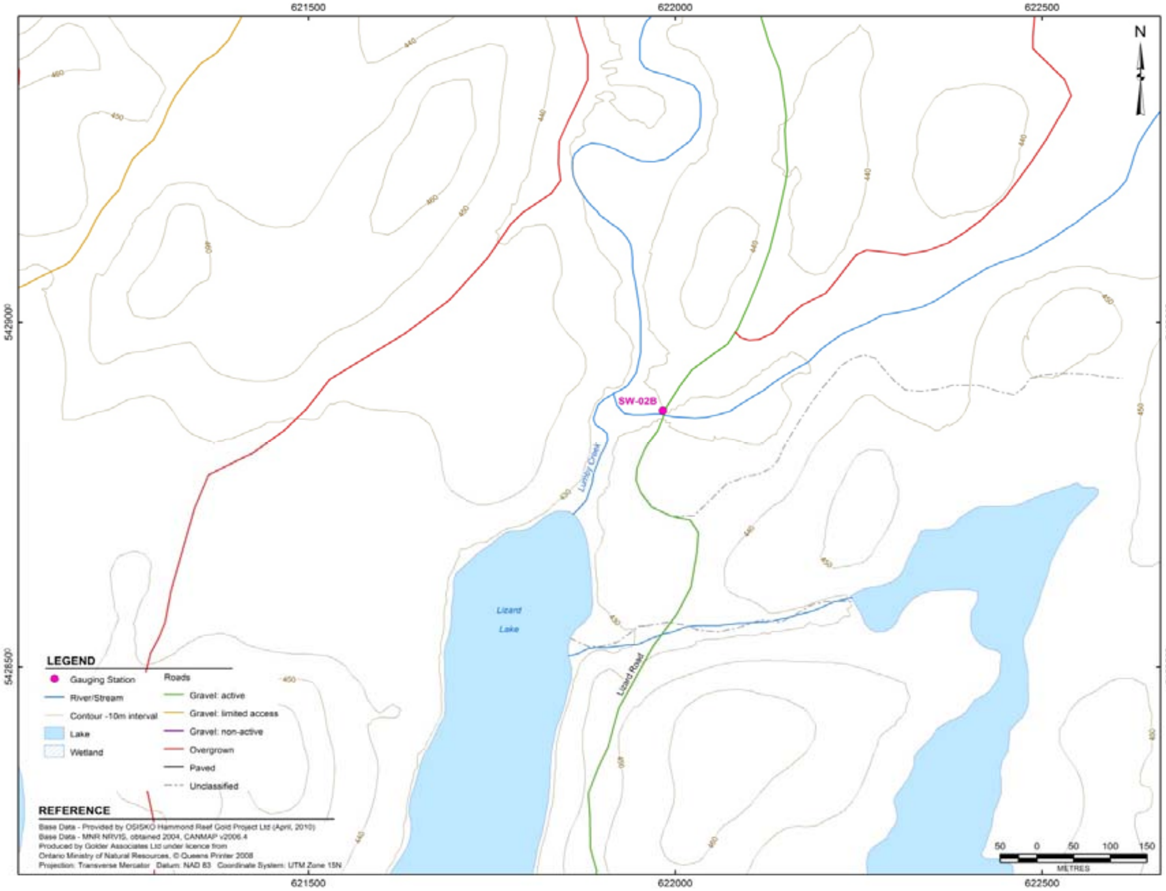
Golder Associates

Flow Monitoring Station SW-02A

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 12

ATTACHMENT 5.I.3

Local Scale Monitoring Station SW-02B ;Lumby Creek East Tributary above Lizard Lake



Station ID:	SW-02B	**Installation Date:**	26-Aug-2010
Watercourse Name:	Lumby Creek East Tributary at Lizard Lake	**Equipment Installed:**	Staff gauge
UTM Coordinates:	15U E 621983 N 5428872	**Logger Serial No.:**	N/A
Location Description:	The station is located at the culvert crossing on the gravel road to the south off Premier Road between KM36 and KM37. It is located in the middle of the catchment draining to Turtle Bay ~35 m upstream of the confluence with Lumby Creek and ~215 m upstream of Lizard Lake.	**Installation Type:**	T-post with ruler installed in stream channel adjacent to culvert outlet.
Elevation:	Benchmark is nail in large tree on northeast side of road which has been flagged. Benchmark surveyed as 428.084 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out in high flows.

Golder Associates

Flow Monitoring Station SW-02B

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

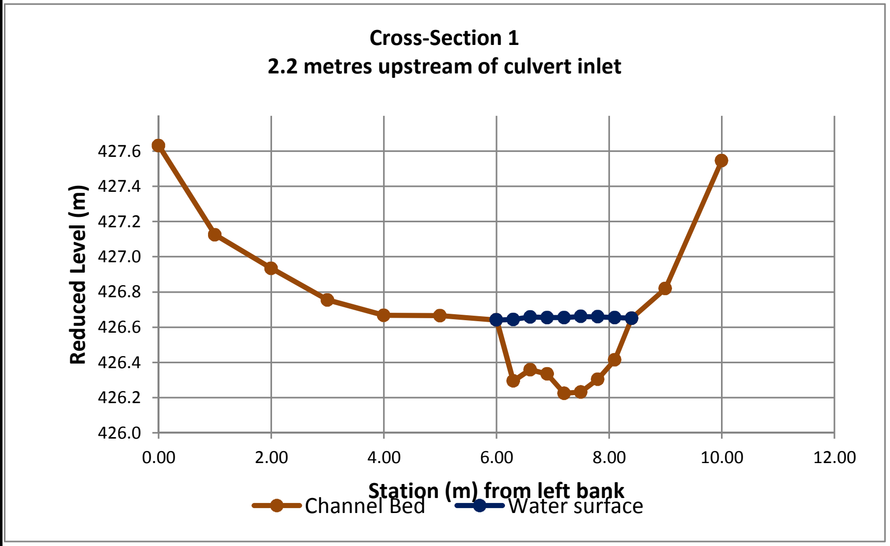
Gauge:	Hydraulic Control:	Staff gauge installed in small pool downstream of culvert outlet. Hydraulic control is provided by narrow channel outlet from pool.
Current Metering Section:	General Section Description:	Discharge measurements are collected at culvert outlet. The culvert consists of an 800 mm diameter CSP with projecting ends. The culvert is 8.9 m long with a barrel slope of 0.5%. Small pool downstream of culvert with outflow at right angles to culvert orientation.
	Thalweg (straight, bend, off-center):	Off-centre; to the right of culvert outlet
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass and brush
	Bankfull Depth (m):	0.25 - 0.75
	Bankfull Width (m):	3.00 - 5.00
	Floodplain Observations:	Flat wide lowlying flood plain downstream of culvert
	General Observations:	Mature fluvial channel; flat gradient; low sinuousity; wetland areas on either side of downstream channel
Substrate:	Left Bank:	Gravel and cobbles
	Bed :	Silt/sand
	Right Bank:	Gravel and cobbles

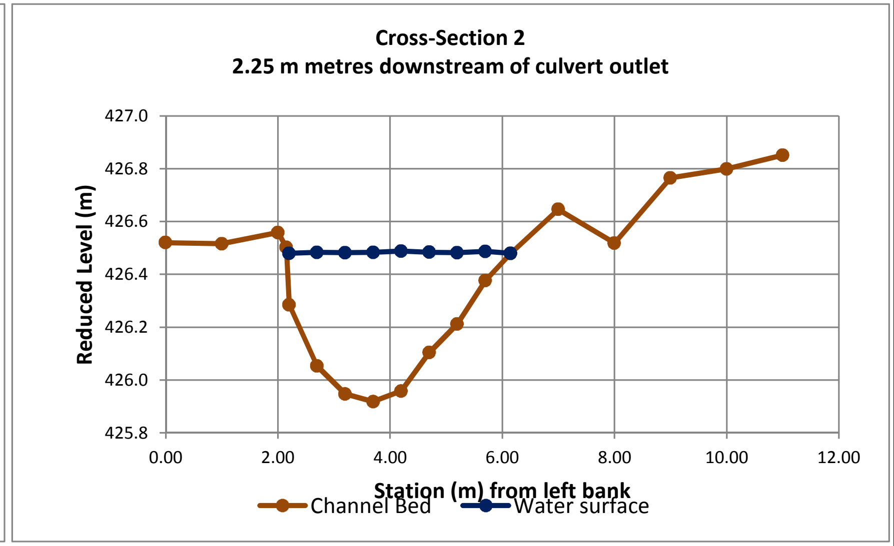
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

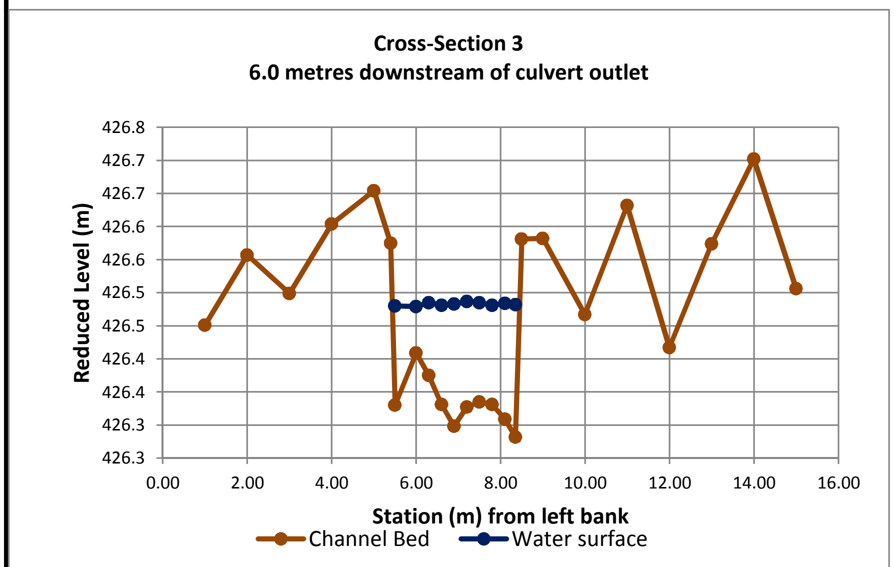
Golder Associates

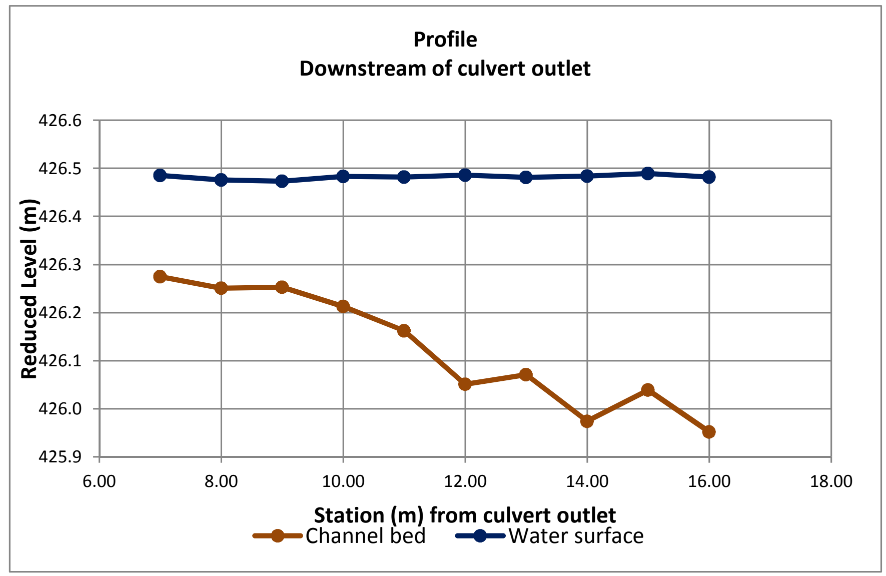
Flow Monitoring Station SW-02B

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2









Note: Survey completed in October 2012.

Golder Associates

Flow Monitoring Station SW-02B

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3

Discharge and Water Level Measurements

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	26-Aug-2010	0.002	426.365
2	09-Oct-2010	0.013	426.481
3	24-Jan-2011	0.000	—
4	05-Mar-2011	0.000	—
5	26-Apr-2011	0.202	426.565
6	22-May-2011	0.033	426.417
7	29-Aug-2011	0.003	426.616
8	10-Feb-2012	0.000	—
9	18-May-2012	0.010	426.659
10	29-Aug-2012	0.002	426.546

NOTES:
1) A rating curve has not been developed for this station since it is a manual gauge.
2) There was no flow during the site visits in Jan and Apr 2011 and Feb 2012 ; the stream was frozen solid.
3) Debris in the culvert was cleared and backed up water run off during the site visit in Aug 2011.

In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
26-Apr-2011	0.02	6.85	3.20	-
22-May-2011	0.01	7.96	13.00	-
29-Aug-2011	0.13	6.85	15.60	-
18-May-2012	0.00	6.85	17.60	6.48
29-Aug-2012	0.11	6.35	26.00	3.25

Golder Associates

PROJECT: 10-1118-0020 (6700)

DATE: September 18, 2012

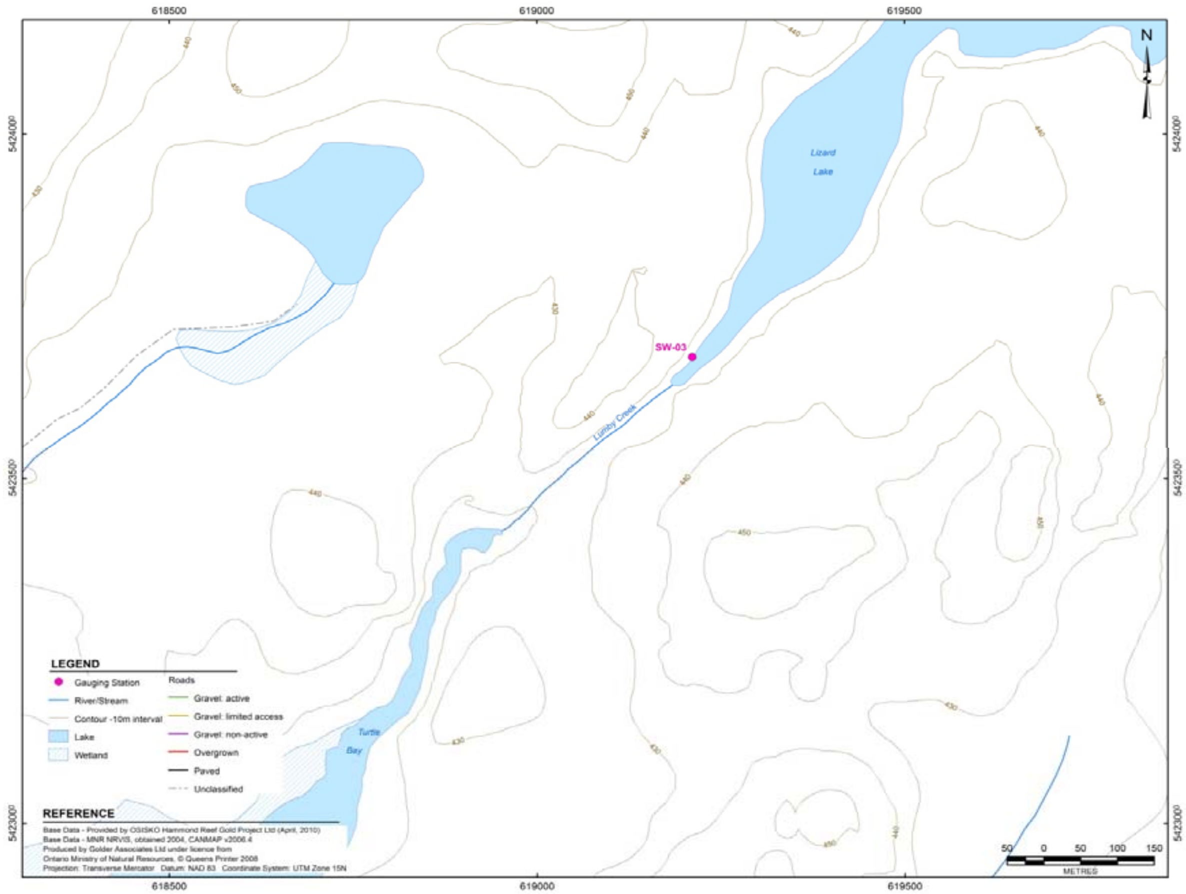
Flow Monitoring Station SW-02B

Hammond Reef Gold Project

SHEET 4

ATTACHMENT 5.I.4

Local Scale Monitoring Station SW-03; Lumby Creek below Lizard Lake



Station ID:	SW-03	**Installation Date:**	25-Aug-2010
Watercourse Name:	Lizard Lake near outlet / Lumby Creek below Lizard Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 619212 N 5423678 / 15U E 610183 N 5423635	**Logger Serial No.:**	21053617
Location Description:	The station is located at the outlet from Lizard Lake and can be accessed by boat from the launch at E 621942 N 5428806 near SW-02B. It is located in the lower catchment draining to Turtle Bay ~1.2 km upstream of the bay.	**Installation Type:**	Staff gauge installed on T-post above outlet near right bank. Levelogger installed in concrete block on lake bed ~20 m upstream of staff gauge. Cable run in flexible pipe to pipe housing on right bank ~25 m upstream of staff gauge beside dead black spruce.
Elevation:	The benchmark is centre of painted "X" on high point of large rock at Lizard Lake outlet. Benchmark surveyed as 426.778 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out by ice breakup and debris

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

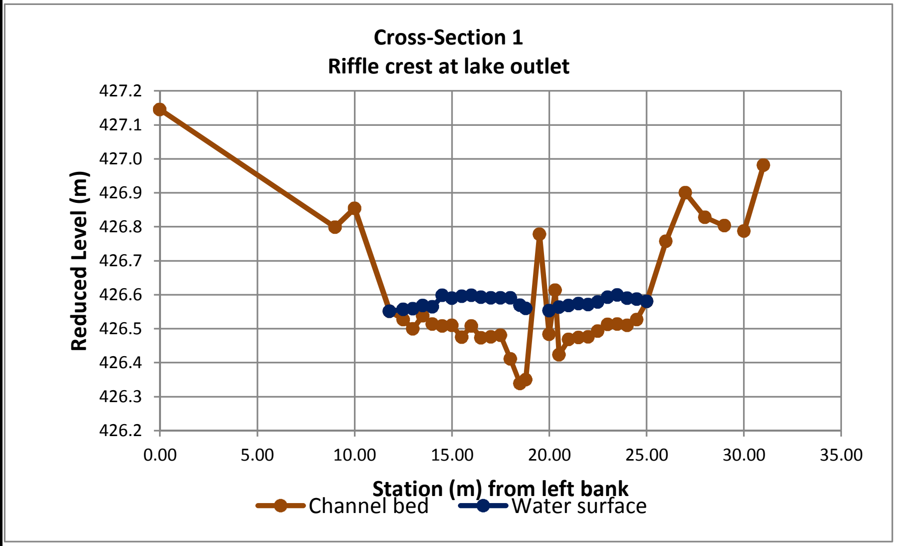
Gauge:	Hydraulic Control:	The staff gauge and Levelogger are installed in the lake upstream of the channel outlet. Hydraulic control is provided by a riffle at the channel outlet.
Current Metering Section:	General Section Description:	The measuring section is located ~50 m downstream in the channel outlet from Lizard Lake.
	Thalweg (straight, bend, off-center):	Off-centre; near left bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush, ferns and moss; shallow root zone
	Bankfull Depth (m):	0.50 - 1.25
	Bankfull Width (m):	8.00 - 17.00
	Floodplain Observations:	Deposition on right bank in bend
	General Observations:	Young fluvial channel; wide shallow cross-section, straight with steep grade; high bed load
Substrate:	Left Bank:	Bedrock outcrop
	Bed :	Boulders
	Right Bank:	Boulders

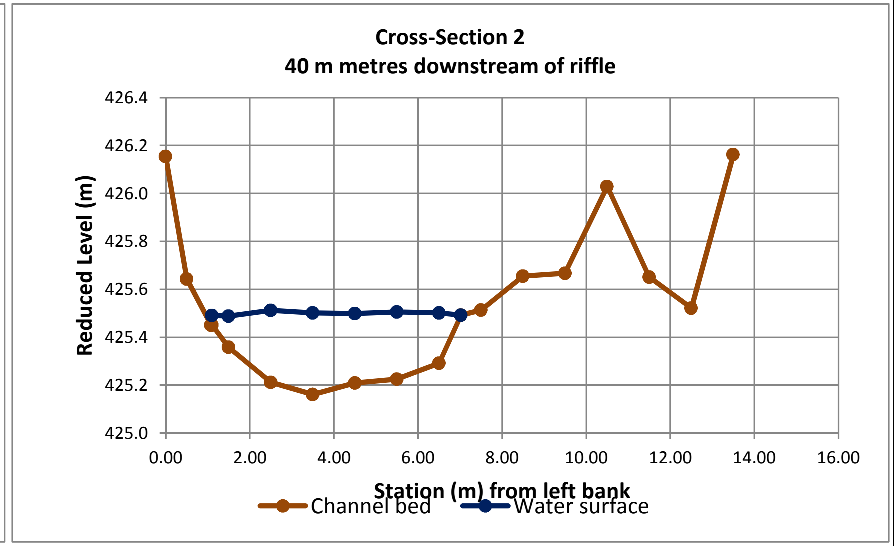
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

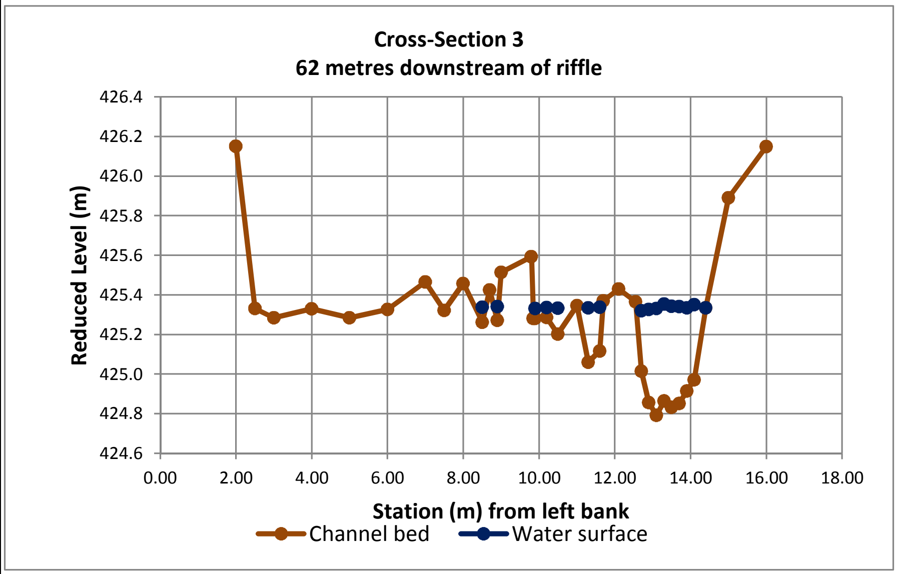
Golder Associates

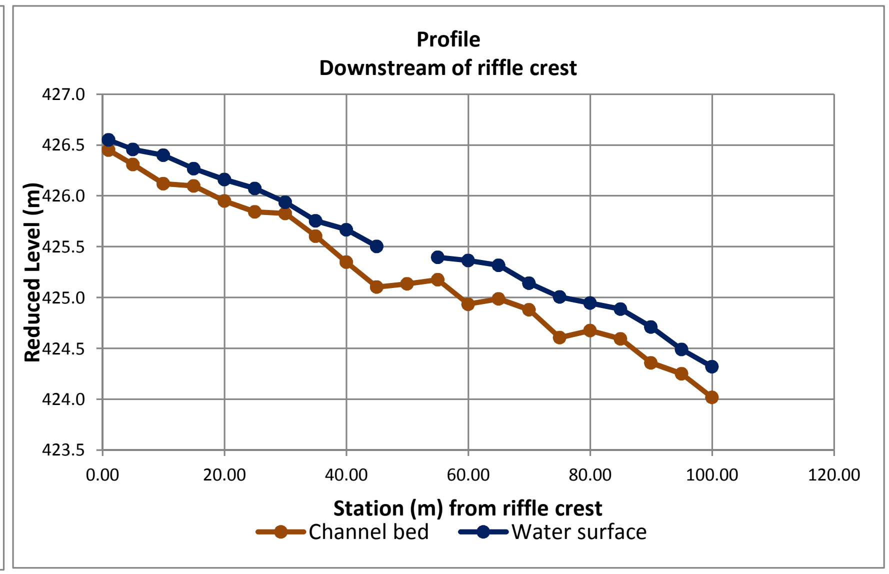
Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2









Note: Survey completed in October 2010.

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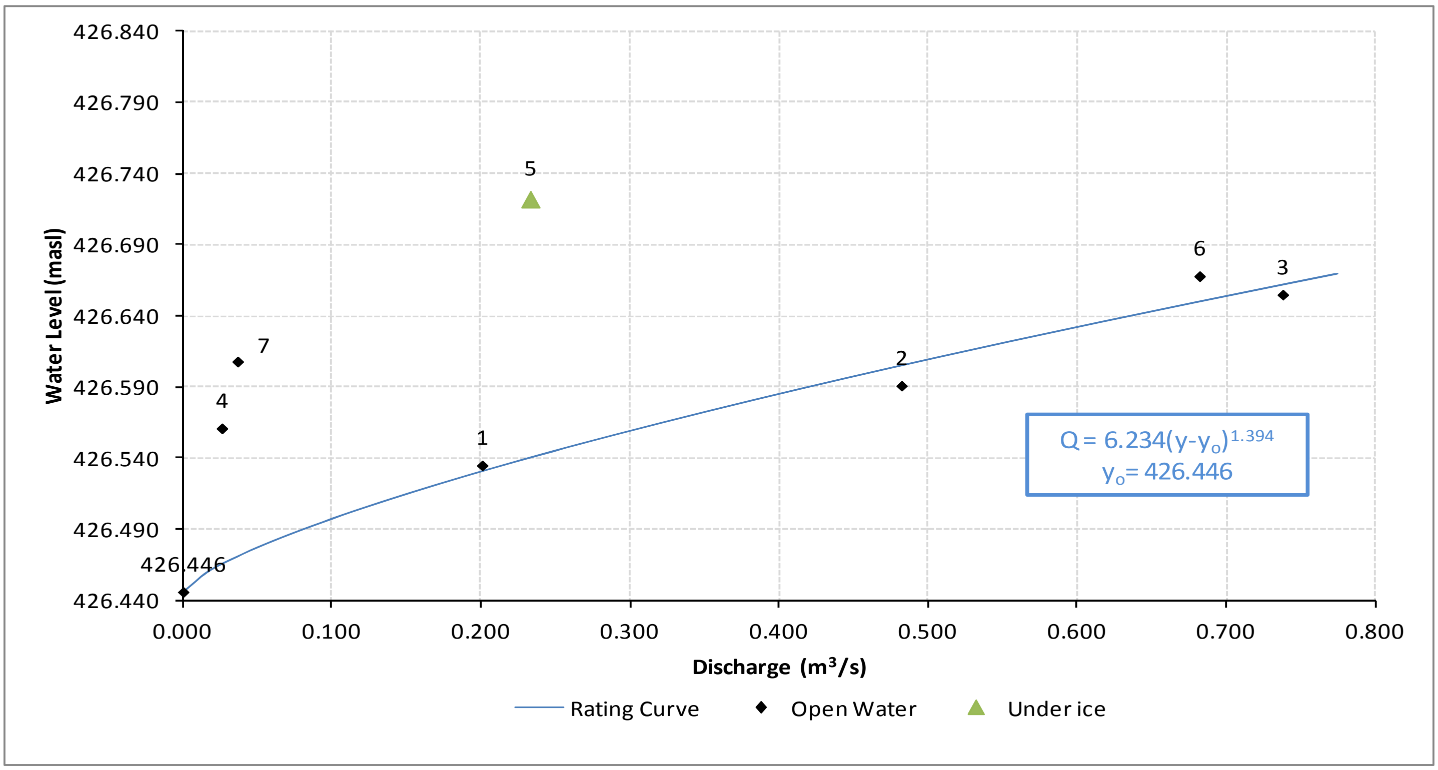
Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	25-Aug-2010	0.201	426.535
2	11-Oct-2010	0.482	426.591
3	22-May-2011	0.738	426.655
4	29-Aug-2011	0.026	426.561
5	11-Feb-2012	0.233	426.722
6	17-May-2012	0.682	426.668
7	31-Aug-2012	0.037	426.608
—	G.H. at zero flow	0.000	426.446

NOTES:
1) The station could not be accessed during the winter 2010 - 2011.
2) Measurement no. 4 was rated E (there were only 10 panels in the cross-section with > 20% total flow per panel).
3) Backwater was observed at measurement no. 6 due to debris build-up approx. 15 m downstream of staff gauge.
4) Measurement no. 7 was affected by a beaver dam located at the lake outlet upstream of the measuring cross-section.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
25-Aug-2010	0.05	6.85	18.35	-
22-May-2011	0.04	7.97	16.60	-
29-Aug-2011	0.05	7.75	19.30	-
17-May-2012	0.05	6.80	14.60	8.26
31-Aug-2012	0.05	6.98	22.50	6.26

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)
DATE:	September 18, 2012

Hammond Reef Gold Project

SHEET 4

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2010

Station Name: Lizard Lake near outlet

Station ID: SW-03

UTM coordinates: 15U E 619212 N 5423678

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									426.495	426.668	426.588	426.628	1
2									426.497	426.661	426.585	426.629	2
3									426.508	426.652	426.583	426.629	3
4									426.507	426.642	426.585	426.626	4
5									426.504	426.633	426.583	426.625	5
6									426.500	426.623	426.578	426.626	6
7									426.532	426.617	426.575	426.625	7
8									426.558	426.610	426.572	426.624	8
9									426.566	426.603	426.570	426.617	9
10									426.567	426.598	426.569	426.619	10
11									426.585	426.594	426.569	426.626	11
12									426.592	426.590	426.573	426.627	12
13									426.594	426.586	426.573	426.629	13
14									426.593	426.580	426.576	426.629	14
15									426.589	426.574	426.577	426.623	15
16									426.581	426.569	426.577	426.612	16
17									426.577	426.567	426.576	426.606	17
18									426.573	426.564	426.578	426.603	18
19									426.569	426.560	426.577	426.601	19
20									426.561	426.558	426.584	426.599	20
21									426.557	426.558	426.580	426.593	21
22									426.554	426.551	426.585	426.595	22
23									426.554	426.549	426.598	426.597	23
24									426.599	426.547	426.594	426.594	24
25								426.533	426.642	426.544	426.599	426.596	25
26								426.519	426.657	426.555	426.605	426.599	26
27								426.504	426.664	426.582	426.603	426.593	27
28								426.499	426.672	426.591	426.602	426.588	28
29								426.496	426.671	426.592	426.600	426.585	29
30								426.495	426.670	426.592	426.619	426.585	30
31								426.495		426.590		426.602	31
MEAN									426.576	426.590	426.584	426.611	
MAX									426.672	426.668	426.619	426.629	
MIN									426.495	426.544	426.569	426.585	

ANNUAL MEAN 426.586 MAX 426.672 MIN 426.495

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 5

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2011

Station Name: Lizard Lake near outlet

Station ID: SW-03

UTM coordinates: 15U E 619212 N 5423678

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	426.607	426.592	426.562	426.543	426.811	426.628	426.598	426.579	426.575	426.611	426.718	426.725	1
2	426.612	426.592	426.574	426.544	426.816	426.609	426.599	426.603	426.584	426.608	426.720	426.721	2
3	426.621	426.575	426.563	426.548	426.805	426.603	426.591	426.617	426.585	426.607	426.718	426.714	3
4	426.616	426.572	426.559	426.556	426.795	426.610	426.587	426.616	426.587	426.607	426.713	426.721	4
5	426.607	426.572	426.559	426.556	426.788	426.597	426.605	426.615	426.587	426.607	426.705	426.723	5
6	426.608	426.577	426.561	426.555	426.791	426.597	426.598	426.611	426.583	426.608	426.703	426.725	6
7	426.606	426.585	426.560	426.554	426.785	426.597	426.601	426.606	426.583	426.607	426.704	426.712	7
8	426.608	426.590	426.560	426.555	426.774	426.606	426.610	426.599	426.584	426.628	426.703	426.720	8
9	426.609	426.585	426.555	426.559	426.763	426.595	426.617	426.609	426.585	426.636	426.703	426.722	9
10	426.601	426.590	426.556	426.572	426.754	426.586	426.629	426.602	426.585	426.636	426.702	426.717	10
11	426.592	426.583	426.552	426.617	426.756	426.582	426.635	426.597	426.585	426.636	426.700	426.711	11
12	426.590	426.577	426.550	426.664	426.756	426.579	426.635	426.600	426.586	426.644	426.696	426.710	12
13	426.589	426.564	426.556	426.724	426.749	426.570	426.626	426.597	426.586	426.690	426.696	426.705	13
14	426.591	426.569	426.554	426.755	426.731	426.561	426.616	426.588	426.590	426.736	426.695	426.698	14
15	426.599	426.563	426.550	426.761	426.718	426.558	426.614	426.584	426.587	426.758	426.697	426.705	15
16	426.605	426.562	426.548	426.769	426.705	426.559	426.617	426.578	426.583	426.767	426.699	426.719	16
17	426.593	426.559	426.550	426.773	426.693	426.555	426.613	426.580	426.579	426.774	426.701	426.717	17
18	426.599	426.574	426.557	426.765	426.682	426.550	426.610	426.572	426.575	426.773	426.701	426.705	18
19	426.600	426.576	426.555	426.756	426.671	426.556	426.598	426.572	426.579	426.768	426.703	426.706	19
20	426.599	426.573	426.552	426.747	426.661	426.555	426.602	426.567	426.583	426.762	426.711	426.705	20
21	426.606	426.575	426.555	426.740	426.651	426.549	426.619	426.565	426.600	426.756	426.710	426.700	21
22	426.602	426.567	426.558	426.735	426.650	426.550	426.620	426.558	426.603	426.750	426.702	426.706	22
23	426.599	426.561	426.563	426.737	426.663	426.557	426.615	426.552	426.602	426.746	426.699	426.704	23
24	426.589	426.570	426.565	426.743	426.656	426.555	426.606	426.568	426.604	426.745	426.701	426.703	24
25	426.590	426.581	426.563	426.754	426.651	426.549	426.606	426.570	426.603	426.742	426.701	426.701	25
26	426.583	426.582	426.563	426.767	426.643	426.542	426.602	426.571	426.603	426.738	426.708	426.699	26
27	426.580	426.571	426.561	426.780	426.628	426.574	426.601	426.572	426.604	426.736	426.718	426.712	27
28	426.586	426.569	426.556	426.787	426.622	426.601	426.604	426.569	426.604	426.735	426.718	426.717	28
29	426.588		426.552	426.787	426.628	426.598	426.599	426.568	426.610	426.732	426.723	426.708	29
30	426.593		426.549	426.783	426.618	426.596	426.591	426.569	426.612	426.729	426.723	426.707	30
31	426.596		426.546		426.609		426.589	426.571		426.725		426.706	31
MEAN	426.599	426.575	426.557	426.683	426.711	426.577	426.608	426.585	426.591	426.697	426.706	426.711	
MAX	426.621	426.592	426.574	426.787	426.816	426.628	426.635	426.617	426.612	426.774	426.723	426.725	
MIN	426.580	426.559	426.546	426.543	426.609	426.542	426.587	426.552	426.575	426.607	426.695	426.698	

ANNUAL MEAN 426.634 MAX 426.816 MIN 426.542

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2012

Station Name: Lizard Lake near outlet

Station ID: SW-03

UTM coordinates: 15U E 619212 N 5423678

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	426.710	426.713	426.701	426.859	426.713	426.882	426.667	426.624					1
2	426.721	426.711	426.696	426.853	426.713	426.855	426.657	426.627					2
3	426.723	426.711	426.703	426.861	426.713	426.823	426.686	426.623					3
4	426.715	426.711	426.710	426.856	426.708	426.791	426.684	426.617					4
5	426.707	426.714	426.706	426.843	426.701	426.764	426.678	426.613					5
6	426.705	426.714	426.690	426.825	426.697	426.739	426.674	426.603					6
7	426.712	426.722	426.691	426.807	426.709	426.715	426.668	426.601					7
8	426.710	426.718	426.694	426.798	426.721	426.707	426.659	426.597					8
9	426.704	426.711	426.698	426.787	426.723	426.718	426.651	426.601					9
10	426.702	426.721	426.687	426.773	426.717	426.711	426.641	426.597					10
11	426.706	426.720	426.684	426.758	426.716	426.714	426.630	426.592					11
12	426.717	426.714	426.684	426.744	426.713	426.714	426.623	426.588					12
13	426.720	426.714	426.692	426.732	426.703	426.701	426.617	426.585					13
14	426.717	426.705	426.693	426.727	426.697	426.703	426.614	426.583					14
15	426.707	426.701	426.698	426.724	426.692	426.730	426.611	426.580					15
16	426.705	426.700	426.699	426.750	426.685	426.738	426.619	426.592					16
17	426.716	426.702	426.705	426.743	426.672	426.755	426.621	426.589					17
18	426.721	426.704	426.721	426.738	426.663	426.755	426.616	426.587					18
19	426.729	426.704	426.754	426.740	426.657	426.757	426.609	426.587					19
20	426.729	426.696	426.796	426.745	426.662	426.765	426.602	426.584					20
21	426.722	426.696	426.822	426.748	426.658	426.791	426.600	426.582					21
22	426.708	426.703	426.826	426.751	426.655	426.804	426.594	426.582					22
23	426.717	426.704	426.844	426.751	426.655	426.800	426.589	426.584					23
24	426.720	426.704	426.877	426.750	426.677	426.790	426.586	426.588					24
25	426.715	426.710	426.880	426.746	426.702	426.772	426.583	426.597					25
26	426.710	426.707	426.862	426.748	426.715	426.750	426.580	426.609					26
27	426.714	426.711	426.868	426.741	426.729	426.731	426.576	426.612					27
28	426.717	426.707	426.888	426.732	426.789	426.712	426.569	426.613					28
29	426.724	426.698	426.888	426.722	426.862	426.693	426.582	426.613					29
30	426.721		426.886	426.716	426.901	426.679	426.626	426.615					30
31	426.713		426.872		426.902		426.630	426.620					31
MEAN	426.715	426.708	426.762	426.769	426.717	426.752	426.624	426.600					
MAX	426.729	426.722	426.888	426.861	426.902	426.882	426.686	426.627					
MIN	426.702	426.696	426.684	426.716	426.655	426.679	426.569	426.580					

ANNUAL MEAN 426.705 MAX 426.902 MIN 426.569

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Lumby Creek below Lizard Lake

Station ID: SW-03

UTM coordinates: 15U E 610183 N 5423635

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.089	0.814E	0.469	0.513B	1
2									0.095	0.784E	0.453	0.511B	2
3									0.128	0.740E	0.445	0.509B	3
4									0.126	0.696	0.452	0.506B	4
5									0.117	0.654	0.448	0.504B	5
6									0.108	0.613	0.424	0.502B	6
7									0.209	0.589	0.415	0.500B	7
8									0.301	0.558	0.400	0.498B	8
9									0.332	0.527	0.393	0.495B	9
10									0.338	0.511	0.388	0.493B	10
11									0.409	0.495	0.389	0.491B	11
12									0.439	0.478	0.405	0.489B	12
13									0.449	0.460	0.405B	0.487B	13
14									0.445	0.435	0.418B	0.485B	14
15									0.429	0.412	0.422B	0.483B	15
16									0.402	0.392	0.422B	0.480B	16
17									0.387	0.383	0.418B	0.478B	17
18									0.372	0.372	0.424B	0.476B	18
19									0.358	0.355	0.422B	0.474B	19
20									0.327	0.347	0.449B	0.472B	20
21									0.314	0.345	0.432B	0.470B	21
22									0.306	0.321	0.454B	0.468B	22
23									0.306	0.314	0.507B	0.466B	23
24									0.491	0.305	0.493B	0.464B	24
25								0.195	0.678	0.295	0.512B	0.462B	25
26								0.152	0.754E	0.338	0.538B	0.460B	26
27								0.108	0.790E	0.441	0.532B	0.458B	27
28								0.097	0.826E	0.482	0.527B	0.456B	28
29								0.089	0.823E	0.485	0.518B	0.454B	29
30								0.087	0.823E	0.482	0.515B	0.452B	30
31								0.089		0.475		0.451B	31
MEAN									0.399	0.481	0.450	0.481	
MAX									0.826	0.814	0.538	0.513	
MIN									0.089	0.295	0.388	0.451	
L/s/km²									6.36	7.66	7.17	7.67	

ANNUAL — MEAN: 0.435 — MAX: 0.826 — MIN: 0.087 — L/s/km²: 6.93

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 8

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Lumby Creek below Lizard Lake — Station ID: SW-03

UTM coordinates: 15U E 610183 N 5423635 — Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.449B	0.402B	0.347B	0.286B	1.604E	0.585	0.330	0.151	0.055	0.106	0.426	0.305B	1
2	0.447B	0.400B	0.346B	0.290B	1.632E	0.500	0.328	0.226	0.075	0.099	0.430	0.303B	2
3	0.446B	0.399B	0.345B	0.302B	1.567E	0.470	0.294	0.269	0.077	0.093	0.422	0.301B	3
4	0.444B	0.397B	0.344B	0.334B	1.509E	0.495	0.278	0.263	0.081	0.094	0.397	0.300B	4
5	0.443B	0.398B	0.348B	0.335B	1.469E	0.437	0.340	0.256	0.078	0.091	0.365	0.298B	5
6	0.441B	0.394B	0.354B	0.332B	1.487E	0.432	0.309	0.237	0.069	0.091	0.353	0.296B	6
7	0.439B	0.389B	0.351B	0.324B	1.452E	0.427	0.316	0.215	0.066	0.088	0.355	0.294B	7
8	0.438B	0.385B	0.349B	0.328B	1.385E	0.457	0.347	0.188	0.067	0.145	0.353	0.292B	8
9	0.436B	0.381B	0.332B	0.344B	1.325E	0.409	0.367	0.220	0.069	0.170	0.348	0.290B	9
10	0.435B	0.377B	0.334B	0.398B	1.275E	0.371	0.411	0.191	0.067	0.167	0.343B	0.288B	10
11	0.433B	0.373B	0.321B	0.586B	1.287E	0.349	0.431	0.173	0.067	0.165	0.334B	0.287B	11
12	0.432B	0.369B	0.310B	0.806E	1.286E	0.332	0.429	0.180	0.067	0.191	0.316B	0.285B	12
13	0.430B	0.365B	0.333B	0.836E	1.244E	0.295	0.386	0.165	0.067	0.353	0.315B	0.283B	13
14	0.428B	0.384B	0.325B	0.868E	1.149E	0.259	0.346	0.134	0.075	0.541	0.311B	0.281B	14
15	0.427B	0.364B	0.310B	0.901E	1.077E	0.247	0.332	0.120	0.067	0.636E	0.315B	0.279B	15
16	0.425B	0.357B	0.304B	0.935E	1.012E	0.246	0.340	0.102	0.057	0.672E	0.322B	0.278B	16
17	0.424B	0.356B	0.311B	0.971E	0.951E	0.228	0.322	0.102	0.046	0.705E	0.326B	0.276B	17
18	0.422B	0.355B	0.340B	1.008E	0.895E	0.207	0.307	0.081	0.037	0.697E	0.323B	0.274B	18
19	0.421B	0.354B	0.331B	1.046E	0.838E	0.223	0.259	0.078	0.044	0.669E	0.329B	0.272B	19
20	0.419B	0.353B	0.321B	1.086E	0.788E	0.215	0.271	0.062	0.051	0.641E	0.327B	0.271B	20
21	0.418B	0.353B	0.318B	1.127E	0.740	0.193	0.329	0.055	0.093	0.613	0.325B	0.269B	21
22	0.416B	0.352B	0.315B	1.170E	0.737	0.192	0.326	0.037	0.097	0.582	0.323B	0.267B	22
23	0.415B	0.351B	0.312B	1.179E	0.794E	0.211	0.304	0.023	0.093	0.561	0.321B	0.266B	23
24	0.413B	0.350B	0.309B	1.213E	0.756E	0.201	0.268	0.058	0.097	0.556	0.319B	0.264B	24
25	0.412B	0.350B	0.306B	1.273E	0.726	0.181	0.264	0.057	0.095	0.540	0.317B	0.262B	25
26	0.410B	0.349B	0.303B	1.348E	0.682	0.156	0.246	0.057	0.093	0.519	0.315B	0.261B	26
27	0.409B	0.348B	0.300B	1.423E	0.609	0.258	0.240	0.056	0.093	0.511	0.313B	0.259B	27
28	0.407B	0.347B	0.297B	1.464E	0.578	0.352	0.244	0.046	0.093	0.502	0.311B	0.257B	28
29	0.406B		0.295B	1.462E	0.598	0.339	0.224	0.044	0.109	0.488	0.309B	0.256B	29
30	0.405B		0.292B	1.440E	0.549	0.325	0.196	0.044	0.113	0.474	0.307B	0.254B	30
31	0.403B		0.289B		0.509		0.186	0.047		0.454		0.253B	31
MEAN	0.426	0.370	0.322	0.847	1.049	0.320	0.309	0.127	0.075	0.394	0.339	0.278	
MAX	0.449	0.402	0.354	1.464	1.632	0.585	0.431	0.269	0.113	0.705	0.430	0.305	
MIN	0.403	0.347	0.289	0.286	0.509	0.156	0.186	0.023	0.037	0.088	0.307	0.253	
L/s/km²	6.79	5.90	5.14	13.51	16.72	5.10	4.92	2.02	1.20	6.28	5.41	4.43	

ANNUAL — MEAN: 0.405 — MAX: 1.632 — MIN: 0.023 — L/s/km²: 6.46

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-03

PROJECT: 10-1118-0020 (6700) | DATE: September 18, 2012 | Hammond Reef Gold Project | SHEET 9

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Lumby Creek below Lizard Lake

Station ID: SW-03

UTM coordinates: 15U E 610183 N 5423635

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.251B	0.231B	0.240B	1.256E	0.755E	1.729	0.447	0.165					1
2	0.249B	0.221B	0.243B	1.231E	0.762E	1.562	0.401	0.172					2
3	0.248B	0.219B	0.247B	1.283E	0.769E	1.369	0.519	0.156					3
4	0.246B	0.218B	0.250B	1.267E	0.753E	1.187	0.506	0.135					4
5	0.245B	0.225B	0.254B	1.204E	0.730	1.040	0.474	0.118					5
6	0.243B	0.227B	0.257B	1.114E	0.715	0.905	0.451	0.088					6
7	0.242B	0.251B	0.261B	1.029E	0.780E	0.777	0.424	0.080					7
8	0.240B	0.237B	0.265B	0.991E	0.847E	0.738	0.385	0.069					8
9	0.239B	0.210B	0.269B	0.941E	0.868E	0.782	0.346	0.075					9
10	0.230B	0.241B	0.272B	0.881E	0.844E	0.744	0.304	0.063					10
11	0.230B	0.236B	0.276B	0.812E	0.850E	0.753	0.263	0.049					11
12	0.230B	0.222B	0.283B	0.754E	0.843E	0.748	0.232	0.038					12
13	0.230B	0.229B	0.318B	0.703B	0.803E	0.680	0.209	0.031					13
14	0.230B	0.203B	0.330B	0.689B	0.779E	0.685	0.197	0.024					14
15	0.230B	0.196B	0.355B	0.684B	0.762E	0.809	0.184	0.018					15
16	0.230B	0.197B	0.366B	0.815E	0.739E	0.845	0.206	0.037					16
17	0.230B	0.208B	0.396B	0.788E	0.681	0.921	0.209	0.031					17
18	0.230B	0.221B	0.467B	0.771E	0.639	0.917	0.189	0.023					18
19	0.230B	0.226B	0.617B	0.791E	0.605	0.923	0.164	0.021					19
20	0.230B	0.207B	0.824E	0.821E	0.624	0.960	0.138	0.016					20
21	0.229B	0.211B	0.963E	0.843E	0.600	1.088	0.128	0.011					21
22	0.229B	0.214B	0.992E	0.866E	0.584	1.149	0.108	0.009					22
23	0.261B	0.217B	1.095E	0.875E	0.578	1.123	0.093	0.011					23
24	0.270B	0.220B	1.281E	0.877E	0.674	1.063	0.082	0.014					24
25	0.251B	0.223B	1.306E	0.867E	0.786	0.964	0.071	0.029					25
26	0.229B	0.226B	1.219E	0.885E	0.841	0.851	0.062	0.052					26
27	0.244B	0.230B	1.258E	0.859E	0.911	0.749	0.050	0.054					27
28	0.250B	0.233B	1.379E	0.825E	1.219	0.655	0.034	0.055					28
29	0.275B	0.236B	1.390E	0.782E	1.629	0.567	0.061	0.053					29
30	0.264B		1.388E	0.761E	1.861	0.500	0.179	0.055					30
31	0.232B		1.319E		1.855		0.186	0.065					31
MEAN	0.241	0.222	0.657	0.909	0.861	0.926	0.236	0.059					
MAX	0.275	0.251	1.390	1.283	1.861	1.729	0.519	0.172					
MIN	0.229	0.196	0.240	0.684	0.578	0.500	0.034	0.009					
L/s/km²	3.84	3.54	10.48	14.49	13.73	14.77	3.76	0.93					

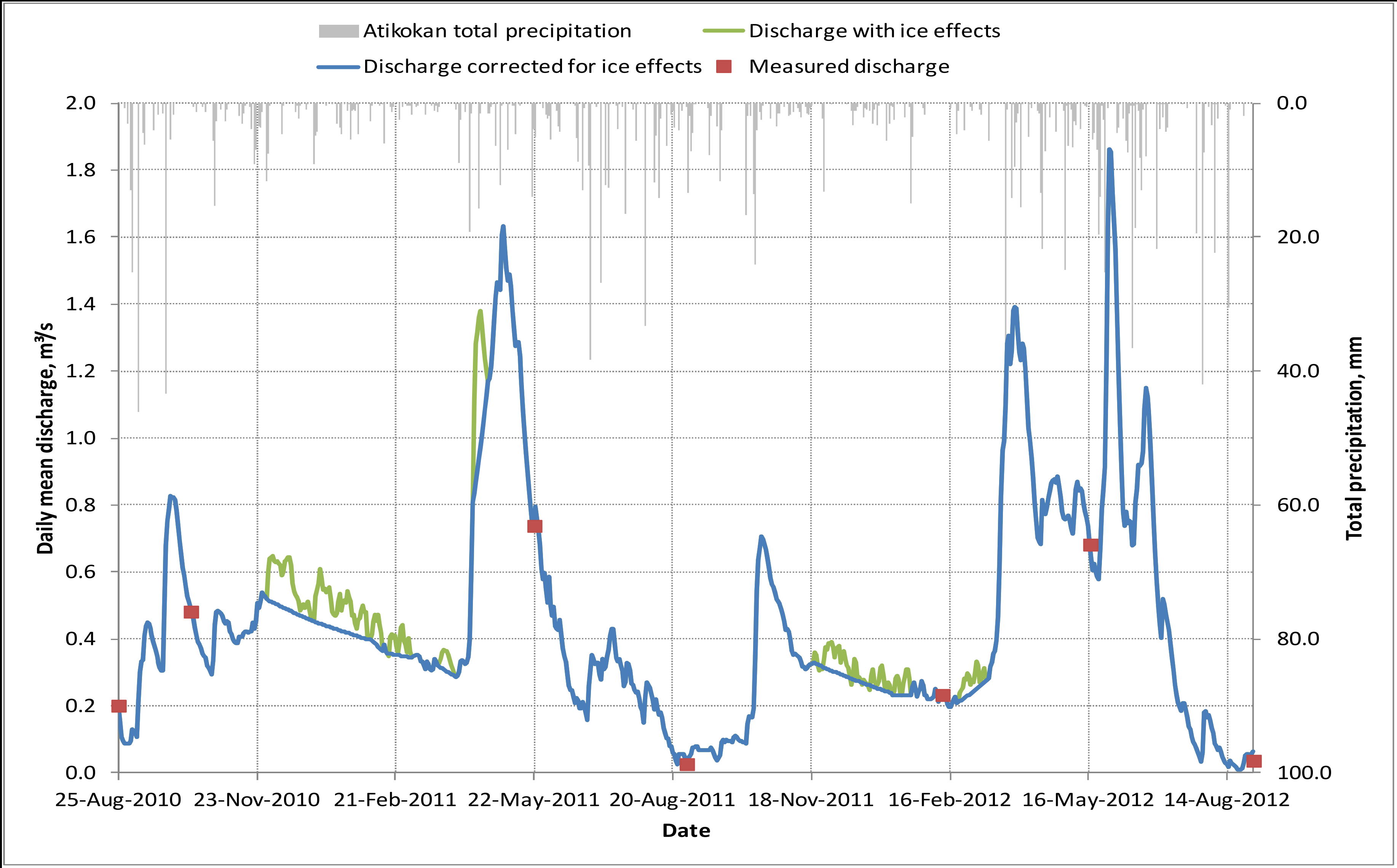
ANNUAL MEAN 0.513 MAX 1.861 MIN 0.009 L/s/km² 8.18

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

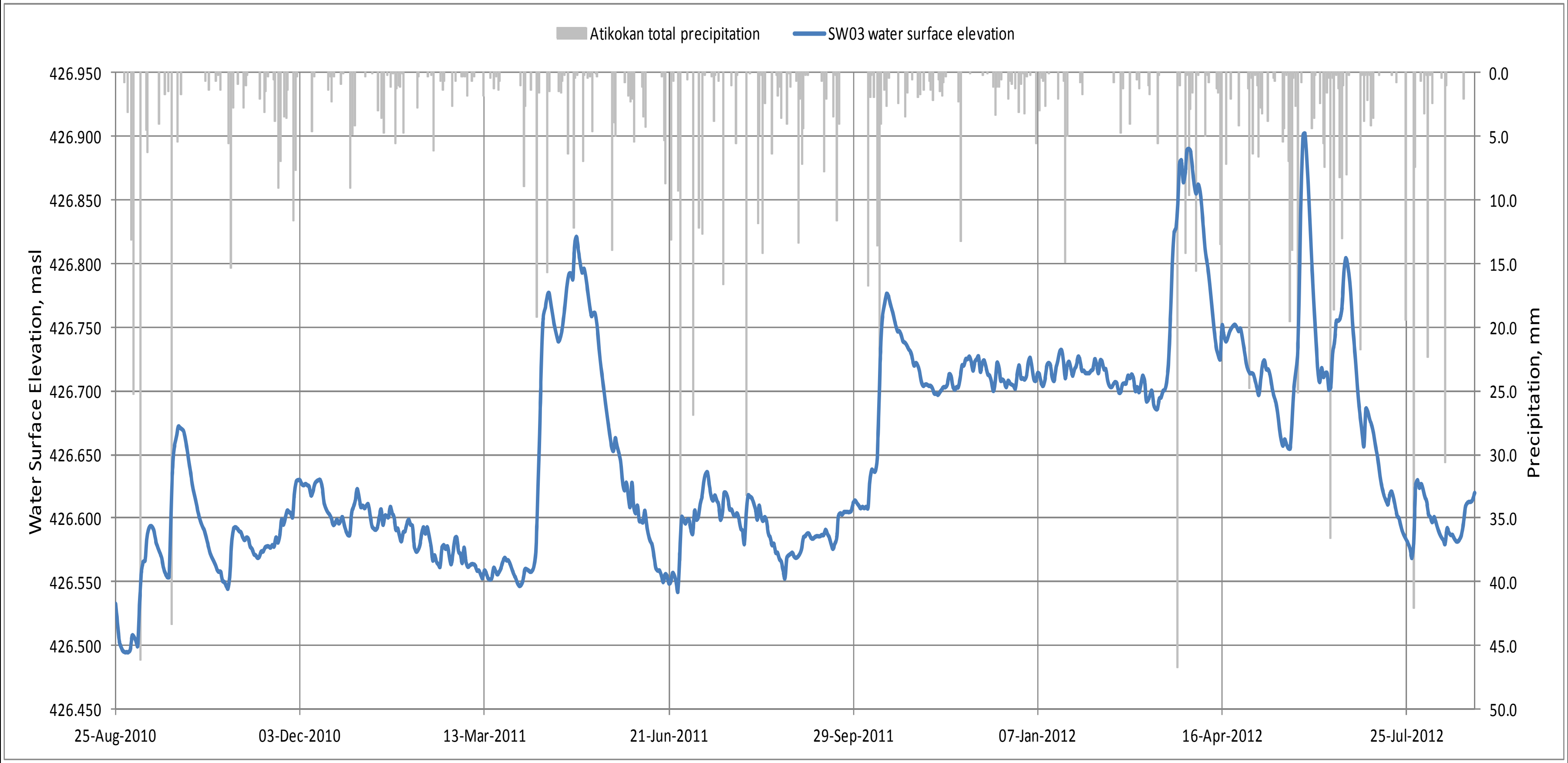
Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 10



Golder Associates			Flow Monitoring Station SW-03	
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11



Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 12

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Lizard Lake near outlet

Station ID: SW-03

UTM coordinates: U15 E 619212 N 5423678

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									20.5	11.6	6.4	1.8	1
2									20.8	11.3	6.2	1.8	2
3									19.6	11.0	6.4	1.8	3
4									18.9	10.7	5.9	1.8	4
5									18.3	10.7	5.4	1.8	5
6									18.0	10.9	5.2	1.7	6
7									17.1	10.9	5.1	1.7	7
8									16.7	12.1	5.3	1.7	8
9									16.3	12.4	5.4	1.7	9
10									16.0	12.6	5.6	1.7	10
11									15.7	12.9	5.4	1.6	11
12									15.2	11.9	5.0	1.6	12
13									15.0	11.2	4.6	1.6	13
14									15.1	10.9	4.2	1.6	14
15									14.6	10.9	4.0	1.5	15
16									14.2	10.7	3.8	1.5	16
17									13.8	10.4	3.5	1.5	17
18									13.3	9.9	2.8	1.5	18
19									13.5	9.7	3.1	1.4	19
20									13.4	9.5	2.1	1.4	20
21									13.0	9.0	1.6	1.4	21
22									13.0	8.8	1.7	1.3	22
23									12.8	8.6	1.5	1.3	23
24									12.2	8.6	1.5	1.3	24
25								20.4	12.3	8.6	1.6	1.2	25
26								19.3	11.8	8.8	1.7	1.2	26
27								19.2	11.6	8.4	1.7	1.2	27
28								19.4	11.6	7.9	1.7	1.2	28
29								20.0	11.6	7.3	1.7	1.2	29
30								20.4	11.8	6.9	1.8	1.2	30
31								20.5		6.7		1.2	31
MEAN (°C)									14.9	10.1	3.7	1.5	
MAX (°C)									20.8	12.9	6.4	1.8	
MIN (°C)									11.6	6.7	1.5	1.2	

ANNUAL MEAN (°C) 7.6 MAX (°C) 20.8 MIN (°C) 1.2

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 13

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Lizard Lake near outlet

Station ID: SW-03

UTM coordinates: U15 E 619212 N 5423678

Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	1.3	1.0	0.7	0.9	3.0	11.9	19.2	22.5	20.3	11.4	6.7	2.2	1
2	1.3	1.0	0.7	1.0	3.3	13.5	20.1	23.7	20.5	11.4	6.5	2.2	2
3	1.3	1.0	0.7	1.0	3.5	13.7	21.2	24.3	20.1	12.4	6.2	2.2	3
4	1.3	1.0	0.7	1.0	3.5	14.9	21.5	23.8	18.5	12.2	5.8	2.2	4
5	1.3	1.1	0.7	1.1	3.9	15.2	22.6	24.1	17.1	12.8	5.7	2.3	5
6	1.3	1.0	0.7	1.1	4.7	16.3	22.8	24.2	17.1	13.1	5.8	2.3	6
7	1.2	1.0	0.7	1.1	5.3	17.8	22.4	24.5	17.4	13.0	5.5	2.2	7
8	1.3	1.0	0.7	1.2	5.8	17.2	23.6	23.5	18.7	13.2	5.2	2.2	8
9	1.2	1.0	0.7	1.3	6.4	17.1	22.4	22.6	19.9	13.1	4.8	2.3	9
10	1.2	1.0	0.7	1.3	7.5	17.1	21.9	22.5	20.2	13.5	4.5	2.3	10
11	1.2	0.9	0.7	1.8	6.8	17.1	23.1	21.8	19.4	13.6	4.3	2.3	11
12	1.2	1.0	0.7	2.4	8.9	17.5	22.8	22.7	19.5	13.2	4.2	2.4	12
13	1.2	1.0	0.8	2.4	9.2	16.4	21.9	23.5	17.1	13.7	4.1	2.4	13
14	1.1	1.0	0.7	2.5	9.1	16.2	20.9	22.8	15.4	13.3	4.0	2.3	14
15	1.1	1.0	0.7	2.6	9.6	17.9	20.9	22.9	14.4	12.5	3.9	2.2	15
16	1.1	1.0	0.8	2.5	10.6	19.0	21.2	22.5	14.2	11.8	3.6	2.3	16
17	1.1	1.0	0.8	2.5	11.5	20.0	23.0	21.2	13.8	11.0	3.3	2.2	17
18	1.1	0.8	0.8	2.5	12.2	20.3	26.0	21.1	14.0	10.4	2.8	2.2	18
19	1.1	0.9	0.8	2.4	13.8	19.2	24.7	21.5	14.4	9.9	2.0	2.1	19
20	1.1	0.9	0.8	2.4	16.2	18.6	24.5	21.1	14.0	9.4	1.8	2.1	20
21	1.0	0.9	0.8	2.4	17.0	18.3	23.0	20.8	13.4	9.0	2.1	2.0	21
22	1.0	0.8	0.7	2.4	16.6	17.6	23.6	20.5	12.3	8.8	2.1	1.9	22
23	1.0	0.8	0.8	2.4	16.5	17.1	22.8	20.4	12.8	8.7	2.1	2.0	23
24	1.1	0.8	0.9	2.5	15.7	18.2	21.8	20.1	12.3	8.3	2.2	2.0	24
25	1.0	0.8	0.9	2.7	15.1	17.4	21.7	19.9	12.2	8.1	2.2	1.8	25
26	1.1	0.8	0.9	2.8	15.5	17.1	21.7	20.7	12.1	7.9	2.2	1.8	26
27	1.0	0.7	0.9	2.8	13.1	17.6	21.0	20.8	13.0	7.6	2.2	1.8	27
28	1.0	0.7	0.9	2.9	13.0	17.8	20.9	20.2	13.6	7.2	2.2	1.8	28
29	1.0		0.9	3.0	13.8	17.7	21.4	20.4	13.1	7.0	2.2	1.8	29
30	1.0		0.9	2.9	14.9	18.2	21.5	20.4	12.0	6.8	2.2	1.9	30
31	1.0		0.9		12.6		22.0	20.6		6.7		1.9	31
MEAN (°C)	1.1	0.9	0.8	2.1	10.3	17.1	22.2	22.0	15.8	10.7	3.7	2.1	
MAX (°C)	1.3	1.1	0.9	3.0	17.0	20.3	26.0	24.5	20.5	13.7	6.7	2.4	
MIN (°C)	1.0	0.7	0.7	0.9	3.0	11.9	19.2	19.9	12.0	6.7	1.8	1.8	

ANNUAL MEAN (°C) 9.1 MAX (°C) 26.0 MIN (°C) 0.7

Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 14

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Lizard Lake near outlet | Station ID: SW-03

UTM coordinates: U15 E 619212 N 5423678 | Drainage area: 6,271.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	1.6	1.5	1.0	3.6	7.6	13.6	23.5	22.4					1
2	1.6	1.5	1.1	3.6	8.5	15.8	24.0	23.5					2
3	1.7	1.4	1.1	3.8	10.3	16.7	24.8	23.5					3
4	1.8	1.4	1.1	4.0	11.4	16.5	25.8	22.4					4
5	1.8	1.4	1.1	4.4	11.3	17.2	24.2	21.8					5
6	1.7	1.4	1.1	4.1	11.0	19.8	24.0	21.2					6
7	1.7	1.4	1.0	4.1	10.4	19.5	24.9	21.7					7
8	1.7	1.4	1.0	4.2	10.6	20.9	25.6	22.3					8
9	1.6	1.3	1.0	4.5	11.1	21.0	25.3	22.0					9
10	1.6	1.3	1.0	4.8	10.5	18.0	24.6	22.1					10
11	1.6	1.3	0.9	5.3	11.1	17.1	23.3	22.8					11
12	1.6	1.3	0.9	5.1	10.9	18.2	23.7	21.7					12
13	1.5	1.3	1.0	4.9	10.6	18.1	24.6	22.0					13
14	1.5	1.3	1.2	5.3	12.2	17.9	26.3	22.7					14
15	1.5	1.3	1.5	5.5	12.6	17.5	27.0	21.6					15
16	1.4	1.2	1.7	4.7	13.5	18.4	25.8	20.5					16
17	1.5	1.1	2.0	4.4	13.4	18.1	25.4	20.2					17
18	1.5	1.1	2.6	4.8	13.6	18.9	25.3	19.9					18
19	1.5	1.1	3.1	4.8	14.3	19.0	24.5	19.8					19
20	1.5	1.1	3.2	5.3	14.7	19.3	23.4	20.1					20
21	1.4	1.1	3.3	5.8	14.9	19.3	24.5	19.6					21
22	1.4	1.1	3.4	5.5	14.7	19.3	24.4	19.2					22
23	1.4	1.1	3.5	6.0	14.6	19.2	24.0	20.3					23
24	1.4	1.1	3.4	7.6	15.1	20.4	24.9	20.0					24
25	1.5	1.1	3.5	7.7	14.8	20.5	24.6	20.5					25
26	1.5	1.1	3.6	7.6	14.8	19.9	24.1	20.0					26
27	1.5	1.2	3.7	8.2	14.6	20.8	23.9	19.9					27
28	1.4	1.1	3.7	8.3	13.9	20.9	22.7	20.0					28
29	1.5	1.1	3.6	7.3	13.5	21.1	22.5	19.9					29
30	1.5		3.4	6.9	13.5	23.1	22.9	20.3					30
31	1.5		3.6		13.3	23.5	22.7	19.9					31
MEAN (°C)	1.5	1.2	2.2	5.4	12.5	19.0	24.4	21.1					
MAX (°C)	1.8	1.5	3.7	8.3	15.1	23.5	27.0	23.5					
MIN (°C)	1.4	1.1	0.9	3.6	7.6	13.6	22.5	19.2					

ANNUAL MEAN (°C) 10.9 MAX (°C) 27.0 MIN (°C) 0.9

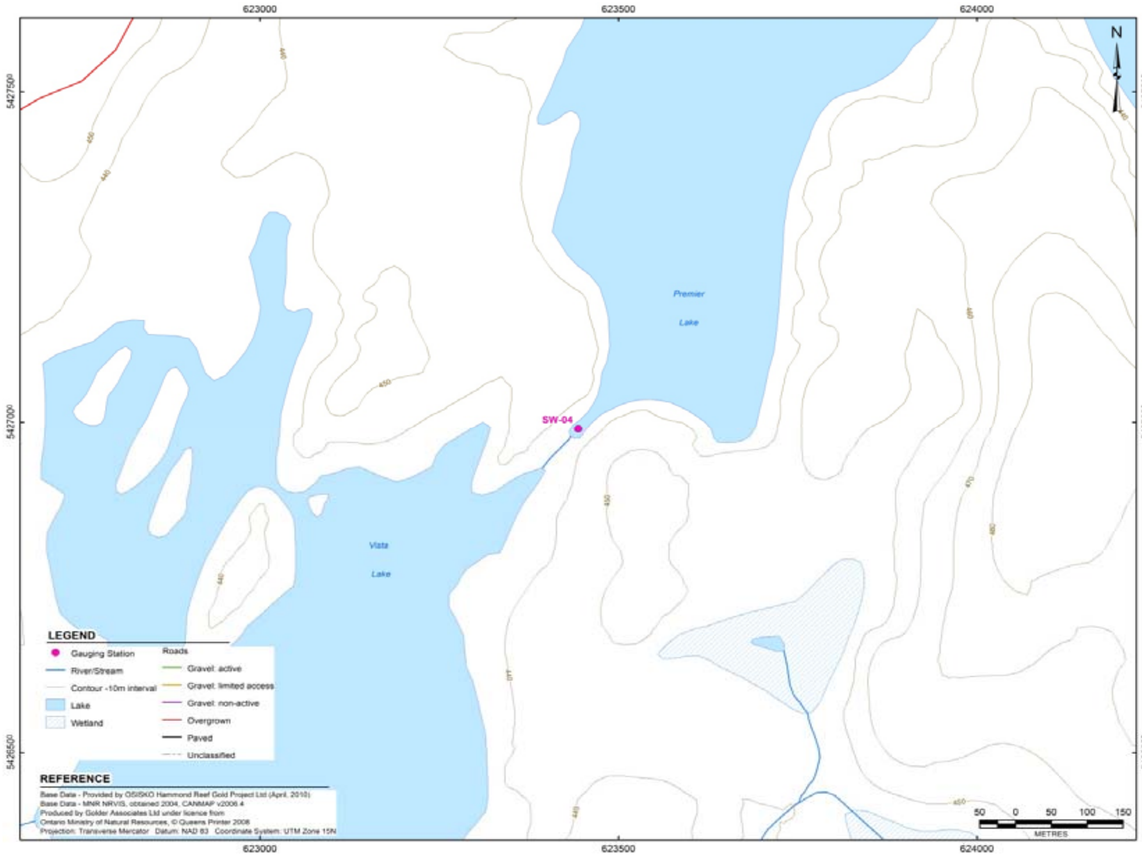
Golder Associates

Flow Monitoring Station SW-03

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 15

ATTACHMENT 5.I.5

Local Scale Monitoring Station SW-04; Premier Lake-Vista Lake



Station ID:	SW-04	**Installation Date:**	23-Aug-2010
Watercourse Name:	Premier Lake near outlet / Premier Lake-Vista Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 623443 N 5426989 / 15U E 623404 N 5426952	**Logger Serial No.:**	21053613
Location Description:	This station is located near the outlet from Premier Lake, upstream of the channel outflow to Vista Lake. Boat access is from the launch between KM32 and KM33 on Premier Road. The station is located in the middle of the catchment draining to Light Bay.	**Installation Type:**	Staff gauge installed on T-post in lake upstream of outlet from Premier Lake near left bank. Logger installed in concrete block on lake bed downstream of staff gauge. Cable run in flexible pipe to pipe housing attached to cedar on left bank.
Elevation:	The benchmark is centre of painted "X" on high point of bedrock outcrop on southeast bank of Premier Lake outlet next to cable housing. Benchmark surveyed as 433.258 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out by ice breakup and debris

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1


Looking downstream and right bank


Looking upstream


Outflow from Premier Lake


Inflow to Vista Lake

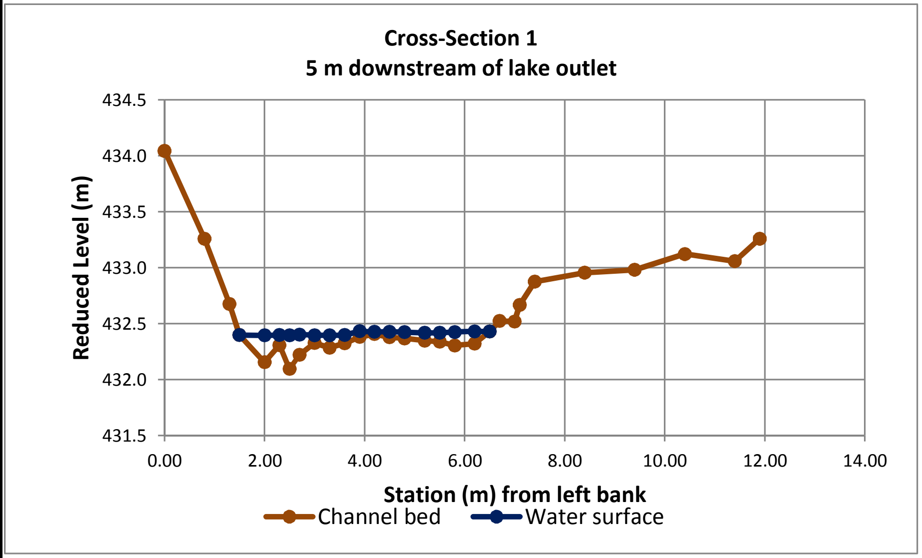
Gauge:	Hydraulic Control:	The staff gauge and Levelogger are installed in Premier Lake near the outlet. Hydraulic control is provided by a riffle at the channel outlet.
Current Metering Section:	General Section Description:	The measuring section is located in the short channel joining Premier Lake to Vista Lake upstream of two large trees leaning over the channel towards the portage on the right bank and ~60 cm downstream of a large 1.8 m boulder.
	Thalweg (straight, bend, off-center):	Off centre; towards left bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush, ferns and moss; shallow root zone
	Bankfull Depth (m):	0.75 - 1.00
	Bankfull Width (m):	4.50 - 9.50
	Floodplain Observations:	Deposition on right bank; flatter terrain
	General Observations:	Young fluvial channel; wide shallow cross-section, straight with a steep grade; high bed load
Substrate:	Left Bank:	Bedrock outcrop
	Bed :	Cobbles and boulders
	Right Bank:	Boulders

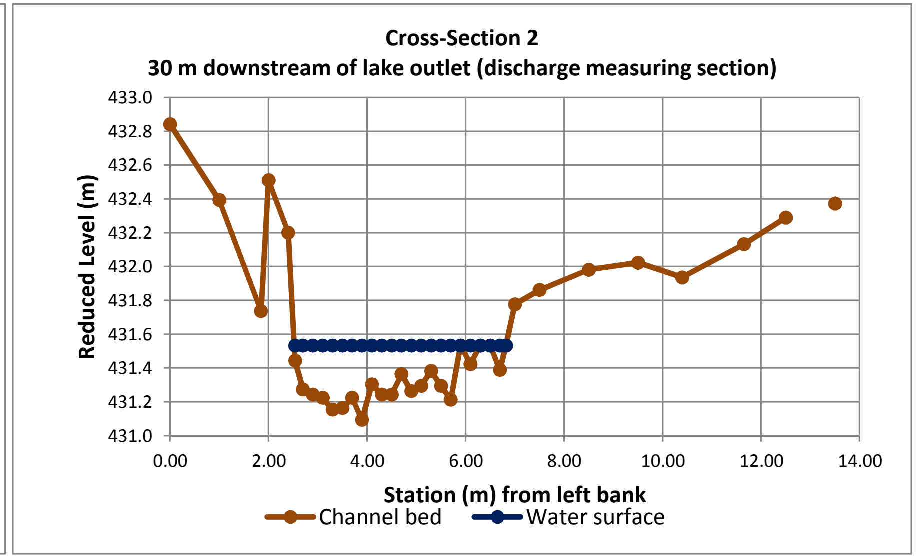
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

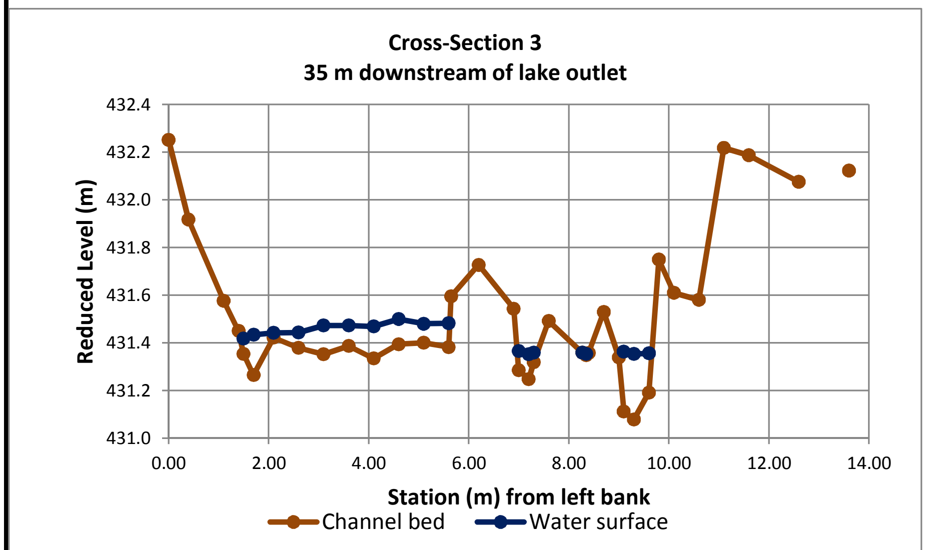
Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2





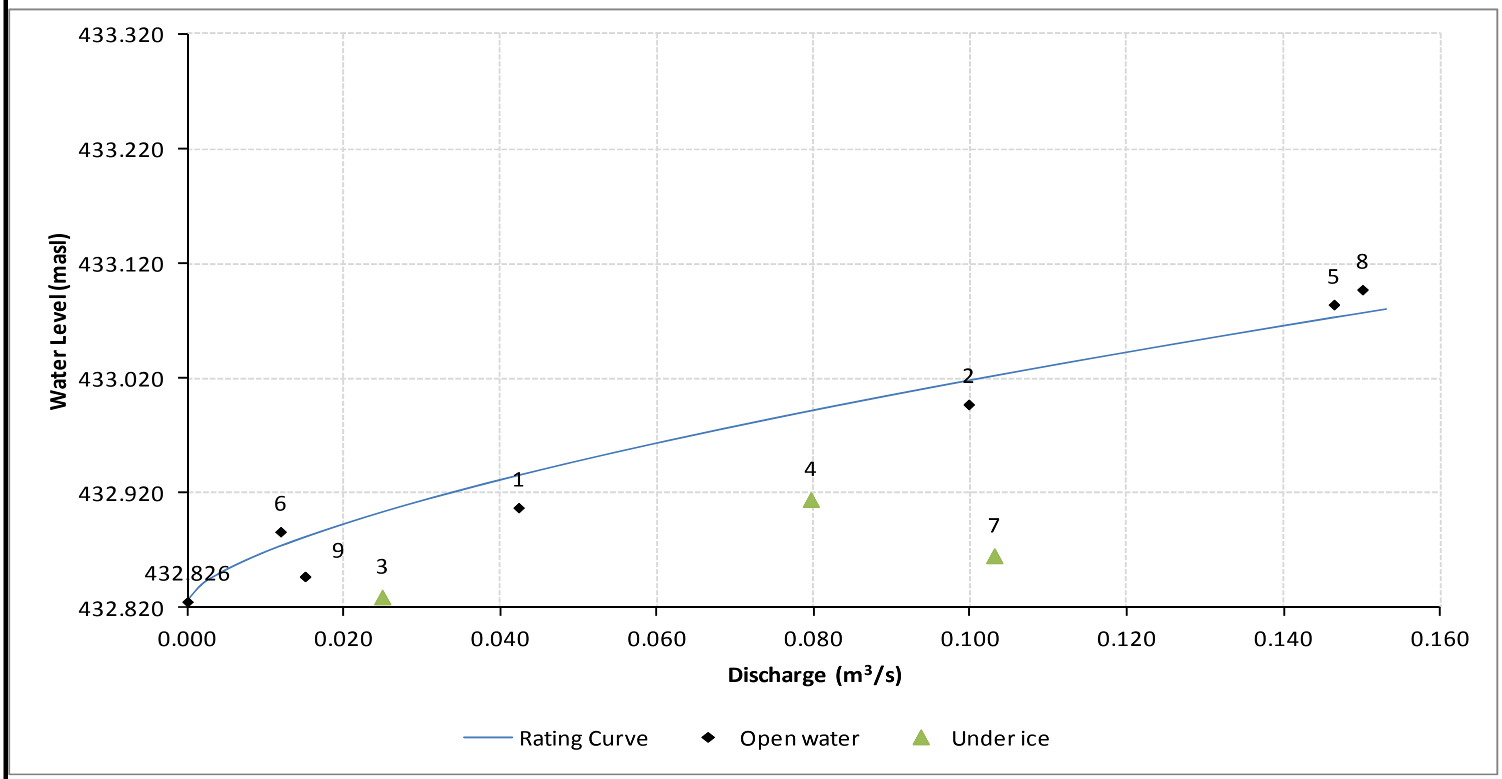


Note: Survey completed in October 2010.

Golder Associates				Flow Monitoring Station SW-04	
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3

Rating Curve

Date	Date	Discharge (m^3/s)	Water level (masl)
1	23-Aug-2010	0.042	432.908
2	09-Oct-2010	0.100	432.998
3	23-Jan-2011	0.025	432.830
4	05-Mar-2011	0.080	432.915
5	21-May-2011	0.146	433.085
6	30-Aug-2011	0.012	432.887
7	07-Feb-2012	0.103	432.866
8	16-May-2012	0.150	433.098
9	30-Aug-2012	0.015	432.848
—	G.H. at zero flow	0.000	432.826



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
23-Aug-2010	0.03	7.56	22.95	-
05-Mar-2011	0.00	7.44	0.90	-
21-May-2011	0.01	7.96	16.40	-
30-Aug-2011	0.01	7.66	19.30	-
16-May-2012	0.30	7.40	15.10	11.77
30-Aug-2012	0.01	6.69	22.40	6.00

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	Hammond Reef Gold Project	SHEET 4
DATE:	September 18, 2012		

Daily Mean Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2010

Station Name: Premier Lake near outlet

Station ID: SW-04

UTM coordinates: 15U E 623443 N 5426989

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									432.851	433.035	432.941	432.940	1
2									432.852	433.031	432.938	432.942	2
3									432.860	433.026	432.936	432.941	3
4									432.857	433.018	432.935	432.937	4
5									432.853	433.012	432.935	432.934	5
6									432.850	433.004	432.929	432.933	6
7									432.877	433.001	432.926	432.931	7
8									432.899	432.997	432.922	432.929	8
9									432.902	432.993	432.919	432.921	9
10									432.902	432.989	432.916	432.921	10
11									432.921	432.985	432.913	432.926	11
12									432.928	432.979	432.914	432.926	12
13									432.931	432.973	432.913	432.926	13
14									432.933	432.962	432.913	432.925	14
15									432.934	432.955	432.914	432.918	15
16									432.932	432.950	432.913	432.904	16
17									432.931	432.944	432.909	432.896	17
18									432.930	432.941	432.909	432.892	18
19									432.927	432.936	432.906	432.888	19
20									432.923	432.930	432.909	432.883	20
21									432.921	432.926	432.905	432.876	21
22									432.921	432.919	432.908	432.873	22
23								432.900	432.923	432.914	432.915	432.872	23
24								432.892	432.968	432.911	432.912	432.867	24
25								432.889	433.002	432.910	432.913	432.867	25
26								432.877	433.016	432.920	432.917	432.869	26
27								432.863	433.025	432.937	432.916	432.861	27
28								432.859	433.034	432.940	432.916	432.854	28
29								432.856	433.037	432.942	432.913	432.849	29
30								432.855	433.036	432.942	432.932	432.846	30
31								432.855		432.941		432.861	31
MEAN									432.929	432.963	432.919	432.900	
MAX									433.037	433.035	432.941	432.942	
MIN									432.850	432.910	432.905	432.846	

ANNUAL MEAN 432.924 MAX 433.037 MIN 432.846

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 5

Daily Mean Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2011

Station Name: Premier Lake near outlet

Station ID: SW-04

UTM coordinates: 15U E 623443 N 5426989

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	432.865	432.858	432.909	432.871	433.205	433.095	433.003	432.911	432.888	432.829	432.938	432.895	1
2	432.867	432.865	432.922	432.869	433.209	433.081	433.003	432.932	432.892	432.823	432.937	432.892	2
3	432.876	432.855	432.914	432.873	433.198	433.082	432.991	432.942	432.891	432.821	432.935	432.882	3
4	432.869	432.858	432.910	432.880	433.189	433.091	432.984	432.937	432.885	432.819	432.930	432.889	4
5	432.859	432.864	432.913	432.881	433.180	433.080	432.998	432.934	432.881	432.818	432.922	432.889	5
6	432.858	432.873	432.915	432.880	433.184	433.082	432.986	432.929	432.874	432.816	432.919	432.895	6
7	432.855	432.886	432.914	432.877	433.180	433.083	432.990	432.924	432.870	432.814	432.918	432.947	7
8	432.855	432.894	432.912	432.877	433.171	433.093	433.003	432.918	432.868	432.830	432.915	433.005	8
9	432.855	432.892	432.907	432.879	433.164	433.083	433.004	432.929	432.866	432.834	432.914	433.038	9
10	432.846	432.902	432.906	432.889	433.156	433.076	433.006	432.922	432.862	432.832	432.912	433.049	10
11	432.836	432.898	432.902	432.918	433.160	433.070	433.004	432.920	432.859	432.830	432.910	433.050	11
12	432.833	432.894	432.896	432.946	433.161	433.066	432.997	432.924	432.855	432.838	432.906	433.049	12
13	432.831	432.885	432.900	432.987	433.157	433.056	432.985	432.922	432.850	432.885	432.904	433.040	13
14	432.831	432.892	432.897	433.019	433.145	433.045	432.974	432.914	432.847	432.920	432.903	433.029	14
15	432.838	432.889	432.892	433.036	433.137	433.039	432.971	432.911	432.843	432.934	432.902	433.028	15
16	432.843	432.890	432.889	433.061	433.129	433.036	432.974	432.908	432.836	432.938	432.902	433.036	16
17	432.830	432.889	432.889	433.080	433.120	433.030	432.969	432.910	432.830	432.947	432.903	433.027	17
18	432.834	432.902	432.895	433.087	433.111	433.021	432.966	432.902	432.823	432.950	432.902	433.009	18
19	432.834	432.908	432.891	433.087	433.101	433.021	432.953	432.903	432.826	432.951	432.899	433.002	19
20	432.831	432.908	432.888	433.085	433.094	433.016	432.956	432.896	432.828	432.951	432.903	432.994	20
21	432.838	432.913	432.889	433.085	433.088	433.006	432.973	432.893	432.840	432.953	432.900	432.984	21
22	432.833	432.907	432.891	433.085	433.089	433.004	432.966	432.884	432.839	432.952	432.889	432.983	22
23	432.831	432.902	432.894	433.091	433.107	433.006	432.954	432.879	432.837	432.952	432.884	432.975	23
24	432.824	432.911	432.896	433.101	433.103	433.002	432.943	432.894	432.837	432.953	432.885	432.968	24
25	432.826	432.923	432.894	433.117	433.102	432.995	432.944	432.897	432.834	432.953	432.884	432.960	25
26	432.823	432.927	432.893	433.136	433.096	432.985	432.937	432.897	432.833	432.950	432.888	432.953	26
27	432.821	432.917	432.890	433.156	433.085	433.009	432.936	432.895	432.832	432.950	432.895	432.959	27
28	432.831	432.916	432.885	433.170	433.082	433.026	432.938	432.889	432.831	432.950	432.894	432.961	28
29	432.834		432.880	433.177	433.089	433.015	432.932	432.887	432.833	432.949	432.897	432.946	29
30	432.845		432.877	433.178	433.083	433.007	432.924	432.887	432.832	432.948	432.896	432.940	30
31	432.855		432.874		433.078		432.921	432.887		432.945		432.935	31
MEAN	432.842	432.894	432.898	433.013	433.134	433.043	432.970	432.909	432.851	432.898	432.906	432.974	
MAX	432.876	432.927	432.922	433.178	433.209	433.095	433.006	432.942	432.892	432.953	432.938	433.050	
MIN	432.821	432.855	432.874	432.869	433.078	432.985	432.921	432.879	432.823	432.814	432.884	432.882	

ANNUAL MEAN 432.945 MAX 433.209 MIN 432.814

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Daily Mean Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2012

Station Name: Premier Lake near outlet

Station ID: SW-04

UTM coordinates: 15U E 623443 N 5426989

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	432.932	432.871	432.836	433.178	433.093	433.213	433.088	432.947					1
2	432.939	432.867	432.832	433.175	433.094	433.200	433.078	432.949					2
3	432.940	432.865	432.838	433.182	433.093	433.184	433.117	432.947					3
4	432.928	432.864	432.844	433.180	433.092	433.169	433.118	432.943					4
5	432.917	432.865	432.840	433.173	433.087	433.156	433.112	432.938					5
6	432.912	432.866	432.824	433.161	433.085	433.143	433.105	432.929					6
7	432.915	432.872	432.824	433.150	433.098	433.129	433.098	432.926					7
8	432.912	432.868	432.828	433.144	433.110	433.125	433.087	432.921					8
9	432.902	432.861	432.830	433.137	433.114	433.130	433.074	432.923					9
10	432.898	432.869	432.820	433.128	433.113	433.120	433.060	432.918					10
11	432.899	432.865	432.817	433.116	433.116	433.119	433.045	432.912					11
12	432.908	432.859	432.817	433.105	433.118	433.120	433.031	432.906					12
13	432.907	432.859	432.822	433.094	433.110	433.108	433.019	432.900					13
14	432.903	432.850	432.823	433.088	433.107	433.109	433.011	432.896					14
15	432.891	432.845	432.826	433.086	433.106	433.133	433.003	432.891					15
16	432.886	432.842	432.827	433.113	433.103	433.141	433.004	432.897					16
17	432.893	432.843	432.830	433.108	433.095	433.159	433.001	432.890					17
18	432.898	432.844	432.842	433.099	433.087	433.162	432.991	432.885					18
19	432.903	432.843	432.865	433.098	433.082	433.166	432.979	432.881					19
20	432.902	432.835	432.897	433.098	433.083	433.171	432.965	432.874					20
21	432.894	432.834	432.927	433.098	433.079	433.182	432.957	432.868					21
22	432.881	432.840	432.949	433.099	433.076	433.182	432.946	432.863					22
23	432.888	432.841	432.993	433.103	433.075	433.175	432.935	432.860					23
24	432.890	432.840	433.063	433.107	433.093	433.168	432.927	432.856					24
25	432.884	432.846	433.106	433.108	433.111	433.158	432.919	432.860					25
26	432.877	432.844	433.125	433.112	433.116	433.144	432.911	432.867					26
27	432.880	432.846	433.157	433.110	433.126	433.132	432.903	432.862					27
28	432.880	432.843	433.183	433.104	433.168	433.122	432.894	432.859					28
29	432.885	432.834	433.189	433.097	433.215	433.107	432.901	432.855					29
30	432.882		433.195	433.094	433.228	433.096	432.949	432.853					30
31	432.872		433.186		433.224		432.952						31
MEAN	432.900	432.852	432.928	433.122	433.113	433.147	433.006	432.896					
MAX	432.940	432.872	433.195	433.182	433.228	433.213	433.118	432.949					
MIN	432.872	432.834	432.817	433.086	433.075	433.096	432.894	432.853					

ANNUAL MEAN 432.996 MAX 433.228 MIN 432.817

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Premier Lake-Vista Lake

Station ID: SW-04

UTM coordinates: 15U E 623404 N 5426952

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.013	0.132	0.066	0.046B	1
2									0.013	0.128	0.065	0.046B	2
3									0.017	0.124	0.064	0.045B	3
4									0.015	0.117	0.064	0.045B	4
5									0.014	0.112	0.064	0.045B	5
6									0.012	0.105	0.060	0.044B	6
7									0.025	0.103	0.058	0.044B	7
8									0.036	0.099	0.056	0.044B	8
9									0.037	0.097	0.054	0.044B	9
10									0.037	0.094	0.053	0.043B	10
11									0.048	0.091	0.052	0.043B	11
12									0.053	0.087	0.052	0.043B	12
13									0.054	0.082	0.052	0.042B	13
14									0.056	0.075	0.053B	0.042B	14
15									0.056	0.070	0.053B	0.042B	15
16									0.054	0.067	0.053B	0.041B	16
17									0.054	0.064	0.051B	0.041B	17
18									0.053	0.062	0.051B	0.041B	18
19									0.051	0.058	0.049B	0.041B	19
20									0.049	0.055	0.052B	0.040B	20
21									0.048	0.053	0.049B	0.040B	21
22									0.047	0.049	0.049B	0.040B	22
23								0.037	0.049	0.046	0.049B	0.039B	23
24								0.033	0.079	0.045	0.048B	0.037B	24
25								0.031	0.105	0.044	0.048B	0.037B	25
26								0.025	0.116	0.051	0.048B	0.038B	26
27								0.018	0.123	0.062	0.047B	0.034B	27
28								0.016	0.131	0.065	0.047B	0.031B	28
29								0.015	0.133	0.066	0.047B	0.028B	29
30								0.015	0.133	0.066	0.046B	0.027B	30
31								0.015		0.066		0.027B	31
MEAN									0.057	0.079	0.053	0.040	
MAX									0.133	0.132	0.066	0.046	
MIN									0.012	0.044	0.046	0.027	
L/s/km²									4.05	5.57	3.78	2.84	

ANNUAL MEAN 0.055 MAX 0.133 MIN 0.012 L/s/km² 3.89

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 8

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Premier Lake-Vista Lake

Station ID: SW-04

UTM coordinates: 15U E 623404 N 5426952

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.027B	0.034B	0.076B	0.032B	0.293E	0.155E	0.079	0.023	0.013	0.004	0.080	0.072B	1
2	0.027B	0.036B	0.085B	0.030B	0.297E	0.143	0.079	0.034	0.016	0.003	0.080	0.070B	2
3	0.026B	0.039B	0.080B	0.032B	0.283E	0.143	0.070	0.039	0.015	0.003	0.079	0.064B	3
4	0.026B	0.041B	0.077B	0.035B	0.271E	0.151E	0.066	0.036	0.014	0.003	0.076B	0.064B	4
5	0.026B	0.042B	0.079B	0.035B	0.260E	0.141	0.075	0.034	0.012	0.003	0.071B	0.064B	5
6	0.026B	0.044B	0.079B	0.034B	0.264E	0.144	0.067	0.032	0.010	0.002	0.070B	0.064B	6
7	0.026B	0.046B	0.078B	0.032B	0.258E	0.144	0.070	0.029	0.009	0.002	0.070B	0.064B	7
8	0.026B	0.048B	0.076B	0.031B	0.247E	0.153E	0.079	0.026	0.009	0.007	0.068B	0.063B	8
9	0.026B	0.049B	0.071B	0.031B	0.237E	0.144	0.079	0.032	0.008	0.008	0.069B	0.063B	9
10	0.025B	0.051B	0.070B	0.036B	0.228E	0.138	0.081	0.028	0.007	0.008	0.068B	0.063B	10
11	0.025B	0.054B	0.066B	0.053B	0.231E	0.133	0.080	0.027	0.007	0.008	0.067B	0.063B	11
12	0.024B	0.056B	0.061B	0.071B	0.231E	0.130	0.075	0.029	0.006	0.011	0.065B	0.063B	12
13	0.023B	0.058B	0.063B	0.101B	0.226E	0.120	0.066	0.028	0.005	0.033	0.065B	0.063B	13
14	0.024B	0.063B	0.060B	0.126B	0.212E	0.111	0.059	0.024	0.004	0.054	0.064B	0.063B	14
15	0.027B	0.061B	0.056B	0.140B	0.202E	0.107	0.056	0.023	0.003	0.064	0.065B	0.063B	15
16	0.030B	0.061B	0.053B	0.145B	0.193E	0.104	0.058	0.021	0.002	0.068	0.065B	0.063B	16
17	0.024B	0.061B	0.053B	0.150E	0.184E	0.099	0.055	0.022	0.001	0.075	0.066B	0.063B	17
18	0.026B	0.063B	0.056B	0.155E	0.174E	0.092	0.054	0.019	0.000	0.078	0.067B	0.062B	18
19	0.026B	0.064B	0.053B	0.161E	0.163E	0.093	0.046	0.019	0.001	0.079	0.065B	0.062B	19
20	0.025B	0.066B	0.050B	0.166E	0.155E	0.088	0.048	0.016	0.001	0.080	0.069B	0.062B	20
21	0.029B	0.067B	0.050B	0.172E	0.149	0.081	0.058	0.015	0.004	0.082	0.067B	0.062B	21
22	0.026B	0.069B	0.050B	0.178E	0.149	0.079	0.053	0.011	0.004	0.082	0.061B	0.062B	22
23	0.026B	0.070B	0.052B	0.182E	0.166E	0.081	0.046	0.009	0.004	0.083	0.058B	0.062B	23
24	0.022B	0.071B	0.052B	0.191E	0.162E	0.078	0.040	0.015	0.004	0.085	0.060B	0.062B	24
25	0.023B	0.072B	0.050B	0.206E	0.162E	0.073	0.040	0.016	0.004	0.085	0.059B	0.062B	25
26	0.022B	0.073B	0.049B	0.224E	0.156E	0.066	0.036	0.016	0.004	0.084	0.063B	0.062B	26
27	0.021B	0.074B	0.046B	0.244E	0.146	0.084	0.036	0.015	0.004	0.085	0.069B	0.061B	27
28	0.026B	0.075B	0.043B	0.258E	0.143	0.096	0.036	0.013	0.004	0.086	0.068B	0.061B	28
29	0.028B		0.039B	0.264E	0.150	0.088	0.033	0.012	0.005	0.086	0.071B	0.061B	29
30	0.030B		0.037B	0.264E	0.144	0.082	0.029	0.012	0.005	0.086	0.071B	0.061B	30
31	0.032B		0.034B		0.140		0.027	0.013		0.084		0.061B	31
MEAN	0.026	0.057	0.059	0.126	0.202	0.111	0.057	0.022	0.006	0.049	0.068	0.063	
MAX	0.032	0.075	0.085	0.264	0.297	0.155	0.081	0.039	0.016	0.086	0.080	0.072	
MIN	0.021	0.034	0.034	0.030	0.140	0.066	0.027	0.009	0.000	0.002	0.058	0.061	
L/s/km²	1.82	4.07	4.22	8.94	14.36	7.90	4.06	1.58	0.44	3.48	4.82	4.47	

ANNUAL MEAN 0.071 MAX 0.297 MIN 0.000 L/s/km² 5.01

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-04

PROJECT: 10-1118-0020 (6700) DATE: September 18, 2012

Hammond Reef Gold Project

SHEET 9

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Premier Lake-Vista Lake

Station ID: SW-04

UTM coordinates: 15U E 623404 N 5426952

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.061B	0.102B	0.052B	0.317E	0.170E	0.273E	0.161E	0.061					1
2	0.061B	0.100B	0.048B	0.312E	0.168E	0.260E	0.153E	0.063					2
3	0.061B	0.099B	0.051B	0.318E	0.167E	0.244E	0.191E	0.062					3
4	0.061B	0.099B	0.054B	0.314E	0.163E	0.228E	0.192E	0.060					4
5	0.061B	0.101B	0.050B	0.303E	0.158E	0.215E	0.187E	0.057					5
6	0.060B	0.102B	0.039B	0.288E	0.154E	0.202E	0.180E	0.051					6
7	0.060B	0.108B	0.038B	0.273E	0.164E	0.189E	0.174E	0.049					7
8	0.060B	0.104B	0.039B	0.265E	0.174E	0.185E	0.164E	0.047					8
9	0.060B	0.097B	0.039B	0.255E	0.176E	0.191E	0.153E	0.048					9
10	0.060B	0.101B	0.033B	0.243E	0.173E	0.181E	0.140	0.045					10
11	0.062B	0.097B	0.031B	0.228E	0.175E	0.181E	0.128	0.042					11
12	0.063B	0.091B	0.030B	0.215E	0.174E	0.182E	0.117	0.039					12
13	0.065B	0.090B	0.031B	0.202E	0.166E	0.172E	0.107	0.036					13
14	0.066B	0.081B	0.031B	0.195E	0.161E	0.173E	0.101	0.034					14
15	0.068B	0.077B	0.031B	0.191E	0.158E	0.197E	0.095	0.032					15
16	0.070B	0.073B	0.031B	0.216E	0.154E	0.205E	0.097	0.035					16
17	0.072B	0.072B	0.032B	0.209E	0.147	0.224E	0.094	0.032					17
18	0.074B	0.072B	0.037B	0.199E	0.139	0.229E	0.087	0.029					18
19	0.075B	0.070B	0.050B	0.195E	0.135	0.233E	0.079	0.027					19
20	0.077B	0.063B	0.070B	0.194E	0.137	0.238E	0.069	0.024					20
21	0.079B	0.061B	0.090B	0.192E	0.134	0.251E	0.064	0.022					21
22	0.081B	0.064B	0.106B	0.191E	0.132	0.252E	0.057	0.020					22
23	0.083B	0.063B	0.143B	0.193E	0.131	0.245E	0.050	0.019					23
24	0.086B	0.062B	0.208E	0.196E	0.148	0.238E	0.045	0.017					24
25	0.088B	0.064B	0.251E	0.195E	0.165E	0.228E	0.041	0.019					25
26	0.090B	0.062B	0.270E	0.197E	0.170E	0.214E	0.037	0.022					26
27	0.092B	0.062B	0.304E	0.193E	0.180E	0.203E	0.033	0.021					27
28	0.095B	0.059B	0.332E	0.186E	0.223E	0.192E	0.028	0.019					28
29	0.097B	0.052B	0.337E	0.177E	0.274E	0.178E	0.033	0.018					29
30	0.100B		0.342E	0.172E	0.290E	0.168E	0.062	0.017					30
31	0.102B		0.330E		0.285E		0.064						31
MEAN	0.074	0.081	0.114	0.228	0.172	0.212	0.103	0.036					
MAX	0.102	0.108	0.342	0.318	0.290	0.273	0.192	0.063					
MIN	0.060	0.052	0.030	0.172	0.131	0.168	0.028	0.017					
L/s/km²	5.24	5.74	8.07	16.14	12.23	15.07	7.28	2.52					

ANNUAL MEAN 0.127 MAX 0.342 MIN 0.017 L/s/km² 9.04

LEGEND B - Ice Conditions E - Extrapolated from rating curve

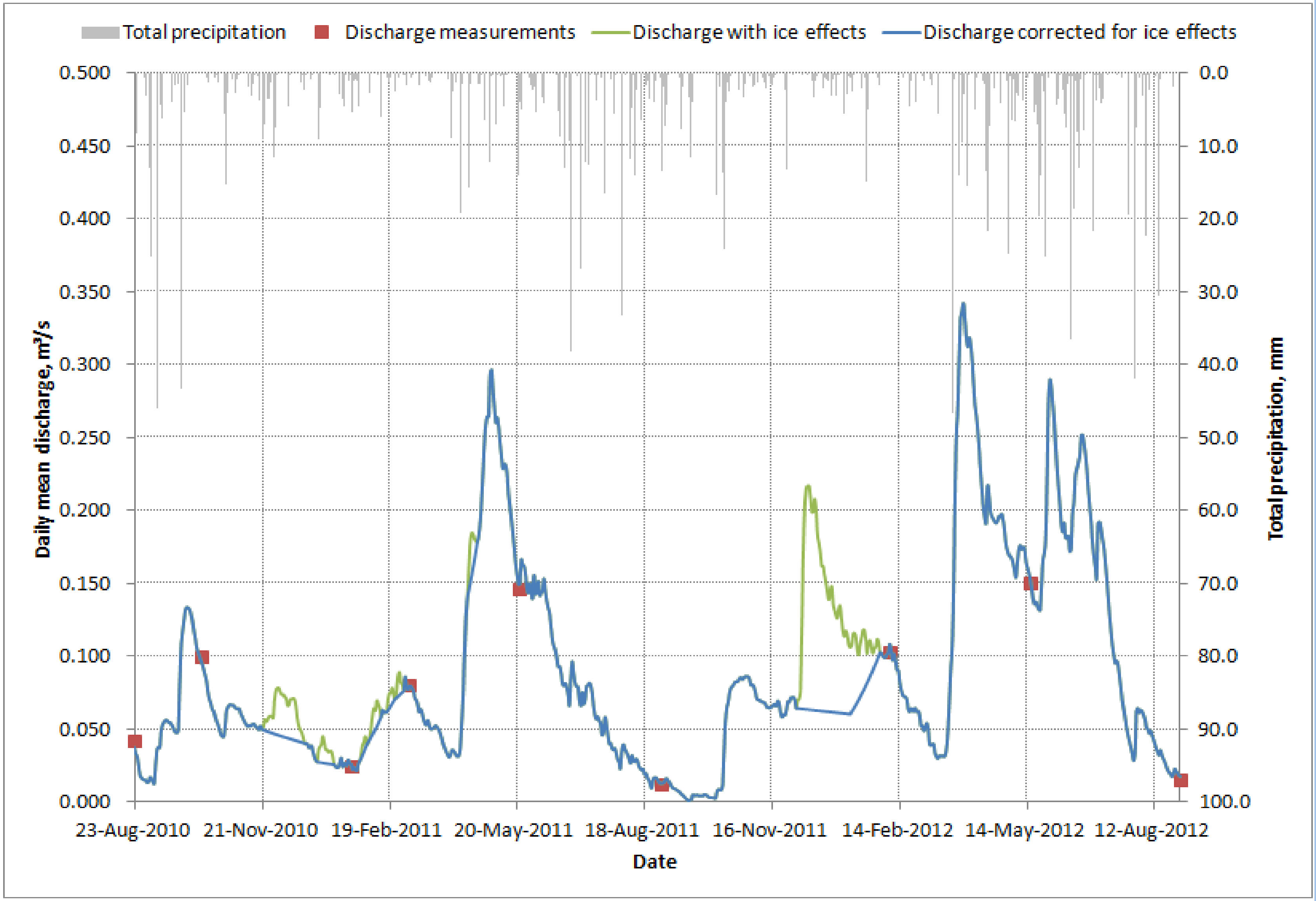
Golder Associates

Flow Monitoring Station SW-04

PROJECT: 10-1118-0020 (6700) DATE: September 18, 2012

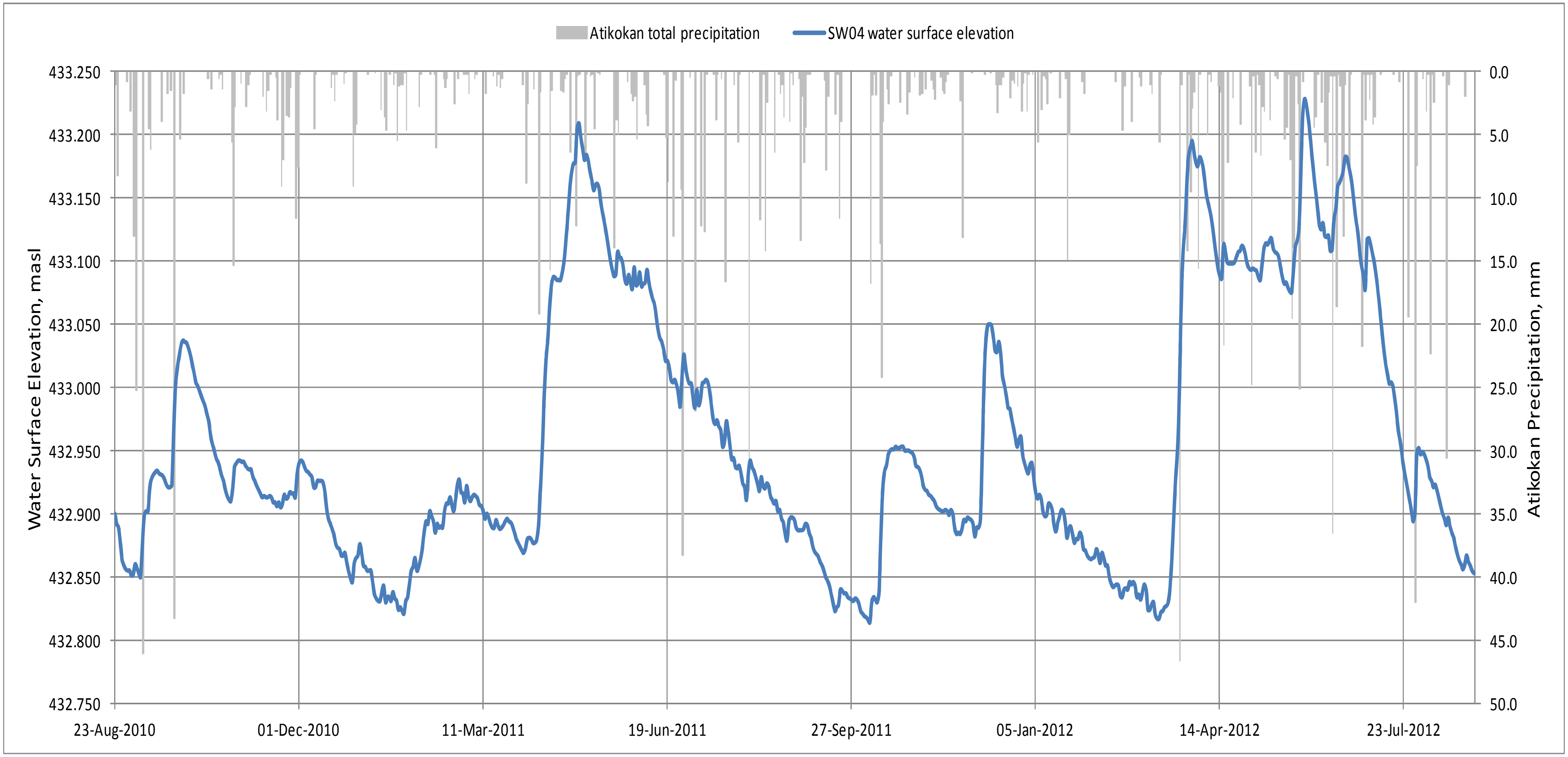
Hammond Reef Gold Project

SHEET 10



Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11



Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 12

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Premier Lake near outlet

Station ID: SW-04

UTM coordinates: U15 E 623443 N 5426989

Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									20.5	11.4	7.0	1.8	1
2									20.3	11.2	6.8	2.0	2
3									19.0	10.9	6.9	2.1	3
4									18.3	10.7	6.2	2.1	4
5									17.9	10.7	6.1	2.1	5
6									17.9	11.0	6.1	2.0	6
7									16.3	10.9	6.0	2.0	7
8									16.2	11.2	6.1	2.1	8
9									16.0	12.0	6.1	1.9	9
10									15.7	12.1	6.1	1.9	10
11									15.5	12.4	6.1	2.0	11
12									15.4	11.7	5.6	1.9	12
13									15.1	11.2	5.4	1.9	13
14									14.8	10.9	4.9	1.9	14
15									14.4	10.7	4.9	1.9	15
16									14.0	10.5	4.9	1.8	16
17									14.1	10.2	4.6	1.8	17
18									13.6	9.7	4.1	1.8	18
19									13.2	9.6	3.7	1.7	19
20									13.2	9.4	3.4	1.7	20
21									13.2	8.8	3.5	1.7	21
22									13.1	8.8	3.3	1.6	22
23								20.3	12.6	8.6	2.2	1.6	23
24								20.2	12.0	8.4	2.4	1.6	24
25								19.5	12.2	8.6	2.2	1.6	25
26								19.2	12.0	8.9	2.1	1.5	26
27								19.2	11.8	8.3	2.3	1.4	27
28								19.6	11.7	7.7	2.4	1.4	28
29								20.2	11.7	7.4	2.4	1.4	29
30								20.5	11.7	7.4	2.1	1.4	30
31								21.0		7.1		1.0	31
MEAN (°C)									14.8	10.0	4.5	1.8	
MAX (°C)									20.5	12.4	7.0	2.1	
MIN (°C)									11.7	7.1	2.1	1.0	

ANNUAL MEAN (°C) 7.8 MAX (°C) 20.5 MIN (°C) 1.0

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 13

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Premier Lake near outlet | Station ID: SW-04

UTM coordinates: U15 E 623443 N 5426989 | Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	1.2	0.6	0.0	0.2	2.3	10.1	17.0	20.9	18.5	10.6	5.8	1.3	1
2	1.2	0.6	0.1	0.2	2.7	11.0	18.8	21.8	18.8	10.5	5.6	1.2	2
3	1.3	0.4	0.1	0.2	3.0	11.4	19.3	22.1	18.6	11.1	5.1	1.1	3
4	1.3	0.5	0.1	0.1	3.1	12.7	19.7	22.0	17.5	10.9	4.9	1.3	4
5	1.3	0.5	0.1	0.2	2.8	12.8	20.0	22.4	16.6	11.6	4.8	1.4	5
6	1.2	0.5	0.1	0.2	3.3	13.6	20.0	22.8	16.3	11.5	4.9	1.3	6
7	1.1	0.5	0.1	0.3	3.8	15.0	20.1	22.3	16.7	11.4	4.6	1.2	7
8	1.1	0.4	0.1	0.3	4.1	14.4	20.5	21.9	17.8	11.5	4.3	1.1	8
9	1.2	0.3	0.1	0.4	4.5	14.0	20.5	20.9	18.9	11.6	4.1	1.0	9
10	1.1	0.4	0.1	0.5	4.6	14.3	20.1	20.2	19.1	11.7	3.9	1.0	10
11	1.1	0.3	0.0	0.4	4.8	14.4	20.9	20.3	18.6	11.8	3.6	1.0	11
12	1.1	0.3	0.0	0.7	6.5	14.9	20.5	20.4	18.3	11.6	3.8	1.0	12
13	1.1	0.3	0.0	1.0	6.4	14.6	19.6	21.4	16.7	11.7	3.6	1.0	13
14	1.1	0.3	0.0	1.2	6.3	14.5	19.4	20.9	15.1	11.3	3.5	1.0	14
15	1.0	0.3	0.0	1.4	6.7	15.5	19.2	20.7	14.3	10.5	3.3	0.9	15
16	1.0	0.3	0.0	1.4	7.7	16.1	19.5	20.9	14.0	9.8	3.0	1.0	16
17	1.0	0.3	0.0	1.4	8.0	16.9	20.6	20.4	13.5	9.1	2.6	1.0	17
18	0.9	-0.1	0.0	1.5	9.3	17.5	23.0	19.9	13.2	8.6	2.6	1.0	18
19	0.9	0.2	0.0	1.4	10.4	16.8	23.0	20.1	13.3	8.2	2.3	0.9	19
20	0.9	0.2	0.0	1.4	12.1	16.3	22.2	19.6	13.1	7.7	1.9	0.7	20
21	0.9	0.2	0.0	1.4	13.3	16.3	22.3	19.4	12.2	7.6	2.3	0.8	21
22	0.9	0.2	-0.1	1.4	12.7	15.4	22.0	19.0	11.4	7.5	2.1	0.8	22
23	0.9	0.2	-0.1	1.6	13.3	14.9	20.6	19.0	11.7	7.5	2.1	0.9	23
24	0.8	0.2	0.1	1.8	12.7	15.5	19.9	18.8	11.4	7.1	2.2	0.9	24
25	0.8	0.2	0.1	2.0	13.0	16.1	20.0	18.3	11.2	6.8	2.0	0.7	25
26	0.8	0.2	0.1	2.0	12.5	15.9	19.7	19.0	11.6	6.7	1.5	0.6	26
27	0.8	0.2	0.2	2.0	11.5	16.1	19.5	18.9	12.4	6.5	1.0	0.6	27
28	0.7	0.2	0.2	2.2	11.2	16.0	19.8	18.7	12.7	6.2	1.0	0.8	28
29	0.7		0.2	2.5	11.7	16.0	20.2	19.0	12.1	6.2	1.1	0.7	29
30	0.7		0.2	2.5	12.8	16.4	20.3	18.8	11.0	5.8	1.3	0.7	30
31	0.7		0.2		11.3		20.5	18.7		5.8		0.7	31
MEAN (°C)	1.0	0.3	0.1	1.1	8.0	14.9	20.3	20.3	14.9	9.2	3.2	1.0	
MAX (°C)	1.3	0.6	0.2	2.5	13.3	17.5	23.0	22.8	19.1	11.8	5.8	1.4	
MIN (°C)	0.7	-0.1	-0.1	0.1	2.3	10.1	17.0	18.3	11.0	5.8	1.0	0.6	

ANNUAL — MEAN (°C): 7.9 — MAX (°C): 23.0 — MIN (°C): -0.1

Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 14

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Premier Lake near outlet — Station ID: SW-04

UTM coordinates: U15 E 623443 N 5426989 — Drainage area: 1,409.88 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.3	-0.4	-0.9	2.1	5.4	12.3	21.0	21.0					1
2	0.1	-0.4	-0.9	2.2	6.3	13.9	21.4	21.6					2
3	0.5	-0.4	-0.9	2.4	7.3	14.4	21.8	21.6					3
4	0.5	-0.4	-0.9	2.4	8.1	14.7	22.8	21.1					4
5	0.4	-0.4	-1.0	2.7	8.1	15.3	22.6	20.4					5
6	0.4	-0.5	-1.0	2.9	8.2	16.6	22.6	20.0					6
7	0.4	-0.5	-1.0	2.5	7.9	18.0	22.2	20.1					7
8	0.3	-0.5	-1.0	2.5	8.1	18.7	22.9	20.3					8
9	0.2	-0.5	-1.2	2.5	8.5	18.7	22.9	20.1					9
10	0.2	-0.5	-1.1	2.5	9.0	17.7	22.6	19.9					10
11	0.2	-0.6	-1.1	3.0	9.3	16.5	22.2	20.5					11
12	0.1	-0.6	-1.1	3.4	9.5	17.2	22.3	20.7					12
13	0.1	-0.5	-1.2	3.5	9.0	16.9	22.8	20.0					13
14	0.1	-0.5	-1.0	3.1	9.8	16.5	23.6	20.2					14
15	0.1	-0.5	-0.7	3.4	10.3	16.1	24.4	20.2					15
16	0.0	-0.6	-0.5	2.6	10.5	16.7	23.7	19.5					16
17	0.0	-0.6	-0.2	2.8	11.0	17.0	23.0	18.5					17
18	0.0	-0.6	0.1	2.8	10.7	17.2	23.0	18.6					18
19	0.0	-0.6	0.5	2.9	11.7	17.3	23.0	18.3					19
20	-0.1	-0.6	0.9	3.2	12.0	17.2	22.3	18.4					20
21	-0.1	-0.6	1.0	3.6	12.3	17.6	22.7	18.3					21
22	-0.1	-0.6	1.3	3.5	12.4	17.6	22.9	18.4					22
23	-0.2	-0.6	1.3	4.3	12.2	17.9	22.6	19.5					23
24	-0.2	-0.6	1.3	5.8	12.3	18.2	22.4	18.9					24
25	-0.2	-0.7	1.4	5.6	12.6	18.6	22.8	19.5					25
26	-0.3	-0.8	1.7	5.1	12.5	18.4	22.3	19.3					26
27	-0.3	-0.8	1.9	5.5	12.3	18.9	21.6	19.2					27
28	-0.4	-0.8	2.1	5.6	11.9	19.9	21.5	19.1					28
29	-0.4	-0.9	2.0	5.2	11.9	20.0	21.2	19.0					29
30	-0.3		2.1	5.0	11.8	20.5	21.1	19.2					30
31	-0.3		1.9		11.9	21.0	21.0						31
MEAN (°C)	0.0	-0.6	0.1	3.5	10.2	17.3	22.4	19.7					
MAX (°C)	0.5	-0.4	2.1	5.8	12.6	21.0	24.4	21.6					
MIN (°C)	-0.4	-0.9	-1.2	2.1	5.4	12.3	21.0	18.3					

ANNUAL MEAN (°C) 9.1 MAX (°C) 24.4 MIN (°C) -1.2

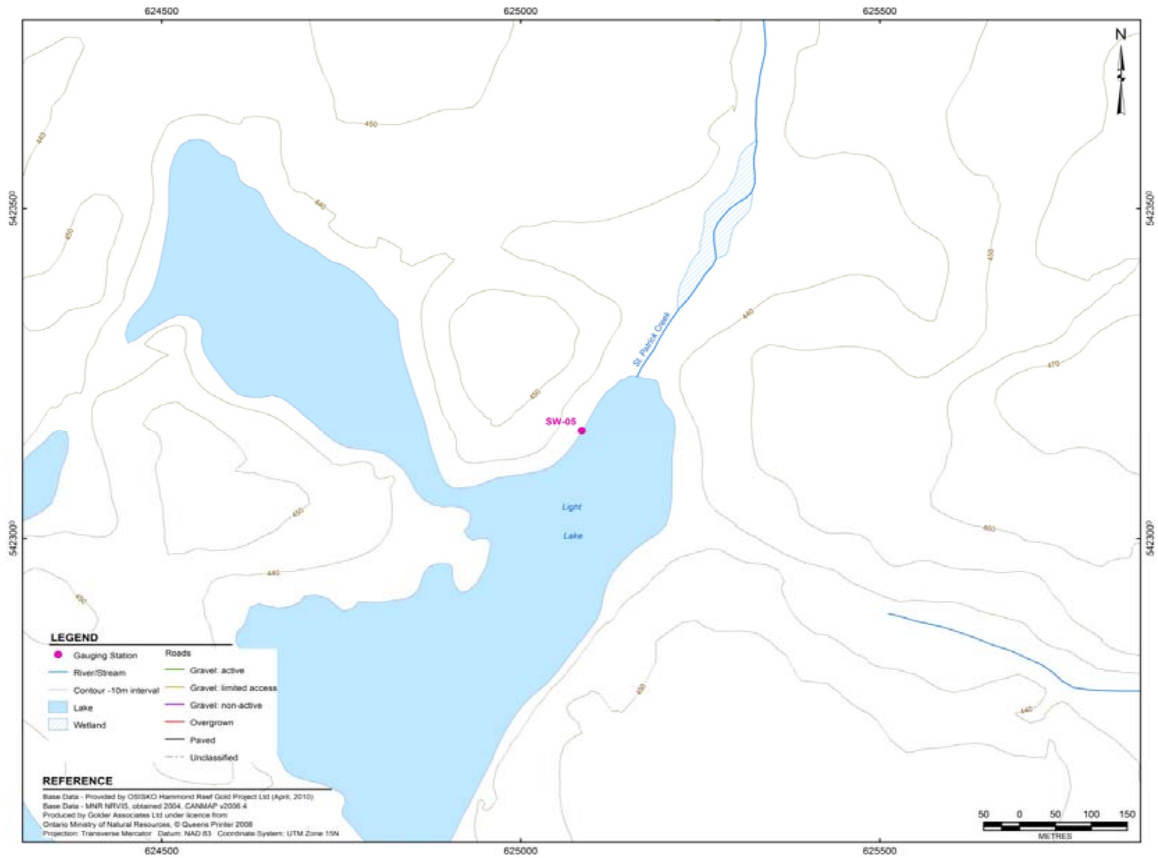
Golder Associates

Flow Monitoring Station SW-04

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 15

ATTACHMENT 5.I.6

Local Scale Monitoring Station SW-05; St Patrick Creek above Light Lake



Station ID:	SW-05	**Installation Date:**	20-Aug-2010
Watercourse Name:	Upper Light Lake / St. Patrick Creek above Upper Light Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 625085 N 5423163 / 15U E 625325 N 5423669	**Logger Serial No.:**	21053618 M5
Location Description:	The station is located in Light Lake immediately downstream of the inflow from St. Patrick Creek. Canoe access is from the launch between KM32 and KM33 on Premier Road. The station is located in the lower catchment draining to Light Bay.	**Installation Type:**	Levelogger installed in concrete block on lake bed in bay just south of bedrock outcrop on right bank. Cable run in flexible pipe to pipe housing on right bank. Staff gauge installed on T-post in lake ~5 m north of Levelogger and ~3.5 m from shore.
Elevation:	Benchmarks are centre of painted "X" on high point of bedrock outcrop on NW shore of the bay for the logger, and centre of painted "X" on high point of a large rock at the inlet for the cross-section. Benchmarks were surveyed as 433.143 masl for the logger and 432.33 masl for the cross-section.	**Instal. Problems/Risks:**	Staff gauge could be ripped out by ice breakup and debris

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

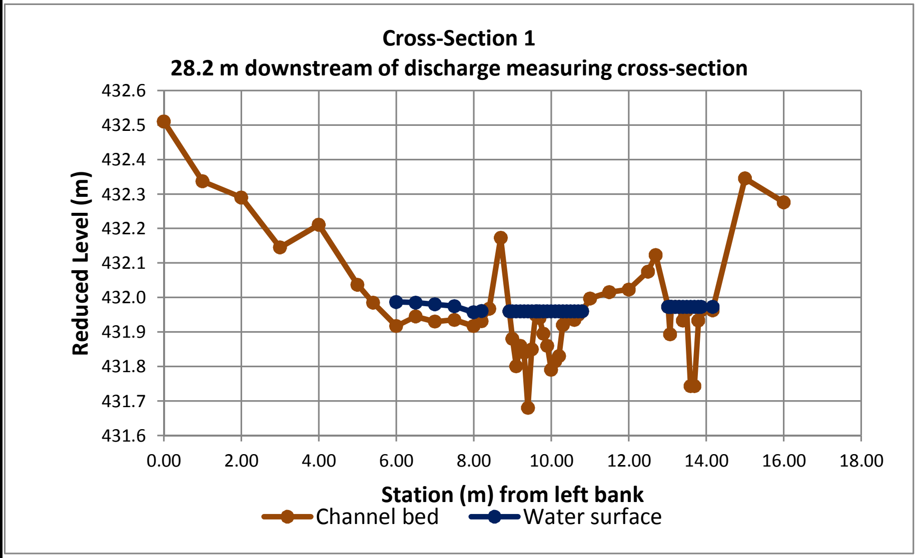
Gauge:	Hydraulic Control:	The staff gauge and Levelogger are installed on the bed in the east bay of Light Lake. Hydraulic control is provided by narrow bay outlet.
Current Metering Section:	General Section Description:	The measuring section is located in St. Patrick Creek ~ 550 m upstream of Light Lake and consists of two channels. The majority of the flow occurs in the left channel.
	Thalweg (straight, bend, off-center):	Off-centre; towards left bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush and grass
	Bankfull Depth (m):	0.50 - 2.00
	Bankfull Width (m):	11.00 - 17.00
	Floodplain Observations:	Flat lowlying flood plain ~15 m wide; poorly drained
	General Observations:	Mature fluvial channel; flat gradient; low sinuousity; wetland areas on either side of channel
Substrate:	Left Bank:	Peat, boulders and grass
	Bed :	Stones and cobbles
	Right Bank:	Peat, boulders and grass

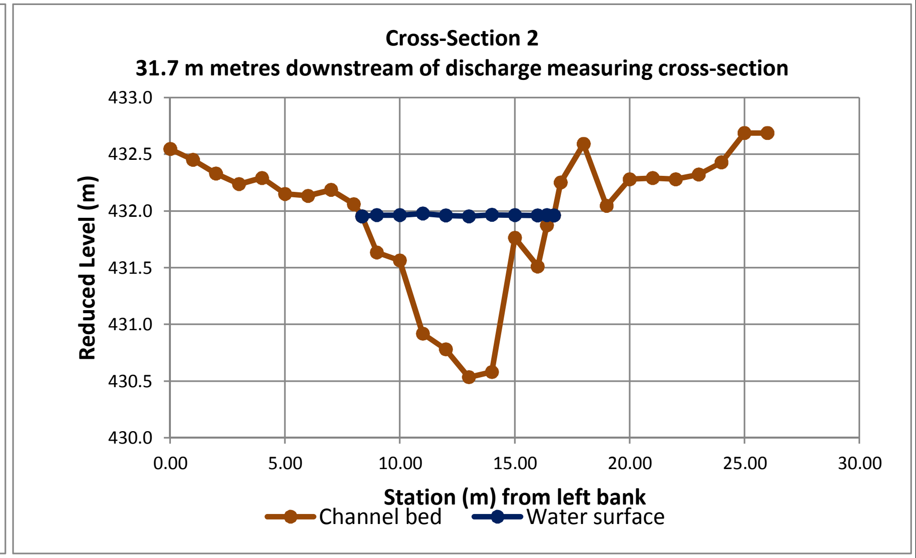
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

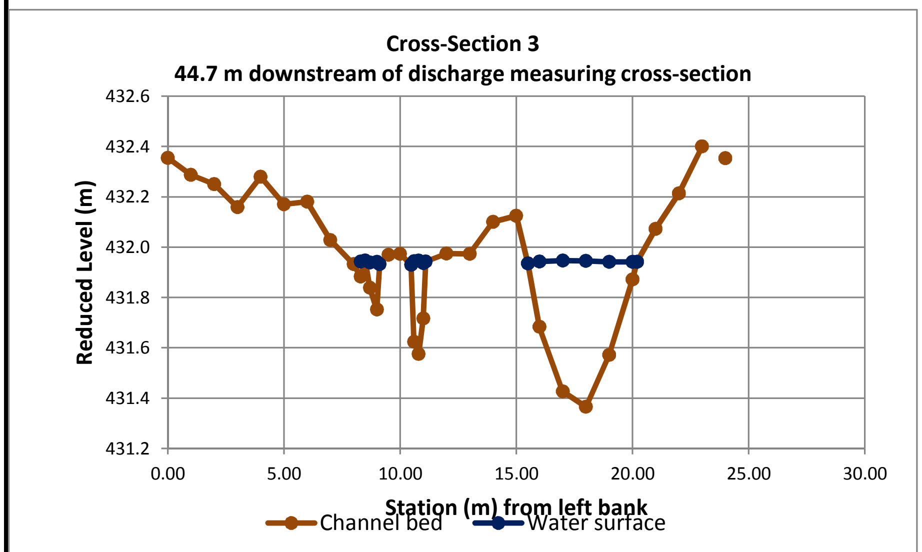
Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2







Note: Survey completed in October 2010.

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Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3

Water Level Measurements at Logger Installation

Measurement No.	Date	Discharge (m^3/s)	Water level (masl)
1	20-Aug-2010	--	431.593
2	08-Oct-2010	--	431.683
3	21-May-2011	--	431.718
4	30-Aug-2011	--	431.618
5	16-May-2012	--	431.873
6	30-Aug-2012	--	431.713

Discharge and Water Level Measurements at Flow Measurement Cross-Section

Measurement No.	Date	Discharge (m^3/s)	Water level (masl)
1	20-Aug-2010	0.007	--
2	08-Oct-2010	0.041	432.405
3	21-May-2011	0.099	432.393
4	30-Aug-2011	0.003	432.535
5	16-May-2012	0.076	432.380
6	30-Aug-2012	0.013	432.555

NOTE: This station could not be accessed during the winter seasons 2010-2012.

In-Situ Water Quality at Flow Measurement Cross-Section

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
20-Aug-2010	0.01	5.69	17.70	-
21-May-2011	0.00	7.30	17.40	-
30-Aug-2011	0.00	7.58	17.50	-
16-May-2012	0.00	7.68	13.50	9.71
30-Aug-2012	0.00	6.69	19.60	2.55

Water Surface Elevation in Metres Above Sea Level for the Calandar Year: 2010

Station Name: Upper Light Lake

Station ID: SW-05

UTM coordinates: 15U E 625085 N 5423163

Drainage area: 981.55 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									431.553	431.716	431.687	431.705	1
2									431.554	431.709	431.684	431.705	2
3									431.560	431.702	431.680	431.704	3
4									431.559	431.696	431.680	431.700	4
5									431.558	431.691	431.679	431.698	5
6									431.554	431.685	431.673	431.698	6
7									431.585	431.685	431.671	431.697	7
8									431.615	431.683	431.668	431.696	8
9									431.627	431.684	431.667	431.691	9
10									431.636	431.681	431.666	431.692	10
11									431.662	431.681	431.669	431.698	11
12									431.676	431.679	431.669	431.700	12
13									431.681	431.676	431.667	431.702	13
14									431.682	431.671	431.669	431.702	14
15									431.679	431.667	431.670	431.697	15
16									431.674	431.664	431.670	431.685	16
17									431.672	431.661	431.669	431.681	17
18									431.669	431.659	431.672	431.679	18
19									431.665	431.654	431.673	431.678	19
20								431.591	431.659	431.651	431.678	431.675	20
21								431.592	431.657	431.651	431.675	431.669	21
22								431.598	431.655	431.646	431.678	431.671	22
23								431.596	431.656	431.643	431.689	431.673	23
24								431.587	431.700	431.640	431.686	431.671	24
25								431.584	431.733	431.640	431.688	431.674	25
26								431.575	431.741	431.650	431.690	431.679	26
27								431.562	431.740	431.672	431.688	431.676	27
28								431.559	431.735	431.679	431.686	431.672	28
29								431.557	431.728	431.683	431.682	431.670	29
30								431.557	431.721	431.685	431.697	431.670	30
31								431.557		431.687		431.688	31
MEAN									431.653	431.673	431.677	431.687	
MAX									431.741	431.716	431.697	431.705	
MIN									431.553	431.640	431.666	431.669	

ANNUAL MEAN 431.664 MAX 431.741 MIN 431.553

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 5

Water Surface Elevation in Metres Above Sea Level for the Calandar Year: 2011

Station Name: Upper Light Lake

Station ID: SW-05

UTM coordinates: 15U E 625085 N 5423163

Drainage area: 981.55 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	431.694	431.682	431.676	431.665	431.861	431.719	431.729	431.724	431.623	431.575	431.661	431.643	1
2	431.700	431.684	431.687	431.664	431.856	431.704	431.730	431.753	431.626	431.570	431.662	431.642	2
3	431.709	431.670	431.677	431.668	431.843	431.700	431.721	431.759	431.624	431.567	431.659	431.635	3
4	431.704	431.668	431.671	431.676	431.832	431.707	431.722	431.749	431.619	431.567	431.655	431.642	4
5	431.695	431.669	431.671	431.677	431.822	431.696	431.743	431.742	431.616	431.564	431.649	431.645	5
6	431.697	431.675	431.672	431.677	431.823	431.698	431.737	431.733	431.610	431.564	431.648	431.649	6
7	431.694	431.685	431.671	431.675	431.818	431.692	431.736	431.728	431.606	431.563	431.648	431.638	7
8	431.697	431.691	431.672	431.676	431.810	431.697	431.736	431.721	431.603	431.575	431.645	431.647	8
9	431.699	431.687	431.667	431.682	431.801	431.687	431.741	431.727	431.599	431.575	431.644	431.651	9
10	431.692	431.693	431.667	431.696	431.792	431.682	431.750	431.719	431.598	431.573	431.642	431.649	10
11	431.683	431.687	431.665	431.741	431.810	431.679	431.749	431.715	431.594	431.571	431.642	431.646	11
12	431.681	431.683	431.661	431.787	431.809	431.682	431.745	431.716	431.590	431.579	431.638	431.647	12
13	431.681	431.671	431.668	431.812	431.796	431.678	431.738	431.708	431.588	431.628	431.639	431.644	13
14	431.682	431.678	431.669	431.817	431.778	431.670	431.733	431.699	431.586	431.662	431.637	431.640	14
15	431.689	431.675	431.667	431.818	431.766	431.664	431.732	431.692	431.583	431.679	431.638	431.646	15
16	431.695	431.675	431.667	431.826	431.755	431.664	431.736	431.686	431.578	431.689	431.638	431.661	16
17	431.683	431.674	431.670	431.831	431.747	431.660	431.736	431.685	431.573	431.697	431.638	431.660	17
18	431.687	431.688	431.678	431.826	431.735	431.656	431.736	431.673	431.567	431.700	431.637	431.648	18
19	431.688	431.692	431.678	431.816	431.728	431.660	431.730	431.669	431.570	431.699	431.637	431.648	19
20	431.685	431.689	431.676	431.809	431.725	431.660	431.730	431.660	431.571	431.698	431.644	431.647	20
21	431.693	431.693	431.678	431.805	431.721	431.656	431.738	431.654	431.582	431.698	431.642	431.641	21
22	431.687	431.686	431.681	431.804	431.724	431.660	431.731	431.645	431.582	431.695	431.633	431.646	22
23	431.686	431.680	431.686	431.808	431.742	431.670	431.723	431.637	431.580	431.692	431.627	431.643	23
24	431.675	431.687	431.688	431.815	431.740	431.673	431.719	431.648	431.580	431.690	431.629	431.641	24
25	431.675	431.697	431.687	431.827	431.734	431.676	431.725	431.648	431.578	431.687	431.626	431.638	25
26	431.669	431.698	431.687	431.842	431.727	431.671	431.729	431.644	431.575	431.681	431.631	431.636	26
27	431.665	431.687	431.684	431.854	431.715	431.699	431.733	431.639	431.574	431.678	431.640	431.646	27
28	431.672	431.684	431.679	431.858	431.709	431.734	431.738	431.632	431.573	431.675	431.639	431.652	28
29	431.673		431.675	431.850	431.715	431.733	431.737	431.628	431.574	431.673	431.643	431.641	29
30	431.679		431.671	431.841	431.704	431.728	431.732	431.625	431.576	431.670	431.642	431.639	30
31	431.684		431.668		431.704		431.731	431.623		431.666		431.638	31
MEAN	431.687	431.683	431.675	431.771	431.769	431.685	431.734	431.686	431.590	431.639	431.642	431.645	
MAX	431.709	431.698	431.688	431.858	431.861	431.734	431.750	431.759	431.626	431.700	431.662	431.661	
MIN	431.665	431.668	431.661	431.664	431.704	431.656	431.719	431.623	431.567	431.563	431.626	431.635	

ANNUAL MEAN 431.684 MAX 431.861 MIN 431.563

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Water Surface Elevation in Metres Above Sea Level for the Calandar Year: 2012

Station Name: Upper Light Lake

Station ID: SW-05

UTM coordinates: 15U E 625085 N 5423163

Drainage area: 981.55 ha

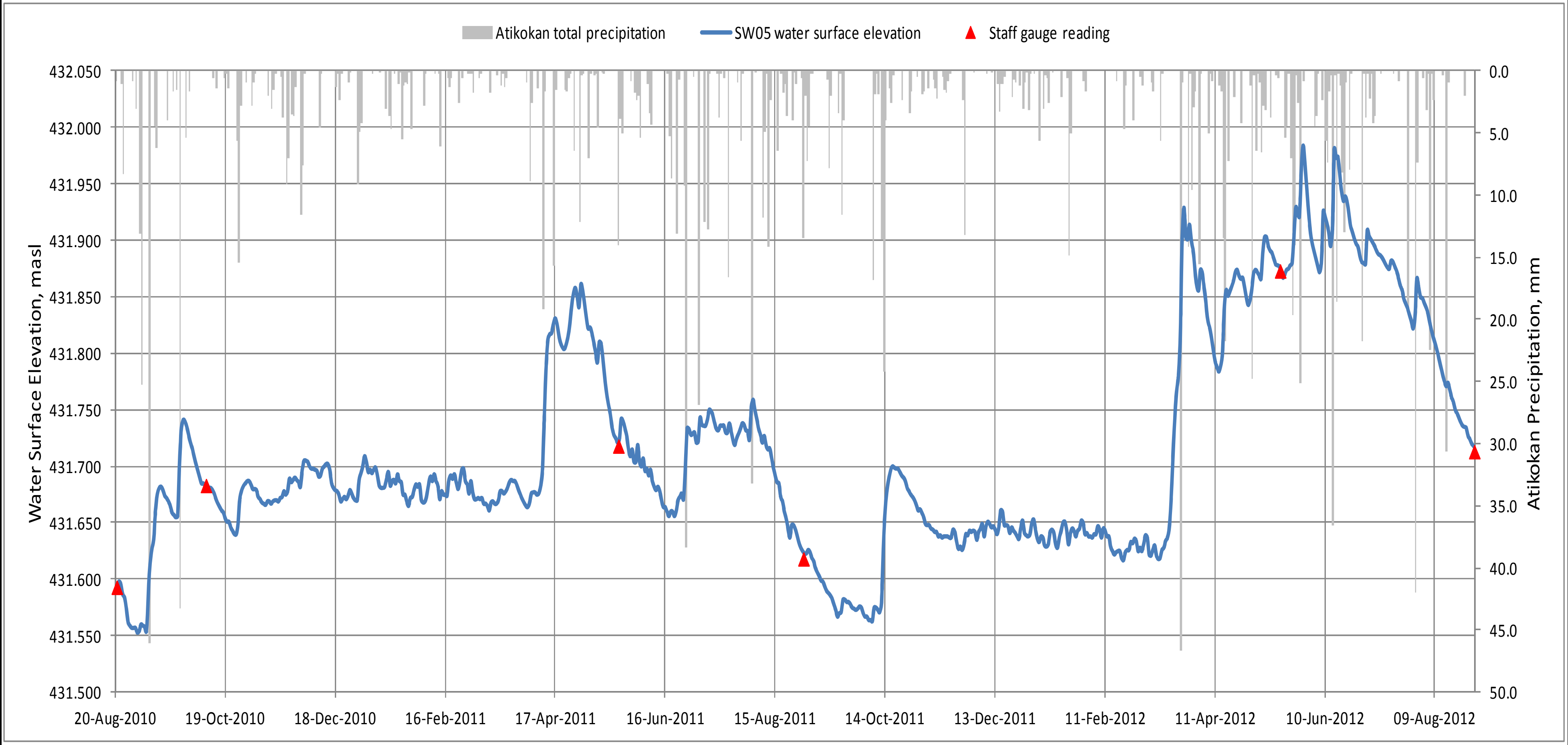
Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	431.640	431.641	431.628	431.859	431.857	431.925	431.880	431.850					1
2	431.650	431.638	431.625	431.856	431.871	431.907	431.879	431.849					2
3	431.653	431.638	431.631	431.874	431.874	431.897	431.909	431.845					3
4	431.644	431.637	431.639	431.871	431.872	431.890	431.904	431.841					4
5	431.636	431.640	431.637	431.858	431.869	431.884	431.901	431.836					5
6	431.633	431.640	431.622	431.844	431.866	431.877	431.898	431.828					6
7	431.638	431.647	431.621	431.829	431.889	431.872	431.895	431.821					7
8	431.637	431.644	431.626	431.823	431.903	431.881	431.891	431.814					8
9	431.630	431.637	431.630	431.814	431.903	431.926	431.888	431.809					9
10	431.629	431.645	431.621	431.803	431.895	431.921	431.887	431.803					10
11	431.631	431.643	431.618	431.793	431.891	431.915	431.885	431.796					11
12	431.642	431.638	431.619	431.788	431.889	431.907	431.882	431.789					12
13	431.644	431.638	431.626	431.784	431.884	431.895	431.879	431.782					13
14	431.641	431.629	431.628	431.789	431.879	431.910	431.876	431.776					14
15	431.631	431.625	431.634	431.800	431.878	431.981	431.875	431.771					15
16	431.628	431.622	431.637	431.840	431.877	431.973	431.882	431.774					16
17	431.637	431.624	431.646	431.856	431.872	431.974	431.881	431.768					17
18	431.643	431.625	431.671	431.851	431.867	431.958	431.877	431.761					18
19	431.650	431.625	431.709	431.855	431.870	431.943	431.873	431.757					19
20	431.651	431.619	431.743	431.859	431.874	431.935	431.867	431.750					20
21	431.644	431.617	431.767	431.864	431.875	431.939	431.860	431.747					21
22	431.631	431.624	431.781	431.872	431.878	431.934	431.856	431.743					22
23	431.640	431.626	431.815	431.874	431.880	431.923	431.848	431.739					23
24	431.645	431.626	431.903	431.869	431.904	431.912	431.844	431.736					24
25	431.643	431.633	431.929	431.866	431.929	431.907	431.840	431.735					25
26	431.638	431.632	431.903	431.867	431.923	431.901	431.834	431.734					26
27	431.643	431.636	431.901	431.859	431.921	431.897	431.829	431.727					27
28	431.645	431.634	431.914	431.850	431.962	431.894	431.822	431.724					28
29	431.652	431.625	431.900	431.843	431.984	431.886	431.831	431.720					29
30	431.650		431.891	431.847	431.968	431.881	431.866	431.718					30
31	431.640		431.874		431.946		431.859						31
MEAN	431.641	431.633	431.722	431.842	431.895	431.915	431.871	431.778					
MAX	431.653	431.647	431.929	431.874	431.984	431.981	431.909	431.850					
MIN	431.628	431.617	431.618	431.784	431.857	431.872	431.822	431.718					

ANNUAL MEAN 431.788 MAX 431.984 MIN 431.617

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7



Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	################	Hammond Reef Gold Project	SHEET 8

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Upper Light Lake — Station ID: SW-05

UTM coordinates: U15 E 625085 N 5423163 — Drainage area: 981.55 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									22.2	10.9	5.0	1.6	1
2									21.3	10.4	5.1	1.5	2
3									19.9	10.2	5.1	1.5	3
4									18.3	10.4	4.6	1.5	4
5									18.1	10.8	3.9	1.4	5
6									17.3	11.4	3.4	1.4	6
7									16.0	11.4	3.6	1.4	7
8									15.5	11.4	3.9	1.4	8
9									15.2	12.2	4.1	1.3	9
10									14.9	12.0	4.3	1.3	10
11									14.9	12.3	4.3	1.2	11
12									14.7	11.7	3.3	1.2	12
13									14.4	11.4	3.4	1.2	13
14									14.3	10.9	2.8	1.1	14
15									13.7	10.7	2.7	1.1	15
16									13.7	10.4	2.5	1.1	16
17									13.7	9.8	2.6	1.0	17
18									12.9	9.4	2.5	1.0	18
19									12.7	8.9	2.5	1.0	19
20								19.6	12.6	8.4	2.6	1.0	20
21								20.0	12.6	7.8	2.5	1.0	21
22								21.4	12.5	7.8	2.4	0.9	22
23								22.2	12.0	7.6	2.2	0.9	23
24								22.0	11.5	7.1	2.1	0.9	24
25								20.2	11.2	7.2	2.0	0.9	25
26								19.9	11.2	7.4	2.0	0.9	26
27								20.5	11.1	7.2	1.9	0.9	27
28								21.4	11.1	6.3	1.8	0.9	28
29								22.0	11.1	5.5	1.8	0.9	29
30								22.6	11.3	5.3	1.7	0.9	30
31								22.8		5.1		0.9	31
MEAN (°C)									14.4	9.3	3.1	1.1	
MAX (°C)									22.2	12.3	5.1	1.6	
MIN (°C)									11.1	5.1	1.7	0.9	

ANNUAL — MEAN (°C): 7.0 — MAX (°C): 22.2 — MIN (°C): 0.9

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 9

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Upper Light Lake — Station ID: SW-05

UTM coordinates: U15 E 625085 N 5423163 — Drainage area: 981.55 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.8	-0.1	-0.3	-0.2	3.6	14.5	21.8	24.2	20.2	11.8	5.0	1.1	1
2	0.8	-0.1	-0.3	-0.2	3.5	14.9	23.2	24.8	20.8	12.2	4.9	1.1	2
3	0.8	-0.1	-0.3	-0.2	4.9	15.6	23.3	24.8	20.3	12.7	4.1	1.0	3
4	0.8	-0.2	-0.3	-0.2	6.1	16.8	23.2	24.7	19.1	13.5	3.8	1.0	4
5	0.7	-0.2	-0.3	-0.3	6.5	17.4	23.1	25.1	18.4	13.2	4.0	1.0	5
6	0.7	-0.2	-0.3	-0.2	6.7	19.4	23.8	24.6	18.2	13.7	4.3	1.0	6
7	0.7	-0.2	-0.3	-0.2	6.8	18.6	23.6	24.3	19.1	13.9	3.4	1.0	7
8	0.7	-0.2	-0.3	-0.1	8.1	16.7	23.4	23.7	19.8	14.7	3.2	0.9	8
9	0.6	-0.2	-0.3	0.1	9.0	16.0	23.0	22.4	19.9	14.3	3.0	0.9	9
10	0.6	-0.3	-0.3	0.2	9.1	16.7	23.2	21.9	21.0	14.2	2.6	0.8	10
11	0.6	-0.3	-0.3	0.1	11.6	16.7	23.8	22.2	21.2	14.6	2.6	0.7	11
12	0.5	-0.3	-0.3	0.1	12.1	18.4	22.7	22.6	20.1	14.2	2.7	0.6	12
13	0.5	-0.3	-0.4	0.4	10.3	19.1	22.6	22.4	18.3	13.9	2.6	0.6	13
14	0.5	-0.3	-0.4	0.6	9.6	19.8	22.5	23.0	16.0	12.8	2.4	0.5	14
15	0.5	-0.3	-0.4	1.1	10.2	20.0	22.1	23.4	15.1	11.4	2.0	0.5	15
16	0.5	-0.3	-0.4	1.0	11.3	19.9	22.8	23.4	14.7	10.0	1.6	0.4	16
17	0.5	-0.3	-0.4	1.0	13.2	20.1	25.2	22.5	14.1	8.8	0.8	0.4	17
18	0.4	-0.3	-0.4	1.0	13.9	20.2	26.3	22.4	13.7	8.1	0.6	0.3	18
19	0.4	-0.3	-0.4	1.2	16.1	18.9	26.6	22.3	14.0	7.8	0.7	0.2	19
20	0.4	-0.3	-0.4	1.4	16.9	17.9	25.7	21.3	13.8	7.3	0.8	0.2	20
21	0.3	-0.3	-0.4	1.6	16.5	17.5	24.6	20.9	13.2	7.1	0.8	0.2	21
22	0.3	-0.3	-0.3	2.1	16.8	17.0	24.2	20.5	12.2	7.4	0.9	0.2	22
23	0.3	-0.3	-0.3	2.4	16.4	16.4	22.4	21.2	12.2	7.3	0.9	0.1	23
24	0.2	-0.3	-0.3	2.5	15.0	17.4	21.4	20.8	12.2	6.7	1.1	0.1	24
25	0.2	-0.3	-0.3	3.3	14.7	19.8	21.6	20.8	12.6	6.4	1.3	0.1	25
26	0.2	-0.3	-0.3	3.4	15.2	19.9	22.3	21.2	12.1	6.1	1.3	0.0	26
27	0.1	-0.3	-0.3	3.2	15.3	19.1	21.8	20.9	12.9	5.5	1.3	0.0	27
28	0.1	-0.3	-0.3	3.5	14.8	18.3	21.8	21.0	13.8	5.1	1.2	0.0	28
29	0.0		-0.3	3.7	15.4	19.2	22.8	20.7	13.3	5.2	1.1	0.0	29
30	0.0		-0.3	3.9	15.1	20.2	23.0	20.6	12.3	4.9	1.1	-0.1	30
31	-0.1		-0.2		15.5		23.4	20.3		4.7		-0.1	31
MEAN (°C)	0.4	-0.3	-0.3	1.2	11.6	18.1	23.3	22.4	16.2	10.0	2.2	0.5	
MAX (°C)	0.8	-0.1	-0.2	3.9	16.9	20.2	26.6	25.1	21.2	14.7	5.0	1.1	
MIN (°C)	-0.1	-0.3	-0.4	-0.3	3.5	14.5	21.4	20.3	12.1	4.7	0.6	-0.1	

ANNUAL — MEAN (°C): 8.8 — MAX (°C): 26.6 — MIN (°C): -0.4

Golder Associates

Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Upper Light Lake

Station ID: SW-05

UTM coordinates: U15 E 625085 N 5423163

Drainage area: 981.55 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.1	-0.6	-0.7	3.1	10.1	15.8	24.2	23.5					1
2	-0.2	-0.6	-0.7	3.5	11.2	16.2	25.4	23.5					2
3	-0.2	-0.6	-0.7	4.2	12.0	17.9	25.6	23.0					3
4	-0.2	-0.7	-0.7	4.3	11.6	19.2	25.7	22.5					4
5	-0.2	-0.7	-0.7	4.9	11.6	20.0	25.6	21.6					5
6	-0.2	-0.7	-0.7	5.9	11.3	20.3	24.6	21.8					6
7	-0.2	-0.7	-0.7	6.3	11.4	22.0	24.0	21.6					7
8	-0.3	-0.7	-0.7	6.1	11.4	21.2	24.7	21.6					8
9	-0.3	-0.7	-0.7	5.7	11.7	21.7	24.3	21.2					9
10	-0.3	-0.7	-0.7	5.2	13.0	23.0	24.6	20.8					10
11	-0.3	-0.7	-0.7	5.8	13.5	21.9	24.9	21.7					11
12	-0.3	-0.7	-0.7	7.3	13.2	19.7	25.5	21.7					12
13	-0.3	-0.7	-0.7	7.3	13.6	19.0	26.0	21.9					13
14	-0.3	-0.7	-0.7	7.3	14.5	18.6	26.2	21.4					14
15	-0.3	-0.7	-0.6	6.9	14.7	18.5	26.1	21.2					15
16	-0.3	-0.7	-0.4	3.5	14.5	19.9	24.9	20.4					16
17	-0.4	-0.7	-0.1	3.6	15.3	19.7	23.8	19.6					17
18	-0.4	-0.7	0.3	4.5	16.5	20.1	24.0	19.3					18
19	-0.4	-0.7	0.6	4.8	17.6	20.0	24.8	18.8					19
20	-0.4	-0.7	1.1	5.2	17.2	19.1	24.9	19.0					20
21	-0.4	-0.7	1.3	5.8	16.6	19.1	25.0	19.5					21
22	-0.4	-0.7	1.9	7.1	16.6	19.8	25.1	20.4					22
23	-0.5	-0.7	2.9	8.1	16.0	20.9	24.6	21.0					23
24	-0.5	-0.7	2.2	7.5	16.0	20.9	24.0	21.7					24
25	-0.5	-0.7	2.6	8.1	15.3	21.8	24.0	22.2					25
26	-0.5	-0.7	2.7	7.4	14.7	21.9	23.2	21.8					26
27	-0.5	-0.7	3.3	7.5	13.9	23.2	23.0	21.1					27
28	-0.5	-0.7	3.1	8.3	13.5	24.1	23.0	21.3					28
29	-0.6	-0.7	3.1	9.1	13.8	23.3	22.9	21.3					29
30	-0.6		3.1	9.9	13.5	23.3	22.0	21.5					30
31	-0.6		3.1		14.6	24.2	22.6						31
MEAN (°C)	-0.4	-0.7	0.6	6.1	13.9	20.5	24.5	21.3					
MAX (°C)	-0.1	-0.6	3.3	9.9	17.6	24.2	26.2	23.5					
MIN (°C)	-0.6	-0.7	-0.7	3.1	10.1	15.8	22.0	18.8					

ANNUAL MEAN (°C) 10.7 MAX (°C) 26.2 MIN (°C) -0.7

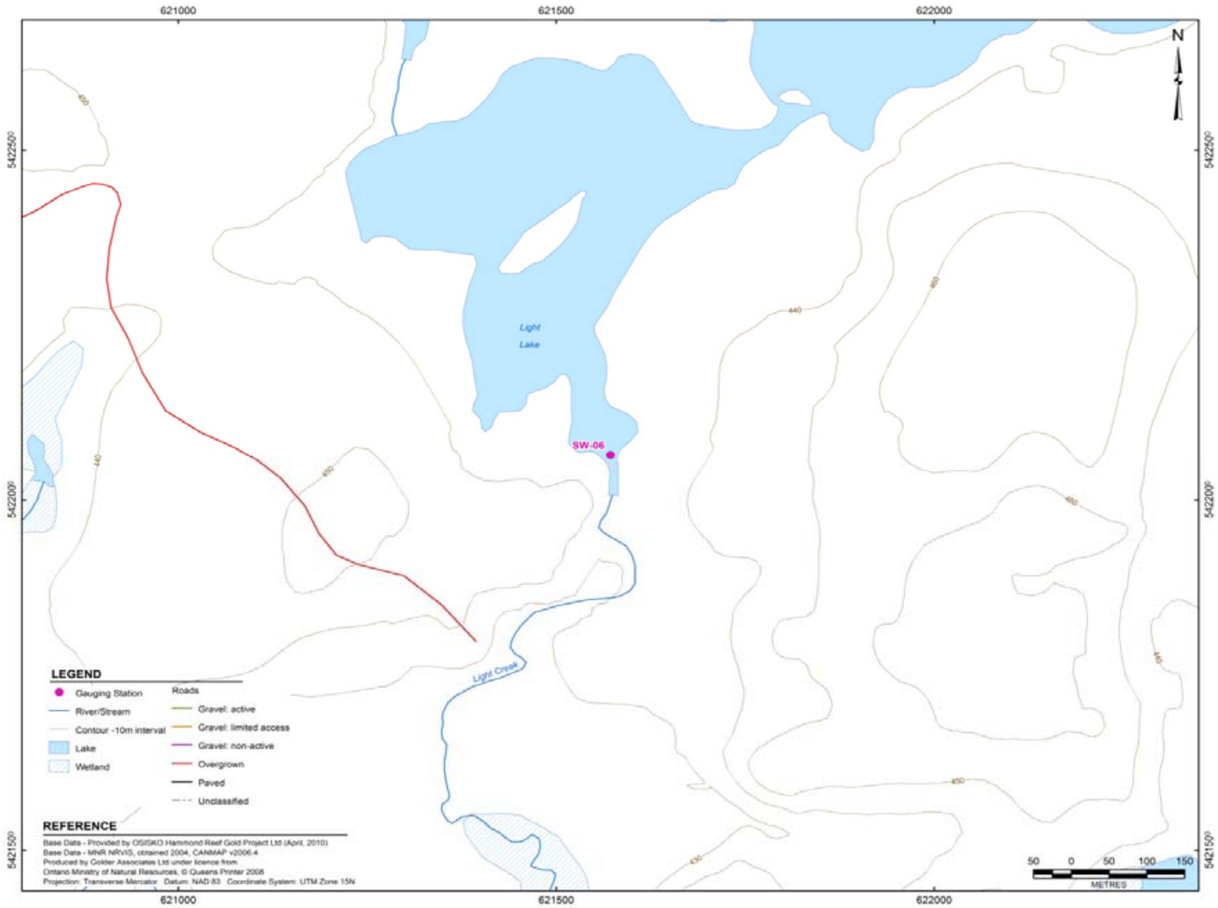
Golder Associates

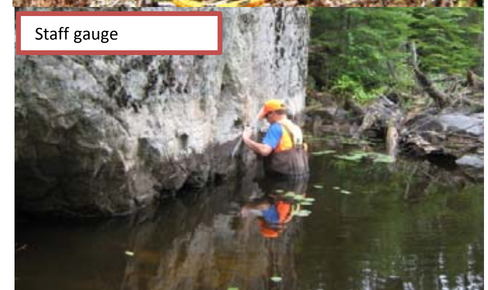
Flow Monitoring Station SW-05

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11

ATTACHMENT 5.I.7

Local Scale Monitoring Station SW-06; Light Creek below Light Lake





Station ID:	SW-06	**Installation Date:**	19-Aug-2010
Watercourse Name:	Light Lake near outlet / Light Creek below Light Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 621581 N 5422023 / 15U E 621569 N 5421997	**Logger Serial No.:**	Not recorded
Location Description:	The station is located near the outlet from Light Lake. Canoe access is from the launch between KM32 and KM33 on Premier Road. The station is located in the lower catchment draining to Light Bay.	**Installation Type:**	Logger installed in concrete block on lake bed. Cable run in flexible pipe to pipe housing on right bank, armoured by boulders. Staff gauge installed in lake above outlet against rock wall on right bank.
Elevation:	The benchmark is centre of "Γ" on lip of large rock at outlet of Light Lake between staff gauge and beaver dam. Benchmark surveyed as 431.18 masl.	**Instal. Problems/Risks:**	

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 1

Gauge:	Hydraulic Control:	The staff gauge and Levelogger are installed in the lake near the outlet. Hydraulic control is provided by channel outlet.
Current Metering Section:	General Section Description:	The measuring section is located ~12 m downstream of the lake outlet in Lumby Creek. The channel bed steepens downstream of the cross-section.
	Thalweg (straight, bend, off-center):	Off centre; towards right bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush, ferns and moss; shallow root zone
	Bankfull Depth (m):	0.75 - 1.75
	Bankfull Width (m):	6.50 - 13.50
	Floodplain Observations:	Deposition on left bank; flatter terrain
	General Observations:	Young fluvial channel; wide shallow cross-section, steep grade, low sinuousity; high bed load
Substrate:	Left Bank:	Bedrock outcrop and boulders
	Bed :	Cobbles and boulders
	Right Bank:	Bedrock wall

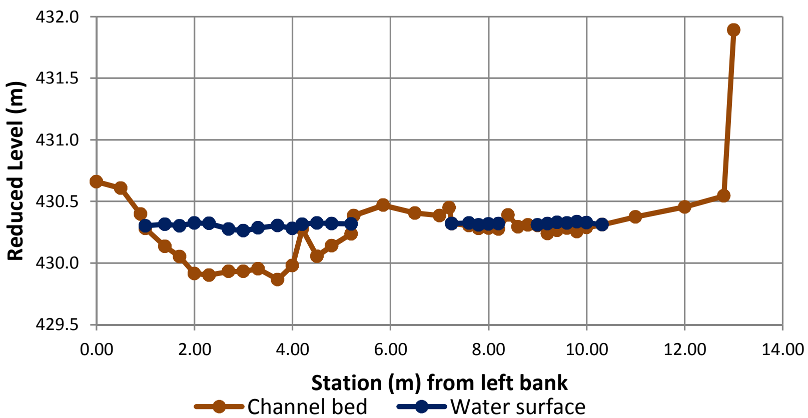
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

Golder Associates

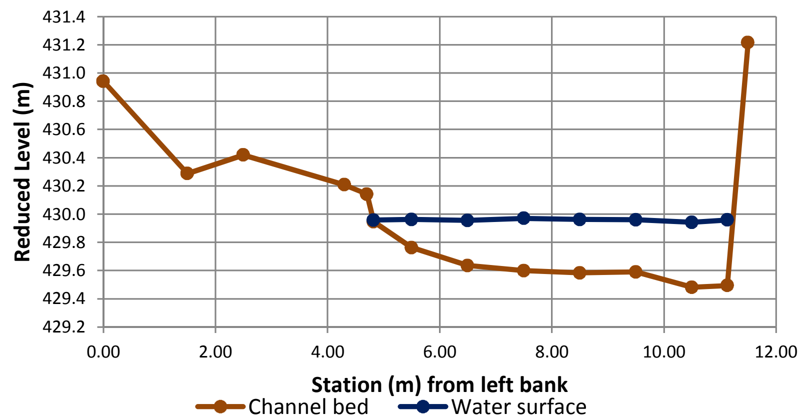
Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 2

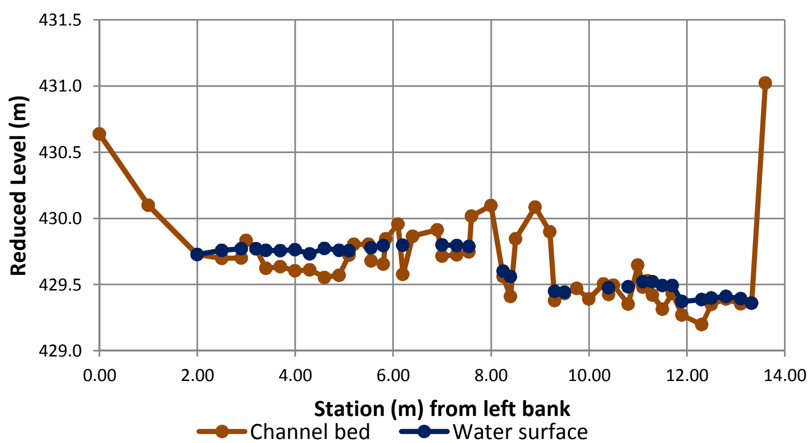
Cross-Section 1
Riffle in channel outlet from lake



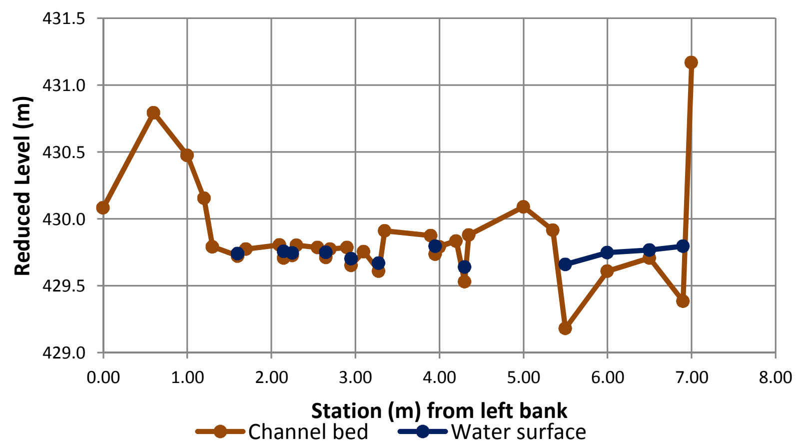
Cross-Section 2
11.5 m downstream of riffle



Cross-Section 3
21.5 m downstream of riffle



Cross-Section 4
21.5 m downstream of riffle (right channel branch)

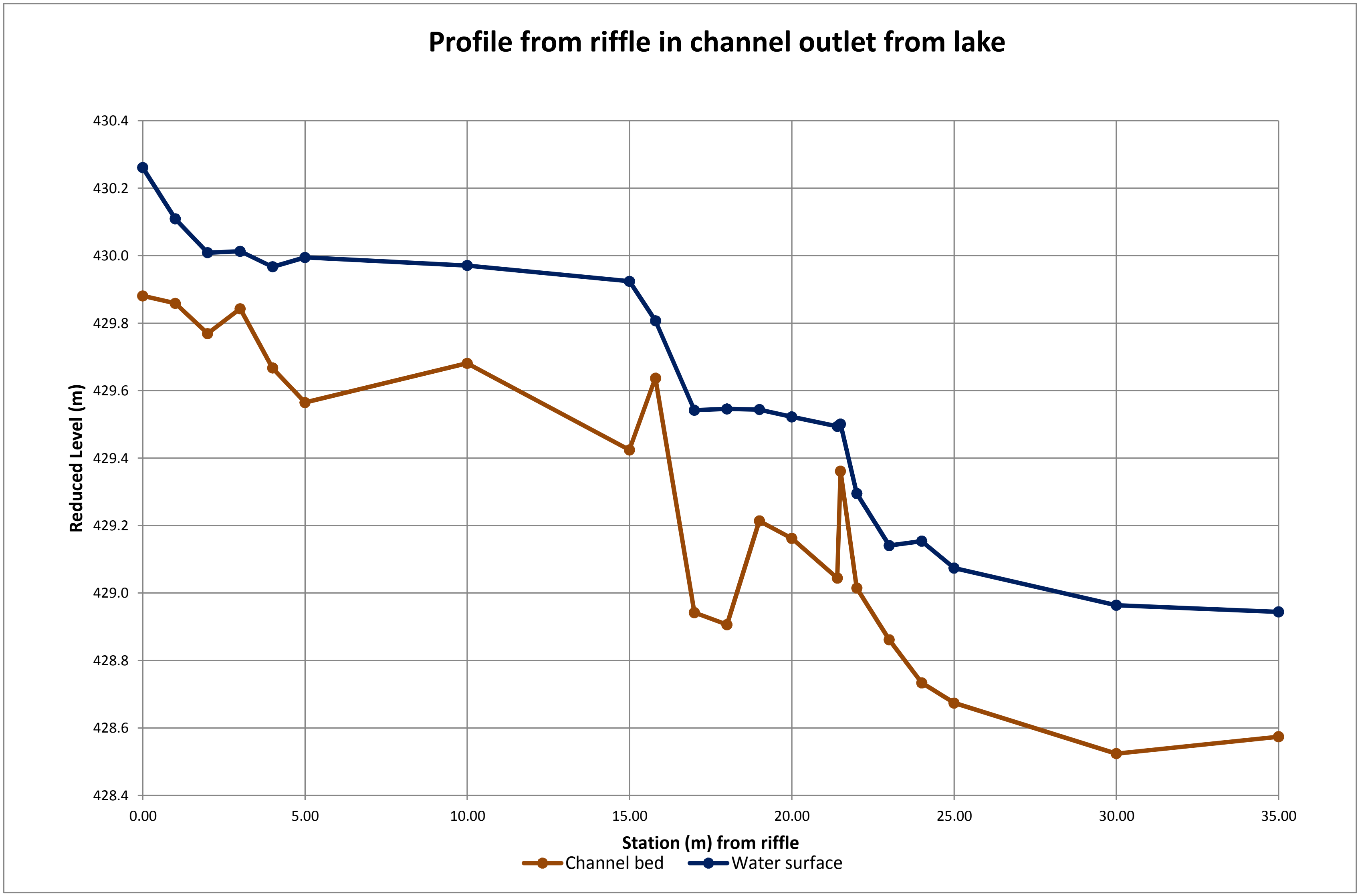


Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 3



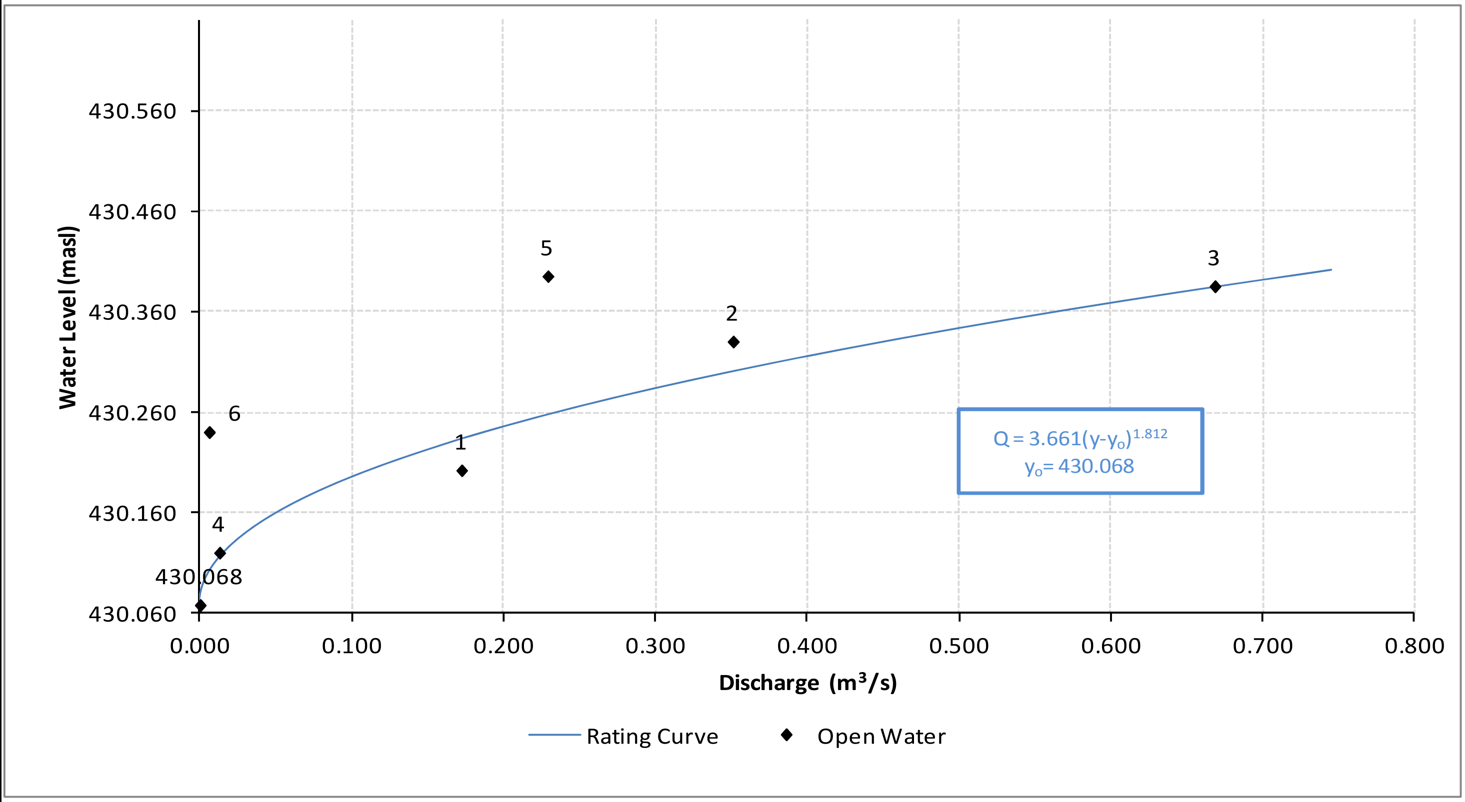
Note: Survey completed in October 2010.

Golder Associates				Flow Monitoring Station SW-06
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project — SHEET 4

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	19-Aug-2010	0.172	430.202
2	10-Oct-2010	0.351	430.330
3	21-May-2011	0.668	430.385
4	30-Aug-2011	0.013	430.120
5	16-May-2012	0.229	430.395
6	30-Aug-2012	0.006	430.240
—	G.H. at zero flow	0.000	430.068

NOTES:
1) The station could be accessed during the winter seasons 2010-2012.
2) Backwater was observed during measurement no. 5 because of debris downstream.
3) Measurement no. 6 was affected by a beaver dam upstream.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
19-Aug-2010	0.00	7.51	20.30	-
21-May-2011	0.00	7.77	18.20	-
30-Aug-2011	0.00	8.07	21.70	-
16-May-2012	0.00	7.09	16.50	11.16
30-Aug-2012	0.01	6.61	21.40	4.95

Golder Associates

Flow Monitoring Station SW-06

PROJECT: 10-1118-0020 (6700)
DATE: September 18, 2012

Hammond Reef Gold Project

SHEET 5

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Light Creek below Light Lake

Station ID: SW-06

UTM coordinates: U15 E 621569 N 5421997

Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.072	0.401	0.235	0.239B	1
2									0.073	0.404	0.231	0.238B	2
3									0.080	0.399	0.228	0.237B	3
4									0.075	0.389	0.231B	0.235B	4
5									0.071	0.379	0.230B	0.234B	5
6									0.065	0.364	0.221B	0.233B	6
7									0.096	0.362	0.216B	0.232B	7
8									0.115	0.353	0.208B	0.230B	8
9									0.113	0.345	0.204B	0.229B	9
10									0.108	0.342	0.201B	0.228B	10
11									0.131	0.335	0.200B	0.227B	11
12									0.137	0.326	0.201B	0.226B	12
13									0.140	0.314	0.199B	0.224B	13
14									0.143	0.299	0.202B	0.223B	14
15									0.144	0.286	0.205B	0.222B	15
16									0.140	0.271	0.205B	0.221B	16
17									0.140	0.261	0.202B	0.220B	17
18									0.138	0.251	0.206B	0.219B	18
19								0.163	0.136	0.238	0.204B	0.217B	19
20								0.168	0.131	0.228	0.216B	0.216B	20
21								0.156	0.128	0.222	0.212B	0.215B	21
22								0.164	0.129	0.209	0.221B	0.214B	22
23								0.153	0.133	0.201	0.246B	0.213B	23
24								0.133	0.209	0.193	0.240B	0.212B	24
25								0.129	0.270	0.187	0.247B	0.211B	25
26								0.114	0.301	0.206	0.256B	0.210B	26
27								0.094	0.324	0.240	0.252B	0.208B	27
28								0.086	0.354	0.247	0.249B	0.207B	28
29								0.082	0.370	0.244	0.242B	0.206B	29
30								0.079	0.387	0.241	0.240B	0.205B	30
31								0.077		0.237		0.205B	31
MEAN								0.123	0.162	0.289	0.222	0.221	
MAX								0.168	0.387	0.404	0.256	0.239	
MIN								0.077	0.065	0.187	0.199	0.205	
L/s/km²								2.97	3.91	7.00	5.36	5.35	

ANNUAL MEAN 0.214 MAX 0.404 MIN 0.065 L/s/km² 5.18

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 6

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Light Creek below Light Lake

Station ID: SW-06

UTM coordinates: U15 E 621569 N 5421997

Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.205B	0.198B	0.196B	0.160B	1.151E	0.515	0.249	0.060	0.016	0.000	0.024B	0.028B	1
2	0.205B	0.198B	0.196B	0.159B	1.162E	0.467	0.254	0.089	0.018	0.000	0.026B	0.025B	2
3	0.204B	0.198B	0.196B	0.164B	1.125E	0.445	0.240	0.100	0.016	0.000	0.025B	0.021B	3
4	0.204B	0.198B	0.195B	0.180B	1.093E	0.447	0.241	0.092	0.015	0.000	0.023B	0.026B	4
5	0.204B	0.197B	0.197B	0.182B	1.069E	0.414	0.286	0.097	0.012	0.000	0.019B	0.027B	5
6	0.204B	0.195B	0.200B	0.181B	1.088E	0.409	0.273	0.122	0.009	0.000	0.018B	0.028B	6
7	0.204B	0.194B	0.197B	0.177B	1.073E	0.399	0.272	0.120	0.008	0.000	0.018B	0.021B	7
8	0.203B	0.193B	0.198B	0.178B	1.035E	0.412	0.274	0.112	0.006	0.000	0.017B	0.027B	8
9	0.203B	0.192B	0.188B	0.183B	1.004E	0.381	0.275	0.119	0.005	0.000	0.016B	0.031B	9
10	0.203B	0.190B	0.189B	0.200B	0.980E	0.355	0.279	0.104	0.004	0.000	0.016B	0.030B	10
11	0.203B	0.189B	0.183B	0.267B	0.999E	0.336	0.274	0.096	0.003	0.000	0.015B	0.031B	11
12	0.203B	0.188B	0.175B	0.332B	0.993E	0.320	0.264	0.097	0.003	0.001	0.013B	0.037B	12
13	0.202B	0.187B	0.184B	0.435B	0.974E	0.298	0.242	0.089	0.002	0.012	0.013B	0.038B	13
14	0.202B	0.196B	0.181B	0.537B	0.924E	0.270	0.222	0.076	0.002	0.027	0.012B	0.040B	14
15	0.202B	0.189B	0.173B	0.601B	0.883E	0.254	0.209	0.070	0.001	0.030	0.013B	0.059B	15
16	0.202B	0.187B	0.169B	0.624B	0.845E	0.244	0.201	0.064	0.000	0.027	0.014B	0.084B	16
17	0.202B	0.184B	0.170B	0.647B	0.811E	0.231	0.187	0.061	0.000	0.032	0.014B	0.091B	17
18	0.201B	0.187B	0.181B	0.671E	0.778E	0.213	0.175	0.051	0.000	0.032	0.013B	0.084B	18
19	0.201B	0.189B	0.177B	0.696E	0.743E	0.213	0.152	0.049	0.000	0.031	0.014B	0.096B	19
20	0.201B	0.191B	0.172B	0.722E	0.713E	0.204	0.147	0.041	0.000	0.030	0.018B	0.095B	20
21	0.201B	0.193B	0.175B	0.749E	0.686E	0.187	0.151	0.036	0.001	0.031	0.017B	0.098B	21
22	0.200B	0.196B	0.181B	0.777E	0.674E	0.185	0.137	0.029	0.001	0.030	0.012B	0.108B	22
23	0.200B	0.198B	0.189B	0.789E	0.703E	0.192	0.123	0.023	0.000	0.030	0.010B	0.106B	23
24	0.200B	0.198B	0.194B	0.816E	0.674E	0.186	0.104	0.031	0.000	0.031	0.011B	0.107B	24
25	0.200B	0.197B	0.192B	0.853E	0.647	0.178	0.098	0.030	0.000	0.030	0.011B	0.109B	25
26	0.200B	0.197B	0.192B	0.908E	0.614	0.165	0.091	0.027	0.000	0.028	0.014B	0.105B	26
27	0.199B	0.197B	0.188B	0.975E	0.568	0.211	0.089	0.024	0.000	0.029	0.021B	0.126B	27
28	0.199B	0.196B	0.181B	1.031E	0.540	0.254	0.088	0.020	0.000	0.028B	0.022B	0.131B	28
29	0.199B		0.174B	1.055E	0.545	0.248	0.082	0.017	0.000	0.028B	0.026B	0.120B	29
30	0.199B		0.169B	1.050E	0.507	0.244	0.073	0.016	0.000	0.028B	0.026B	0.120B	30
31	0.199B		0.164B		0.485		0.071	0.016		0.026B		0.118B	31
MEAN	0.202	0.193	0.184	0.543	0.842	0.296	0.188	0.064	0.004	0.017	0.017	0.070	
MAX	0.205	0.198	0.200	1.055	1.162	0.515	0.286	0.122	0.018	0.032	0.026	0.131	
MIN	0.199	0.184	0.164	0.159	0.485	0.165	0.071	0.016	0.000	0.000	0.010	0.021	
L/s/km²	4.88	4.67	4.46	13.14	20.35	7.15	4.54	1.54	0.10	0.42	0.41	1.69	

ANNUAL MEAN 0.219 MAX 1.162 MIN 0.000 L/s/km² 5.29

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Light Creek below Light Lake

Station ID: SW-06

UTM coordinates: U15 E 621569 N 5421997

Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.124B	0.082B	0.039B	0.759E	0.318	0.741E	0.263	0.110					1
2	0.139B	0.078B	0.035B	0.742E	0.312	0.693E	0.246	0.120					2
3	0.140B	0.075B	0.040B	0.773E	0.308	0.633	0.287	0.121					3
4	0.130B	0.073B	0.047B	0.772E	0.303	0.568	0.284	0.116					4
5	0.114B	0.074B	0.044B	0.747E	0.286	0.514	0.268	0.109					5
6	0.114B	0.077B	0.029B	0.700E	0.269	0.464	0.258	0.098					6
7	0.122B	0.082B	0.029B	0.652B	0.296	0.420	0.245	0.091					7
8	0.117B	0.076B	0.032B	0.622B	0.329	0.419	0.228	0.080					8
9	0.109B	0.067B	0.034B	0.593B	0.341	0.471	0.211	0.073					9
10	0.104B	0.077B	0.025B	0.549B	0.340	0.474	0.192	0.062					10
11	0.108B	0.072B	0.024B	0.501B	0.344	0.473	0.174	0.052					11
12	0.121B	0.063B	0.022B	0.459B	0.334	0.466	0.158	0.048					12
13	0.123B	0.063B	0.028B	0.417B	0.304	0.430	0.144	0.043					13
14	0.118B	0.053B	0.028B	0.395B	0.280	0.442	0.135	0.040					14
15	0.101B	0.049B	0.030B	0.373B	0.263	0.571	0.129	0.035					15
16	0.099B	0.045B	0.029B	0.437B	0.245	0.613	0.137	0.037					16
17	0.108B	0.045B	0.029B	0.430B	0.218	0.653	0.134	0.032					17
18	0.112B	0.046B	0.033B	0.407B	0.190	0.632	0.124	0.028					18
19	0.125B	0.045B	0.045B	0.406	0.169	0.601	0.112	0.024					19
20	0.124B	0.037B	0.070B	0.405	0.164	0.580	0.097	0.020					20
21	0.111B	0.035B	0.109B	0.406	0.153	0.582	0.086	0.018					21
22	0.092B	0.041B	0.150B	0.412	0.147	0.566	0.072	0.015					22
23	0.103B	0.043B	0.236B	0.419	0.143	0.526	0.058	0.014					23
24	0.109B	0.042B	0.435B	0.429	0.182	0.489	0.048	0.013					24
25	0.100B	0.048B	0.594B	0.432	0.245	0.447	0.040	0.013					25
26	0.092B	0.044B	0.651B	0.442	0.293	0.404	0.033	0.012					26
27	0.096B	0.049B	0.709E	0.424	0.345	0.363	0.025	0.010					27
28	0.097B	0.045B	0.787E	0.399	0.476	0.327	0.018	0.009					28
29	0.103B	0.036B	0.794E	0.369	0.669E	0.296	0.037	0.007					29
30	0.096B		0.812E	0.343	0.773E	0.280	0.091	0.007					30
31	0.083B		0.788E		0.783E		0.107						31
MEAN	0.111	0.057	0.218	0.507	0.317	0.505	0.143	0.049					
MAX	0.140	0.082	0.812	0.773	0.783	0.741	0.287	0.121					
MIN	0.083	0.035	0.022	0.343	0.143	0.280	0.018	0.007					
L/s/km²	2.68	1.38	5.27	12.26	7.66	12.20	3.46	1.17					

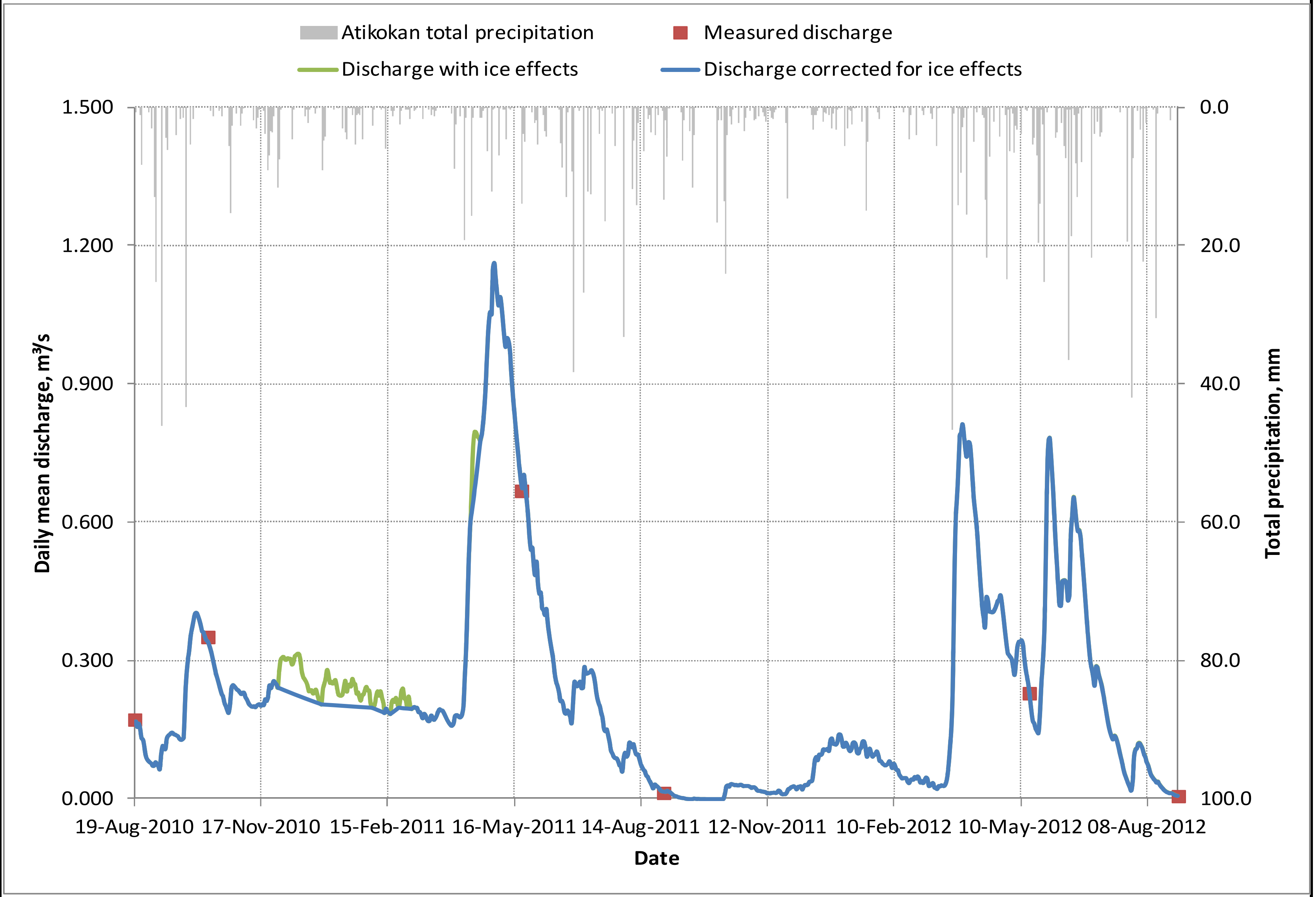
ANNUAL MEAN 0.238 MAX 0.812 MIN 0.007 L/s/km² 5.76

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-06

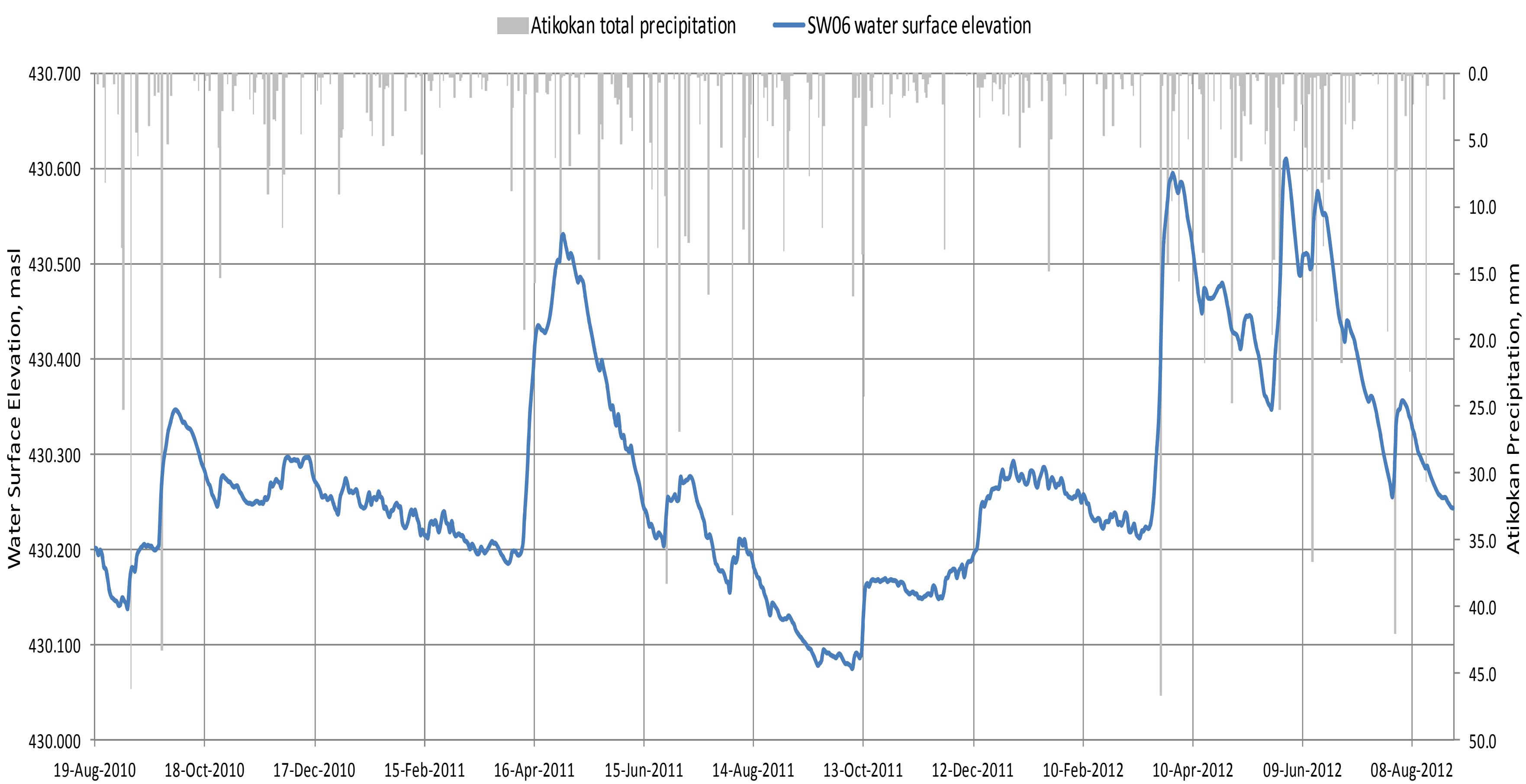
PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 8



Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 9



Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Light Lake near outlet

Station ID: SW-06

UTM coordinates: U15 E 621581 N 5422023

Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									22.1	11.2	4.3	1.7	1
2									21.3	10.5	4.4	1.7	2
3									19.0	10.1	5.1	1.7	3
4									17.0	10.3	4.3	1.6	4
5									17.4	10.5	3.6	1.6	5
6									17.6	11.3	3.5	1.6	6
7									15.6	11.3	3.6	1.6	7
8									14.7	11.8	3.8	1.5	8
9									14.4	11.9	4.0	1.4	9
10									14.4	12.7	4.4	1.4	10
11									14.7	12.7	4.7	1.4	11
12									14.7	12.1	3.8	1.4	12
13									14.1	11.5	3.4	1.4	13
14									13.7	11.1	2.5	1.4	14
15									13.2	10.7	2.2	1.4	15
16									12.8	10.4	2.5	1.4	16
17									13.4	9.5	2.7	1.4	17
18									12.5	8.7	2.9	1.4	18
19								19.6	12.2	8.4	3.0	1.4	19
20								19.1	12.1	8.2	3.0	1.4	20
21								20.4	12.3	7.1	2.9	1.4	21
22								20.4	12.2	7.0	2.7	1.4	22
23								20.8	11.9	7.2	2.6	1.4	23
24								21.8	11.1	6.8	2.4	1.4	24
25								20.0	10.7	7.1	2.3	1.4	25
26								19.7	10.9	7.8	2.2	1.4	26
27								19.8	11.1	7.3	2.1	1.4	27
28								20.9	11.0	6.1	2.0	1.4	28
29								21.9	11.1	5.0	1.9	1.4	29
30								22.5	11.4	4.9	1.8	1.4	30
31								22.9		4.5		1.2	31
MEAN (°C)									14.0	9.2	3.2	1.4	
MAX (°C)									22.1	12.7	5.1	1.7	
MIN (°C)									10.7	4.5	1.8	1.2	

ANNUAL MEAN (°C) 7.0 MAX (°C) 22.1 MIN (°C) 1.2

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 11

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Light Lake near outlet — Station ID: SW-06

UTM coordinates: U15 E 621581 N 5422023 — Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	1.2	0.9	0.6	1.1	3.6	14.7	21.1	23.4	19.9	10.7	4.6	1.8	1
2	1.2	0.9	0.6	1.2	3.4	14.1	23.0	25.0	20.6	11.0	4.8	1.8	2
3	1.2	0.9	0.6	1.2	5.2	15.0	23.1	24.9	20.1	12.2	3.9	1.8	3
4	1.2	0.9	0.6	1.2	6.0	16.8	22.8	24.8	18.2	12.4	3.6	1.9	4
5	1.2	1.0	0.6	1.2	6.2	16.7	23.6	25.4	16.5	13.0	3.6	1.9	5
6	1.2	1.0	0.7	1.2	7.0	18.9	23.9	25.0	17.0	12.9	4.2	1.9	6
7	1.2	1.0	0.6	1.3	7.7	19.2	23.8	24.5	18.2	13.2	3.8	1.9	7
8	1.1	0.9	0.7	1.3	8.1	17.4	23.7	24.1	19.6	14.2	3.1	2.0	8
9	1.1	0.9	0.7	1.4	8.6	16.6	22.7	22.5	20.4	14.3	3.3	2.0	9
10	1.0	0.9	0.7	1.5	9.2	16.5	22.7	22.0	20.7	13.8	2.7	2.0	10
11	1.0	0.9	0.7	1.5	10.7	17.2	23.8	22.6	20.7	14.0	2.6	1.9	11
12	1.0	0.9	0.7	1.7	12.0	17.7	22.3	22.8	19.8	13.8	2.8	2.0	12
13	1.0	0.9	0.7	1.9	10.9	18.2	21.3	23.4	17.2	13.8	2.9	2.0	13
14	1.0	0.9	0.7	2.2	10.1	18.9	21.9	23.3	13.9	12.4	2.7	2.0	14
15	1.0	0.8	0.7	2.5	10.9	19.7	22.1	23.6	12.8	10.5	2.7	1.9	15
16	1.0	0.8	0.8	2.7	12.2	19.7	22.4	23.7	13.1	9.0	1.6	1.8	16
17	0.9	0.8	0.8	2.7	12.8	20.2	24.8	22.9	12.8	7.7	1.3	1.7	17
18	1.0	0.7	0.8	2.6	14.0	20.7	26.8	22.3	13.0	7.0	1.0	1.6	18
19	1.0	0.7	0.8	2.5	15.2	19.2	26.1	22.1	13.6	6.7	0.7	1.6	19
20	1.0	0.7	0.8	2.5	16.1	18.2	25.8	21.1	13.6	6.7	0.8	1.6	20
21	0.9	0.7	0.8	2.6	17.4	18.0	25.0	20.4	12.7	6.1	0.9	1.6	21
22	0.9	0.7	0.8	2.7	16.6	17.2	24.6	20.1	10.8	6.5	1.0	1.6	22
23	0.9	0.7	0.8	2.8	16.9	16.4	22.2	20.8	11.3	6.8	1.1	1.5	23
24	0.9	0.7	0.8	3.0	15.6	17.7	21.2	20.4	11.1	6.2	1.3	1.5	24
25	0.9	0.7	0.9	3.3	15.6	18.8	21.4	19.8	11.2	5.5	1.5	1.5	25
26	0.9	0.6	0.9	3.5	15.0	19.5	21.4	21.1	11.9	5.4	1.7	1.5	26
27	1.0	0.6	0.9	3.3	14.9	19.2	21.5	20.7	13.3	5.0	1.8	1.5	27
28	1.0	0.6	0.9	3.4	14.9	18.3	22.2	20.5	13.5	4.6	1.7	1.5	28
29	1.0		1.0	3.9	15.2	18.3	22.9	20.7	13.4	4.6	1.8	1.5	29
30	1.0		1.0	3.8	15.7	19.4	22.7	20.6	11.7	4.3	1.8	1.4	30
31	0.9		1.1		15.2		23.3	20.2		4.2		1.4	31
MEAN (°C)	1.0	0.8	0.8	2.3	11.7	17.9	23.1	22.4	15.4	9.3	2.4	1.7	
MAX (°C)	1.2	1.0	1.1	3.9	17.4	20.7	26.8	25.4	20.7	14.3	4.8	2.0	
MIN (°C)	0.9	0.6	0.6	1.1	3.4	14.1	21.1	19.8	10.8	4.2	0.7	1.4	

ANNUAL — MEAN (°C): 9.1 — MAX (°C): 26.8 — MIN (°C): 0.6

Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 12

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Light Lake near outlet

Station ID: SW-06

UTM coordinates: U15 E 621581 N 5422023

Drainage area: 4,135.96 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	1.4	1.2	0.8	3.3	9.9	15.1	23.3	23.5					1
2	1.3	1.2	0.8	3.7	11.2	16.6	23.8	23.8					2
3	1.4	1.2	0.8	4.3	12.4	16.9	25.5	23.3					3
4	1.4	1.2	0.8	4.9	12.1	17.4	25.2	22.7					4
5	1.4	1.1	0.8	5.3	11.8	18.2	25.5	21.8					5
6	1.4	1.1	0.8	5.7	11.4	19.6	24.7	21.9					6
7	1.4	1.1	0.8	5.9	11.1	20.7	24.5	22.0					7
8	1.4	1.1	0.8	6.0	11.4	21.4	25.0	22.0					8
9	1.4	1.1	0.8	5.6	11.5	21.2	24.8	21.9					9
10	1.4	1.0	0.8	5.2	12.0	21.2	24.3	21.7					10
11	1.4	1.0	0.8	5.9	13.2	22.0	24.7	21.7					11
12	1.4	1.0	0.8	6.1	13.0	20.1	25.2	21.9					12
13	1.4	1.0	0.9	6.9	13.3	19.1	25.7	22.2					13
14	1.4	1.0	1.0	7.3	13.9	18.8	27.0	22.5					14
15	1.3	1.0	1.2	7.0	14.3	18.4	26.5	21.8					15
16	1.3	0.9	1.3	4.4	13.9	19.6	25.3	20.7					16
17	1.3	0.9	1.6	4.1	14.4	19.8	24.7	19.2					17
18	1.3	0.9	1.9	4.7	15.0	19.8	24.4	19.5					18
19	1.3	0.9	2.3	5.1	16.1	19.7	24.3	19.0					19
20	1.3	0.9	2.8	5.7	16.8	19.3	24.5	19.3					20
21	1.3	0.9	3.2	6.1	16.0	19.4	25.3	19.6					21
22	1.2	0.9	3.8	6.6	16.4	19.8	24.9	19.9					22
23	1.2	0.9	4.1	7.5	15.8	20.1	24.7	20.7					23
24	1.1	0.9	3.7	8.5	16.0	21.1	24.5	21.0					24
25	1.2	0.8	3.7	8.5	15.5	20.9	24.7	22.1					25
26	1.1	0.8	3.8	7.9	15.0	21.2	23.9	21.8					26
27	1.1	0.8	3.5	8.2	14.3	22.0	23.2	21.1					27
28	1.1	0.8	3.4	8.5	13.6	23.4	23.5	20.7					28
29	1.2	0.8	3.4	8.8	13.9	22.9	23.1	20.8					29
30	1.2		3.2	9.5	13.6	23.1	22.7	21.1					30
31	1.2		3.1		14.1	23.3	22.7						31
MEAN (°C)	1.3	1.0	2.0	6.2	13.6	20.1	24.6	21.4					
MAX (°C)	1.4	1.2	4.1	9.5	16.8	23.4	27.0	23.8					
MIN (°C)	1.1	0.8	0.8	3.3	9.9	15.1	22.7	19.0					

ANNUAL MEAN (°C) 11.3 MAX (°C) 27.0 MIN (°C) 0.8

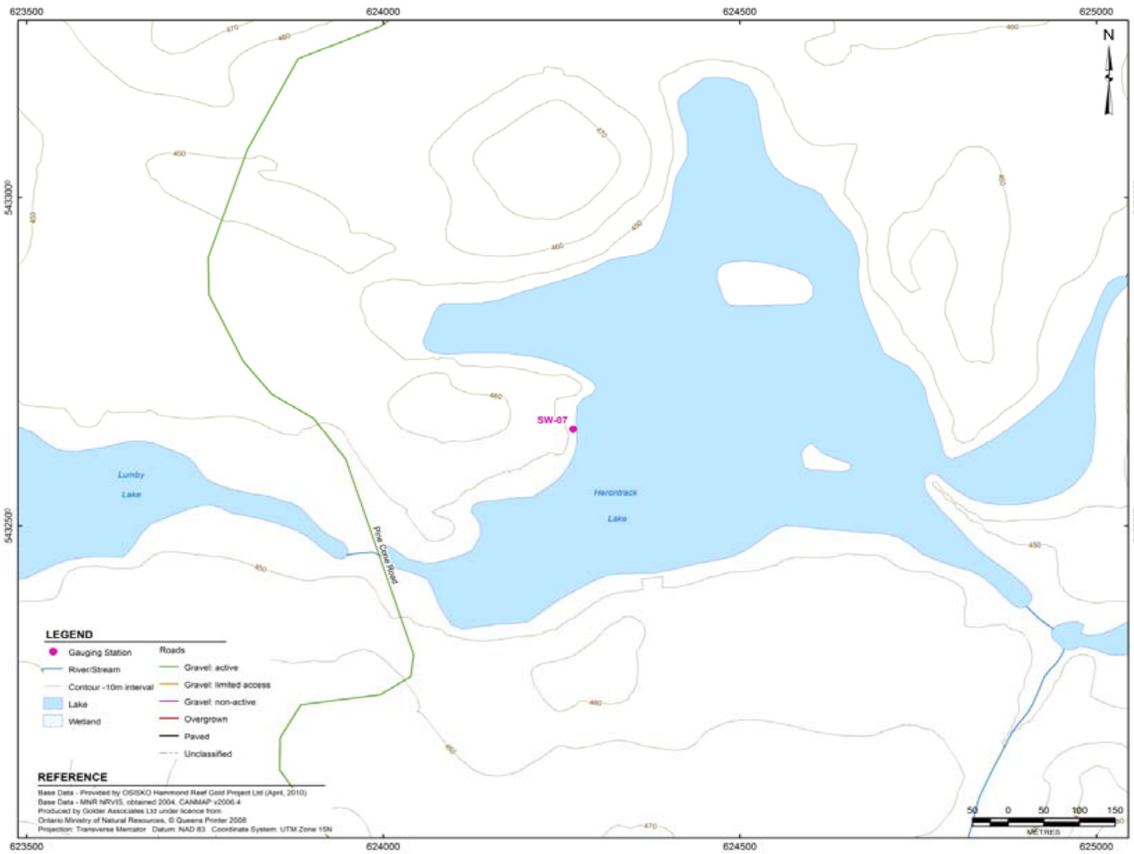
Golder Associates

Flow Monitoring Station SW-06

PROJECT:	10-1118-0020 (6700)	DATE:	September 18, 2012	Hammond Reef Gold Project	SHEET 13

ATTACHMENT 5.I.8

Local Scale Monitoring Station SW-07; Lumby Creek below Herontrack Lake



Station ID:	SW-07	**Installation Date:**	22-Aug-2010
Watercourse Name:	Herontrack Lake / Lumby Creek below Herontrack Lake	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 624266 N 5432648 / 15U E 623987 N 5432453	**Logger Serial No.:**	21053606 M5
Location Description:	The station is located in Herontrack Lake near the outlet to Lumby Lake. It can be accessed by canoe from the culvert crossing under the gravel road to the north off Premier Road between KM34 and KM35. The station is located in the upper catchment draining to Turtle Bay.	**Installation Type:**	Logger installed in concrete block on lake bed near right bank. Cable run in flexible pipe to pipe housing beside large leaning cedar. Staff gauge installed on T-post in lake ~ 2.5 m from right bank.
Elevation:	The benchmark for the logger is the centre of "X" on high point of bedrock outcrop on western bank of Herontrack Lake next to logger casing. The benchmark for the cross-section is centre of "X" on high point of large rock at Herontrack Lake outlet. Benchmarks surveyed as 448.532 masl for the logger and 447.624 masl for the cross-section.	**Instal. Problems/Risks:**	

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 1

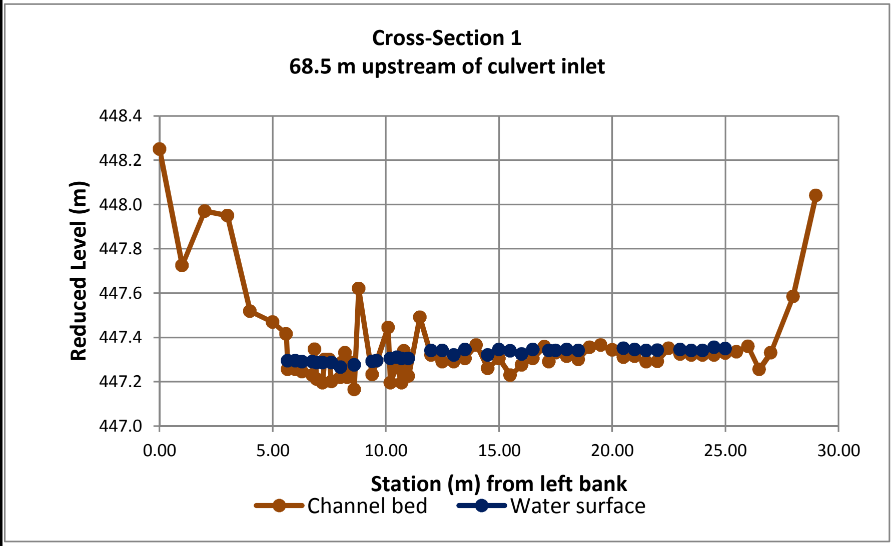
Gauge:	Hydraulic Control:	Staff gauge and Levelogger installed upstream of lake outlet. Hydraulic control is provided by riffle in channel at lake outlet.
Current Metering Section:	General Section Description:	Discharge measurements collected at the outlets of three 1200 mm diameter CSP culverts with projecting ends. Barrel length is 12.2 m and barrel slope is 0.6%-0.7%.
	Thalweg (straight, bend, off-center):	Straight
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush, grass
	Bankfull Depth (m):	0.25 - 1.25
	Bankfull Width (m):	6.00 - 20.00
	Floodplain Observations:	Deposition on left bank
	General Observations:	Young fluvial channel; wide shallow cross-section; low sinuosity; high bed load
Substrate:	Left Bank:	Boulders and cobbles
	Bed :	Sandy gravel with cobbles and boulders
	Right Bank:	Boulders and cobbles

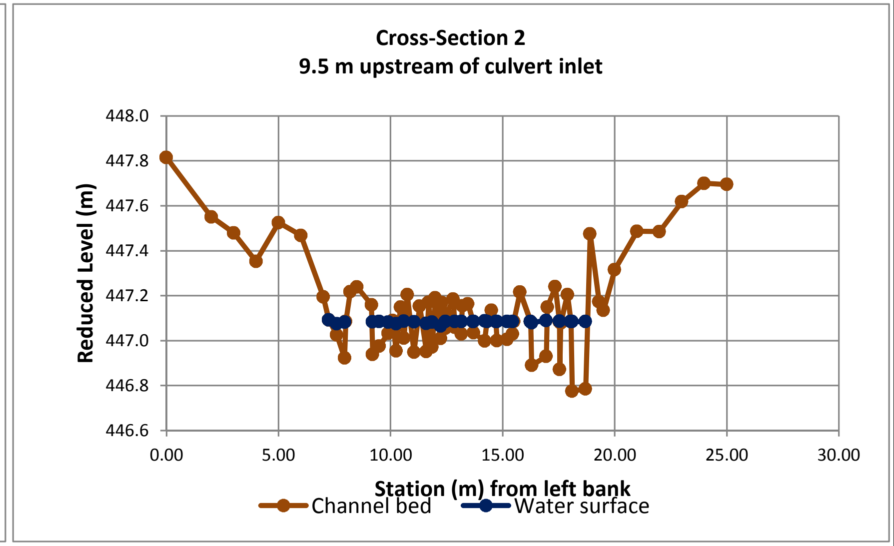
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

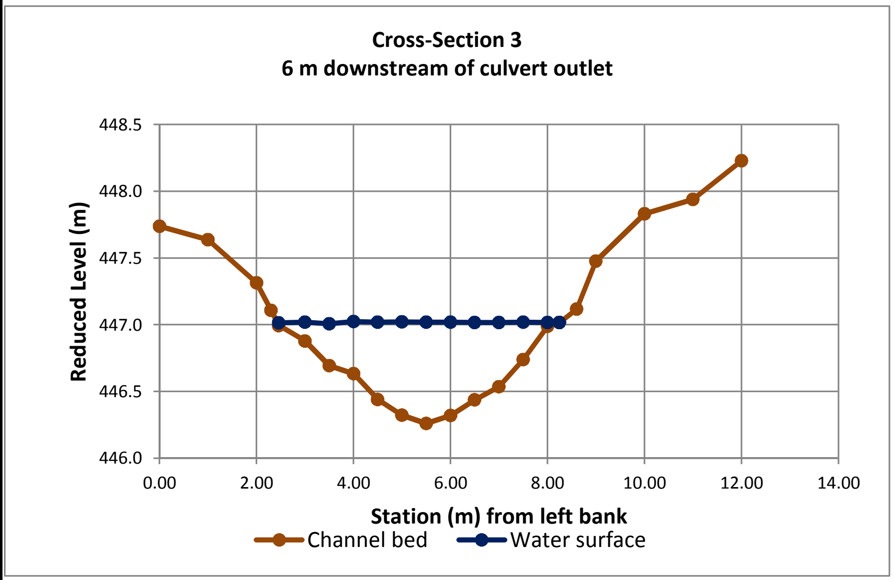
Golder Associates

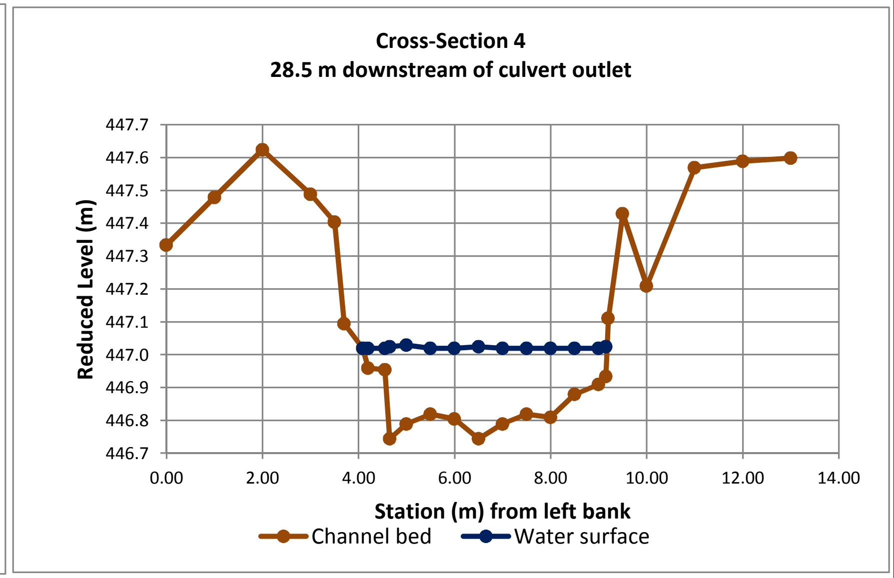
Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 2







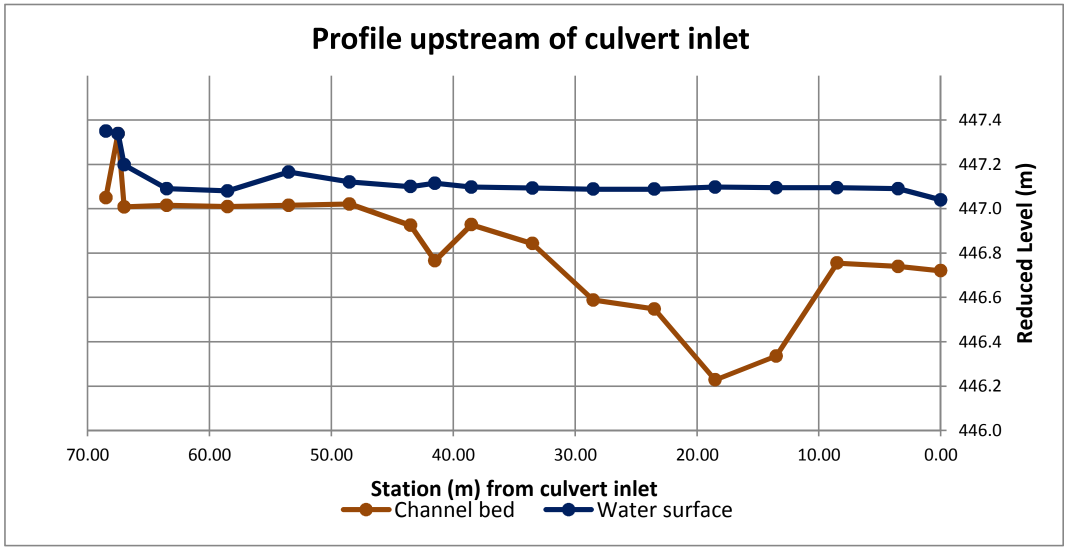


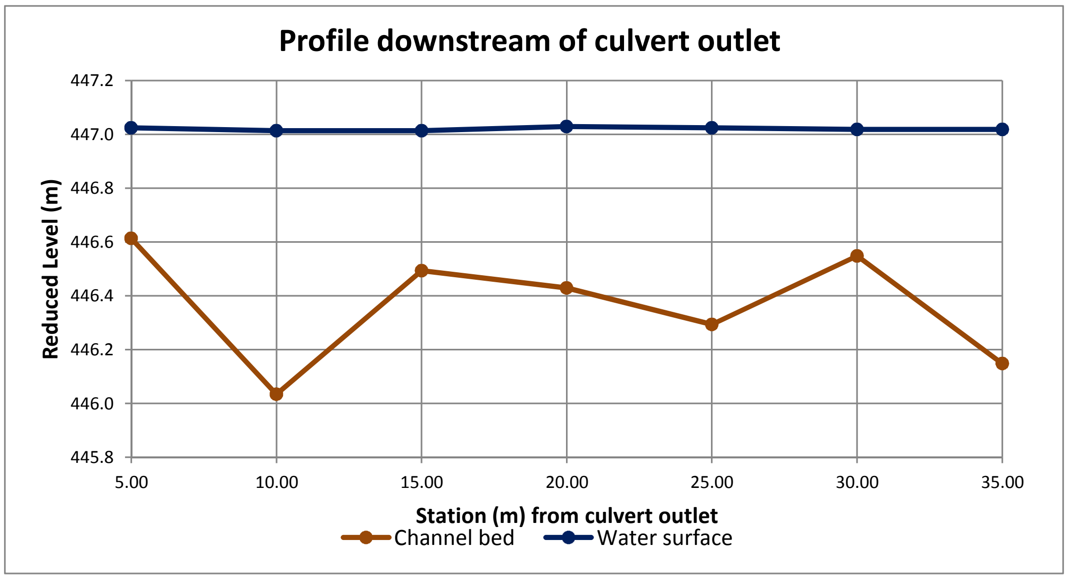
Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 3





Note: Survey completed in October 2010.

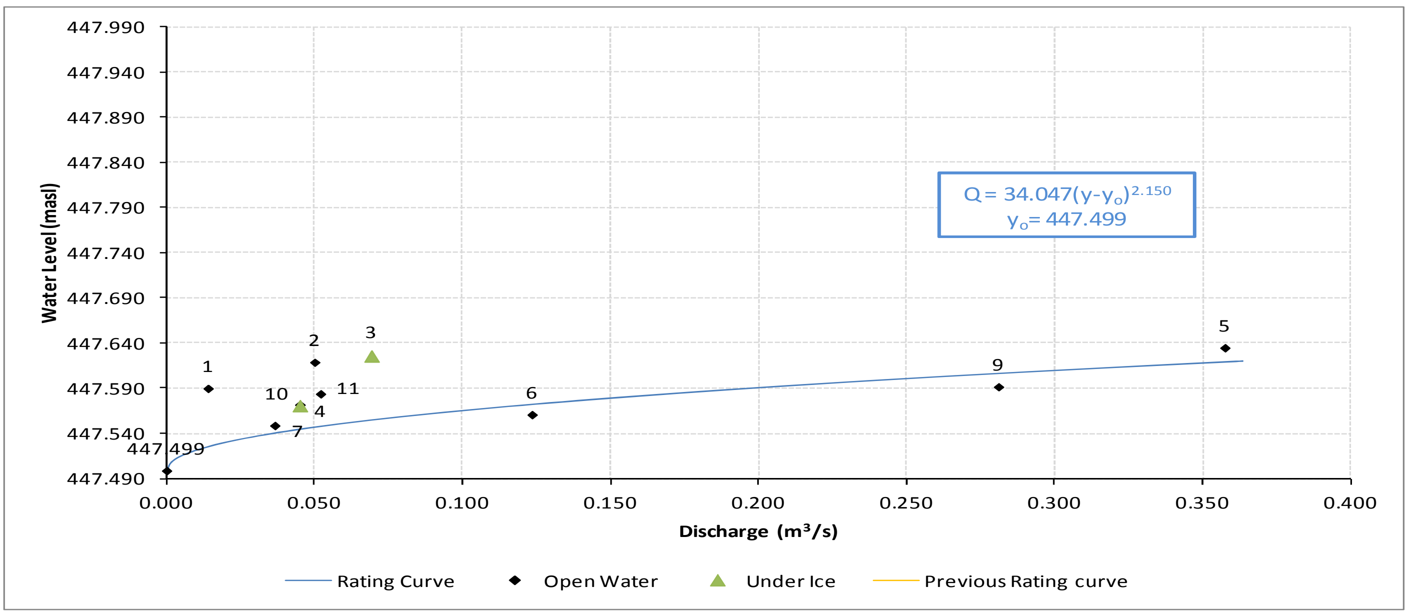
Golder Associates	Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 4

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	22-Aug-2010	0.014	447.590
2	12-Oct-2010	0.050	447.619
3	21-Jan-2011	0.069	447.626
4	05-Mar-2011	0.045	447.571
5	26-Apr-2011	0.357	447.635
6	22-May-2011	0.123	447.561
7	29-Aug-2011	0.037	447.549
8	15-Feb-2012	0.078	447.478
9	15-May-2012	0.281	447.592
10	24-May-2012	0.045	447.572
11	31-Aug-2012	0.052	447.584
—	G.H. at zero flow	0.000	447.499

NOTES:
1) There was debris build up at the lake outlet (backwater) for measurement no.2.
2) The gauge height for measurement no. 8 is suspect.
3) Measurement nos. 9 and 10 were affected by a beaver dam at the lake outlet and blockages in the middle and the left culverts.
5) Measurement no. 11 was affected by a beaver dam at the lake outlet and a blockage in the right culvert.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
22-Aug-2010	0.07	8.07	25.90	-
05-Mar-2011	0.05	6.30	1.20	-
26-Apr-2011	0.02	7.71	4.80	-
22-May-2011	0.04	7.51	20.40	-
29-Aug-2011	0.07	7.79	24.00	-
15-May-2012	0.12	7.65	16.40	0.61
31-Aug-2012	0.05	7.01	23.60	4.60

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	Hammond Reef Gold Project	SHEET 5
DATE:	September 19, 2012		

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2010

Station Name: Herontrack Lake

Station ID: SW-07

UTM coordinates: 15U E 624266 N 5432648

Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									447.538	447.655	447.617	447.652	1
2									447.541	447.651	447.614	447.650	2
3									447.553	447.647	447.613	447.649	3
4									447.558	447.641	447.614	447.645	4
5									447.559	447.637	447.615	447.644	5
6									447.557	447.630	447.612	447.646	6
7									447.587	447.629	447.611	447.645	7
8									447.602	447.628	447.610	447.646	8
9									447.595	447.627	447.610	447.643	9
10									447.590	447.626	447.611	447.644	10
11									447.605	447.625	447.612	447.650	11
12									447.605	447.624	447.614	447.652	12
13									447.601	447.622	447.616	447.655	13
14									447.600	447.618	447.620	447.656	14
15									447.598	447.615	447.624	447.652	15
16									447.596	447.612	447.626	447.644	16
17									447.596	447.610	447.627	447.641	17
18									447.594	447.609	447.634	447.638	18
19									447.594	447.607	447.637	447.636	19
20									447.592	447.606	447.641	447.632	20
21									447.591	447.606	447.639	447.627	21
22								447.587	447.592	447.603	447.641	447.626	22
23								447.584	447.596	447.602	447.649	447.627	23
24								447.573	447.640	447.602	447.646	447.629	24
25								447.571	447.664	447.601	447.647	447.633	25
26								447.564	447.665	447.613	447.648	447.639	26
27								447.553	447.662	447.628	447.644	447.635	27
28								447.549	447.663	447.626	447.642	447.629	28
29								447.546	447.659	447.625	447.638	447.628	29
30								447.544	447.657	447.622	447.651	447.629	30
31								447.542		447.619		447.642	31
MEAN									447.602	447.621	447.627	447.641	
MAX									447.665	447.655	447.651	447.656	
MIN									447.538	447.601	447.610	447.626	

ANNUAL MEAN 447.618 MAX 447.665 MIN 447.538

LEGEND B - Ice conditions E-Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 6

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2011

Station Name: Herontrack Lake

Station ID: SW-07

UTM coordinates: 15U E 624266 N 5432648

Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	447.642	447.621	447.579	447.532	447.683	447.556	447.597	447.584	447.549	447.532	447.567	447.555	1
2	447.641	447.622	447.587	447.530	447.691	447.557	447.602	447.612	447.556	447.529	447.567	447.551	2
3	447.650	447.608	447.578	447.535	447.689	447.552	447.604	447.622	447.554	447.527	447.565	447.543	3
4	447.645	447.606	447.572	447.543	447.685	447.543	447.609	447.614	447.550	447.526	447.560	447.549	4
5	447.637	447.605	447.572	447.544	447.683	447.535	447.627	447.611	447.548	447.524	447.553	447.549	5
6	447.637	447.608	447.573	447.542	447.683	447.529	447.623	447.609	447.543	447.524	447.550	447.551	6
7	447.634	447.615	447.572	447.538	447.671	447.527	447.629	447.610	447.538	447.523	447.548	447.540	7
8	447.633	447.618	447.571	447.537	447.652	447.527	447.632	447.610	447.534	447.540	447.548	447.546	8
9	447.633	447.613	447.568	447.540	447.645	447.526	447.637	447.611	447.531	447.543	447.548	447.547	9
10	447.624	447.619	447.567	447.552	447.636	447.524	447.631	447.604	447.527	447.541	447.548	447.544	10
11	447.617	447.613	447.564	447.586	447.634	447.520	447.622	447.598	447.524	447.538	447.550	447.541	11
12	447.619	447.607	447.559	447.602	447.623	447.517	447.616	447.601	447.522	447.544	447.547	447.539	12
13	447.626	447.596	447.560	447.615	447.619	447.513	447.612	447.601	447.522	447.582	447.548	447.533	13
14	447.631	447.597	447.557	447.620	447.614	447.508	447.610	447.601	447.526	447.612	447.547	447.528	14
15	447.635	447.592	447.552	447.619	447.612	447.505	447.606	447.599	447.527	447.616	447.548	447.535	15
16	447.640	447.591	447.549	447.629	447.605	447.502	447.602	447.599	447.526	447.613	447.548	447.547	16
17	447.627	447.588	447.550	447.635	447.597	447.499	447.593	447.605	447.522	447.618	447.551	447.546	17
18	447.624	447.595	447.554	447.632	447.588	447.496	447.586	447.601	447.517	447.616	447.552	447.537	18
19	447.622	447.597	447.548	447.626	447.579	447.501	447.578	447.595	447.519	447.611	447.553	447.537	19
20	447.620	447.596	447.546	447.620	447.576	447.502	447.586	447.588	447.523	447.607	447.559	447.535	20
21	447.632	447.599	447.547	447.618	447.570	447.503	447.608	447.583	447.535	447.603	447.556	447.532	21
22	447.632	447.591	447.547	447.618	447.566	447.507	447.600	447.577	447.536	447.596	447.548	447.534	22
23	447.629	447.587	447.549	447.618	447.569	447.516	447.592	447.570	447.534	447.593	447.544	447.532	23
24	447.618	447.594	447.548	447.619	447.565	447.520	447.591	447.572	447.534	447.591	447.547	447.530	24
25	447.616	447.604	447.547	447.627	447.563	447.522	447.589	447.577	447.532	447.589	447.546	447.527	25
26	447.610	447.606	447.546	447.637	447.557	447.527	447.586	447.572	447.531	447.584	447.551	447.524	26
27	447.607	447.594	447.545	447.644	447.549	447.558	447.590	447.566	447.529	447.583	447.558	447.534	27
28	447.616	447.588	447.542	447.646	447.545	447.580	447.592	447.560	447.528	447.583	447.555	447.538	28
29	447.617		447.538	447.653	447.546	447.587	447.589	447.554	447.532	447.580	447.558	447.529	29
30	447.620		447.536	447.664	447.548	447.593	447.588	447.549	447.533	447.579	447.557	447.526	30
31	447.623		447.534		447.552		447.586	447.547		447.574		447.525	31
MEAN	447.628	447.603	447.557	447.597	447.610	447.528	447.604	447.590	447.533	447.572	447.553	447.538	
MAX	447.650	447.622	447.587	447.664	447.691	447.593	447.637	447.622	447.556	447.618	447.567	447.555	
MIN	447.607	447.587	447.534	447.530	447.545	447.496	447.578	447.547	447.517	447.523	447.544	447.524	

ANNUAL MEAN 447.576 MAX 447.691 MIN 447.496

LEGEND B - Ice conditions E-Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 7

Water Surface Elevation in Metres Above Sea Level for the Calendar Year: 2012

Station Name: Herontrack Lake

UTM coordinates: 15U E 624266 N 5432648

Station ID: SW-07

Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	447.526	447.549	447.516	447.700	447.607	447.758	447.687	447.595					1
2	447.534	447.545	447.513	447.691	447.605	447.723	447.697	447.601					2
3	447.538	447.543	447.518	447.696	447.602	447.681	447.728	447.603					3
4	447.529	447.543	447.523	447.693	447.596	447.645	447.722	447.604					4
5	447.523	447.546	447.518	447.680	447.588	447.621	447.725	447.603					5
6	447.520	447.547	447.503	447.665	447.583	447.605	447.723	447.597					6
7	447.523	447.551	447.503	447.651	447.595	447.595	447.727	447.594					7
8	447.522	447.547	447.504	447.643	447.605	447.606	447.723	447.590					8
9	447.516	447.544	447.505	447.634	447.607	447.641	447.718	447.612					9
10	447.515	447.552	447.497	447.621	447.609	447.647	447.713	447.618					10
11	447.519	447.547	447.495	447.607	447.616	447.648	447.702	447.623					11
12	447.529	447.542	447.495	447.599	447.616	447.639	447.688	447.619					12
13	447.531	447.544	447.499	447.592	447.607	447.630	447.675	447.613					13
14	447.527	447.536	447.502	447.590	447.600	447.632	447.663	447.607					14
15	447.516	447.531	447.506	447.589	447.595	447.647	447.648	447.605					15
16	447.512	447.528	447.507	447.615	447.591	447.651	447.656	447.615					16
17	447.519	447.528	447.512	447.613	447.584	447.670	447.656	447.610					17
18	447.525	447.528	447.522	447.606	447.581	447.679	447.645	447.608					18
19	447.531	447.528	447.536	447.605	447.580	447.713	447.634	447.607					19
20	447.534	447.519	447.557	447.605	447.576	447.728	447.625	447.603					20
21	447.529	447.520	447.576	447.604	447.565	447.748	447.613	447.600					21
22	447.520	447.523	447.585	447.602	447.562	447.751	447.602	447.596					22
23	447.534	447.523	447.619	447.604	447.562	447.743	447.589	447.594					23
24	447.541	447.522	447.680	447.608	447.577	447.725	447.580	447.591					24
25	447.540	447.526	447.697	447.611	447.592	447.703	447.575	447.594					25
26	447.539	447.526	447.692	447.614	447.594	447.694	447.570	447.603					26
27	447.544	447.526	447.715	447.612	447.601	447.691	447.564	447.598					27
28	447.547	447.523	447.736	447.609	447.665	447.686	447.558	447.596					28
29	447.553	447.516	447.729	447.605	447.766	447.681	447.565	447.594					29
30	447.555		447.726	447.605	447.813	447.680	447.600	447.590					30
31	447.551		447.714		447.795		447.601	447.589					31
MEAN	447.530	447.535	447.571	447.626	447.614	447.675	447.651	447.602					
MAX	447.555	447.552	447.736	447.700	447.813	447.758	447.728	447.623					
MIN	447.512	447.516	447.495	447.589	447.562	447.595	447.558	447.589					

ANNUAL MEAN 447.601 MAX 447.813 MIN 447.495

LEGEND B - Ice conditions E-Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-07

PROJECT: 10-1118-0020 (6700) DATE: September 19, 2012

Hammond Reef Gold Project

SHEET 8

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Lumby Creek below Herontrack Lake

Station ID: SW-07

UTM coordinates: 15U E 623987 N 5432453

Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.000	0.177	0.047	0.145	1
2									0.000	0.157	0.041	0.140	2
3									0.000	0.140	0.037	0.135	3
4									0.000	0.120	0.039	0.130	4
5									0.000	0.105	0.041	0.125	5
6									0.000	0.080	0.035	0.121	6
7									0.020	0.080	0.035	0.117	7
8									0.030	0.075	0.033	0.112	8
9									0.020	0.071	0.032	0.108	9
10									0.014	0.068	0.035	0.105	10
11									0.034	0.064	0.036	0.101	11
12									0.034	0.064B	0.040B	0.097B	12
13									0.028	0.057B	0.043B	0.094B	13
14									0.025	0.048B	0.053B	0.091B	14
15									0.022	0.041B	0.061B	0.087B	15
16									0.019	0.035B	0.068B	0.084B	16
17									0.019	0.032B	0.072B	0.081B	17
18									0.016	0.031B	0.089B	0.079B	18
19									0.015	0.027B	0.099B	0.076B	19
20									0.013	0.026B	0.114B	0.073B	20
21									0.012	0.026B	0.106B	0.070B	21
22								0.014	0.013	0.021B	0.113B	0.068B	22
23								0.012	0.017	0.019B	0.143B	0.072B	23
24								0.003	0.139	0.019B	0.134B	0.076B	24
25								0.002	0.223	0.018B	0.135B	0.090B	25
26								0.002	0.227	0.040B	0.141B	0.107B	26
27								0.000	0.214	0.071B	0.123B	0.095B	27
28								0.000	0.214	0.068B	0.119B	0.076B	28
29								0.000	0.197	0.065B	0.105B	0.074B	29
30								0.000	0.185	0.057B	0.150B	0.077B	30
31								0.000		0.049B		0.074B	31
MEAN									0.058	0.063	0.077	0.096	
MAX									0.227	0.177	0.150	0.145	
MIN									0.000	0.018	0.032	0.068	
L/s/km²									4.05	4.37	5.36	6.67	

ANNUAL MEAN 0.068 MAX 0.227 MIN 0.000 L/s/km² 4.75

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 9

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Lumby Creek below Herontrack Lake — Station ID: SW-07

UTM coordinates: 15U E 623987 N 5432453 — Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.071B	0.052B	0.045B	0.002B	0.787E	0.099	0.246	0.157	0.037	0.021	0.129B	0.111B	1
2	0.069B	0.055B	0.045B	0.002B	0.876E	0.103	0.272	0.304	0.051	0.017	0.128B	0.098B	2
3	0.066B	0.058B	0.045B	0.005B	0.862E	0.085	0.279	0.353	0.048	0.015	0.123B	0.076B	3
4	0.063B	0.054B	0.045B	0.011B	0.836E	0.062	0.309	0.305	0.039	0.015	0.106B	0.094B	4
5	0.061B	0.055B	0.045B	0.012B	0.821E	0.043	0.425E	0.281	0.037	0.012	0.085B	0.093B	5
6	0.058B	0.055B	0.049B	0.011B	0.837E	0.030	0.394	0.273	0.029	0.012	0.078B	0.102B	6
7	0.056B	0.054B	0.047B	0.007B	0.729E	0.026	0.435E	0.278	0.021	0.012	0.072B	0.069B	7
8	0.054B	0.054B	0.046B	0.007B	0.575E	0.026	0.457E	0.275	0.016	0.038	0.071B	0.086B	8
9	0.052B	0.054B	0.039B	0.009B	0.523E	0.025	0.489E	0.278	0.013	0.043	0.074B	0.091B	9
10	0.050B	0.053B	0.039B	0.025B	0.466E	0.022	0.446E	0.241	0.010	0.039	0.074B	0.084B	10
11	0.048B	0.053B	0.034B	0.106B	0.453E	0.016	0.385E	0.211	0.007	0.034	0.080B	0.075B	11
12	0.052B	0.053B	0.024B	0.165B	0.385E	0.012	0.342	0.225	0.006	0.048	0.074B	0.071B	12
13	0.052B	0.052B	0.027B	0.173B	0.368E	0.008	0.319	0.221	0.006	0.176	0.075B	0.055B	13
14	0.052B	0.058B	0.023B	0.180B	0.345	0.004	0.306	0.219	0.009	0.329	0.073B	0.046B	14
15	0.053B	0.049B	0.016B	0.188B	0.333	0.003	0.281	0.210	0.011	0.353	0.076B	0.051B	15
16	0.053B	0.049B	0.013B	0.196B	0.303	0.001	0.258	0.211	0.010	0.335	0.079B	0.056B	16
17	0.054B	0.046B	0.014B	0.205B	0.259	0.001	0.210	0.237	0.007	0.365E	0.086B	0.062B	17
18	0.054B	0.046B	0.019B	0.214B	0.222	0.000	0.175	0.217	0.003	0.356	0.092B	0.068B	18
19	0.054B	0.046B	0.013B	0.223B	0.184	0.001	0.143	0.187	0.005	0.328	0.095B	0.069B	19
20	0.055B	0.046B	0.010B	0.233B	0.175	0.001	0.180	0.159	0.008	0.303	0.115B	0.064B	20
21	0.069B	0.046B	0.012B	0.244B	0.152	0.002	0.287	0.136	0.022	0.281	0.108B	0.057B	21
22	0.071B	0.045B	0.012B	0.254B	0.140	0.003	0.239	0.115	0.023	0.246	0.082B	0.064B	22
23	0.069B	0.045B	0.014B	0.253B	0.154	0.009	0.201	0.092	0.021	0.234	0.072B	0.060B	23
24	0.056B	0.045B	0.015B	0.259B	0.135	0.013	0.192	0.096	0.022	0.224	0.080B	0.054B	24
25	0.055B	0.045B	0.014B	0.307B	0.128	0.015	0.183	0.113	0.019	0.214B	0.077B	0.048B	25
26	0.043B	0.045B	0.014B	0.372E	0.105	0.020	0.170	0.094	0.018	0.190B	0.095B	0.044B	26
27	0.040B	0.045B	0.012B	0.426E	0.083	0.095	0.188	0.077	0.016	0.191B	0.117B	0.047B	27
28	0.042B	0.045B	0.010B	0.445E	0.070	0.169	0.193	0.061	0.015	0.191B	0.109B	0.051B	28
29	0.044B		0.007B	0.507E	0.072	0.201	0.182	0.045	0.021	0.179B	0.119B	0.055B	29
30	0.047B		0.005B	0.605E	0.075	0.226	0.174	0.036	0.022	0.176B	0.117B	0.050B	30
31	0.049B		0.004B		0.086		0.167	0.033		0.155B		0.047B	31
MEAN	0.055	0.050	0.024	0.188	0.372	0.044	0.275	0.185	0.019	0.166	0.092	0.068	
MAX	0.071	0.058	0.049	0.605	0.876	0.226	0.489	0.353	0.051	0.365	0.129	0.111	
MIN	0.040	0.045	0.004	0.002	0.070	0.000	0.143	0.033	0.003	0.012	0.071	0.044	
L/s/km²	3.83	3.48	1.70	13.06	25.84	3.06	19.10	12.85	1.32	11.49	6.39	4.70	

ANNUAL — MEAN 0.129 — MAX 0.876 — MIN 0.000 — L/s/km² 8.98

LEGEND — B - Ice Conditions — E - Extrapolated from rating curve

Golder Associates		Flow Monitoring Station SW-07	
PROJECT: 10-1118-0020 (6700)	DATE: September 19, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Lumby Creek below Herontrack Lake — Station ID: SW-07

UTM coordinates: 15U E 623987 N 5432453 — Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.050B	0.118B	0.038B	1.201E	0.261	1.652E	0.720E	0.102					1
2	0.048B	0.121B	0.031B	1.091E	0.250	1.181E	0.811E	0.122					2
3	0.047B	0.123B	0.040B	1.147E	0.229	0.729E	1.147E	0.128					3
4	0.046B	0.125B	0.049B	1.106E	0.198	0.429E	1.079E	0.133					4
5	0.045B	0.120B	0.041B	0.954E	0.162	0.276	1.109E	0.127					5
6	0.040B	0.115B	0.015B	0.788E	0.140	0.193	1.086E	0.104					6
7	0.047B	0.110B	0.013B	0.659E	0.189	0.150	1.120E	0.094					7
8	0.045B	0.105B	0.014B	0.583E	0.231	0.202	1.077E	0.083					8
9	0.033B	0.101B	0.016B	0.506E	0.239	0.393E	1.015E	0.158					9
10	0.033B	0.097B	0.007B	0.409E	0.247	0.431E	0.959E	0.183					10
11	0.041B	0.093B	0.005B	0.316B	0.283	0.435E	0.839E	0.205					11
12	0.038B	0.089B	0.004B	0.266B	0.283	0.377E	0.701E	0.187					12
13	0.036B	0.085B	0.007B	0.229B	0.232	0.317	0.590E	0.158					13
14	0.034B	0.081B	0.009B	0.216B	0.195	0.328	0.490E	0.135					14
15	0.032B	0.078B	0.013B	0.208B	0.171	0.421E	0.383E	0.124					15
16	0.030B	0.081B	0.014B	0.351B	0.154	0.450E	0.439E	0.163					16
17	0.032B	0.082B	0.019B	0.336B	0.125	0.598E	0.436E	0.144					17
18	0.035B	0.079B	0.033B	0.292B	0.114	0.675E	0.358E	0.133					18
19	0.038B	0.078B	0.062B	0.282B	0.109	1.018E	0.292	0.128					19
20	0.041B	0.055B	0.125B	0.279B	0.094	1.190E	0.238	0.116					20
21	0.045B	0.054B	0.201B	0.270B	0.065	1.443E	0.181	0.103					21
22	0.049B	0.061B	0.246B	0.258	0.055	1.474E	0.135	0.090					22
23	0.059B	0.061B	0.471E	0.265	0.054	1.364E	0.089	0.083					23
24	0.071B	0.056B	1.010E	0.285	0.097	1.140E	0.064	0.075					24
25	0.085B	0.065B	1.206E	0.300	0.148	0.895E	0.051	0.082					25
26	0.102B	0.063B	1.142E	0.317	0.155	0.794E	0.040	0.108					26
27	0.104B	0.063B	1.430E	0.302	0.185	0.769E	0.030	0.093					27
28	0.107B	0.055B	1.712E	0.282	0.609E	0.715E	0.020	0.087					28
29	0.109B	0.038B	1.604E	0.255	1.799E	0.666E	0.033	0.079					29
30	0.112B		1.550E	0.252	2.545E	0.658E	0.122	0.069					30
31	0.115B		1.384E		2.229E		0.124	0.065					31
MEAN	0.056	0.085	0.404	0.467	0.382	0.712	0.509	0.118					
MAX	0.115	0.125	1.712	1.201	2.545	1.652	1.147	0.205					
MIN	0.030	0.038	0.004	0.208	0.054	0.150	0.020	0.065					
L/s/km²	3.92	5.87	28.02	32.40	26.53	49.43	35.33	8.19					

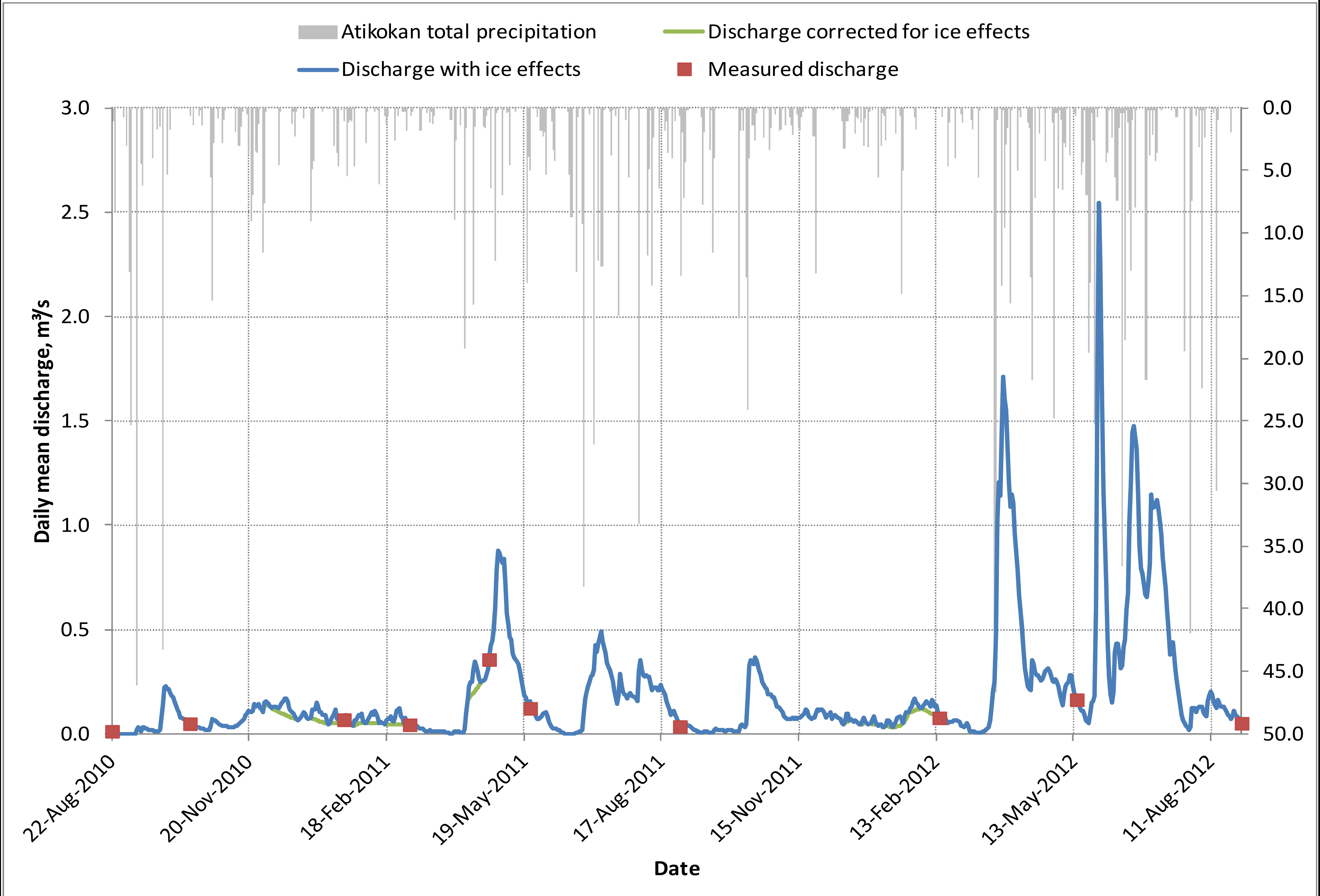
ANNUAL — MEAN 0.342 — MAX 2.545 — MIN 0.004 — L/s/km² 23.72

LEGEND — B - Ice Conditions — E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 11



Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 12

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Herontrack Lake — Station ID: SW-07

UTM coordinates: U15 E 624266 N 5432648 — Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									22.1	10.8	3.7	3.3	1
2									20.7	9.9	4.1	3.2	2
3									18.2	9.3	4.4	3.2	3
4									15.7	9.5	4.1	3.1	4
5									15.2	10.3	3.9	3.1	5
6									15.7	11.2	4.0	3.1	6
7									14.1	11.3	4.2	3.1	7
8									13.1	11.8	4.2	3.0	8
9									12.8	12.6	4.2	3.0	9
10									13.0	13.0	4.7	3.0	10
11									13.5	13.1	5.1	3.0	11
12									13.8	12.3	4.1	2.9	12
13									13.5	11.3	3.8	2.9	13
14									13.0	10.6	3.5	2.8	14
15									12.6	10.1	3.2	2.8	15
16									12.1	9.6	3.3	2.7	16
17									12.7	8.7	3.5	2.7	17
18									11.9	7.6	3.7	2.6	18
19									11.3	7.1	3.8	2.6	19
20									11.3	6.8	3.9	2.5	20
21									11.5	6.1	3.8	2.5	21
22								21.6	11.5	5.7	3.7	2.5	22
23								21.9	11.2	5.9	3.6	2.5	23
24								22.5	10.2	5.8	3.6	2.4	24
25								19.7	9.8	6.0	3.7	2.4	25
26								18.8	10.3	7.2	3.7	2.4	26
27								19.6	10.8	7.2	3.6	2.4	27
28								21.1	10.5	5.7	3.5	2.3	28
29								22.3	10.5	4.5	3.5	2.3	29
30								23.2	10.9	4.1	3.4	2.3	30
31								23.5		3.9		2.3	31
MEAN (°C)									13.1	8.7	3.8	2.7	
MAX (°C)									22.1	13.1	5.1	3.3	
MIN (°C)									9.8	3.9	3.2	2.3	

ANNUAL — MEAN (°C): 7.1 — MAX (°C): 22.1 — MIN (°C): 2.3

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 14

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Herontrack Lake | Station ID: SW-07

UTM coordinates: U15 E 624266 N 5432648 | Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	2.3	0.9	0.3	0.3	2.7	13.6	19.3	21.7	18.4	10.4	2.8	2.4	1
2	2.2	0.9	0.3	0.3	2.4	13.2	20.6	22.9	19.1	10.2	3.2	2.4	2
3	2.2	0.8	0.3	0.3	3.4	14.2	20.8	22.8	18.8	11.2	3.0	2.3	3
4	2.2	0.8	0.3	0.3	5.6	15.4	20.9	22.9	17.4	11.9	2.7	2.1	4
5	2.1	0.8	0.3	0.2	7.2	15.8	21.3	22.9	15.4	12.4	2.2	2.1	5
6	2.1	0.7	0.3	0.2	7.7	17.4	21.6	23.0	15.2	12.6	2.6	1.9	6
7	2.1	0.7	0.3	0.2	8.5	18.0	22.0	22.4	16.1	13.2	2.3	1.8	7
8	2.0	0.7	0.3	0.2	9.2	15.6	21.7	22.2	17.3	14.0	1.8	1.8	8
9	2.0	0.7	0.3	0.4	9.6	14.1	21.6	20.9	18.7	13.9	1.9	1.9	9
10	2.0	0.6	0.3	0.5	9.9	14.8	20.6	19.4	19.5	13.4	2.1	1.9	10
11	1.9	0.6	0.2	0.6	11.5	15.1	21.7	19.6	19.6	13.5	2.2	1.9	11
12	1.9	0.6	0.2	0.9	12.8	15.9	21.1	20.4	19.0	13.2	2.3	1.9	12
13	1.8	0.6	0.2	1.2	11.3	17.6	19.2	21.3	16.7	12.7	2.6	1.9	13
14	1.8	0.5	0.2	1.4	9.3	18.7	19.9	21.2	13.3	11.3	2.6	1.8	14
15	1.7	0.5	0.2	1.8	10.0	19.0	20.2	21.4	11.0	8.6	2.6	1.7	15
16	1.7	0.5	0.2	1.9	11.3	18.6	20.0	21.6	10.5	6.5	2.6	1.7	16
17	1.7	0.5	0.2	1.8	13.1	19.2	22.2	21.0	10.7	4.9	1.9	1.5	17
18	1.6	0.5	0.2	1.5	14.4	19.2	24.4	20.2	10.8	4.4	1.5	1.3	18
19	1.6	0.5	0.2	1.3	15.5	17.3	25.0	20.5	11.1	4.1	1.7	1.2	19
20	1.5	0.5	0.2	1.3	16.5	15.5	24.5	19.5	11.7	4.2	1.8	1.2	20
21	1.5	0.4	0.2	1.4	16.4	15.3	22.9	18.8	10.8	4.2	1.9	1.1	21
22	1.4	0.4	0.2	1.6	15.4	14.7	22.2	18.4	9.3	4.3	2.0	1.1	22
23	1.4	0.4	0.2	1.8	15.6	13.8	20.3	19.1	9.4	4.5	2.1	1.0	23
24	1.3	0.4	0.3	2.0	14.1	14.6	18.0	19.3	9.5	4.5	2.2	1.0	24
25	1.2	0.4	0.3	2.2	14.2	16.8	18.4	18.1	9.7	3.9	2.4	0.9	25
26	1.2	0.4	0.3	2.5	13.8	18.4	18.6	18.9	10.9	3.6	2.5	0.9	26
27	1.2	0.4	0.3	2.7	14.3	17.9	19.5	19.1	11.7	3.4	2.4	0.8	27
28	1.1	0.3	0.3	2.7	13.8	16.6	19.3	18.9	12.5	3.1	2.4	0.8	28
29	1.1		0.3	3.2	13.6	16.8	20.4	19.0	12.8	2.8	2.4	0.7	29
30	1.0		0.3	3.1	14.5	18.4	21.0	19.3	11.3	2.8	2.4	0.7	30
31	1.0		0.3		14.1		21.3	19.0		2.8		0.6	31
MEAN (°C)	1.7	0.6	0.3	1.3	11.3	16.4	21.0	20.5	13.9	8.0	2.3	1.5	
MAX (°C)	2.3	0.9	0.3	3.2	16.5	19.2	25.0	23.0	19.6	14.0	3.2	2.4	
MIN (°C)	1.0	0.3	0.2	0.2	2.4	13.2	18.0	18.1	9.3	2.8	1.5	0.6	

ANNUAL — MEAN (°C): 8.2 — MAX (°C): 25.0 — MIN (°C): 0.2

Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 15

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Herontrack Lake

Station ID: SW-07

UTM coordinates: U15 E 624266 N 5432648

Drainage area: 1,440.58 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.5	-0.5	-1.1	1.1	9.5	12.9	21.6	21.4					1
2	0.5	-0.6	-1.1	1.6	10.6	14.5	22.7	21.9					2
3	0.5	-0.7	-1.1	2.5	11.6	15.2	23.2	21.7					3
4	0.5	-0.7	-1.1	4.2	11.3	16.1	23.7	21.2					4
5	0.5	-0.8	-1.1	5.2	10.7	17.5	23.3	19.8					5
6	0.4	-0.8	-1.1	5.8	10.0	18.5	22.8	19.5					6
7	0.3	-0.9	-1.1	6.6	9.5	19.3	21.9	19.9					7
8	0.4	-0.8	-1.1	6.2	9.9	19.7	22.4	20.0					8
9	0.3	-0.9	-1.2	5.3	10.0	18.8	22.4	19.6					9
10	0.3	-1.0	-1.2	4.2	11.3	20.1	22.3	19.2					10
11	0.3	-0.9	-1.2	4.0	12.3	20.4	22.7	19.6					11
12	0.2	-0.9	-1.2	5.0	12.0	18.2	23.4	20.2					12
13	0.2	-0.9	-1.2	6.8	12.4	16.7	24.2	20.4					13
14	0.2	-0.9	-1.1	7.2	12.9	16.7	24.6	20.3					14
15	0.2	-0.9	-0.9	6.5	13.5	16.2	24.6	20.5					15
16	0.2	-0.9	-0.7	2.4	12.8	17.9	23.3	19.6					16
17	0.1	-0.9	-0.4	2.2	13.6	17.9	21.8	17.6					17
18	0.1	-1.0	-0.1	2.5	14.6	17.9	22.1	17.4					18
19	0.0	-0.9	0.3	3.0	16.4	17.8	22.4	17.4					19
20	0.0	-1.0	0.5	3.8	16.2	17.2	22.7	17.4					20
21	0.0	-1.0	0.7	4.8	14.8	16.6	23.0	17.9					21
22	0.0	-1.0	1.2	5.7	15.0	16.9	23.0	18.5					22
23	-0.1	-1.0	1.8	6.8	14.5	18.0	23.1	19.9					23
24	-0.1	-1.0	1.9	7.9	14.4	18.7	22.5	20.4					24
25	-0.2	-1.0	1.9	8.0	13.8	18.9	22.7	21.0					25
26	-0.2	-1.0	2.4	7.0	13.1	19.7	22.1	20.9					26
27	-0.3	-1.0	2.0	7.2	12.2	20.6	20.8	20.1					27
28	-0.3	-1.0	2.0	7.9	10.7	21.8	21.2	19.4					28
29	-0.3	-1.0	1.9	8.5	11.1	21.2	21.3	19.5					29
30	-0.4		1.5	9.1	10.7	21.2	20.7	20.3					30
31	-0.5		0.9		11.3	21.6	20.7	19.9					31
MEAN (°C)	0.1	-0.9	0.0	5.3	12.4	18.2	22.5	19.8					
MAX (°C)	0.5	-0.5	2.4	9.1	16.4	21.8	24.6	21.9					
MIN (°C)	-0.5	-1.0	-1.2	1.1	9.5	12.9	20.7	17.4					

ANNUAL — MEAN (°C): 9.7 — MAX (°C): 24.6 — MIN (°C): -1.2

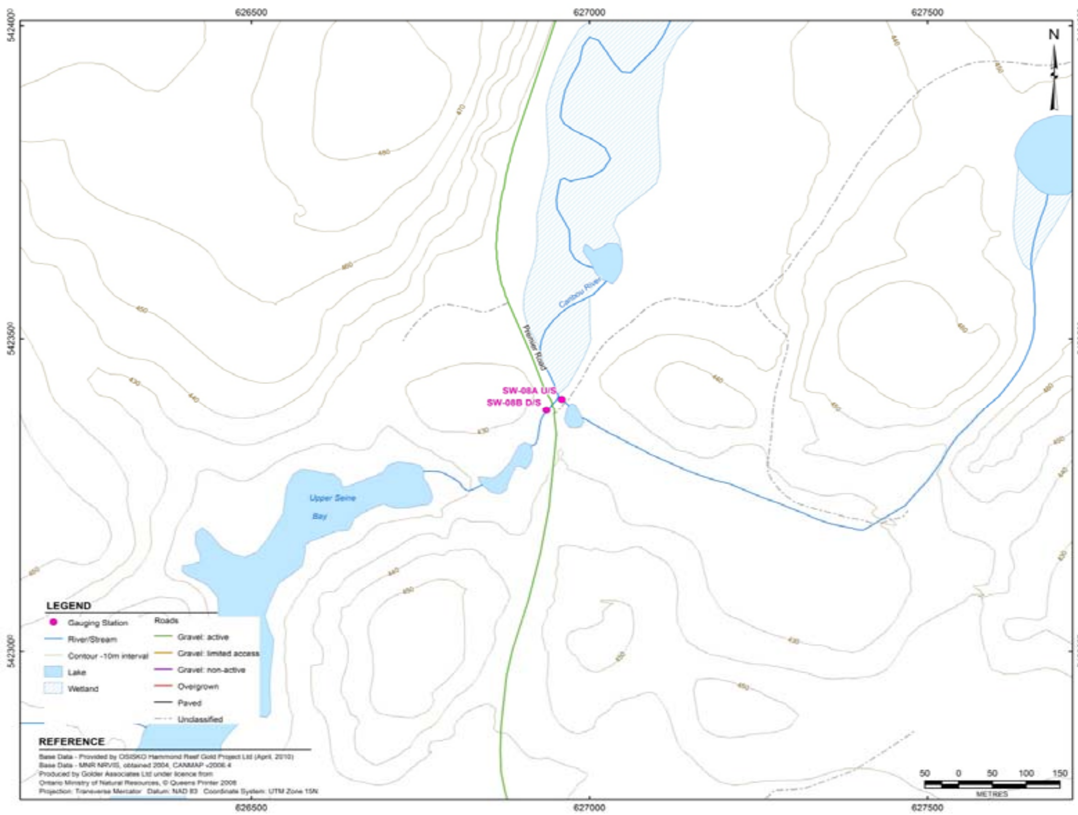
Golder Associates

Flow Monitoring Station SW-07

PROJECT:	10-1118-0020 (6700)	DATE:	September 19, 2012	Hammond Reef Gold Project	SHEET 16

ATTACHMENT 5.I.9

Local Scale Monitoring Station SW-08; Caribou River at Upper Seine Bay



Station ID:	SW-08	**Installation Date:**	27-Aug-2010
Watercourse Name:	Caribou River at Upper Seine Bay	**Equipment Installed:**	Solinst Model 3001 Leveloggers Gold with direct read cables and staff gauges
UTM Coordinates:	15U E 626937 N 5423385 (downstream Levelogger) 15U E 626958 N 5423402 (upstream Levelogger)	**Logger Serial No.:**	0021030673 downstream and 0021053607 upstream
Location Description:	The station is located at a culvert crossing on Premier Road between KM25 and KM26. It is located in the lower catchment draining to Upper Seine Bay.	**Installation Type:**	Downstream Levelogger installed in concrete block on stream bed next to culvert outlet - cable run in flexible pipe to pipe housing at culvert. Downstream staff gauge installed on T-post mid channel. Upstream Levelogger installed on T-post in stream bed upstream of culvert inlet; cable run in flexible pipe to pipe housing next to large fallen tree on left bank. Upstream staff gauge to be installed on next field visit on T-post driven near left bank.
Elevation:	The benchmark is centre of "X" on high point of bedrock outcrop on the east side bank of Caribou River, next to downstream staff gauge. Benchmark surveyed as 425.255 masl.	**Instal. Problems/Risks:**	Staff gauges could be ripped out by debris and ice. Ratings could be affected by beaver dams at culvert inlet and downstream of culvert outlet.

Golder Associates

Flow Monitoring Station SW-08

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 1

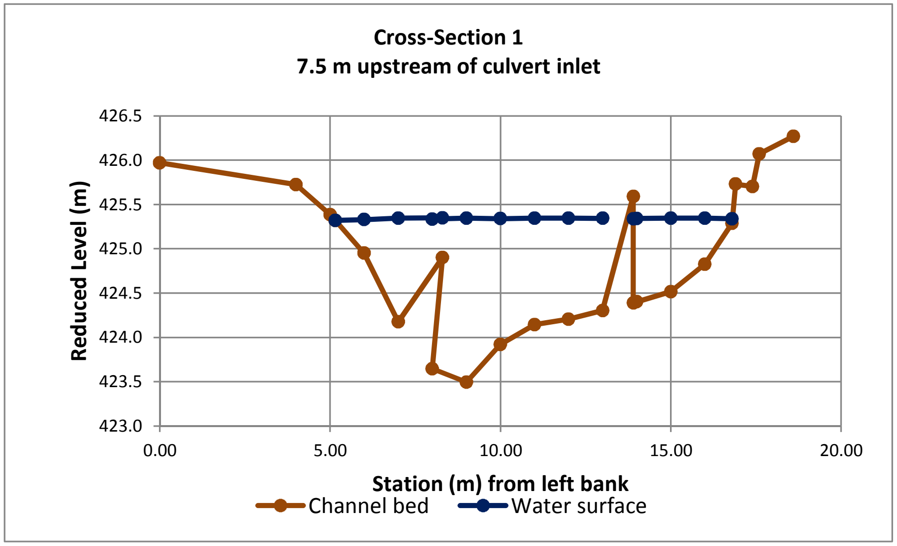
Gauge:	Hydraulic Control:	Staff gauges and Leveloggers have been installed upstream and downstream of the culvert. Hydraulic control for the upstream station is provided by the culvert and road embankment. Hydraulic control for the downstream station is provided by a riffle section/beaver dam.
Current Metering Section:	General Section Description:	Discharge measurements are collected at the outlet of a 900 mm diameter CSP culvert with projecting ends.
	Thalweg (straight, bend, off-center):	Off-centre, towards left bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Brush and grass
	Bankfull Depth (m):	0.70 - 1.75
	Bankfull Width (m):	9.5 - 12.75
	Floodplain Observations:	Wide flat flood plain, deposition on left bank, small creek flowing on right bank side
	General Observations:	Mature fluvial channel; wide shallow cross-section, steep channel slope downstream; meandering during low flow
Substrate:	Left Bank:	Sandy gravel with cobbles and boulders
	Bed :	Sandy gravel with cobbles and boulders
	Right Bank:	Bedrock outcrop

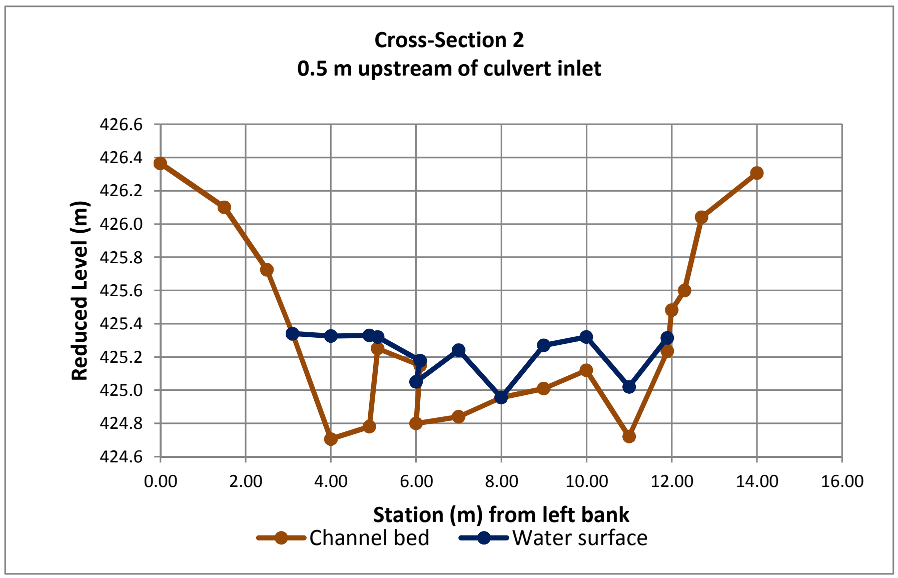
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

Golder Associates

Flow Monitoring Station SW-08

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 2



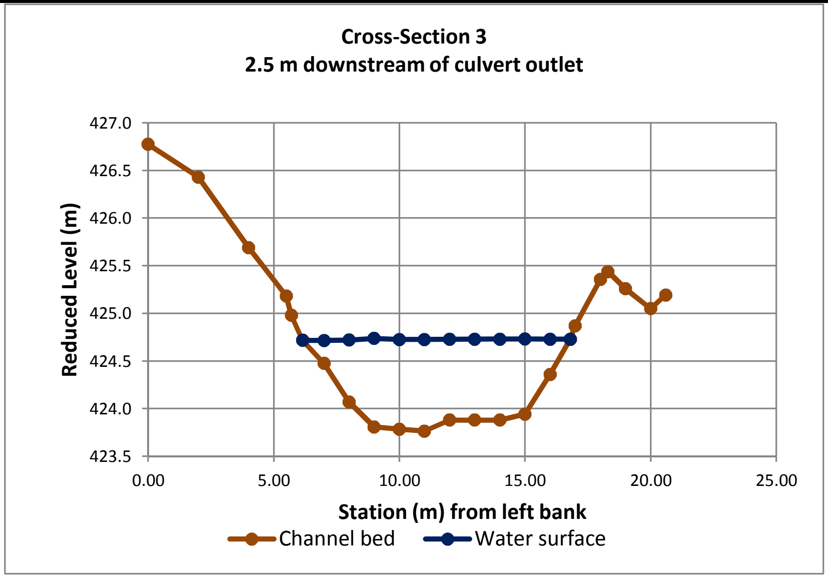


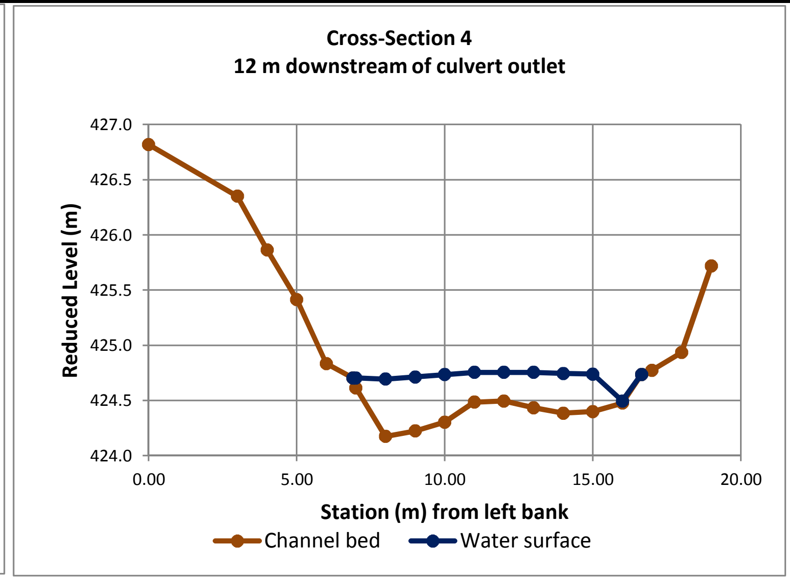
Note: Survey completed in October 2010.

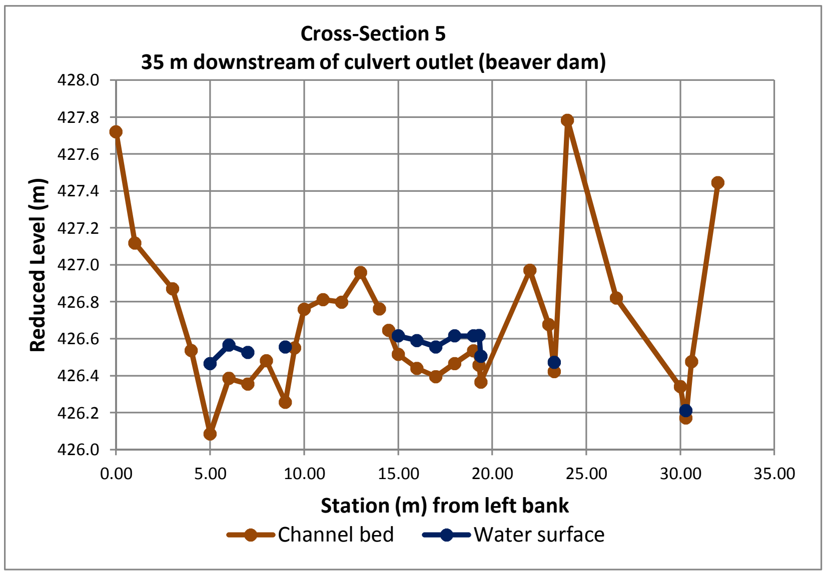
Golder Associates

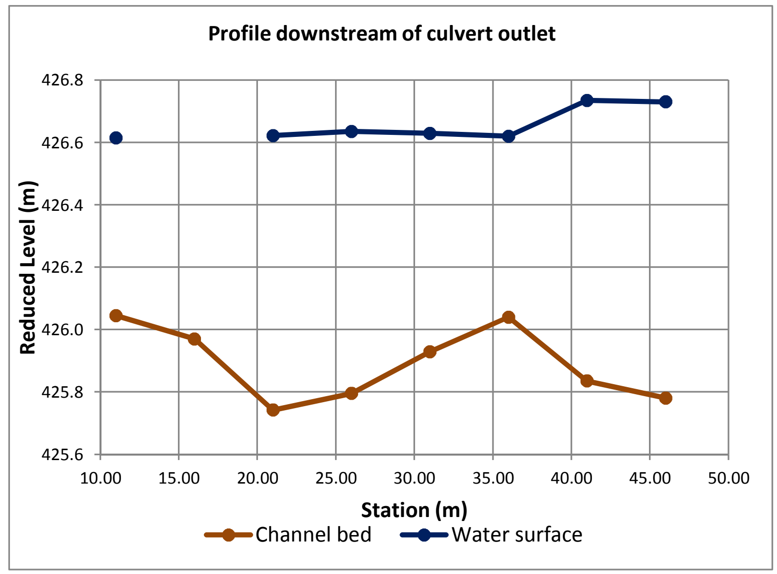
Flow Monitoring Station SW-08

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 3









Note: Survey completed in October 2010.

Golder Associates

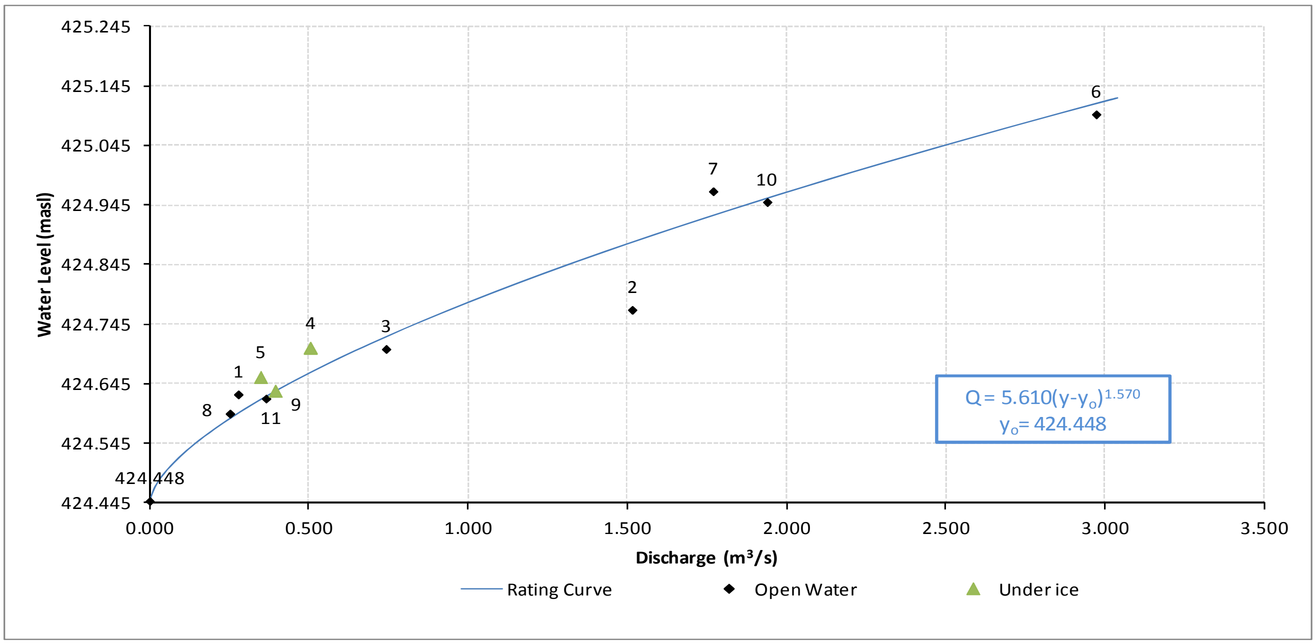
Flow Monitoring Station SW-08

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 4

Rating Curve for Downstream Gauge

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	27-Aug-2010	0.278	424.627
2	02-Oct-2010	1.515	424.682
3	14-Oct-2010	0.742	424.612
4	21-Jan-2011	0.504	424.612B
5	06-Mar-2011	0.348	424.562B
6	26-Apr-2011	2.972	424.992
7	22-May-2011	1.769	424.872
8	29-Aug-2011	0.252	424.497
9	08-Feb-2012	0.394	424.633
10	15-May-2012	1.939	424.950
11	30-Aug-2012	0.365	424.620
—	GH at Zero Flow	0.000	424.448

NOTE: Rating affected by beaver dam construction.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
27-Aug-2010	0.05	7.37	19.00	-
02-Oct-2010	0.02	6.06	8.60	-
06-Mar-2011	0.02	7.20	0.10	-
26-Apr-2011	0.02	7.86	2.90	-
22-May-2011	0.03	7.46	18.40	-
29-Aug-2011	0.04	7.57	21.80	-
15-May-2012	0.01	7.81	13.10	8.95
30-Aug-2012	0.04	6.74	21.10	5.98

Golder Associates

Flow Monitoring Station SW-08

PROJECT: 10-1118-0020 (6700)

DATE: September 20, 2012

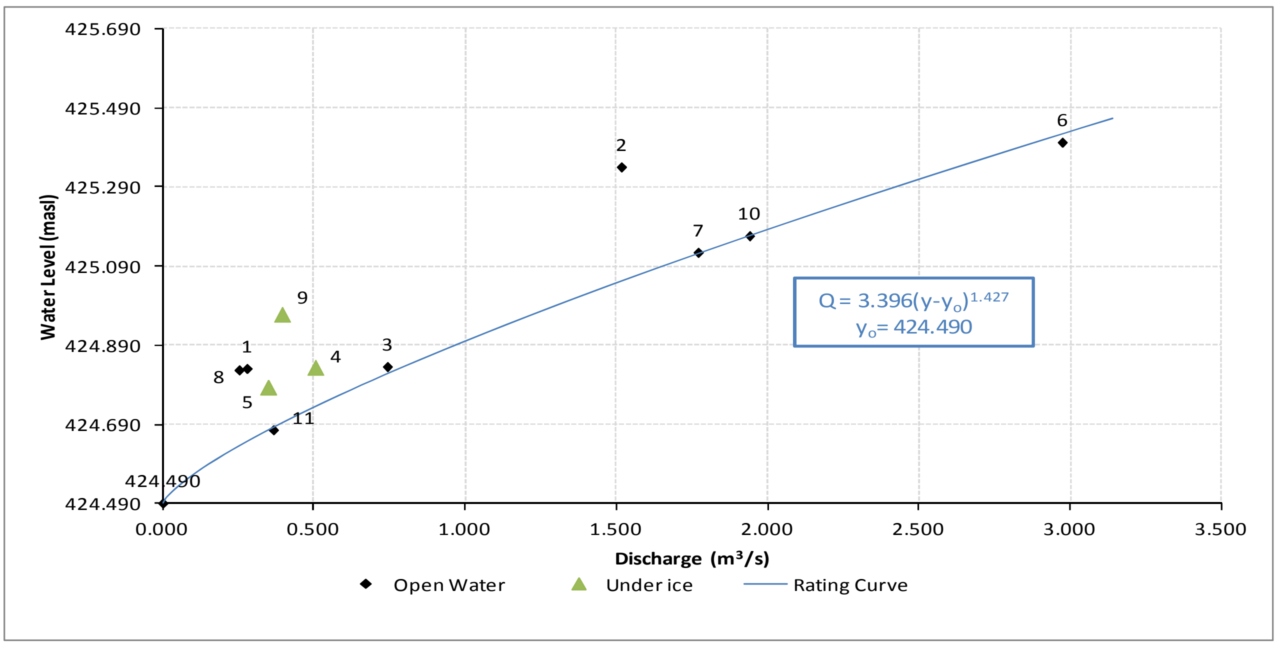
Hammond Reef Gold Project

SHEET 5

Rating Curve for Upstream Gauge

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	27-Aug-2010	0.278	424.830
2	02-Oct-2010	1.515	425.339
3	14-Oct-2010	0.742	424.835
4	21-Jan-2011	0.504	424.833
5	06-Mar-2011	0.348	424.782
6	26-Apr-2011	2.972	425.401
7	22-May-2011	1.769	425.123
8	29-Aug-2011	0.252	424.826
9	08-Feb-2012	0.394	424.967
10	15-May-2012	1.939	425.165
11	30-Aug-2012	0.365	424.675
—	G.H. at zero flow	0.000	424.490

NOTES:
1) Beaver dam being constructed upstream of culvert inlet for measurement no. 1.
2) Beaver dam 1.5 m upstream of culvert inlet for measurement no. 2.
3) Beaver dam upstream of culvert inlet washed out for measurement no. 3.
4) Measurement no. 8 likely influenced by beaver dam upstream of culvert inlet based on water level hydrograph.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
27-Aug-2010	0.05	7.37	19.00	-
02-Oct-2010	0.02	6.06	8.60	-
06-Mar-2011	0.02	7.20	0.10	-
26-Apr-2011	0.02	7.86	2.90	-
22-May-2011	0.03	7.46	18.40	-
29-Aug-2011	0.04	7.57	21.80	-
15-May-2012	0.01	7.81	13.10	8.95
30-Aug-2012	0.04	6.74	21.10	5.98

Golder Associates

Flow Monitoring Station SW-08

PROJECT: 10-1118-0020 (6700)
DATE: July 31, 2012

Hammond Reef Gold Project

SHEET 6

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Caribou River at Upper Seine Bay
Station ID: SW-08 (downstream)
UTM coordinates: U15 E 626937 N 5423385
Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.218	1.493	0.786	0.787B	1
2									0.238	1.479	0.771	0.781B	2
3									0.260	1.393	0.760	0.775B	3
4									0.259	1.290	0.769	0.769B	4
5									0.323	1.202	0.765	0.764B	5
6									0.334	1.457	0.744	0.758B	6
7									0.478	1.220	0.734	0.752B	7
8									0.528	1.093	0.713	0.747B	8
9									0.609	1.007	0.691	0.741B	9
10									0.649	0.926	0.671	0.735B	10
11									0.730	0.863	0.655	0.730B	11
12									0.779	0.829	0.660B	0.724B	12
13									0.795	0.784	0.653B	0.719B	13
14									0.829	0.735	0.660B	0.714B	14
15									0.847	0.713	0.660B	0.708B	15
16									0.847	0.688	0.653B	0.703B	16
17									0.854	0.679	0.640B	0.698B	17
18									0.844	0.660	0.642B	0.692B	18
19									0.824	0.621	0.644B	0.687B	19
20									0.799	0.576	0.660B	0.682B	20
21									0.790	0.547	0.657B	0.677B	21
22									0.786	0.521	0.690B	0.672B	22
23									0.793	0.496	0.741B	0.667B	23
24									1.031	0.470	0.753B	0.662B	24
25									1.256	0.458	0.761B	0.651B	25
26								0.253	1.363	0.527	0.781B	0.649B	26
27								0.247	1.369	0.669	0.788B	0.614B	27
28								0.216	1.437	0.759	0.802B	0.580B	28
29								0.236	1.452	0.795	0.799B	0.557B	29
30								0.238	1.486	0.791	0.793B	0.540B	30
31								0.224		0.783		0.535B	31
MEAN									0.794	0.856	0.717	0.693	
MAX									1.486	1.493	0.802	0.787	
MIN									0.218	0.458	0.640	0.535	
L/s/km²									7.05	7.60	6.36	6.15	

ANNUAL MEAN 0.740 MAX 1.493 MIN 0.216 L/s/km² 6.57

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Caribou River at Upper Seine Bay | Station ID: SW-08 (downstream)

UTM coordinates: U15 E 626937 N 5423385 | Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.530B	0.313B	0.324B	0.273B	3.435E	1.442	0.504	0.384	0.225	0.083	0.362	0.325B	1
2	0.525B	0.307B	0.326B	0.274B	3.447E	1.408	0.520	0.419	0.236	0.074	0.380	0.318B	2
3	0.520B	0.302B	0.327B	0.277B	3.419E	1.371	0.493	0.449	0.236	0.074	0.374	0.291B	3
4	0.515B	0.296B	0.329B	0.283B	3.357E	1.338	0.465	0.442	0.228	0.084	0.363	0.314B	4
5	0.510B	0.291B	0.331B	0.292B	3.264E	1.275	0.564	0.426	0.222	0.086	0.341	0.322B	5
6	0.505B	0.286B	0.333B	0.297B	3.218E	1.207	0.567	0.416	0.199	0.074	0.334	0.331B	6
7	0.500B	0.281B	0.330B	0.298B	3.202E	1.188	0.582	0.406	0.202	0.077	0.330B	0.291B	7
8	0.495B	0.276B	0.322B	0.307B	3.157E	1.140	0.666	0.403	0.191	0.085	0.329B	0.312B	8
9	0.490B	0.271B	0.292B	0.327B	3.091E	1.060	0.667	0.409	0.174	0.099	0.328B	0.320B	9
10	0.485B	0.266B	0.282B	0.357B	3.003E	0.961	0.677	0.406	0.181	0.108	0.320B	0.312B	10
11	0.481B	0.261B	0.258B	0.476B	2.981E	0.858	0.638	0.399	0.169	0.113	0.323B	0.295B	11
12	0.476B	0.256B	0.226B	0.594B	2.940	0.763	0.581	0.403	0.146	0.128	0.327B	0.295B	12
13	0.471B	0.252B	0.234B	0.925B	2.876	0.675	0.532	0.388	0.160	0.198	0.326B	0.284B	13
14	0.467B	0.247B	0.228B	1.362B	2.755	0.596	0.487	0.380	0.169	0.285	0.322B	0.267B	14
15	0.493B	0.243B	0.217B	1.674B	2.631	0.526	0.468	0.363	0.163	0.374	0.322B	0.276B	15
16	0.535B	0.238B	0.217B	1.758B	2.498	0.462	0.467	0.355	0.148	0.437	0.322B	0.324B	16
17	0.497B	0.234B	0.228B	1.846B	2.362	0.416	0.455	0.352	0.139	0.446	0.322B	0.324B	17
18	0.504B	0.258B	0.242B	1.939B	2.214	0.383	0.435	0.341	0.102	0.462	0.318B	0.292B	18
19	0.478B	0.292B	0.243B	2.036B	2.054	0.370	0.415	0.329	0.142	0.459	0.311B	0.299B	19
20	0.445B	0.286B	0.240B	2.138B	1.934	0.348	0.407	0.323	0.161	0.486	0.339B	0.304B	20
21	0.503B	0.337B	0.247B	2.245B	1.830	0.326	0.436	0.312	0.160	0.484	0.331B	0.288B	21
22	0.502B	0.354B	0.262B	2.358B	1.780	0.320	0.462	0.304	0.151	0.448	0.303B	0.311B	22
23	0.507B	0.316B	0.278B	2.430B	1.806	0.328	0.482	0.287	0.107	0.423	0.286B	0.308B	23
24	0.486B	0.315B	0.295B	2.554B	1.776	0.321	0.475	0.287	0.124	0.421	0.279B	0.306B	24
25	0.475B	0.317B	0.299B	2.755B	1.720	0.307	0.472	0.298	0.124	0.416	0.271B	0.297B	25
26	0.413B	0.319B	0.301B	2.951B	1.666	0.291	0.462	0.290	0.112	0.403	0.276B	0.295B	26
27	0.340B	0.320B	0.297B	3.198E	1.588	0.348	0.454	0.287	0.091	0.393	0.295B	0.300B	27
28	0.337B	0.322B	0.288B	3.327E	1.531	0.478	0.443	0.262	0.082	0.395	0.301B	0.304B	28
29	0.330B		0.280B	3.280E	1.467	0.512	0.433	0.253	0.082	0.393	0.320B	0.309B	29
30	0.325B		0.278B	3.294E	1.452	0.519	0.417	0.265	0.090	0.391	0.319B	0.310B	30
31	0.319B		0.276B		1.427		0.402	0.272		0.377		0.310B	31
MEAN	0.466	0.288	0.278	1.537	2.448	0.718	0.501	0.352	0.157	0.283	0.322	0.304	
MAX	0.535	0.354	0.333	3.327	3.447	1.442	0.677	0.449	0.236	0.486	0.380	0.331	
MIN	0.319	0.234	0.217	0.273	1.427	0.291	0.402	0.253	0.082	0.074	0.271	0.267	
L/s/km²	4.14	2.55	2.47	13.65	21.73	6.37	4.45	3.12	1.39	2.51	2.86	2.70	

ANNUAL MEAN 0.640 MAX 3.447 MIN 0.074 L/s/km² 5.68

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT: 10-1118-0020 (6700) | DATE: September 20, 2012 | Hammond Reef Gold Project | SHEET 8

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Caribou River at Upper Seine Bay — Station ID: SW-08 (downstream)

UTM coordinates: U15 E 626937 N 5423385 — Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.312B	0.311B	0.292B	3.143E	2.395	3.484E	1.226	0.601					1
2	0.309B	0.306B	0.281B	3.129E	2.372	3.296E	1.129	0.601					2
3	0.306B	0.305B	0.280B	3.180E	2.346	3.059E	1.306	0.593					3
4	0.303B	0.308B	0.278B	3.214E	2.298	2.805	1.315	0.582					4
5	0.301B	0.326B	0.277B	3.178E	2.232	2.564	1.240	0.577					5
6	0.298B	0.355B	0.276B	3.106E	2.168	2.320	1.197	0.556					6
7	0.313B	0.372B	0.273B	2.990E	2.274	2.087	1.155	0.547					7
8	0.313B	0.352B	0.286B	2.929B	2.387	1.958	1.087	0.530					8
9	0.292B	0.336B	0.299B	2.864B	2.425	2.146	1.020	0.545					9
10	0.291B	0.357B	0.274B	2.801B	2.366	2.153	0.948	0.602					10
11	0.299B	0.351B	0.272B	2.712B	2.318	2.101	0.885	0.662					11
12	0.298B	0.333B	0.272B	2.631B	2.283	2.016	0.822	0.677					12
13	0.298B	0.335B	0.287B	2.561B	2.168	1.831	0.776	0.666					13
14	0.297B	0.305B	0.303B	2.498B	2.029	1.776	0.738	0.640					14
15	0.297B	0.293B	0.328B	2.467B	1.932	2.231	0.706	0.614					15
16	0.296B	0.281B	0.343B	2.630B	1.810	2.486	0.718	0.599					16
17	0.300B	0.288B	0.379B	2.698B	1.646	2.660	0.722	0.577					17
18	0.305B	0.296B	0.444B	2.651	1.503	2.711	0.714	0.552					18
19	0.309B	0.300B	0.539B	2.670	1.408	2.701	0.683	0.532					19
20	0.313B	0.281B	0.949B	2.679	1.346	2.732	0.657	0.505					20
21	0.317B	0.272B	1.174B	2.668	1.243	2.765	0.639	0.485					21
22	0.321B	0.280B	1.330B	2.657	1.162	2.755	0.620	0.462					22
23	0.326B	0.288B	1.685B	2.660	1.146	2.682	0.595	0.446					23
24	0.333B	0.287B	2.464B	2.664	1.364	2.538	0.581	0.426					24
25	0.327B	0.305B	2.797B	2.659	1.700	2.330	0.561	0.420					25
26	0.307B	0.303B	2.860B	2.686	1.964	2.110	0.539	0.416					26
27	0.319B	0.318B	2.959B	2.652	2.170	1.877	0.519	0.408					27
28	0.326B	0.311B	3.196E	2.599	2.658	1.697	0.496	0.396					28
29	0.354B	0.281B	3.327E	2.510	3.200E	1.505	0.507	0.386					29
30	0.357B		3.299E	2.445	3.466E	1.351	0.598	0.371					30
31	0.317B		3.251E		3.587E		0.623						31
MEAN	0.311	0.312	1.138	2.764	2.109	2.358	0.817	0.532					
MAX	0.357	0.372	3.327	3.214	3.587	3.484	1.315	0.677					
MIN	0.291	0.272	0.272	2.445	1.146	1.351	0.496	0.371					
L/s/km²	2.77	2.77	10.10	24.54	18.72	20.93	7.25	4.73					

ANNUAL — MEAN 1.293 — MAX 3.587 — MIN 0.272 — L/s/km² 11.48

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 9

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08 (upstream)

UTM coordinates: 15U E 626958 N 5423402

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.542	1.538	0.684	0.641B	1
2									0.634	1.511	0.672	0.641B	2
3									0.771	1.469	0.666	0.640B	3
4									0.902	1.421	0.669	0.640B	4
5									0.983	1.382	0.656B	0.639B	5
6									1.003	1.224	0.638B	0.639B	6
7									1.061	1.032	0.634B	0.638B	7
8									1.083	0.953	0.619B	0.638B	8
9									1.103	0.912	0.605B	0.637B	9
10									1.113	0.861	0.590B	0.637B	10
11									1.155	0.816	0.581B	0.636B	11
12									1.191	0.768	0.582B	0.636B	12
13									1.224	0.745	0.558B	0.636B	13
14									1.239	0.729	0.559B	0.635B	14
15									1.238	0.694	0.560B	0.635B	15
16									1.218	0.660	0.554B	0.634B	16
17									1.203	0.639	0.538B	0.634B	17
18									1.186	0.624	0.535B	0.633B	18
19									1.164	0.594	0.531B	0.633B	19
20									1.127	0.558	0.536B	0.632B	20
21									1.102	0.532	0.533B	0.611B	21
22									1.092	0.515	0.556B	0.606B	22
23									1.080	0.493	0.594B	0.602B	23
24									1.225	0.457	0.595B	0.585B	24
25									1.353	0.448	0.602B	0.585B	25
26									1.455	0.504	0.624B	0.590B	26
27								0.257	1.515	0.621	0.635B	0.567B	27
28								0.349	1.560	0.691	0.646B	0.548B	28
29								0.388	1.554	0.708	0.642B	0.536B	29
30								0.392	1.552	0.705	0.641B	0.532B	30
31								0.460		0.691		0.527B	31
MEAN									1.154	0.822	0.601	0.614	
MAX									1.560	1.538	0.684	0.641	
MIN									0.542	0.448	0.531	0.527	
L/s/km²									10.25	7.30	5.34	5.45	

ANNUAL MEAN 0.780 MAX 1.560 MIN 0.257 L/s/km² 6.92

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT: 10-1118-0020 (6700) DATE: September 20, 2012 Hammond Reef Gold Project SHEET 10

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Caribou River at Upper Seine Bay | Station ID: SW-08 (upstream)

UTM coordinates: 15U E 626958 N 5423402 | Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.523B	0.414B	0.334B	0.291B	3.951E	1.299	0.482	0.193	0.309	0.875	0.740	0.446B	1
2	0.519B	0.412B	0.337B	0.291B	4.034E	1.267	0.492	0.246	0.417	0.878	0.749	0.434B	2
3	0.514B	0.411B	0.341B	0.292B	4.036E	1.232	0.463	0.275	0.436	0.887	0.725B	0.404B	3
4	0.510B	0.410B	0.345B	0.302B	3.920E	1.203	0.439	0.259	0.458	0.888	0.699B	0.418B	4
5	0.506B	0.408B	0.349B	0.307B	3.776E	1.144	0.512	0.232	0.486	0.873	0.662B	0.420B	5
6	0.502B	0.407B	0.353B	0.312B	3.725E	1.095	0.524	0.206	0.566	0.871	0.638B	0.422B	6
7	0.498B	0.406B	0.341B	0.315B	3.685E	1.072	0.535	0.186	0.587	0.877	0.620B	0.381B	7
8	0.494B	0.404B	0.320B	0.330B	3.608E	1.021	0.605	0.172	0.579	0.921	0.603B	0.395B	8
9	0.490B	0.403B	0.298B	0.356B	3.501E	0.952	0.604	0.171	0.629	0.954	0.592B	0.395B	9
10	0.486B	0.402B	0.290B	0.401B	3.371E	0.879	0.614	0.158	0.626	0.951	0.578B	0.382B	10
11	0.482B	0.400B	0.275B	0.599B	3.341E	0.803	0.587	0.149	0.616	0.931	0.576B	0.363B	11
12	0.478B	0.399B	0.254B	0.764B	3.285E	0.736	0.545	0.149	0.679	0.933	0.584B	0.360B	12
13	0.474B	0.398B	0.262B	1.061B	3.186E	0.668	0.495	0.131	0.742	1.030	0.575B	0.348B	13
14	0.470B	0.376B	0.255B	1.439B	3.018E	0.601	0.446	0.117	0.744	1.122	0.563B	0.330B	14
15	0.489B	0.342B	0.247B	1.703B	2.819	0.541	0.414	0.099	0.724	1.224	0.557B	0.338B	15
16	0.529B	0.316B	0.244B	1.773B	2.627	0.493	0.417	0.087	0.738	1.129	0.546B	0.376B	16
17	0.504B	0.289B	0.247B	1.845B	2.445	0.457	0.405	0.081	0.755	1.038	0.537B	0.380B	17
18	0.507B	0.308B	0.264B	1.921B	2.263	0.422	0.377	0.065	0.842	1.053	0.525B	0.357B	18
19	0.502B	0.328B	0.267B	2.000B	2.081	0.401	0.333	0.052	0.905	1.043	0.512B	0.367B	19
20	0.483B	0.318B	0.266B	2.081B	1.944	0.373	0.310	0.039	0.827	1.082	0.516B	0.368B	20
21	0.523B	0.338B	0.275B	2.167B	1.834	0.347	0.347	0.028	0.820	1.047	0.490B	0.347B	21
22	0.502B	0.344B	0.288B	2.255B	1.786	0.331	0.377	0.018	0.781	0.977	0.459B	0.367B	22
23	0.481B	0.313B	0.338B	2.316B	1.812	0.337	0.381	0.012	0.853	0.931	0.430B	0.369B	23
24	0.461B	0.315B	0.316B	2.446B	1.764	0.327	0.363	0.011	0.914	0.913	0.402B	0.371B	24
25	0.442B	0.319B	0.318B	2.676B	1.689	0.305	0.356	0.014	0.922	0.891	0.390B	0.364B	25
26	0.424B	0.322B	0.317B	2.975E	1.616	0.275	0.334	0.011	0.904	0.849	0.400B	0.363B	26
27	0.407B	0.326B	0.313B	3.303E	1.526	0.338	0.315	0.017	0.876	0.824	0.427B	0.380B	27
28	0.405B	0.330B	0.303B	3.572E	1.432	0.466	0.300	0.123	0.860	0.823	0.436B	0.394B	28
29	0.418B		0.296B	3.706E	1.358	0.494	0.278	0.247	0.875	0.814	0.449B	0.370B	29
30	0.416B		0.294B	3.780E	1.329	0.486	0.249	0.238	0.886	0.798	0.446B	0.370B	30
31	0.415B		0.292B		1.296		0.222	0.205		0.767		0.369B	31
MEAN	0.479	0.363	0.298	1.586	2.647	0.679	0.423	0.129	0.712	0.942	0.547	0.379	
MAX	0.529	0.414	0.353	3.780	4.036	1.299	0.614	0.275	0.922	1.224	0.749	0.446	
MIN	0.405	0.289	0.244	0.291	1.296	0.275	0.222	0.011	0.309	0.767	0.390	0.330	
L/s/km²	4.25	3.22	2.65	14.08	23.50	6.03	3.76	1.14	6.32	8.36	4.86	3.36	

ANNUAL — MEAN: 0.767 — MAX: 4.036 — MIN: 0.011 — L/s/km²: 6.81

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 11

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08

UTM coordinates: 15U E 626958 N 5423402

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.378B	0.340B	0.408B	3.130E	2.107	5.758E	1.719	0.850					1
2	0.403B	0.327B	0.405B	3.040E	2.122	5.244E	1.623	0.835					2
3	0.408B	0.325B	0.429B	3.153E	2.106	4.606E	1.875	0.809					3
4	0.370B	0.317B	0.454B	3.236E	2.065	3.975E	1.922	0.780					4
5	0.347B	0.347B	0.455B	3.171E	2.004	3.414E	1.859	0.757					5
6	0.336B	0.404B	0.420B	2.997E	1.956	2.950	1.809	0.719					6
7	0.350B	0.396B	0.423B	2.781	2.106	2.574	1.781	0.695					7
8	0.347B	0.367B	0.439B	2.651	2.283	2.387	1.716	0.666					8
9	0.328B	0.349B	0.456B	2.526	2.348	2.681	1.624	0.696					9
10	0.323B	0.358B	0.439B	2.404	2.313	2.708	1.526	0.810					10
11	0.330B	0.346B	0.441B	2.279	2.266	2.640	1.429	0.949					11
12	0.357B	0.335B	0.450B	2.173	2.243	2.510	1.323	0.995					12
13	0.360B	0.339B	0.487B	2.068	2.136	2.291	1.230	0.964					13
14	0.352B	0.328B	0.510B	2.013	2.020	2.231	1.151	0.905					14
15	0.323B	0.319B	0.542B	1.972	1.928	2.887	1.079	0.841					15
16	0.307B	0.316B	0.586B	2.140	1.809	3.335E	1.083	0.813					16
17	0.317B	0.326B	0.666B	2.240	1.669	3.690E	1.097	0.754					17
18	0.325B	0.336B	0.804B	2.230	1.545	3.823E	1.061	0.707					18
19	0.346B	0.342B	0.987B	2.271	1.456	3.802E	1.009	0.655					19
20	0.327B	0.331B	0.940B	2.291	1.405	3.871E	0.954	0.606					20
21	0.310B	0.333B	1.063B	2.299	1.323	3.954E	0.921	0.565					21
22	0.290B	0.357B	1.157B	2.311	1.265	3.937E	0.875	0.526					22
23	0.307B	0.361B	1.453B	2.334	1.263	3.782E	0.826	0.492					23
24	0.326B	0.368B	2.266B	2.354	1.483	3.500E	0.780	0.460					24
25	0.332B	0.394B	2.582B	2.364	1.831	3.146E	0.745	0.450					25
26	0.327B	0.398B	2.636B	2.412	2.113	2.806	0.703	0.440					26
27	0.337B	0.410B	2.818B	2.373	2.362	2.509	0.659	0.421					27
28	0.341B	0.412B	3.214E	2.308	3.105E	2.281	0.616	0.403					28
29	0.361B	0.397B	3.437E	2.213	4.352E	2.037	0.634	0.386					29
30	0.364B		3.503E	2.147	5.486E	1.845	0.834	0.368					30
31	0.341B		3.362E		5.953E		0.883						31
MEAN	0.341	0.354	1.233	2.463	2.272	3.239	1.205	0.677					
MAX	0.408	0.412	3.503	3.236	5.953	5.758	1.922	0.995					
MIN	0.290	0.316	0.405	1.972	1.263	1.845	0.616	0.368					
L/s/km²	3.03	3.15	10.95	21.86	20.17	28.75	10.69	6.01					

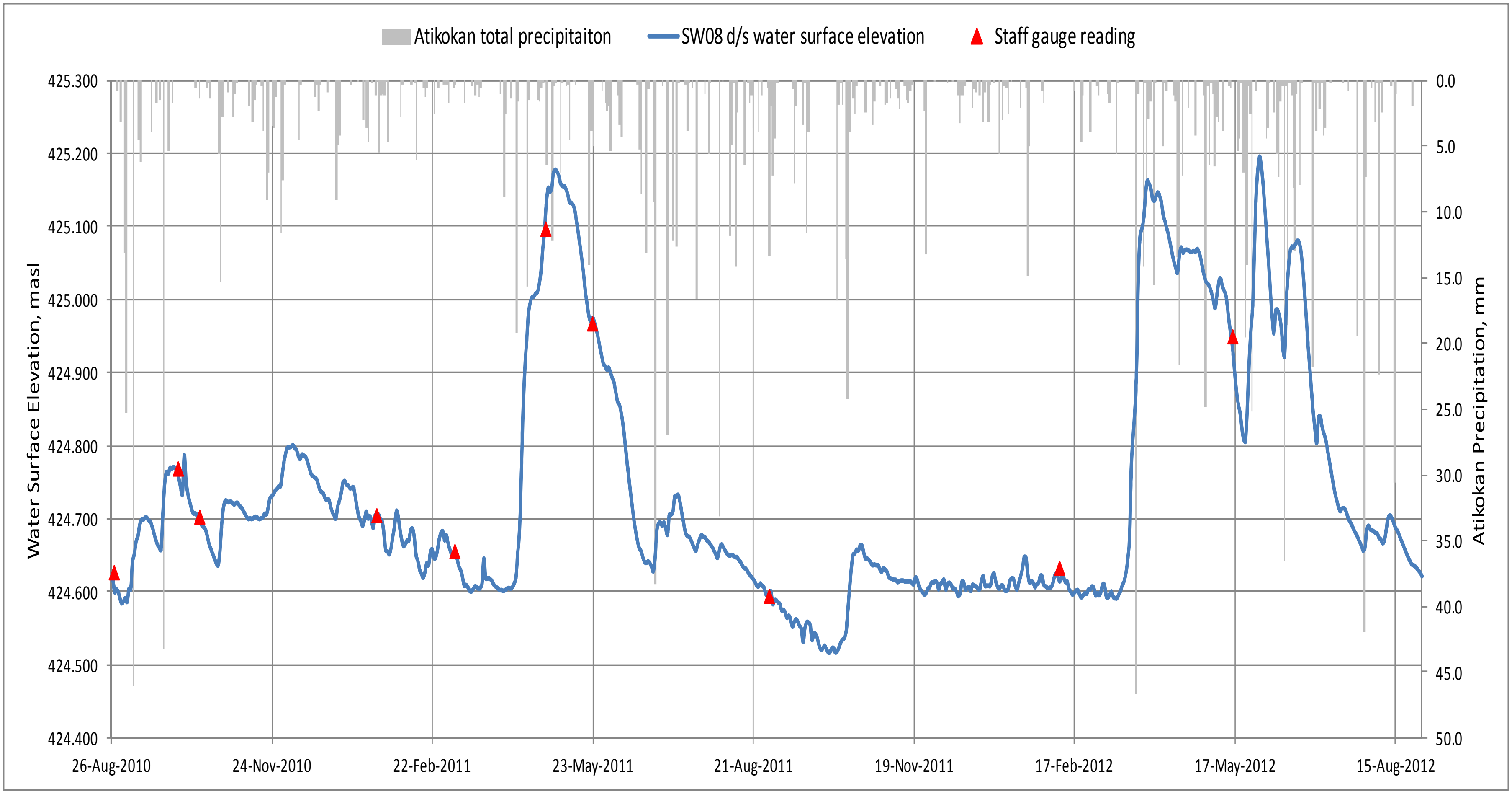
ANNUAL MEAN 1.474 MAX 5.953 MIN 0.290 L/s/km² 13.09

LEGEND: B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

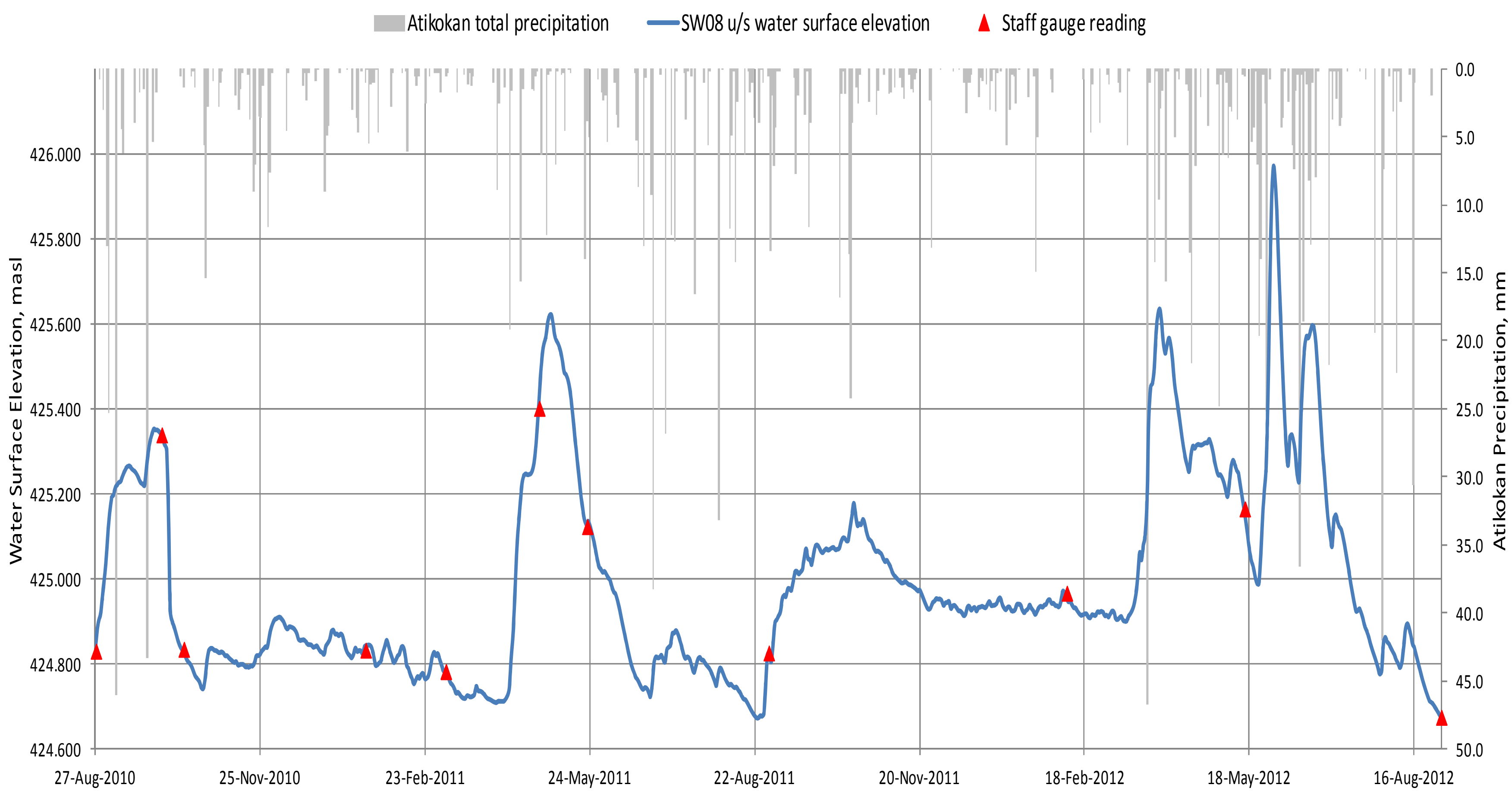
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 12



Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

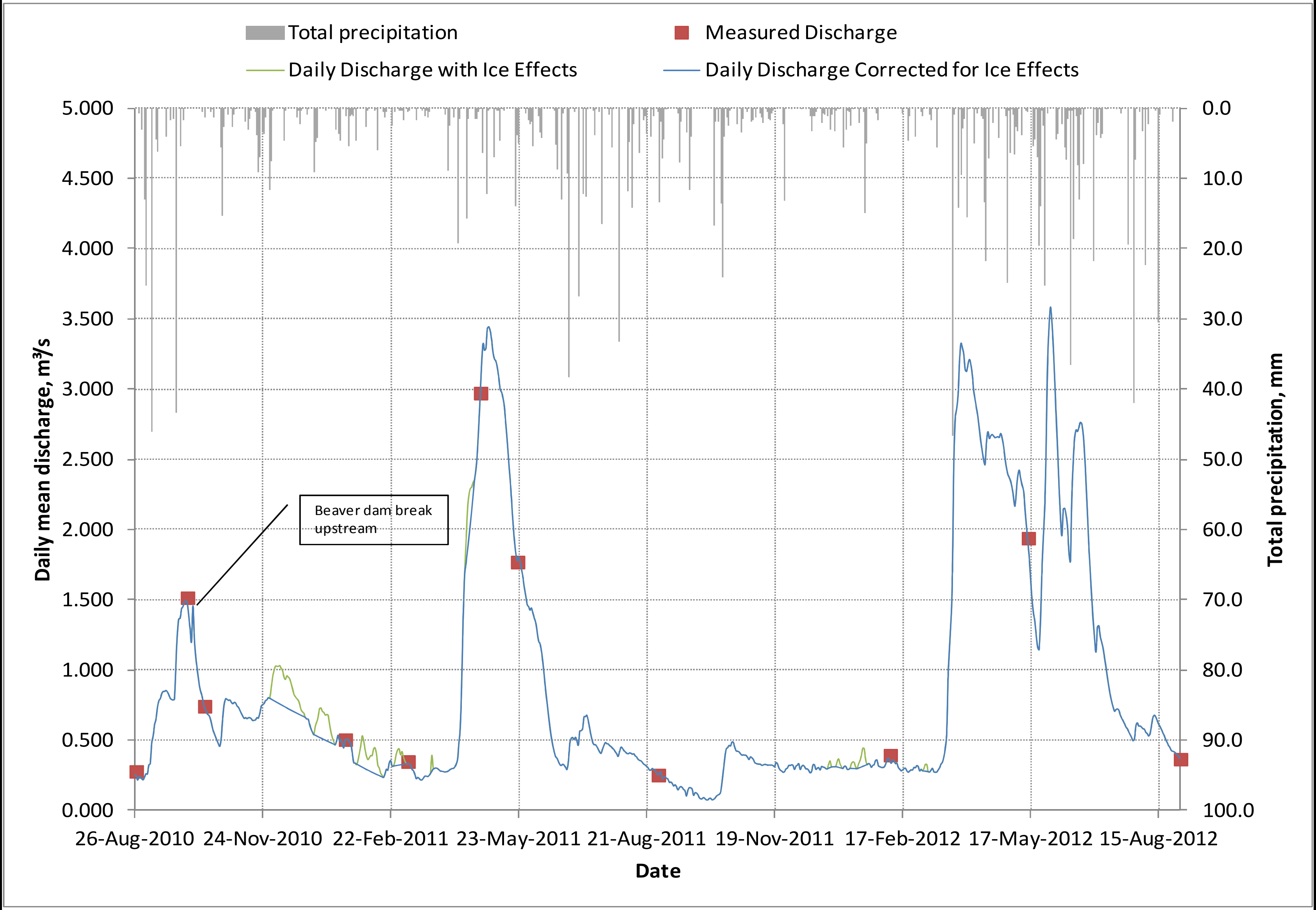
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 13



Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

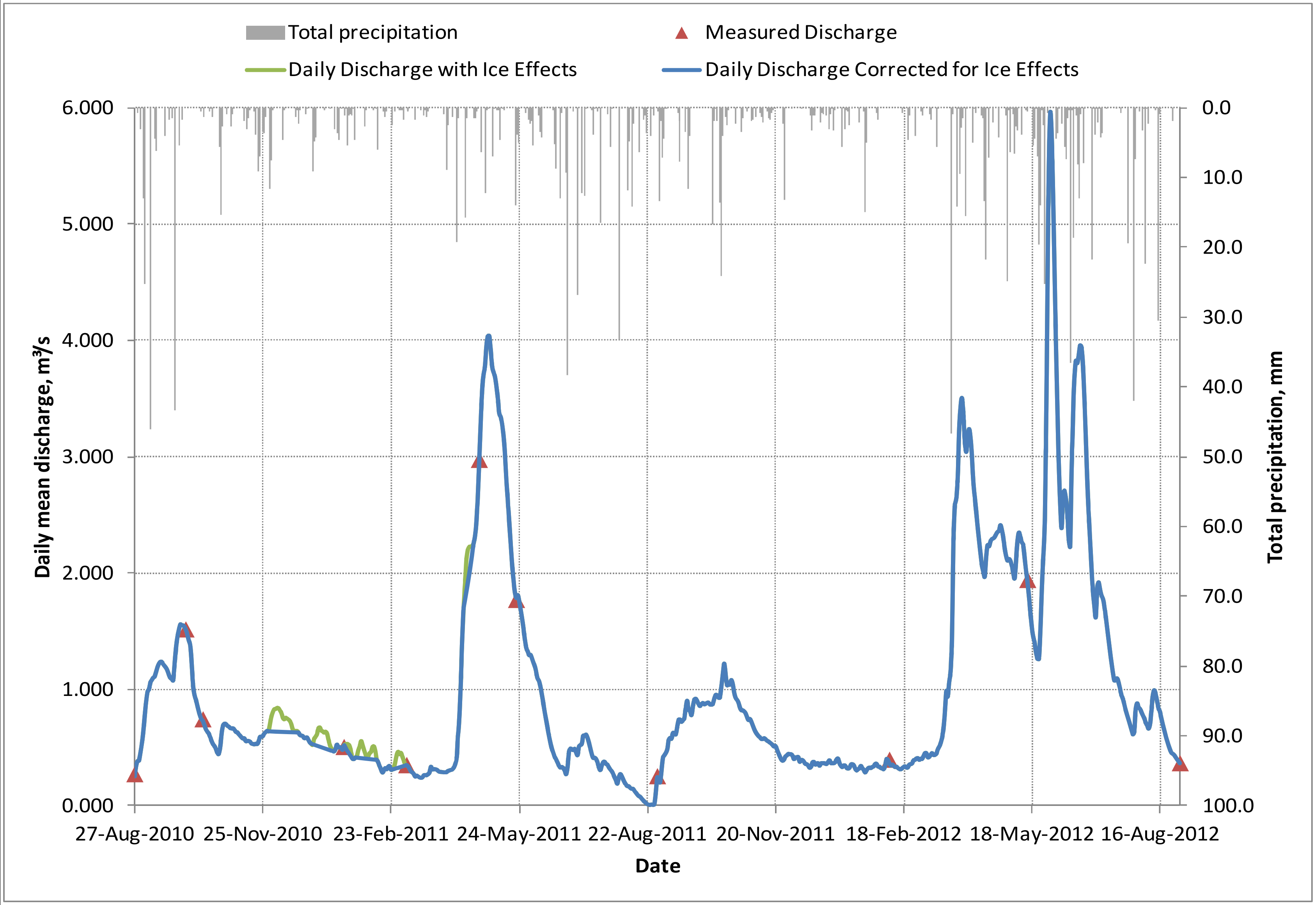
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 14



Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 15



Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 16

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08DS

UTM coordinates:

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									21.8	11.0	5.3	0.5	1
2									19.9	10.3	5.2	0.5	2
3									17.2	10.2	6.2	0.5	3
4									15.5	10.5	4.7	0.5	4
5									15.7	10.9	3.6	0.4	5
6									15.8	11.6	4.0	0.3	6
7									14.0	11.3	4.3	0.2	7
8									13.3	11.8	4.5	0.2	8
9									13.6	12.7	4.8	0.2	9
10									14.1	12.6	5.2	0.2	10
11									14.8	12.6	5.0	0.2	11
12									14.7	11.4	3.6	0.1	12
13									14.6	10.9	3.3	0.1	13
14									14.0	10.6	2.7	0.1	14
15									13.1	10.6	2.7	0.1	15
16									12.9	10.3	2.7	0.1	16
17									13.8	9.5	2.1	0.1	17
18									12.7	8.6	1.4	0.1	18
19									12.5	8.7	0.9	0.1	19
20									12.3	8.7	0.5	0.1	20
21									12.9	7.5	0.4	0.2	21
22									12.9	8.1	0.6	0.2	22
23									12.3	8.1	0.2	0.2	23
24									11.2	7.5	0.3	0.2	24
25									11.2	8.0	0.5	0.2	25
26								20.6	11.5	9.0	0.3	0.1	26
27								20.3	11.4	7.5	0.6	0.1	27
28								22.2	11.5	6.3	0.7	0.1	28
29								23.0	11.5	5.6	1.0	0.1	29
30								23.7	11.6	5.8	0.7	0.1	30
31								23.7		5.4		0.1	31
MEAN (°C)									13.8	9.5	2.6	0.2	
MAX (°C)									21.8	12.7	6.2	0.5	
MIN (°C)									11.2	5.4	0.2	0.1	

ANNUAL MEAN (°C) 6.5 MAX (°C) 21.8 MIN (°C) 0.1

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT: 10-1118-0020 (6700) DATE: September 20, 2012

Hammond Reef Gold Project

SHEET 17

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08DS

UTM coordinates:

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.1	0.1	0.1	1.7	4.0	14.4	21.6	24.0	20.2	10.4	6.1	0.5	1
2	0.1	0.1	0.1	1.9	4.3	14.9	22.9	25.0	21.6	10.8	5.9	0.4	2
3	0.1	0.1	0.1	1.2	5.0	15.7	22.7	24.3	20.0	11.7	4.6	0.4	3
4	0.1	0.1	0.1	1.4	5.4	16.6	22.5	24.4	18.0	12.8	4.1	0.5	4
5	0.1	0.1	0.1	1.9	4.9	16.9	23.4	24.8	16.2	13.4	4.5	0.3	5
6	0.1	0.1	0.1	2.4	5.9	19.1	23.4	24.4	16.8	13.8	5.6	0.3	6
7	0.1	0.1	0.1	2.3	6.4	18.7	23.1	24.3	18.3	14.0	4.3	0.3	7
8	0.1	0.1	0.1	2.5	7.1	17.0	23.8	23.3	19.6	15.6	3.8	0.3	8
9	0.1	0.1	0.1	3.2	7.9	16.3	22.6	21.9	20.5	15.3	3.3	0.2	9
10	0.1	0.1	0.1	2.3	8.8	17.0	23.4	21.3	20.9	14.5	3.3	0.2	10
11	0.1	0.1	0.1	3.0	10.2	17.4	23.9	22.5	20.8	14.9	2.7	0.2	11
12	0.1	0.1	0.1	2.8	11.2	18.5	22.1	22.8	19.4	14.2	3.5	0.3	12
13	0.1	0.1	0.1	1.9	10.6	19.6	21.7	23.4	16.5	13.5	3.4	0.2	13
14	0.1	0.1	0.1	2.2	10.2	19.9	22.4	22.9	13.3	11.6	3.2	0.3	14
15	0.1	0.1	0.3	2.7	10.8	19.6	21.5	23.6	11.4	9.5	3.0	0.4	15
16	0.1	0.1	0.6	2.0	11.8	19.9	23.1	23.6	11.4	8.8	2.4	0.2	16
17	0.1	0.1	0.9	2.4	13.0	20.9	25.2	22.6	11.4	8.5	1.2	0.2	17
18	0.1	0.1	0.5	2.9	14.0	20.3	26.7	22.2	11.9	8.4	0.9	0.2	18
19	0.1	0.1	0.7	3.0	15.5	18.4	26.6	22.2	13.0	8.2	0.8	0.2	19
20	0.1	0.1	0.8	3.1	17.0	17.9	25.2	20.4	13.2	8.2	0.5	0.2	20
21	0.1	0.1	1.2	3.3	17.0	18.2	24.8	20.3	12.5	7.3	0.4	0.3	21
22	0.1	0.1	1.0	3.2	17.0	17.1	24.5	19.9	10.6	7.6	0.3	0.3	22
23	0.1	0.1	0.6	3.2	17.0	16.5	21.4	21.9	11.2	7.9	0.7	0.2	23
24	0.1	0.1	0.7	3.7	15.5	18.6	21.2	20.7	11.0	7.3	1.1	0.2	24
25	0.1	0.1	0.7	4.1	15.5	20.4	21.8	20.1	11.4	6.4	1.3	0.3	25
26	0.1	0.1	0.7	3.7	15.3	19.9	22.0	21.5	12.3	6.5	1.0	0.3	26
27	0.1	0.1	0.8	3.1	15.4	18.8	21.5	20.7	13.0	5.9	0.5	0.3	27
28	0.1	0.1	0.8	4.3	14.7	17.7	22.6	19.8	13.4	5.5	0.6	0.2	28
29	0.1		1.0	4.8	15.8	19.0	22.8	20.5	13.2	6.0	0.6	0.1	29
30	0.1		1.4	4.2	15.5	19.9	22.9	20.6	11.8	5.5	0.5	0.2	30
31	0.1		1.7		15.8		23.4	20.1		5.5		0.2	31
MEAN (°C)	0.1	0.1	0.5	2.8	11.6	18.2	23.1	22.3	15.2	10.0	2.5	0.3	
MAX (°C)	0.1	0.1	1.7	4.8	17.0	20.9	26.7	25.0	21.6	15.6	6.1	0.5	
MIN (°C)	0.1	0.1	0.1	1.2	4.0	14.4	21.2	19.8	10.6	5.5	0.3	0.1	

ANNUAL MEAN (°C) 8.9 MAX (°C) 26.7 MIN (°C) 0.1

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 18

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Caribou River at Upper Seine Bay | Station ID: SW-08DS

UTM coordinates: | Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.2	0.1	0.1	4.6	10.3	15.4	24.5	23.8					1
2	0.1	0.1	0.1	4.4	11.6	16.7	25.2	23.8					2
3	0.1	0.2	0.1	5.0	12.3	17.6	25.3	23.2					3
4	0.1	0.2	0.1	4.8	12.5	18.7	25.4	22.6					4
5	0.1	0.2	0.1	5.1	11.9	19.4	25.7	21.8					5
6	0.1	0.2	0.1	5.5	11.8	20.6	24.4	22.3					6
7	0.1	0.2	0.1	5.8	11.9	21.7	24.6	21.8					7
8	0.1	0.2	0.1	5.8	11.8	21.2	25.1	21.9					8
9	0.1	0.1	0.1	5.5	12.3	21.7	24.7	21.8					9
10	0.2	0.1	0.2	5.5	13.4	22.3	24.6	21.1					10
11	0.2	0.1	0.3	6.1	13.3	21.5	25.2	21.9					11
12	0.1	0.1	0.4	6.8	13.5	19.6	25.7	22.0					12
13	0.1	0.1	0.9	7.4	13.8	19.1	26.1	22.1					13
14	0.1	0.1	1.5	7.2	14.9	18.6	26.5	21.8					14
15	0.1	0.1	1.7	6.9	14.5	18.8	26.1	21.6					15
16	0.1	0.1	2.0	4.2	14.5	19.8	24.8	20.7					16
17	0.1	0.1	3.1	4.9	15.5	19.7	24.6	19.3					17
18	0.1	0.1	3.6	5.3	16.5	20.0	24.4	19.8					18
19	0.1	0.1	3.7	5.9	17.9	19.7	25.0	19.0					19
20	0.1	0.1	3.8	6.2	16.4	19.5	25.0	19.7					20
21	0.1	0.1	3.2	6.4	16.4	19.7	25.1	20.0					21
22	0.1	0.1	3.9	6.9	16.3	20.0	24.9	21.0					22
23	0.1	0.1	4.0	7.5	16.2	20.6	24.7	22.1					23
24	0.1	0.1	3.8	8.7	15.8	21.1	24.2	22.7					24
25	0.1	0.1	3.3	8.1	15.3	21.3	24.4	22.8					25
26	0.1	0.1	3.8	7.9	15.1	21.5	23.3	21.9					26
27	0.1	0.1	4.2	8.3	14.3	22.6	22.7	21.1					27
28	0.1	0.1	4.2	8.9	14.0	23.6	23.5	21.1					28
29	0.1	0.1	4.0	9.3	14.2	23.3	22.6	21.6					29
30	0.1		3.6	9.6	13.9	23.5	22.3	21.6					30
31	0.1		3.8		14.5	24.5	22.7						31
MEAN (°C)	0.1	0.1	2.1	6.5	14.1	20.4	24.6	21.6					
MAX (°C)	0.2	0.2	4.2	9.6	17.9	24.5	26.5	23.8					
MIN (°C)	0.1	0.1	0.1	4.2	10.3	15.4	22.3	19.0					

ANNUAL MEAN (°C) 11.2 MAX (°C) 26.5 MIN (°C) 0.1

Golder Associates

Flow Monitoring Station SW-08 (Downstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 19

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08US

UTM coordinates:

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									21.1	10.6	4.7	-0.1	1
2									19.1	9.8	4.7	-0.1	2
3									16.7	9.7	5.7	-0.1	3
4									14.4	10.0	4.2	0.0	4
5									13.5	10.6	3.1	-0.1	5
6									13.4	11.3	3.5	-0.3	6
7									13.3	10.9	3.7	-0.3	7
8									12.6	11.5	4.0	-0.3	8
9									12.6	12.4	4.3	-0.4	9
10									13.2	12.3	4.8	-0.4	10
11									14.2	12.2	4.6	-0.4	11
12									14.1	10.9	3.1	-0.4	12
13									14.1	10.4	2.8	-0.4	13
14									13.5	10.1	2.2	-0.4	14
15									12.6	10.2	2.1	-0.4	15
16									12.4	9.8	2.2	-0.4	16
17									13.5	9.0	1.6	-0.4	17
18									12.2	8.1	0.8	-0.4	18
19									12.0	8.2	0.4	-0.4	19
20									11.9	8.2	0.0	-0.4	20
21									12.5	7.0	-0.2	-0.4	21
22									12.5	7.6	0.1	-0.4	22
23									11.9	7.6	-0.2	-0.4	23
24									10.8	7.0	-0.2	-0.4	24
25									10.7	7.6	-0.1	-0.4	25
26									10.9	8.6	-0.3	-0.4	26
27								21.4	10.8	6.9	0.0	-0.4	27
28								22.1	11.1	5.6	0.2	-0.4	28
29								22.8	11.2	5.0	0.4	-0.4	29
30								23.6	11.3	5.2	0.1	-0.4	30
31								23.5		4.7		-0.5	31
MEAN (°C)									13.1	9.0	2.1	-0.3	
MAX (°C)									21.1	12.4	5.7	0.0	
MIN (°C)									10.7	4.7	-0.3	-0.5	

ANNUAL MEAN (°C) 6.0 MAX (°C) 21.1 MIN (°C) -0.5

Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 20

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08US

UTM coordinates:

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.5	-0.5	-0.5	1.2	3.6	14.2	21.6	23.8	20.0	8.7	5.6	0.0	1
2	-0.5	-0.5	-0.5	1.3	3.9	14.7	22.9	24.9	21.4	8.9	5.3	-0.1	2
3	-0.5	-0.5	-0.5	0.7	4.7	15.6	22.5	23.9	19.7	10.0	3.9	-0.1	3
4	-0.5	-0.5	-0.5	0.8	5.0	16.5	22.4	24.2	17.7	10.8	3.5	-0.1	4
5	-0.5	-0.5	-0.5	1.4	4.5	16.8	23.4	24.5	15.6	11.6	3.9	-0.2	5
6	-0.5	-0.5	-0.5	1.9	5.6	19.1	23.3	24.2	15.9	12.2	5.1	-0.2	6
7	-0.5	-0.5	-0.5	1.8	6.1	18.5	23.0	24.0	17.1	12.4	3.8	-0.3	7
8	-0.5	-0.5	-0.5	1.9	6.8	16.8	23.7	23.1	18.3	13.2	3.2	-0.3	8
9	-0.5	-0.5	-0.5	2.4	7.6	16.0	22.4	21.7	18.9	13.7	2.8	-0.3	9
10	-0.5	-0.5	-0.5	1.6	8.5	16.8	23.4	21.0	19.5	13.0	2.7	-0.3	10
11	-0.5	-0.5	-0.5	2.4	10.0	17.1	23.9	22.2	19.6	13.2	2.2	-0.3	11
12	-0.5	-0.5	-0.5	2.3	11.0	18.3	22.0	22.6	18.1	12.8	3.0	-0.3	12
13	-0.5	-0.5	-0.4	1.5	10.3	19.4	21.5	23.2	15.6	12.7	2.9	-0.3	13
14	-0.5	-0.5	-0.4	1.7	9.9	19.9	22.2	22.6	12.8	11.0	2.6	-0.3	14
15	-0.5	-0.5	-0.3	2.3	10.5	19.5	21.3	23.4	10.5	8.9	2.5	-0.2	15
16	-0.5	-0.5	0.0	1.4	11.5	19.8	23.1	23.5	10.1	8.1	1.9	-0.3	16
17	-0.5	-0.5	0.2	1.8	12.8	20.7	25.3	22.5	10.1	7.6	0.8	-0.4	17
18	-0.5	-0.5	-0.1	2.4	13.7	20.2	26.8	22.0	11.3	7.5	0.4	-0.4	18
19	-0.5	-0.5	0.1	2.5	15.3	18.2	26.6	22.0	12.0	7.5	0.4	-0.3	19
20	-0.5	-0.5	0.3	2.7	16.9	17.7	25.1	20.1	12.3	7.5	0.0	-0.4	20
21	-0.5	-0.5	0.5	2.9	16.9	18.0	24.7	19.9	11.9	6.7	-0.1	-0.3	21
22	-0.5	-0.5	0.4	2.9	16.9	16.9	24.5	19.5	10.0	7.0	-0.2	-0.3	22
23	-0.5	-0.5	0.1	2.8	16.8	16.3	21.1	21.7	10.5	7.3	0.1	-0.4	23
24	-0.5	-0.5	0.2	3.3	15.3	18.4	21.0	20.6	9.7	6.8	0.5	-0.3	24
25	-0.5	-0.5	0.2	3.8	15.3	20.3	21.6	19.7	9.5	5.7	0.7	-0.3	25
26	-0.5	-0.5	0.2	3.4	15.1	19.8	21.8	21.2	10.1	5.9	0.4	-0.3	26
27	-0.5	-0.5	0.3	2.6	15.2	18.6	21.4	20.2	10.7	5.3	0.0	-0.3	27
28	-0.5	-0.5	0.3	4.0	14.5	17.6	22.5	19.5	11.1	4.8	0.1	-0.4	28
29	-0.5		0.5	4.4	15.7	18.9	22.7	20.2	12.2	5.4	0.1	-0.4	29
30	-0.5		0.9	3.8	15.3	19.8	22.8	20.3	11.2	4.9	0.0	-0.4	30
31	-0.5		1.2		15.6		23.2	19.9		4.9		-0.4	31
MEAN (°C)	-0.5	-0.5	-0.1	2.3	11.3	18.0	23.0	22.0	14.1	8.9	1.9	-0.3	
MAX (°C)	-0.5	-0.5	1.2	4.4	16.9	20.7	26.8	24.9	21.4	13.7	5.6	0.0	
MIN (°C)	-0.5	-0.5	-0.5	0.7	3.6	14.2	21.0	19.5	9.5	4.8	-0.2	-0.4	

ANNUAL MEAN (°C) 8.4 MAX (°C) 26.8 MIN (°C) -0.5

Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 21

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Caribou River at Upper Seine Bay

Station ID: SW-08US

UTM coordinates:

Drainage area: 11,264.36 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.4	-0.5	-0.5	4.3	10.0	15.2	24.4	23.7					1
2	-0.4	-0.5	-0.5	3.9	11.4	16.6	25.1	23.7					2
3	-0.4	-0.4	-0.5	4.6	12.0	17.5	25.0	23.1					3
4	-0.4	-0.4	-0.5	4.5	12.2	18.6	24.7	22.5					4
5	-0.4	-0.4	-0.5	4.7	11.6	19.3	25.4	21.7					5
6	-0.4	-0.4	-0.5	5.1	11.5	20.4	24.1	22.2					6
7	-0.4	-0.4	-0.5	5.3	11.6	21.6	24.3	21.7					7
8	-0.4	-0.4	-0.4	5.4	11.5	20.9	25.0	21.8					8
9	-0.4	-0.5	-0.5	5.0	12.1	21.6	24.6	21.7					9
10	-0.4	-0.5	-0.4	5.0	13.1	22.2	24.5	21.0					10
11	-0.4	-0.5	-0.3	5.7	13.0	21.3	25.1	21.7					11
12	-0.4	-0.5	-0.2	6.4	13.2	19.2	25.7	21.8					12
13	-0.5	-0.5	0.2	7.1	13.6	19.0	26.1	22.0					13
14	-0.5	-0.5	0.8	6.8	14.7	18.3	26.5	21.7					14
15	-0.5	-0.5	1.0	6.5	14.3	18.2	26.0	21.5					15
16	-0.4	-0.5	1.3	3.7	14.2	19.2	24.7	20.5					16
17	-0.4	-0.5	2.4	4.4	15.3	19.4	24.5	19.1					17
18	-0.5	-0.5	3.0	4.8	16.3	19.9	24.3	19.6					18
19	-0.5	-0.5	3.2	5.5	17.8	19.4	24.9	18.7					19
20	-0.5	-0.5	3.4	5.8	16.2	19.2	25.0	19.5					20
21	-0.5	-0.5	2.8	6.0	16.2	19.5	25.1	19.8					21
22	-0.5	-0.5	3.4	6.6	16.0	19.7	24.8	20.9					22
23	-0.5	-0.5	3.6	7.1	16.0	20.3	24.7	22.0					23
24	-0.5	-0.5	3.4	8.4	15.6	20.7	24.1	22.6					24
25	-0.5	-0.5	2.8	7.8	15.1	21.0	24.3	22.7					25
26	-0.5	-0.5	3.3	7.5	14.8	21.2	23.2	21.7					26
27	-0.5	-0.5	3.8	7.9	14.1	22.4	22.5	20.9					27
28	-0.5	-0.5	3.8	8.6	13.7	23.6	23.4	20.8					28
29	-0.5	-0.5	3.5	8.9	14.0	23.2	22.4	21.2					29
30	-0.5		3.1	9.3	13.7	23.4	22.2	21.4					30
31	-0.5		3.3		14.3	24.4	22.6						31
MEAN (°C)	-0.5	-0.5	1.5	6.1	13.8	20.2	24.5	21.4					
MAX (°C)	-0.4	-0.4	3.8	9.3	17.8	24.4	26.5	23.7					
MIN (°C)	-0.5	-0.5	-0.5	3.7	10.0	15.2	22.2	18.7					

ANNUAL MEAN (°C) 10.8 MAX (°C) 26.5 MIN (°C) -0.5

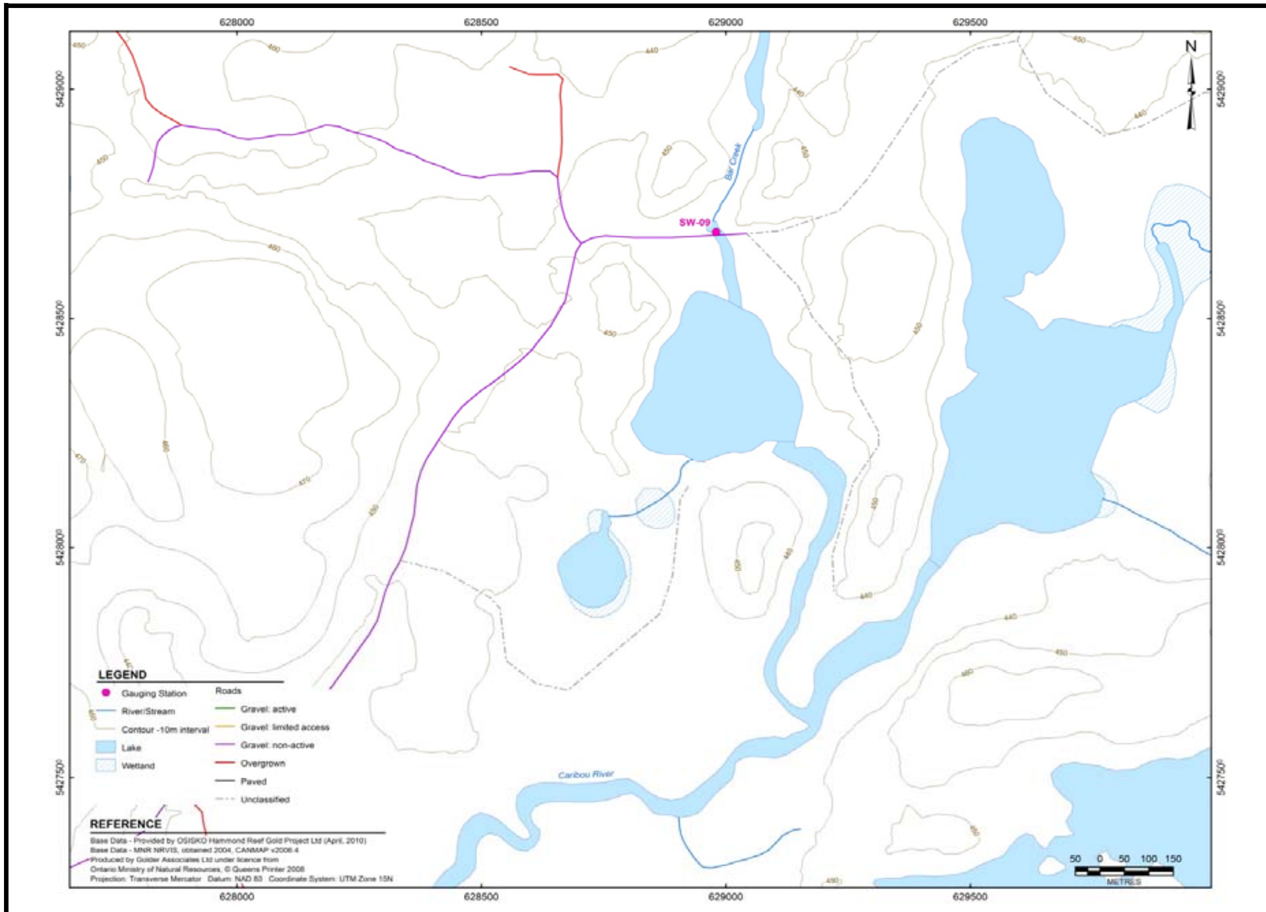
Golder Associates

Flow Monitoring Station SW-08 (Upstream Gauge)

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 22

ATTACHMENT 5.I.10

Local Scale Monitoring Station SW-09; Bar Creek above Caribou River




Logger installation

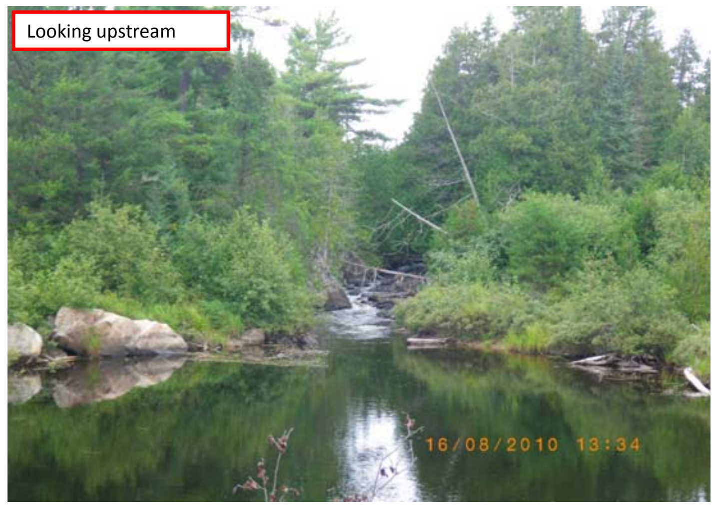

Culvert inlet, staff gauge and cable housing

Station ID:	SW-09	**Installation Date:**	21-Aug-2010
Watercourse Name:	Bar Creek above Caribou River	**Equipment Installed:**	Solinst Model 3001 Levelogger Gold with direct read cable and staff gauge
UTM Coordinates:	15U E 628979 N 5428689	**Logger Serial No.:**	021053611 M5
Location Description:	The station is located at the twin culvert crossing on the gravel road to the northeast off Premier Road at KM29. It is located in the lower catchment draining to Upper Seine Bay.	**Installation Type:**	Logger installed in concrete block on stream bed upstream and between twin culverts. Cable run in flexible pipe to pipe housing at top of road upstream of culverts. Staff gauge installed on T-post in stream bed upstream of culverts.
Elevation:	The benchmark is centre of painted "X" on high point of large boulder on the south side of the road. Benchmark surveyed as 432.816 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out by debris or ice; possible backwater from small beaver dam downstream of culverts

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 1



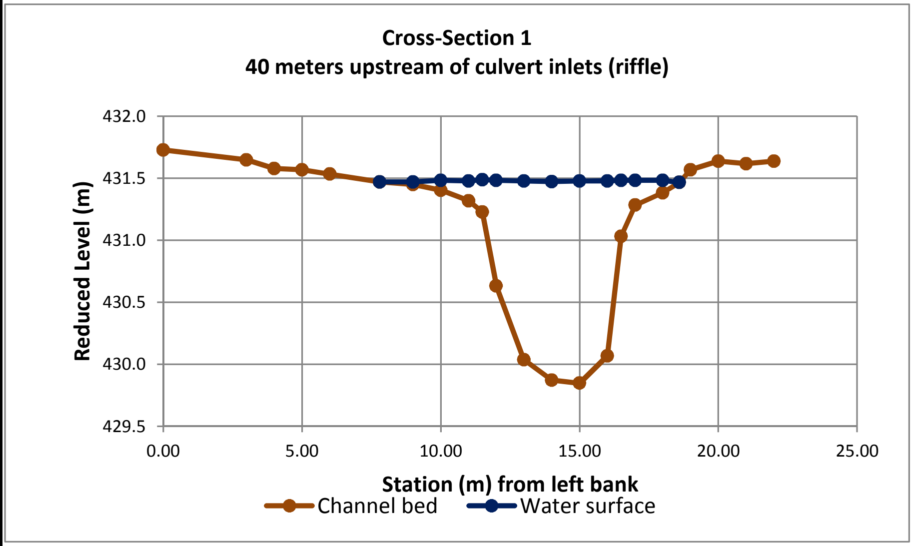
Gauge:	Hydraulic Control:	Hydraulic control is provided by twin 2200 mm diameter CSP culverts with projecting ends and the road embankment.
Current Metering Section:	General Section Description:	Discharge measurements are collected at the culvert outlets. The west culvert is damaged at the inlet.
	Thalweg (straight, bend, off-center):	Off centre, towards right bank
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Trees, brush and grass
	Bankfull Depth (m):	1.75
	Bankfull Width (m):	15.00
	Floodplain Observations:	Deposition on right bank
	General Observations:	Mature fluvial channel; wide shallow cross-section; braided and meandering downstream
Substrate:	Left Bank:	Sandy gravel with cobbles and boulders
	Bed :	Sandy gravel with cobbles and boulders
	Right Bank:	Sandy gravel with cobbles and boulders

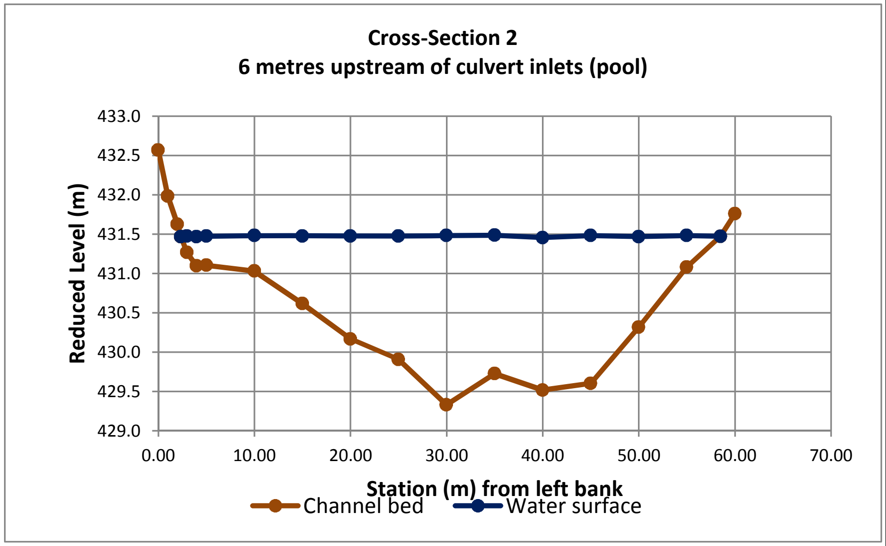
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

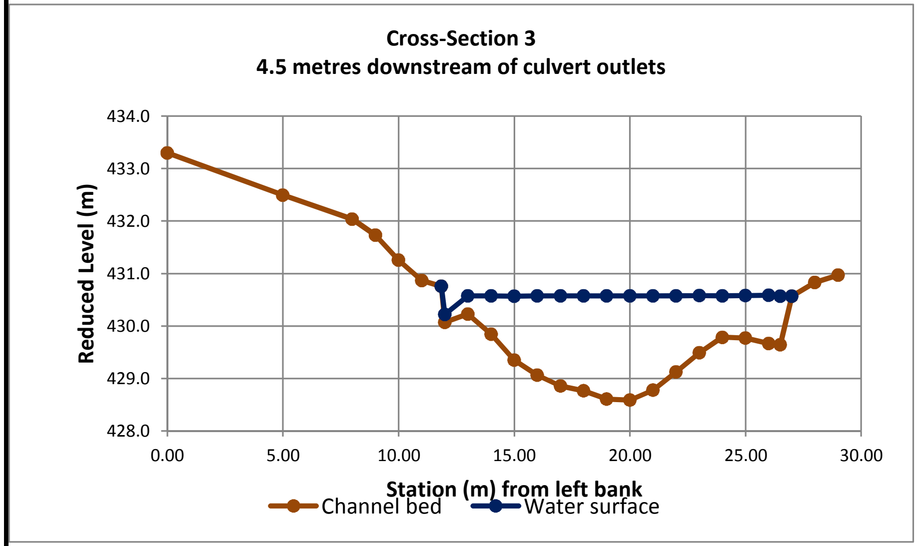
Golder Associates

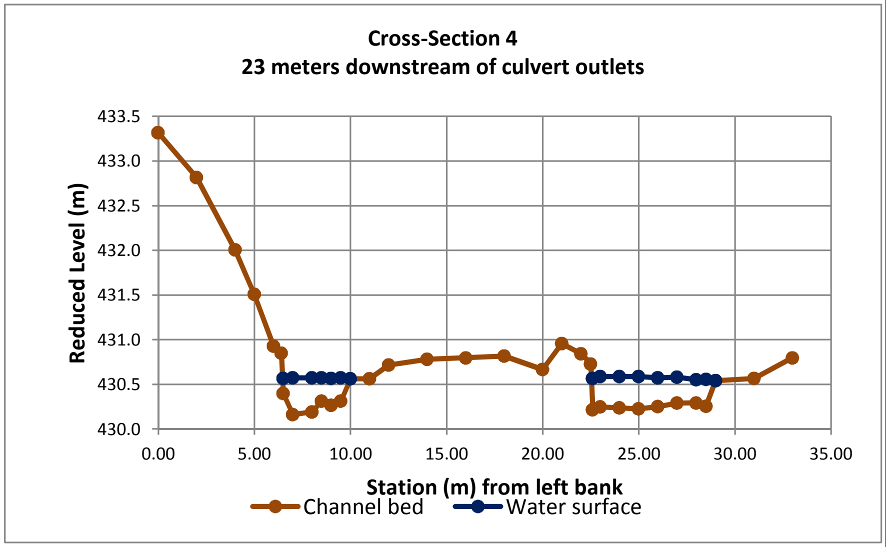
Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 2







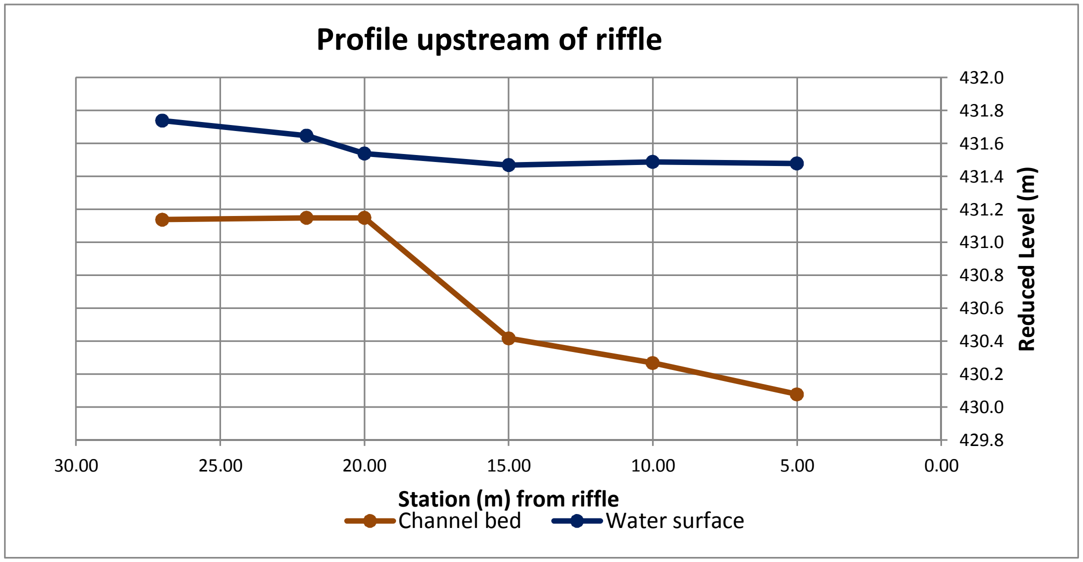


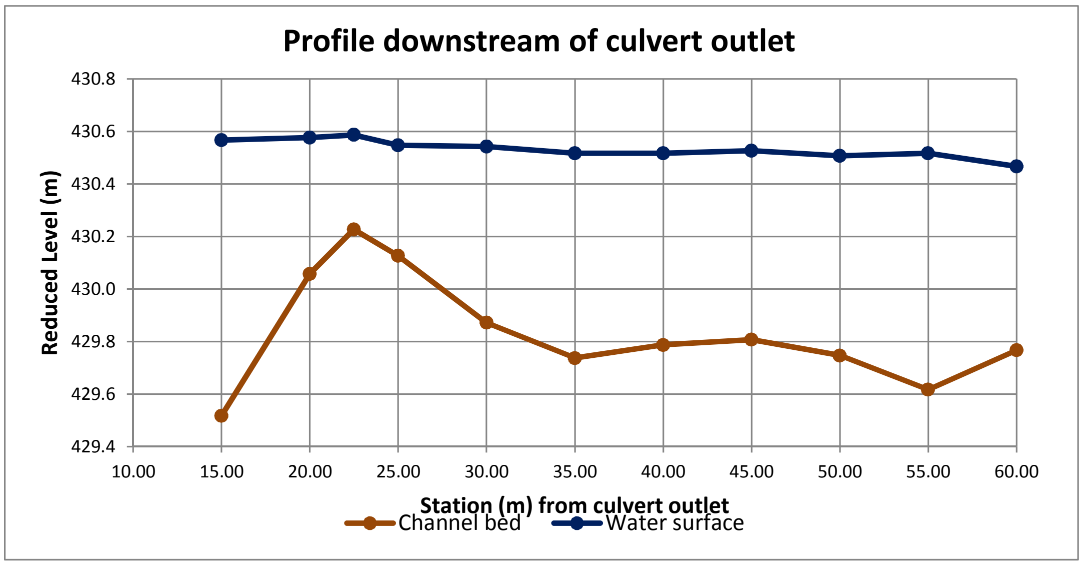
Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 3





Note: Survey completed in October 2010.

Golder Associates

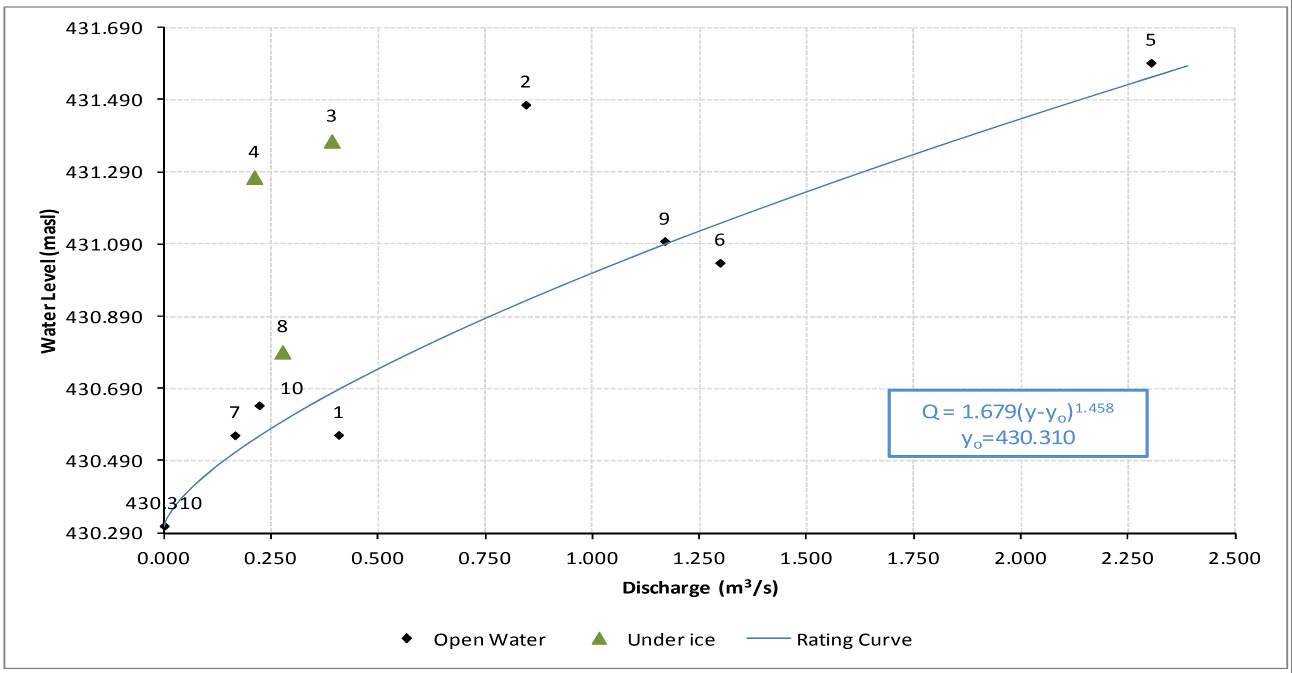
Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 4

Rating Curve

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	21-Aug-2010	0.407	430.562
2	03-Oct-2010	0.844	431.477
3	23-Jan-2011	0.391	431.376
4	06-Mar-2011	0.210	431.276
5	27-Apr-2011	2.303	431.593
6	22-May-2011	1.297	431.039
7	29-Aug-2011	0.165	430.561
8	09-Feb-2012	0.276	430.792
9	15-May-2012	1.168	431.099
10	29-Aug-2012	0.222	430.644
—	G.H. at zero flow	0.000	430.310

NOTES:
1) Measurement no. 1 was affected by a small beaver dam in right channel outflow of pool d/s of culvert.
2) Measurement no. 2 was affected by beaver dams blocking both culverts.
3) Measurement no. 6 was affected by a beaver dam in the left culvert.
4) Measurement no. 9 was affected by a beaver dam in the left culvert, and fallen tree downstream of culverts.
5) Measurement no. 10 was affected by a beaver dam in the right culvert.



In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
21-Aug-2010	0.05	7.35	21.40	-
03-Oct-2010	0.02	6.30	7.40	-
05-Mar-2011	0.02	7.29	0.50	-
27-Apr-2011	0.02	7.55	2.30	-
22-May-2011	0.03	7.48	18.90	-
29-Aug-2011	0.05	7.63	22.00	
15-May-2012	0.05	7.65	13.80	10.01
29-Aug-2012	0.05	6.56	23.60	5.50

Golder Associates

Flow Monitoring Station SW-09

PROJECT: 10-1118-0020 (6700)

DATE: September 20, 2012

Hammond Reef Gold Project

SHEET 5

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2010

Station Name: Bar Creek above Caribou River

Station ID: SW-09

UTM coordinates: 15U E 628979 N 5428689

Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									0.325	0.933	0.561B	0.574B	1
2									0.378	0.885	0.557B	0.562B	2
3									0.436	0.840	0.558B	0.552B	3
4									0.423	0.814	0.554B	0.541B	4
5									0.396	0.789	0.551B	0.530B	5
6									0.426	0.746	0.543B	0.520B	6
7									0.709	0.718	0.536B	0.510B	7
8									0.754	0.697	0.527B	0.500B	8
9									0.757	0.676	0.520B	0.490B	9
10									0.775	0.649	0.516B	0.481B	10
11									0.885	0.617	0.516B	0.472B	11
12									0.937	0.594	0.506B	0.462B	12
13									0.976	0.576	0.502B	0.453B	13
14									0.982	0.553	0.514B	0.445B	14
15									0.956	0.535	0.515B	0.442B	15
16									0.936	0.510	0.508B	0.439B	16
17									0.944	0.482	0.500B	0.436B	17
18									0.920	0.473	0.501B	0.433B	18
19									0.880	0.464	0.515B	0.430B	19
20									0.843	0.458	0.519B	0.427B	20
21								0.388	0.828	0.448	0.518B	0.424B	21
22								0.382	0.809	0.439	0.531B	0.421B	22
23								0.360	0.809	0.435	0.559B	0.419B	23
24								0.332	1.027	0.425	0.555B	0.416B	24
25								0.349	1.132	0.431	0.572B	0.413B	25
26								0.329	1.120	0.495	0.585B	0.410B	26
27								0.298	1.083	0.564	0.592B	0.407B	27
28								0.262	1.056	0.566	0.598B	0.405B	28
29								0.239	1.011	0.563B	0.597B	0.402B	29
30								0.280	0.972	0.563B	0.585B	0.399B	30
31								0.301		0.561B		0.399B	31
MEAN									0.816	0.597	0.540	0.459	
MAX									1.132	0.933	0.598	0.574	
MIN									0.325	0.425	0.500	0.399	
L/s/km²									11.88	8.68	7.86	6.67	

ANNUAL — MEAN 0.578 — MAX 1.132 — MIN 0.239 — L/s/km² 8.42

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 6

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2011

Station Name: Bar Creek above Caribou River

Station ID: SW-09

UTM coordinates: 15U E 628979 N 5428689

Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.399B	0.331B	0.218B	0.463B	2.538E	1.087	0.682	0.424	0.186	0.126	0.384	0.302B	1
2	0.398B	0.324B	0.216B	0.488B	2.566E	1.051	0.676	0.531	0.193	0.111	0.387	0.300B	2
3	0.398B	0.317B	0.215B	0.524B	2.520E	1.052	0.631	0.560	0.175	0.107	0.383B	0.291B	3
4	0.398B	0.311B	0.213B	0.595B	2.441E	1.017	0.613	0.515	0.155	0.107	0.374B	0.299B	4
5	0.397B	0.305B	0.212B	0.605B	2.397E	0.981	0.739	0.512	0.145	0.107	0.361B	0.297B	5
6	0.397B	0.298B	0.210B	0.620B	2.405E	0.961	0.713	0.508	0.134	0.105	0.361B	0.326B	6
7	0.397B	0.292B	0.251B	0.638B	2.365E	0.929	0.725	0.504	0.124	0.104	0.357B	0.298B	7
8	0.396B	0.286B	0.256B	0.678B	2.271	0.904	0.731	0.493	0.117	0.159	0.343B	0.297B	8
9	0.396B	0.280B	0.259B	0.736B	2.180	0.865	0.728	0.501	0.111	0.167	0.339B	0.309B	9
10	0.396B	0.274B	0.256B	0.838B	2.108	0.835	0.735	0.472	0.103	0.150	0.335B	0.337B	10
11	0.395B	0.269B	0.225B	1.133B	2.091	0.797	0.689	0.451	0.098	0.136	0.330B	0.320B	11
12	0.395B	0.263B	0.233B	1.279B	2.019	0.770	0.649	0.453	0.093	0.143	0.319B	0.303B	12
13	0.395B	0.258B	0.264B	1.440B	1.944	0.738	0.623	0.418	0.089	0.285	0.318B	0.291B	13
14	0.394B	0.252B	0.262B	1.534B	1.860	0.704	0.598	0.384	0.096	0.471	0.312B	0.277B	14
15	0.394B	0.247B	0.257B	1.603B	1.777	0.677	0.587	0.358	0.092	0.522	0.314B	0.284B	15
16	0.394B	0.242B	0.259B	1.684B	1.689	0.650	0.604	0.349	0.099	0.496	0.309B	0.304B	16
17	0.393B	0.237B	0.274B	1.749B	1.608	0.629	0.566	0.355	0.078	0.510	0.307B	0.324B	17
18	0.393B	0.235B	0.286B	1.804B	1.528	0.602	0.538	0.317	0.065	0.505	0.303B	0.302B	18
19	0.393B	0.234B	0.289B	1.853B	1.445	0.594	0.512	0.300	0.076	0.494	0.302B	0.284B	19
20	0.392B	0.232B	0.302B	1.887B	1.382	0.569	0.550	0.285	0.081	0.484	0.306B	0.276B	20
21	0.392B	0.230B	0.334B	1.936B	1.330	0.538	0.781	0.271	0.122	0.471	0.299B	0.264B	21
22	0.392B	0.229B	0.349B	1.983B	1.312	0.528	0.734	0.248	0.139	0.456	0.282B	0.265B	22
23	0.391B	0.227B	0.360B	2.035B	1.302	0.542	0.699	0.234	0.130	0.457	0.273B	0.267B	23
24	0.391B	0.226B	0.367B	2.085B	1.268	0.522	0.653	0.246	0.121	0.447	0.270B	0.265B	24
25	0.383B	0.224B	0.381B	2.137B	1.237	0.501	0.623	0.261	0.112	0.431	0.267B	0.260B	25
26	0.375B	0.222B	0.394B	2.228B	1.202	0.478	0.579	0.227	0.106	0.418	0.284B	0.256B	26
27	0.367B	0.221B	0.406B	2.302B	1.174	0.594	0.570	0.198	0.105	0.419	0.310B	0.266B	27
28	0.360B	0.219B	0.414B	2.339E	1.145	0.694	0.557	0.182	0.106	0.419	0.302B	0.325B	28
29	0.352B		0.422B	2.355E	1.122	0.674	0.519	0.173	0.127	0.414	0.303B	0.312B	29
30	0.345B		0.434B	2.404E	1.109	0.675	0.485	0.171	0.141	0.405	0.302B	0.278B	30
31	0.338B		0.447B		1.095		0.456	0.184		0.394		0.260B	31
MEAN	0.387	0.260	0.299	1.465	1.756	0.739	0.630	0.358	0.117	0.323	0.321	0.292	
MAX	0.399	0.331	0.447	2.404	2.566	1.087	0.781	0.560	0.193	0.522	0.387	0.337	
MIN	0.338	0.219	0.210	0.463	1.095	0.478	0.456	0.171	0.065	0.104	0.267	0.256	
L/s/km²	5.63	3.79	4.35	21.32	25.55	10.75	9.17	5.20	1.71	4.70	4.67	4.24	

ANNUAL — MEAN: 0.581 — MAX: 2.566 — MIN: 0.065 — L/s/km²: 8.45

LEGEND: B - Ice Conditions; E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 7

Daily Mean Discharges in Cubic Metres Per Second for the Calendar Year: 2012

Station Name: Bar Creek above Caribou River

Station ID: SW-09

UTM coordinates: 15U E 628979 N 5428689

Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	0.263B	0.271B	0.310B	1.591B	1.225	2.192	1.042	0.576					1
2	0.268B	0.272B	0.311B	1.591B	1.234	2.028	1.009	0.614					2
3	0.289B	0.272B	0.325B	1.631B	1.238	1.856	1.147	0.611					3
4	0.295B	0.273B	0.325B	1.628B	1.236	1.693	1.114	0.598					4
5	0.287B	0.274B	0.314B	1.588	1.227	1.557	1.136	0.568					5
6	0.269B	0.274B	0.300B	1.523	1.218	1.442	1.122	0.529					6
7	0.278B	0.275B	0.295B	1.469	1.291	1.343	1.107	0.517					7
8	0.262B	0.275B	0.301B	1.450	1.316	1.330	1.059	0.518					8
9	0.244B	0.276B	0.312B	1.415	1.308	1.423	1.010	0.843					9
10	0.237B	0.294B	0.298B	1.379	1.292	1.357	0.965	0.879					10
11	0.240B	0.296B	0.293B	1.338	1.281	1.308	0.911	0.797					11
12	0.256B	0.304B	0.287B	1.300	1.270	1.250	0.857	0.702					12
13	0.264B	0.322B	0.318B	1.261	1.239	1.201	0.816	0.630					13
14	0.286B	0.324B	0.298B	1.249	1.204	1.219	0.778	0.568					14
15	0.288B	0.319B	0.289B	1.225	1.171	1.396	0.740	0.514					15
16	0.275B	0.321B	0.286B	1.324	1.135	1.400	0.805	0.528					16
17	0.262B	0.309B	0.322B	1.308	1.091	1.527	0.805	0.471					17
18	0.263B	0.303B	0.380B	1.317	1.044	1.576	0.780	0.433					18
19	0.263B	0.302B	0.493B	1.326	0.997	1.703	0.760	0.405					19
20	0.264B	0.291B	0.633B	1.332	0.960	1.692	0.732	0.376					20
21	0.264B	0.304B	0.716B	1.329	0.930	1.712	0.695	0.350					21
22	0.265B	0.321B	0.746B	1.323	0.928	1.701	0.653	0.325					22
23	0.266B	0.310B	0.922B	1.320	0.928	1.624	0.611	0.313					23
24	0.266B	0.305B	1.227B	1.317	1.046	1.519	0.574	0.300					24
25	0.267B	0.319B	1.320B	1.318	1.174	1.420	0.550	0.304					25
26	0.267B	0.318B	1.364B	1.329	1.189	1.331	0.517	0.324					26
27	0.268B	0.326B	1.525B	1.321	1.258	1.262	0.470	0.282					27
28	0.269B	0.321B	1.644B	1.304	1.616	1.198	0.441	0.251					28
29	0.269B	0.310B	1.672B	1.267	2.117	1.119	0.483	0.235					29
30	0.270B		1.653B	1.248	2.383E	1.068	0.672						30
31	0.270B		1.614B		2.320E		0.619						31
MEAN	0.268	0.299	0.680	1.377	1.286	1.482	0.806	0.495					
MAX	0.295	0.326	1.672	1.631	2.383	2.192	1.147	0.879					
MIN	0.237	0.271	0.286	1.225	0.928	1.068	0.441	0.235					
L/s/km²	3.89	4.36	9.90	20.04	18.71	21.56	11.72	7.21					

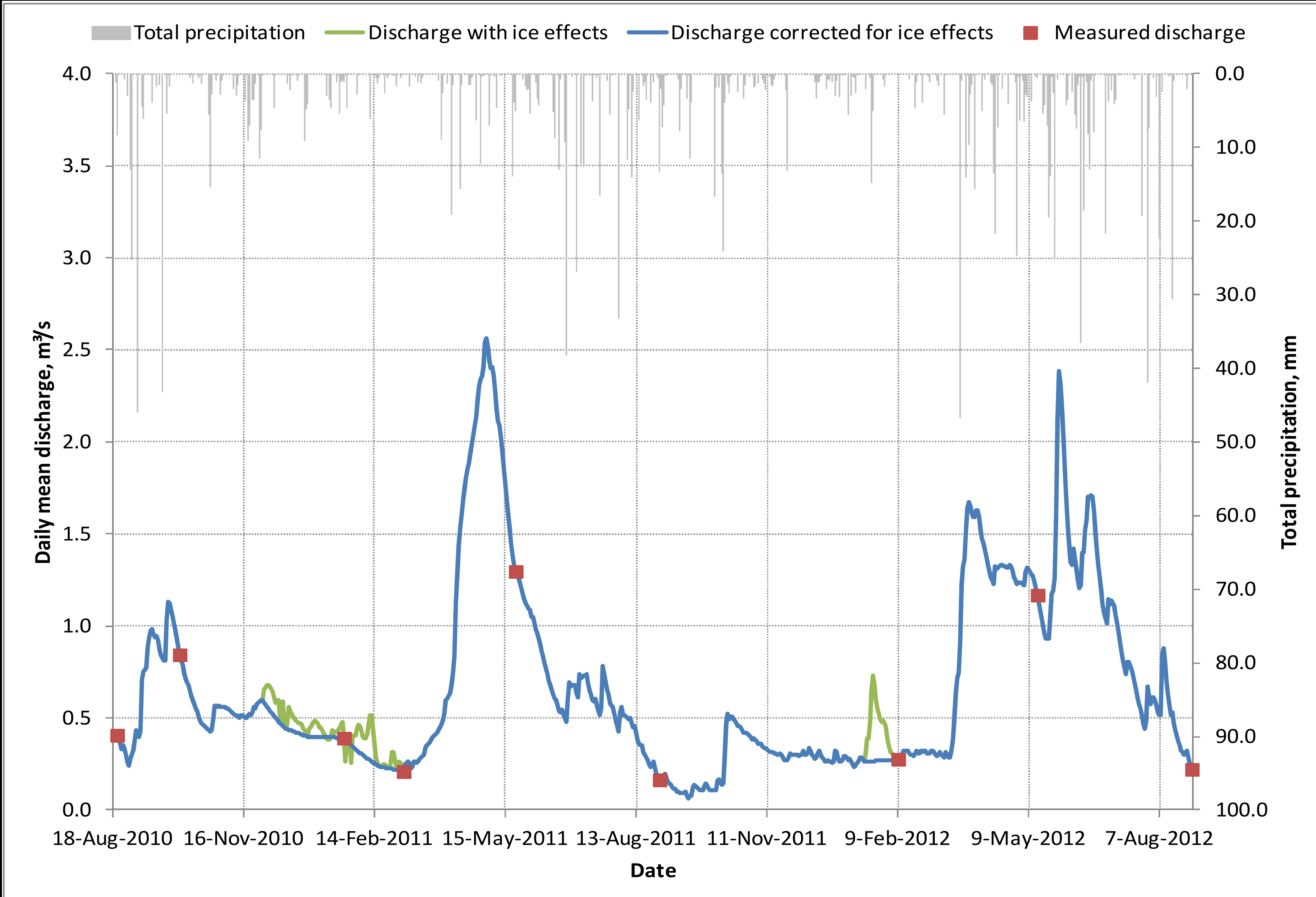
ANNUAL MEAN 0.839 MAX 2.383 MIN 0.235 L/s/km² 12.21

LEGEND B - Ice Conditions E - Extrapolated from rating curve

Golder Associates

Flow Monitoring Station SW-09

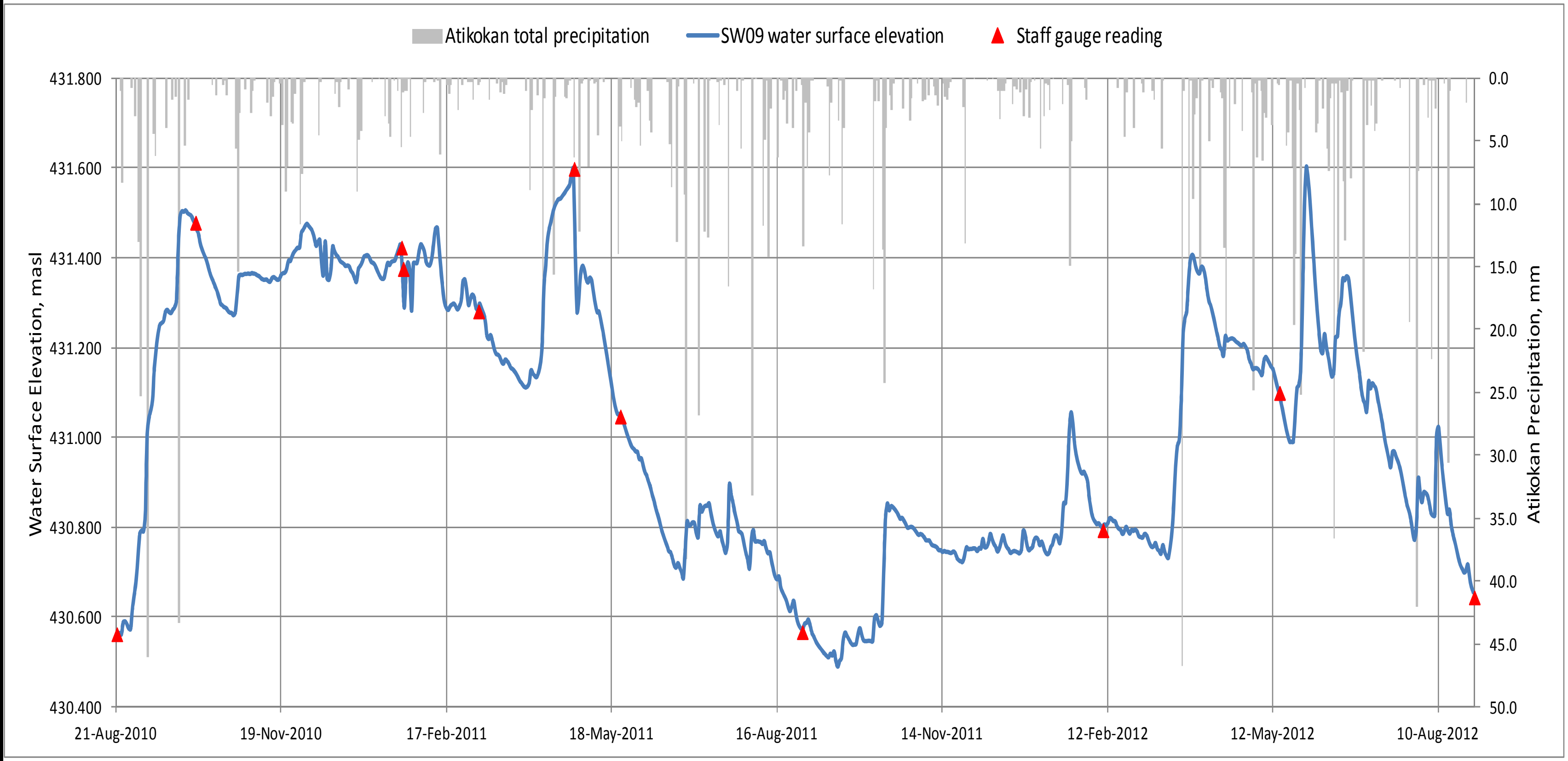
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 8



Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 9



Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 10

Daily Mean Water Temperature (°C) for the Calendar Year: 2010

Station Name: Bar Creek Near Caribou River | Station ID: SW-09

UTM coordinates: U15 E 628979 N 5428689 | Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1									21.0	10.3	3.5	-0.1	1
2									18.9	9.4	3.5	-0.1	2
3									16.1	8.9	4.7	-0.1	3
4									13.9	9.3	4.0	-0.1	4
5									14.1	9.9	2.4	-0.2	5
6									14.6	11.1	2.4	-0.3	6
7									13.5	10.7	2.8	-0.3	7
8									12.7	11.1	3.2	-0.3	8
9									12.6	11.5	3.7	-0.4	9
10									12.7	11.9	4.3	-0.3	10
11									13.8	11.4	5.0	-0.4	11
12									13.7	10.7	3.2	-0.4	12
13									13.4	9.7	2.2	-0.4	13
14									13.0	9.4	1.8	-0.4	14
15									11.8	9.4	1.6	-0.4	15
16									11.2	9.1	1.4	-0.4	16
17									12.8	8.2	1.3	-0.4	17
18									11.5	6.9	0.6	-0.4	18
19									10.7	6.8	0.4	-0.4	19
20									10.7	7.0	0.1	-0.4	20
21								21.9	11.6	5.8	0.0	-0.4	21
22								21.0	11.7	5.8	0.2	-0.4	22
23								22.8	11.5	6.4	-0.1	-0.4	23
24								22.5	10.3	5.8	-0.1	-0.4	24
25								18.4	10.0	6.3	0.0	-0.4	25
26								17.9	9.9	7.6	-0.2	-0.4	26
27								19.6	10.4	6.7	0.0	-0.4	27
28								22.2	10.5	5.1	0.1	-0.4	28
29								23.3	10.7	4.0	0.3	-0.4	29
30								24.1	11.0	4.1	0.2	-0.4	30
31								23.9		3.6		-0.4	31
MEAN (°C)									12.7	8.2	1.8	-0.3	
MAX (°C)									21.0	11.9	5.0	-0.1	
MIN (°C)									9.9	3.6	-0.2	-0.4	

ANNUAL MEAN (°C) 5.6 MAX (°C) 21.0 MIN (°C) -0.4

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 11

Daily Mean Water Temperature (°C) for the Calendar Year: 2011

Station Name: Bar Creek Near Caribou River
Station ID: SW-09
UTM coordinates: U15 E 628979 N 5428689
Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.4	-0.4	-0.4	-0.1	3.3	14.7	21.0	22.8	19.1	10.7	4.6	0.1	1
2	-0.4	-0.4	-0.4	0.0	3.1	14.2	22.2	24.5	20.5	10.7	4.8	0.1	2
3	-0.4	-0.4	-0.4	0.1	4.3	15.5	21.6	23.4	19.5	11.9	3.7	0.1	3
4	-0.4	-0.4	-0.4	-0.1	5.5	16.5	21.7	23.7	18.1	12.8	3.2	0.1	4
5	-0.4	-0.4	-0.4	0.1	5.8	16.5	22.4	23.8	15.7	13.4	3.3	0.0	5
6	-0.4	-0.4	-0.4	0.4	5.7	18.3	22.3	23.9	16.1	13.4	4.4	-0.1	6
7	-0.4	-0.4	-0.4	0.8	6.2	18.1	22.6	23.0	17.2	13.8	4.0	-0.1	7
8	-0.4	-0.4	-0.4	0.9	6.7	16.4	22.4	22.6	18.4	14.8	3.0	-0.1	8
9	-0.4	-0.4	-0.4	1.3	7.1	15.0	22.0	21.4	19.4	14.8	2.5	-0.1	9
10	-0.4	-0.4	-0.4	1.4	8.0	15.8	21.7	20.0	19.9	13.7	2.4	-0.1	10
11	-0.4	-0.4	-0.4	1.5	9.8	16.2	23.2	21.1	20.0	14.2	1.9	-0.1	11
12	-0.4	-0.4	-0.4	1.7	10.6	16.9	21.9	21.9	19.0	13.9	2.5	-0.1	12
13	-0.4	-0.4	-0.4	1.3	9.3	18.6	20.4	22.5	16.7	13.2	2.7	-0.1	13
14	-0.4	-0.4	-0.4	1.0	8.9	19.5	21.5	21.9	13.7	12.0	2.4	-0.1	14
15	-0.4	-0.4	-0.4	1.4	9.8	19.4	21.3	22.3	11.6	10.0	2.3	0.0	15
16	-0.4	-0.4	-0.4	0.9	10.9	19.4	21.6	22.8	11.5	8.6	1.9	-0.1	16
17	-0.4	-0.4	-0.4	0.8	12.3	20.1	24.3	22.1	11.8	7.4	0.8	-0.2	17
18	-0.4	-0.4	-0.4	1.4	13.3	20.3	25.8	21.3	12.1	7.0	0.5	-0.1	18
19	-0.4	-0.4	-0.4	1.7	14.5	18.3	25.5	21.9	12.5	6.7	0.4	-0.1	19
20	-0.4	-0.4	-0.4	1.9	15.5	17.1	25.1	20.2	13.3	6.7	0.3	-0.1	20
21	-0.4	-0.4	-0.4	2.2	15.6	17.4	23.6	19.7	12.5	5.9	0.2	-0.1	21
22	-0.4	-0.4	-0.3	2.4	15.6	16.8	23.5	19.4	10.6	6.1	0.2	-0.1	22
23	-0.4	-0.4	-0.4	2.4	15.8	16.0	21.5	20.6	10.8	6.4	0.3	-0.2	23
24	-0.4	-0.4	-0.4	2.7	14.5	16.9	20.1	21.0	11.2	6.2	0.5	-0.1	24
25	-0.4	-0.4	-0.4	3.3	14.1	19.1	20.7	19.0	11.1	5.3	0.7	-0.1	25
26	-0.4	-0.4	-0.4	3.1	13.9	19.8	20.4	20.4	11.9	5.3	0.7	-0.1	26
27	-0.4	-0.4	-0.4	2.3	14.3	19.0	21.1	20.1	12.7	4.8	0.3	-0.1	27
28	-0.4	-0.4	-0.4	3.0	14.3	17.3	21.0	19.5	13.3	4.3	0.4	-0.2	28
29	-0.4		-0.3	3.9	14.8	17.7	22.1	19.8	13.6	4.4	0.3	-0.2	29
30	-0.4		-0.3	3.7	15.0	19.6	22.1	20.0	12.1	4.0	0.2	-0.2	30
31	-0.4		-0.2		15.2		22.4	19.8		4.2		-0.2	31
MEAN (°C)	-0.4	-0.4	-0.4	1.6	10.8	17.5	22.2	21.5	14.9	9.2	1.8	-0.1	
MAX (°C)	-0.4	-0.4	-0.2	3.9	15.8	20.3	25.8	24.5	20.5	14.8	4.8	0.1	
MIN (°C)	-0.4	-0.4	-0.4	-0.1	3.1	14.2	20.1	19.0	10.6	4.0	0.2	-0.2	

ANNUAL MEAN (°C) 8.2 MAX (°C) 25.8 MIN (°C) -0.4

Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 12

Daily Mean Water Temperature (°C) for the Calendar Year: 2012

Station Name: Bar Creek Near Caribou River

Station ID: SW-09

UTM coordinates: U15 E 628979 N 5428689

Drainage area: 6,872.60 ha

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1	-0.2	-0.4	-0.4	3.3	9.8	14.5	23.3	22.9					1
2	-0.2	-0.4	-0.4	3.8	11.1	15.3	24.3	23.2					2
3	-0.2	-0.3	-0.4	4.1	11.8	16.2	24.4	22.7					3
4	-0.2	-0.3	-0.4	4.5	11.5	17.5	24.5	22.4					4
5	-0.2	-0.3	-0.4	4.9	11.2	18.0	24.6	21.1					5
6	-0.2	-0.3	-0.4	5.3	11.1	18.8	24.0	21.5					6
7	-0.2	-0.3	-0.4	5.8	10.8	19.8	23.4	21.5					7
8	-0.2	-0.4	-0.4	5.8	11.1	20.1	23.8	21.2					8
9	-0.2	-0.4	-0.4	5.3	10.8	19.9	23.8	21.0					9
10	-0.2	-0.4	-0.4	4.7	12.1	21.3	23.7	20.3					10
11	-0.2	-0.4	-0.4	5.2	12.8	21.6	24.4	20.7					11
12	-0.3	-0.4	-0.4	6.1	12.3	19.6	25.2	21.2					12
13	-0.3	-0.4	-0.3	7.0	12.9	18.7	25.7	21.4					13
14	-0.3	-0.4	-0.1	7.4	13.8	18.7	25.9	21.0					14
15	-0.3	-0.4	0.1	6.7	14.2	18.1	25.5	20.9					15
16	-0.3	-0.4	0.3	3.9	13.3	19.4	24.4	20.4					16
17	-0.3	-0.4	1.0	3.1	14.4	19.4	23.5	18.4					17
18	-0.3	-0.4	1.8	4.1	15.7	19.6	23.5	19.1					18
19	-0.3	-0.4	2.3	4.7	17.3	19.5	24.0	18.3					19
20	-0.3	-0.4	2.6	5.3	16.9	18.8	24.4	18.4					20
21	-0.3	-0.4	2.3	5.6	15.1	18.7	24.6	19.0					21
22	-0.4	-0.4	2.4	6.5	15.8	19.0	24.3	20.0					22
23	-0.4	-0.4	3.4	7.2	15.4	19.8	24.5	21.2					23
24	-0.4	-0.4	3.0	7.6	15.6	20.2	23.4	21.8					24
25	-0.4	-0.4	2.4	7.9	14.8	20.3	23.8	22.1					25
26	-0.4	-0.4	2.4	7.4	14.2	21.0	23.2	21.7					26
27	-0.4	-0.4	2.9	7.5	13.7	21.7	22.0	20.8					27
28	-0.4	-0.4	3.1	8.2	12.6	23.0	22.7	20.3					28
29	-0.4	-0.4	2.9	8.9	13.3	22.6	22.7	20.6					29
30	-0.4		2.4	9.6	12.8	22.6	21.5						30
31	-0.4		2.6		13.3	23.3	21.7						31
MEAN (°C)	-0.3	-0.4	1.1	5.9	13.3	19.6	23.9	20.9					
MAX (°C)	-0.2	-0.3	3.4	9.6	17.3	23.3	25.9	23.2					
MIN (°C)	-0.4	-0.4	-0.4	3.1	9.8	14.5	21.5	18.3					

ANNUAL MEAN (°C) 10.5 MAX (°C) 25.9 MIN (°C) -0.4

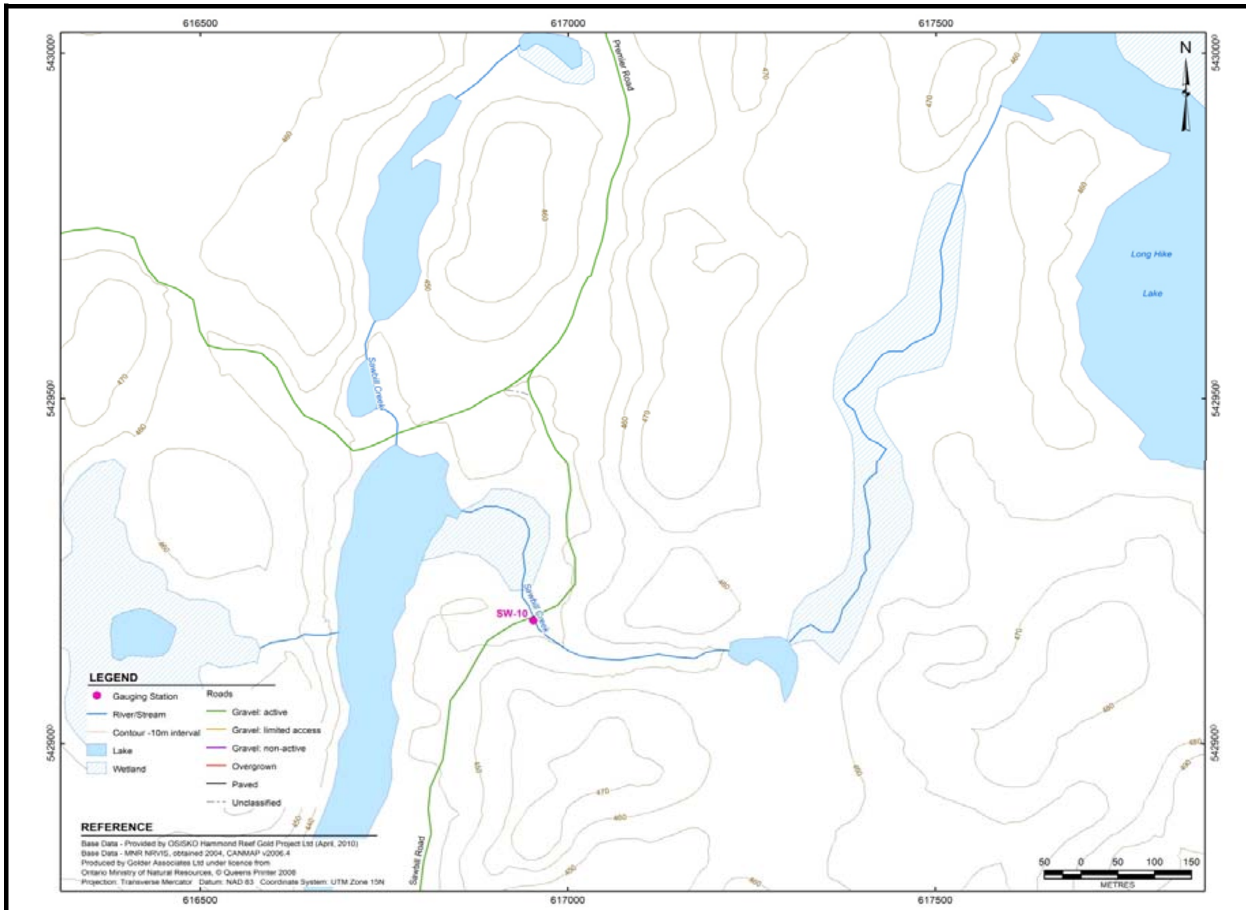
Golder Associates

Flow Monitoring Station SW-09

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 13

ATTACHMENT 5.I.11

Local Scale Monitoring Station SW-10; Sawbill Creek below Long Hike Lake



Station ID:	SW-10	**Installation Date:**	21-Aug-2010
Watercourse Name:	Sawbill Creek below Long Hike Lake	**Equipment Installed:**	Staff gauge
UTM Coordinates:	15U E 616953 N 5429177	**Logger Serial No.:**	N/A
Location Description:	The station is located at the culvert crossing on Sawbill Road ~0.45 km south of intersection with Premier Road. It is located in the lower catchment draining to Sawbill Bay.	**Installation Type:**	Staff gauge installed on T-post ~2 m upstream of culvert inlet near left bank
Elevation:	The benchmark is nail in birch tree on right bank upstream of culvert/road. Benchmark surveyed as 436.573 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out by debris or ice; possible beaver dam downstream of culvert

Golder Associates

Flow Monitoring Station SW-10

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 1

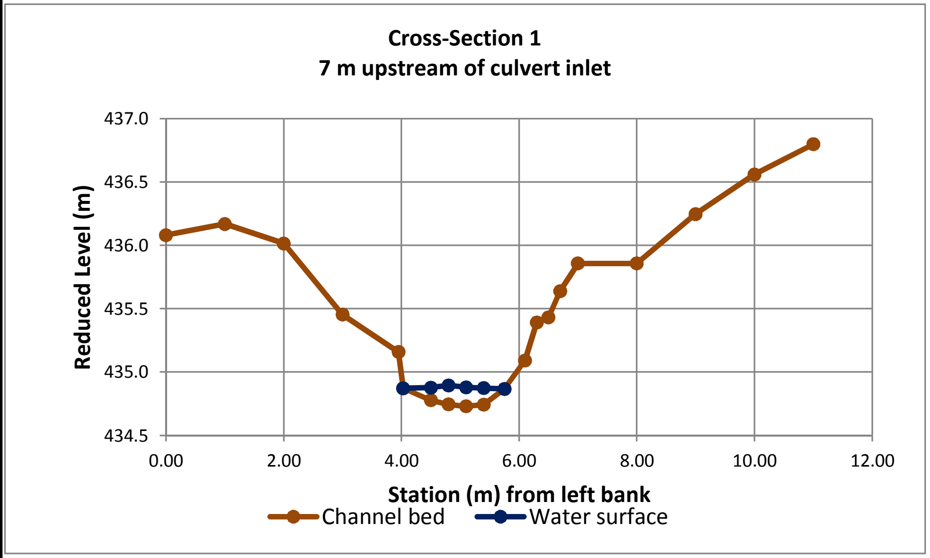
Gauge:	Hydraulic Control:	Hydraulic control is provided by the culvert and the road embankment.
Current Metering Section:	General Section Description:	The measuring section is located upstream of the inlet to one 900 mm CSP culvert with projecting ends. A second culvert has been crushed by the road embankment.
	Thalweg (straight, bend, off-center):	Straight, off-centre
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass and brush, few trees, shallow root zone
	Bankfull Depth (m):	0.75 - 1.20
	Bankfull Width (m):	4.25 - 6.75
	Floodplain Observations:	Wide flat flood plain, deposition on right bank downstream
	General Observations:	Young fluvial channel; wide shallow cross-section; low sinuousity; high bed load
Substrate:	Left Bank:	Gravel, cobbles and boulders
	Bed :	Sand/gravel, cobbles and boulders
	Right Bank:	Gravel, cobbles and boulders

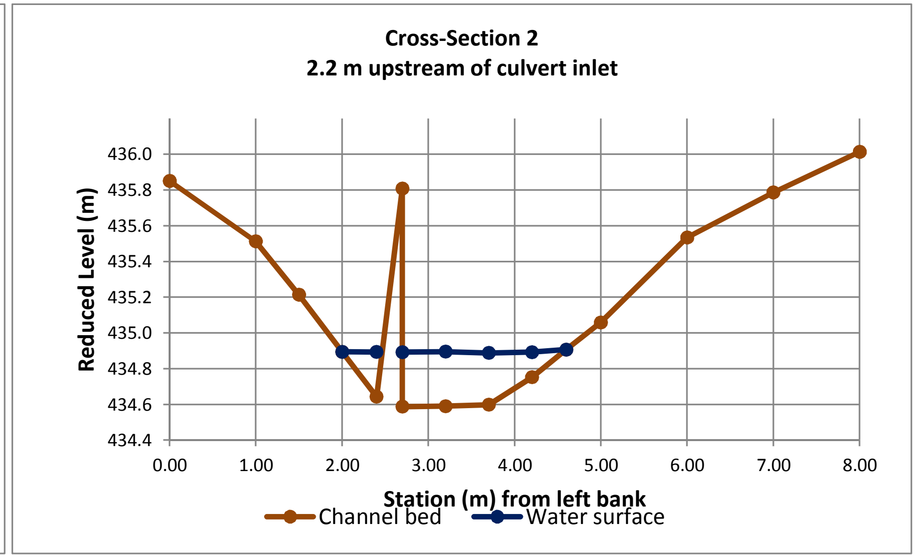
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

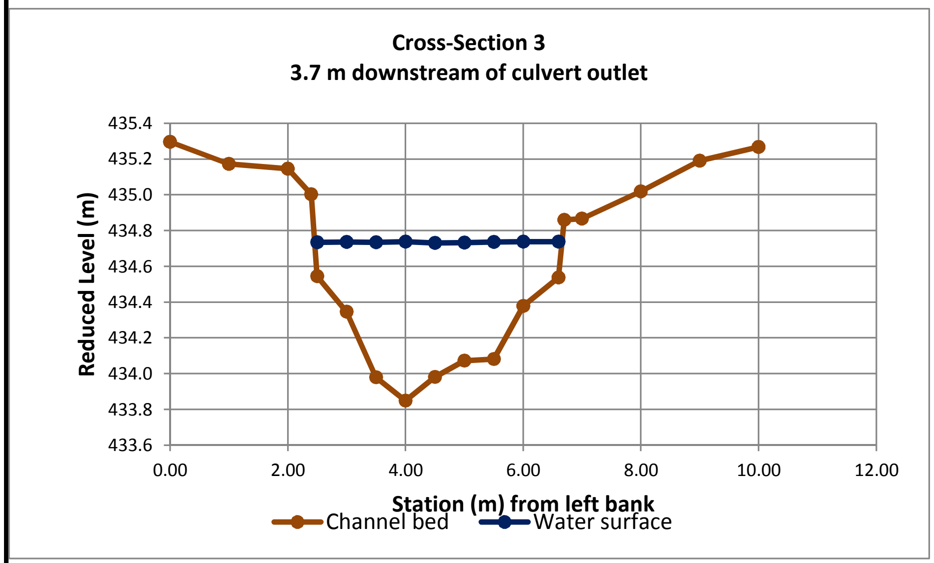
Golder Associates

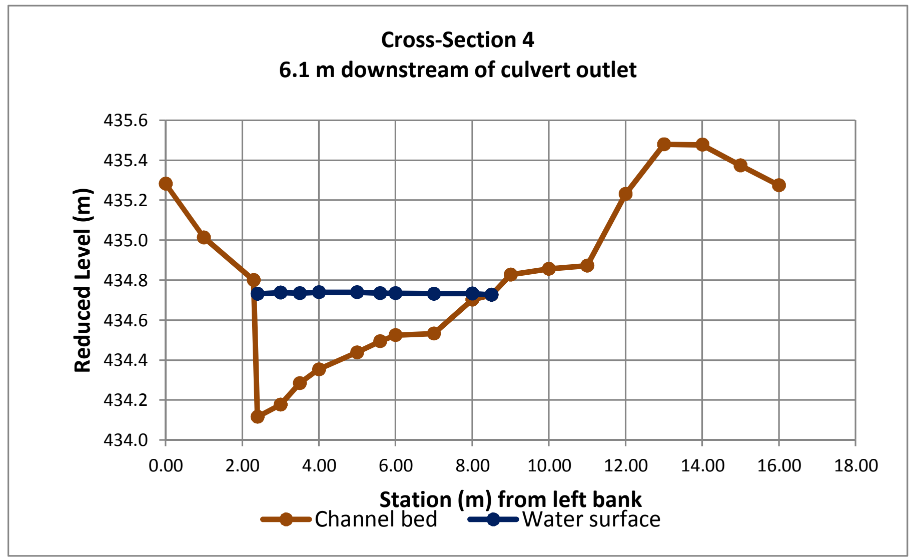
Flow Monitoring Station SW-10

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 2







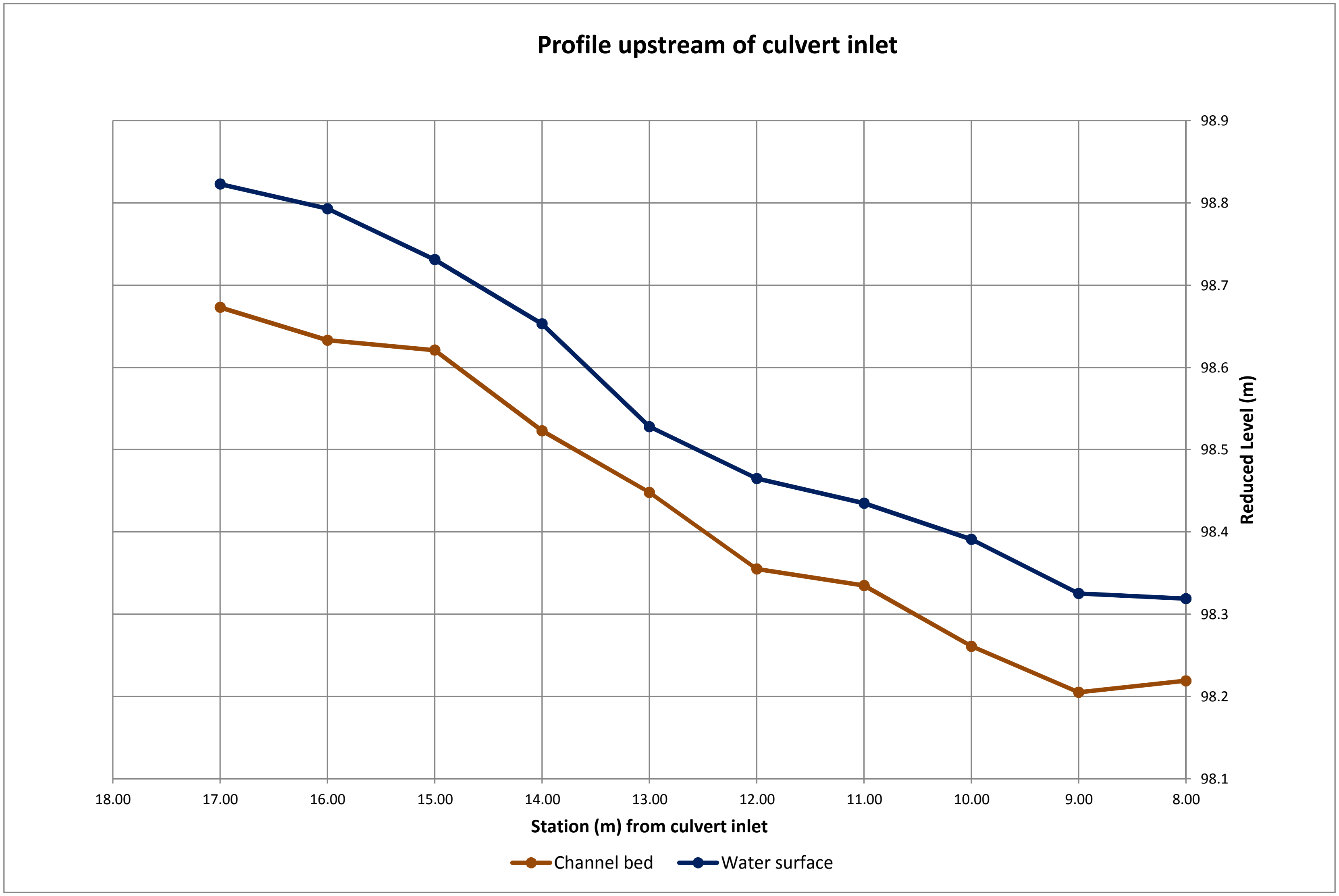


Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-10

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 3



Note: Survey completed in October 2010.

Golder Associates				Flow Monitoring Station SW-10	
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 4

Discharge and Water Level Measurements

Measurement No.	Date	Discharge (m^3/s)	Water Level (masl)
1	21-Aug-2010	0.070	434.898
2	07-Oct-2010	0.037	434.885
3	24-Jan-2011	0.035	434.946
4	03-Mar-2011	0.080	434.898
5	26-Apr-2011	0.162	435.008
6	23-May-2011	0.074	434.845
7	28-Aug-2011	0.030	434.807
8	10-Feb-2012	0.001	435.045
9	18-May-2012	0.026	435.158
10	29-Aug-2012	0.019	435.513

NOTE: A rating curve has not been developed for this station since it is a manual gauge.

In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
21-Aug-2010	0.05	7.03	23.45	-
07-Oct-2010	0.02	5.88	8.60	-
03-Mar-2011	0.00	6.48	0.40	-
26-Apr-2011	0.02	7.27	6.80	-
23-May-2011	0.06	7.86	16.60	-
28-Aug-2011	0.06	6.72	19.30	-
18-May-2012	0.00	6.89	22.20	7.52
29-Aug-2012	0.04	6.60	17.50	7.82

Golder Associates

Flow Monitoring Station SW-10

PROJECT: 10-1118-0020 (6700)

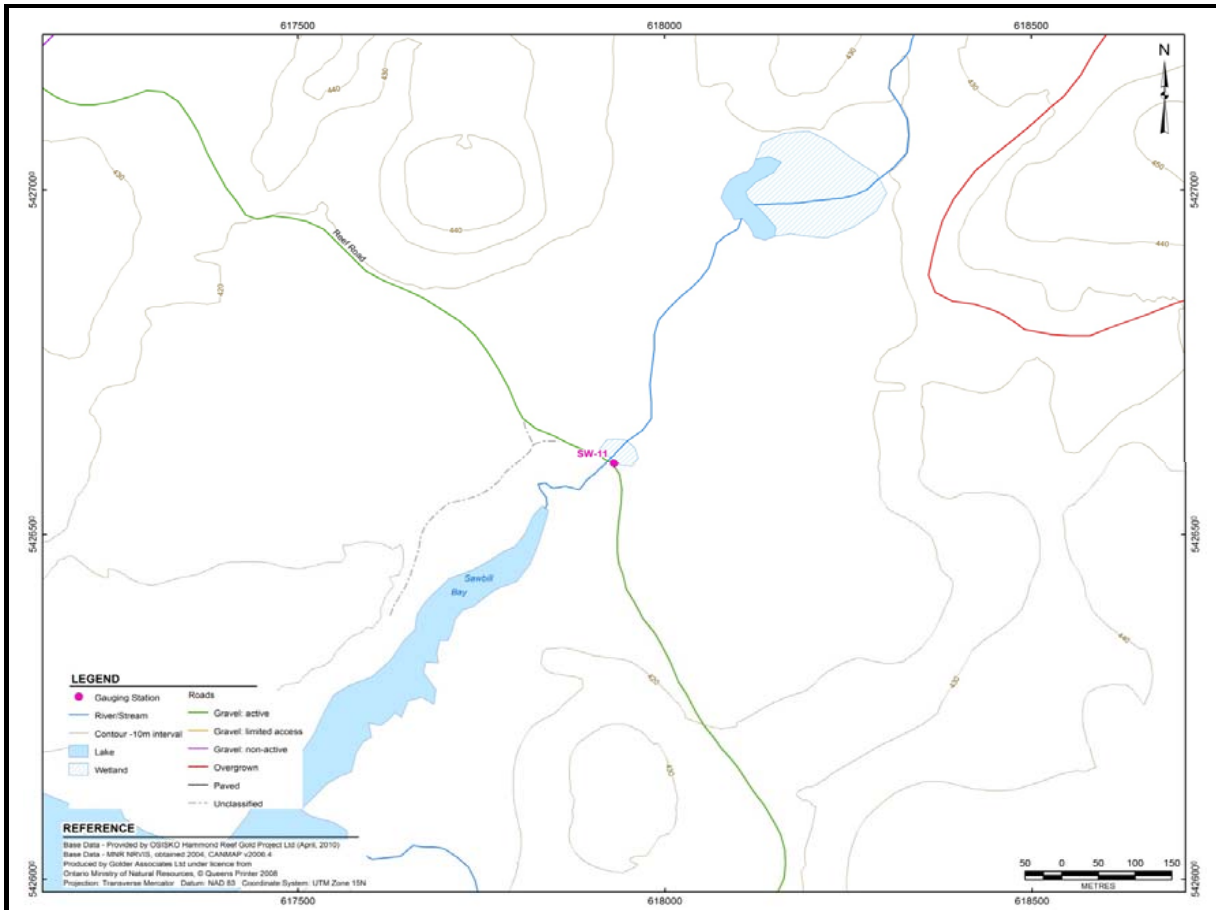
DATE: September 20, 2012

Hammond Reef Gold Project

SHEET 5

ATTACHMENT 5.I.12

Local Scale Monitoring Station SW-11; Sawbill Bay Tributary at Reef Road



Station ID:	SW-11	**Installation Date:**	27-Aug-2010
Watercourse Name:	Sawbill Bay Tributary at Reef Road	**Equipment Installed:**	Staff gauge
UTM Coordinates:	15U E 617930 N 5426603	**Logger Serial No.:**	N/A
Location Description:	The station is located at the culvert crossing on Reef Road ~1.8 km east of camp and ~10 m upstream of Sawbill Bay. It is located in the lower catchment draining to Sawbill Bay.	**Installation Type:**	Staff gauge installed on T-post in stream bed upstream of culverts and roadway
Elevation:	The benchmark is top of metal "Narrow Crossing" sign brace north of culvert. Benchmark surveyed as 416.418 masl.	**Instal. Problems/Risks:**	Staff gauge could be ripped out be debris; flow through the culverts could be affected by backwater from Sawbill Bay

Golder Associates

Flow Monitoring Station SW-11

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 1


Looking downstream


Looking upstream


Culvert inlet


Culvert outlet

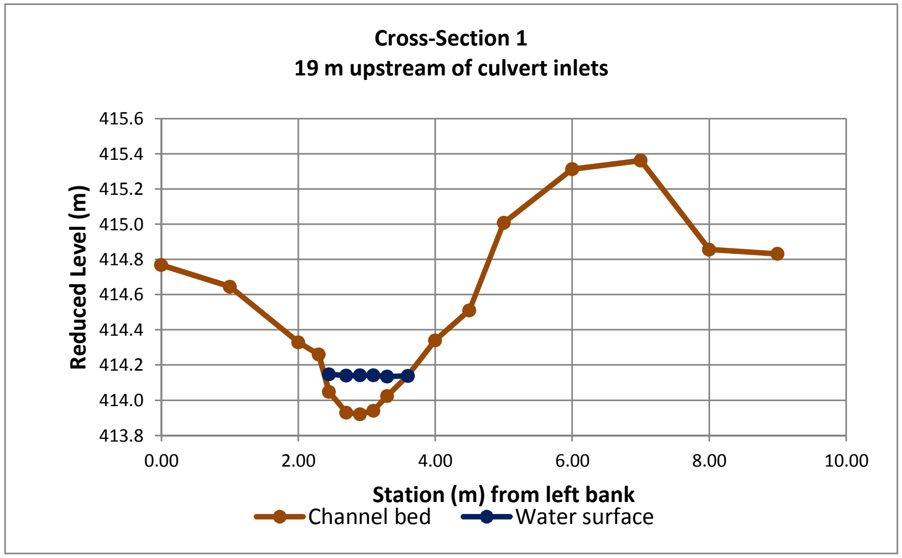
Gauge:	Hydraulic Control:	Hydraulic control is provided by twin 1000 mm diameter CSP culverts with projecting ends and the road embankment. Barrel length is 6.9 m and barrel slope is ~ 0.1%.
Current Metering Section:	General Section Description:	Discharge measurement at toe of embankment and inlet to culverts.
	Thalweg (straight, bend, off-center):	Off-center
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone Depth:	Grass and brush, shallow root zone
	Bankfull Depth (m):	0.50 - 1.25
	Bankfull Width (m):	1.75 - 8.00
	Floodplain Observations:	Flat wide flood plain on both banks, wider on right bank
	General Observations:	Maturing fluvial channel, wide shallow cross-section; straight
Substrate:	Left Bank:	Silt and fine sand
	Bed :	Silt and fine sand with gravel, cobbles and few boulders
	Right Bank:	Silt and fine sand

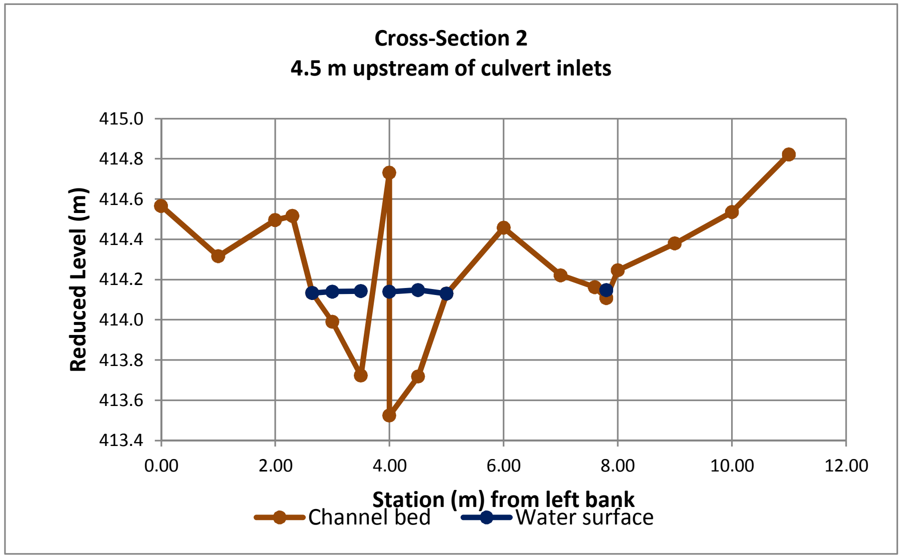
Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

Golder Associates

Flow Monitoring Station SW-11

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 2

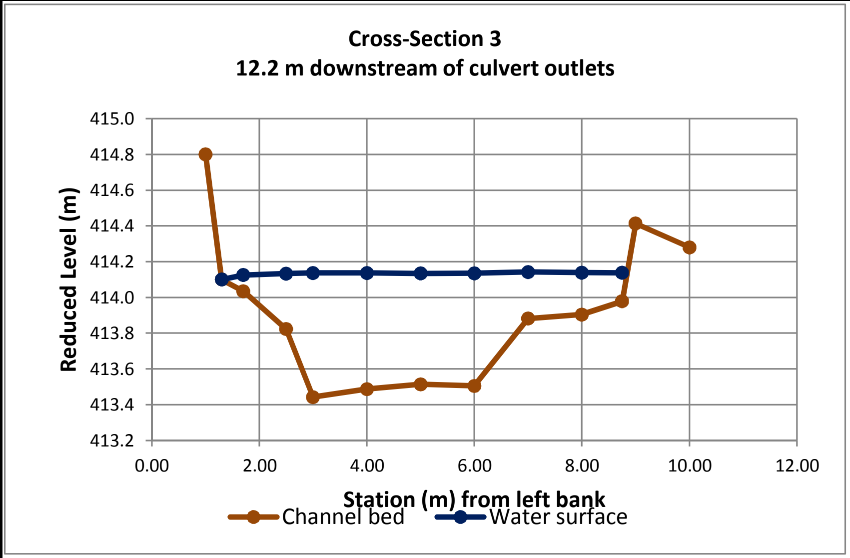


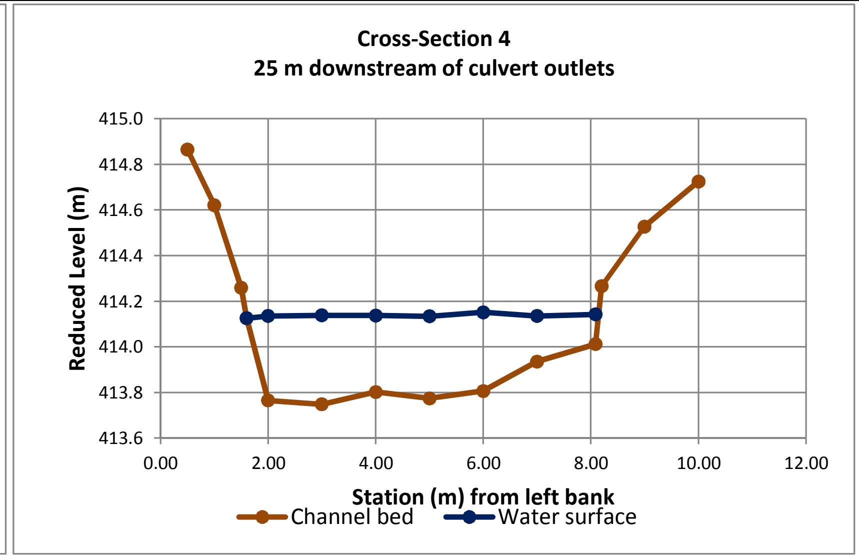


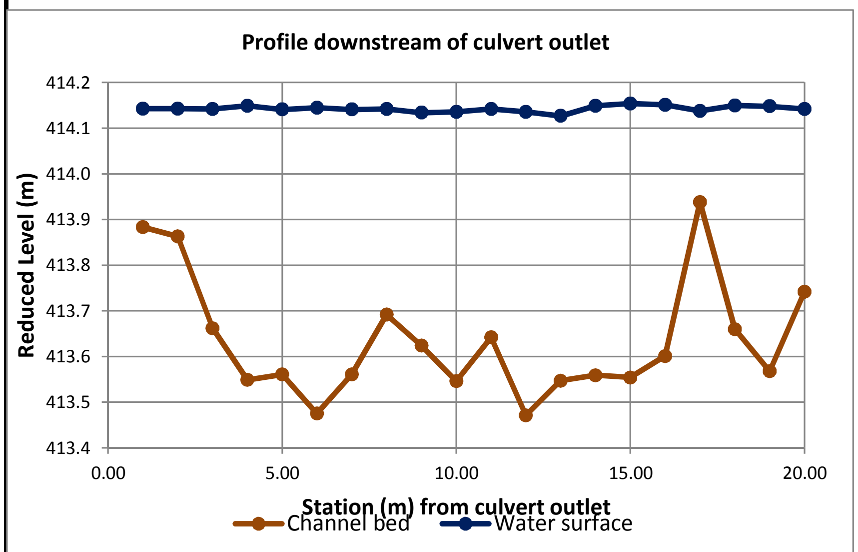
Note: Survey completed in October 2010.

Golder Associates

				Flow Monitoring Station SW-11	
PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 3







Note: Survey completed in October 2010.

Golder Associates

Flow Monitoring Station SW-11

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 4

Discharge and Water Level Measurements

Measurement No.	Date	Discharge (m³/s)	Water Level (masl)
1	27-Aug-2010	0.002	414.004
2	07-Oct-2010	0.019	414.150
3	24-Jan-2011	0.000	—
4	04-Mar-2011	0.000	—
5	26-Apr-2011	0.315	414.360
6	23-May-2011	0.071	414.200
7	28-Aug-2011	0.001	414.090
8	18-May-2012	0.042	414.180
9	29-Aug-2012	0.123	414.300

NOTES:
1) A rating curve has not been developed for this station since it is a manual gauge.
2) There was no flow during the site visits in Jan and Apr 2011; the stream was frozen solid.

In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
17-Aug-2010	0.08	7.16	17.55	-
13-Oct-2010	0.00	5.62	9.70	-
26-Apr-2011	0.02	7.11	1.70	-
23-May-2011	0.02	7.91	10.80	-
28-Aug-2011	0.22	6.70	14.30	-
18-May-2012	0.00	6.77	12.30	8.80
29-Aug-2012	0.10	6.65	13.70	3.24

Golder Associates

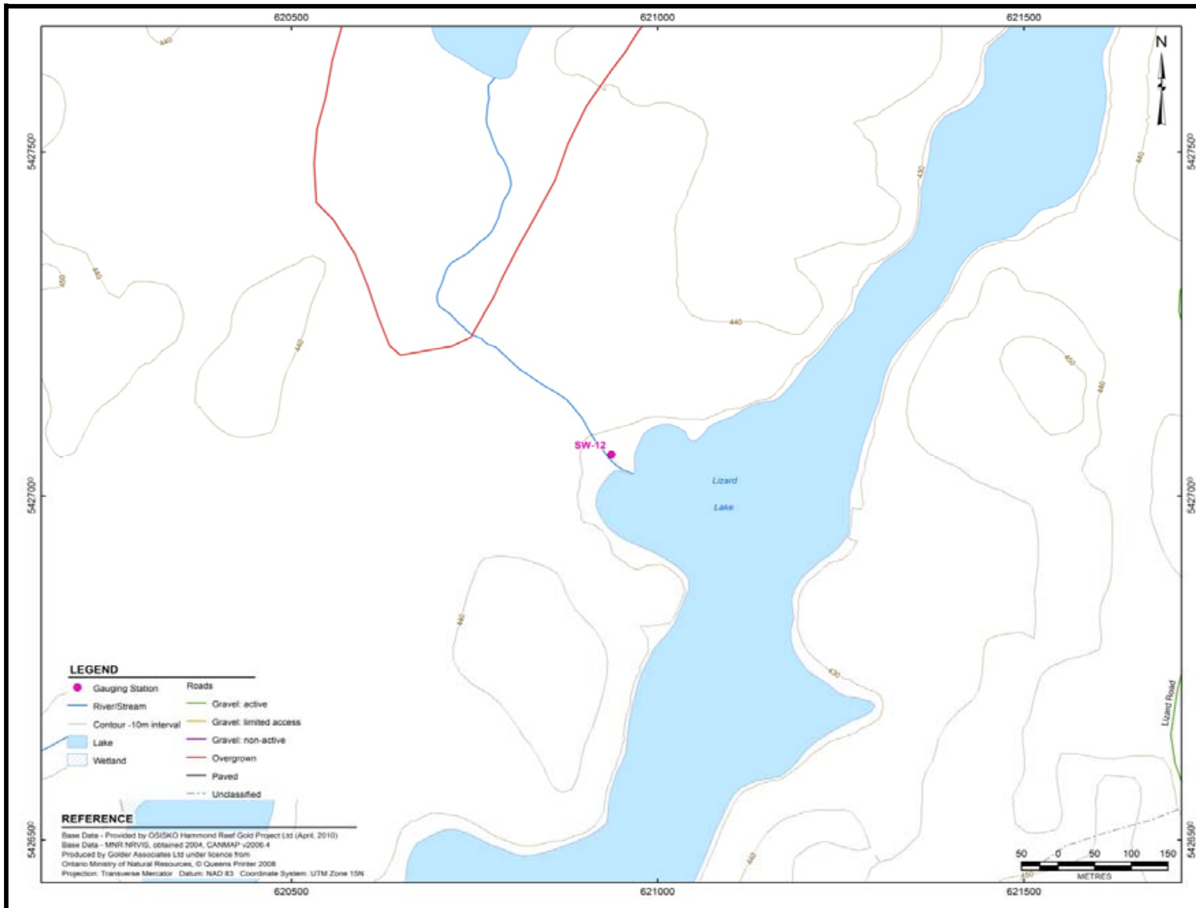
Flow Monitoring Station SW-11

PROJECT: 10-1118-0020 (6700)
DATE: September 20, 2012

Hammond Reef Gold Project

ATTACHMENT 5.I.13

Local Scale Monitoring Station SW-12; Lizard Lake West Tributary



Station ID:	SW-12	**Installation Date:**	25-Aug-2010
Watercourse Name:	Lizard Lake West Tributary	**Equipment Installed:**	Staff gauge
UTM Coordinates:	15U E 620937 N 5427060	**Logger Serial No.:**	N/A
Location Description:	The station is located near the outlet of a small western tributary feeding Lizard Lake. Boat access is from the launch near SW-02B, UTM coordinates 15U E 621942 N 5428806. The station is located in the middle of the catchment draining to Turtle Bay.	**Installation Type:**	Staff gauge installed on T-post in stream bed in one of two outflow points
Elevation:	The benchmark is a large broken branch next to the staff gauge. Benchmark surveyed as 427.105 masl.	**Instal. Problems/Risks:**	Debris catching on T-post and damming channel

Golder Associates

Flow Monitoring Station SW-12

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 1

Gauge:	Hydraulic Control:	Riffle in channel bed.
Current Metering Section:	General Section Description:	Discharge measurements are collected in a narrow drainage channel in wide flat swamp.
	Thalweg (straight, bend, off-center):	Bend
Fluvial Geomorphology: (Basic Observations)	Vegetative Cover/ Root Zone	Grass and brush, few trees, shallow root zone
	Bankfull Depth (m):	0.40 m
	Bankfull Width (m):	1.70 m
	Floodplain Observations:	Wide flat flood plain, poorly drained
	General Observations:	Mature fluvial channel; shallow, gentle slope; low sinousity, braided
Substrate:	Left Bank:	Vegetated (long grass)
	Bed :	Organics
	Right Bank:	Vegetated (long grass)

Notes:
1) Left and right banks are channel banks on left and right hand sides when looking downstream

Golder Associates

Flow Monitoring Station SW-12

PROJECT:	10-1118-0020 (6700)	DATE:	September 20, 2012	Hammond Reef Gold Project	SHEET 2

Discharge and Water Level Measurements

Measure-ment No.	Date	Discharge (m^3/s)	Water Level (masl)
1	25-Aug-2010	0.008	425.930
2	11-Oct-2010	0.010	425.981
3	22-May-2011	0.025	426.048
4	29-Aug-2011	0.002	425.935
5	17-May-2012	0.026	426.077
6	31-Aug-2012	0.000	425.992

NOTES:
1) A rating curve has not been developed for this station since it is a manual gauge.
2) This station could not be accessed during the winter seasons 2010 - 2012.

In-Situ Water Quality

Date	Conductivity mS/cm	pH	Water Temperature °C	Dissolved Oxygen mg/L
22-May-2011	0.03	7.75	16.60	-
29-Aug-2011	0.07	7.36	13.40	-
17-May-2012	0.00	7.17	16.90	7.47

Golder Associates

PROJECT:	10-1118-0020 (6700)
DATE:	September 20, 2012

Flow Monitoring Station SW-12

Hammond Reef Gold Project

SHEET 3