TECHNICAL MEMORANDUM

DATE 5 April 2017 **REFERENCE No.** 1114220046-668-TM-Rev0

TO Derek Homes
BURNCO Rock Products Ltd.

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BRUNCO AGGREGATE PROJECT - MCNAB CREEK SURFACE WATER DATA

1.0 INTRODUCTION

BURNCO Rock Products Ltd. (BURNCO) and 0819042 BC Ltd. are proposing to construct and operate the McNab Valley Aggregate Project ("the Project") on their 320 ha property in McNab Valley, which is located on the northern shore of Thornbrough Channel, immediately north of Gambier Island and northeast of the Town of Gibsons. Current Project plans include mining aggregate resources from a portion of the property situated approximately 500 m from the marine foreshore and extending northward approximately 600 m toward the southern banks of McNab Creek (Figure 1). The proposed extraction footprint will be positioned entirely within the gently sloping valley floor terrain and will be bounded to the west by a north-south aligned forest service road, to the south by a BC Hydro transmission corridor and to the east and north by McNab Creek. Terrain immediately west of the forest service road is comprised of steep, east-facing slopes that extend several hundred metres above the valley floor. Similarly steep and elevated, west-facing slopes are also positioned along the eastern margin of the valley floor, along the eastern shore of McNab Creek.

This technical memorandum provides a description of the surface water data collected at McNab Creek during the EAC Application/EIS baseline study and also provides construction information regarding the stream gauging equipment installed during the hydrological investigation. The information presented in this document were requested by Fisheries and Oceans Canada (DFO) in DFO 2017 and Dakin 2017.

This technical memorandum should be read in conjunction with the "Important Information and Limitations of this Report" which is appended following the text of the technical memorandum. The reader's attention is specifically drawn to this information as it is essential that it be followed for the proper use and interpretation of this technical memorandum.

2.0 INSTALLATION OF MONITORING STATIONS

The hydrological investigation of McNab Creek included the construction and set-up of three stream gauge stations: one upstream from the Project Area and two located adjacent to the Project Area (MC-US-01, MC-US, and MC-DS, respectively). The station MC-US-01 is located on McNab Creek approximately 500 m north of the

project site. The stations MC-US and MC-DS are adjacent to the perimeter of the project area respectively north and east of the site (Figure 1). Each station consist of a staff gauge and pressure transducer installed in the McNab Creek. The purpose of station MC-US-01 located upstream from the Project Area was to monitor the flow in McNab Creek and the two stations located adjacent to the Project Area were intended to monitor the water surface elevation adjacent to the Project Area.

The pressure transducers were installed underwater to record variations in pressure and temperature at 15 minute intervals. Two barologgers were also set up close to the station MC-US-01 and within the Project Area to compensate the readings for barometric pressure. The barologgers were installed in an enclosed 0.3 m standpipe bolted to a tree. The pressure recorded by the pressure transducers represents the combined influence of the depth of water over the sensor and atmospheric pressure. This data was translated into a depth of water by subtracting the atmospheric pressure recorded by the barologger. Water depth and barometric pressure was measured using Hobo level loggers (U-20-001-04).

The station MC-US-01 setup is shown in Figure 2. The staff gauge and pressure transducer were installed in a pond on the west side of McNab Creek. The pressure transducer was attached to a concrete block and placed under water while the staff gauge was affixed to a bedrock outcrop adjacent to the creek. The streambed along this section of the creek is characterized by exposed bedrock which served to keep the geometry stable with time. The pool where the transducer was installed was outlet controlled and the pressure transducer remained submerged even during low flow conditions.

The stations MC-US and MC-DS setups are shown in Figure 3 and Figure 4. The pressure transducers in these two stations were attached to weights made of metal rebar that were installed near the right bank of the creek in as deep a location as could be found. The staff gauge of station MC-US was anchored to a tree on the right bank of the creek (Figure 3). The staff gauge of station MC-DS was installed on a metal post driven into the streambed at the toe of the right bank. The staff gauges were vulnerable to damage by debris and ice. Surveyed benchmarks were established nearby to allow the easy replacement of the staff gauges as required.

The pressure transducers were attached to a wire cable which allowed the download of data without removing the sensors from the water. The water elevations on the staff gauges were collected during each flow measurements and when water level data were downloaded from the transducers. The staff gauge elevations provided a ‘snapshot’ of water levels during the flow monitoring and were used to correct any wandering of the sensor or physical movement of the transducers during the monitoring period.

Setup details are summarised below in Table 1 and shown in photographs in the attached Figure 2, Figure 3, Figure 4 and Figure 5.

Table 1: Summary of Stream Gauging Stations Setup

Site	River	Location	Northing	Easting	Date installed
MC-US-01	McNab Creek	500 m upstream of Project Area	5492074	471582	October 18, 2010
MC-US	McNab Creek	North of the Project Area	5491087	471666	August 11, 2010
MC-DS	McNab Creek	East of the Project Area	5490564	472124	August 11, 2010

3.0 MC-US-01 STAGE- DISCHARGE RELATIONSHIP DEVELOPMENT

A relationship between discharge and stage at MC-US-01 was developed to allow the recorded water level data to be translated into a flow record. Manual flow measurements at MC-US-01 recorded throughout a range of flow levels were plotted together with the corresponding water levels to develop the stage-discharge relationship shown In Figure 6. A tabular record of the recorded flows and stage readings are presented in Table 2.

Table 2: Stage Discharge Field Summary Results

Date	MC-US-01	
	Stage (m)	Flow Rate (m^3/s)
November 15, 2011	0.31	2.33
December 14, 2011	0.18	0.70
January 27, 2012	0.37	3.18
February 21, 2012	0.36	3.48
March 30, 2012	0.59	9.90
July 9, 2012	0.54	7.43
July 13, 2012	0.48	5.96
July 17, 2012	0.42	4.55
September 7, 2012	0.06	0.18
September 14, 2012	0.08	0.26

Stream discharges were measured using the area velocity-method with a Swoffer current meter. A tape meter was placed across the stream along the control section. Water depth (m) and velocity (m/s) were measured using a metric Swoffer Model 2100 Current Velocity Meter. Velocity measurements were collected at 60% total depth when the stream was less than 1 m, at 20% and 80% when the total depth was greater than 1 m. Flow data were collected using the midpoint method. This involved collecting depth and velocity measurements at the midpoint of 10 evenly spaced interval when the channel wetted width was less than 5 m. Data were collected at the midpoints of evenly spaced 20 intervals if the channel wetted widths were greater than 5 m.

4.0 MCNAB CREEK FLOW LOSS MEASUREMENTS

In an attempt to quantify the rate of flow loss from McNab Creek to the groundwater system within the reach adjacent to the Project Area, near concurrent (same day) discharge rates were measured at MC-US-01 and near MC-DS. A total number of 5 matching flow measurements were conducted (Table 3).

It is of note that the channel conditions at MC-DS were not conducive to accurate flow measurements due to the combination of shallow water depth, wide channel section and the large fraction of flow which was passing through the coarse bed materials.

Table 3: Summary of Concurrent Flow Measurements

Date	MC-US-01		MC-DS	
	Time	Flow Rate (m^3/s)	Time	Flow Rate (m^3/s)
July 9, 2012	11:00	7.43	14:00	8.82
July 13, 2012	11:00	5.96	12:30	6.30
July 17, 2012	11:30	4.55	14:00	5.69
September 7, 2012	11:30	0.18	14:00	0.03
September 14, 2012	10:30	0.26	13:30	0.12

5.0 RESULTS

The stage discharge curve for the station MC-US-01 (Figure 6) was used to derive a record of flows at 15 min interval. Average daily water levels and discharges for the MC-US-01 station are shown in Figure 7. Average daily water levels at the station MC-US-01 indicated a range of flows, from a low flow of 0.07 m^3/s to a high flow of 44 m^3/s. Average monthly flow rate for the station MC-US-01 are shown in Table 4.

Table 4: Average Monthly Flow Rates for McNab Creek MC-US-01

Month	Flow Rate (m^3/s)
November, 2011[(a)]	8.97
December, 2011	4.17
January, 2012	7.41
February, 2012	5.30
March, 2012	5.74
April, 2012	8.89
May, 2012	8.39
June, 2012	9.94
July, 2012	5.59
August, 2012	0.54
September, 2012	0.30
October, 2012	6.59
November, 2012[(b)]	10.38

Notes:

a) The average flow from November 15, 2011 to November 31, 2011

b) The average flow from November 1, 2011 to November 22, 2012.

Concurrent flow measurements at MC-US-01 and MC-DS were used to estimate the range of flow losses from McNab Creek to groundwater system adjacent to the Project Area. Estimated loss from McNab Creek around the project area were estimated as the difference between the sum of flow from MC-US-01 and Lower Box Canyon and the simultaneous flow value measured at MC-DS . Box Canyon is a tributary of McNab Creek located on the west side of the valley. The confluence between McNab and Box Canyon is located between the station MC-US-01 and the project area (Figure 1). Flows for Lower Box Canyon were obtained from a gauging station installed to support the design of the Box Canyon Hydroelectric Project (Knight Piesold 2012). The station setup, water level and flow data are shown in Figure 5 and Figure 8 respectively. Simultaneous stream flow data from MC-US-01, Lower Box Canyon and MC-DS and the resulting estimated losses from McNab Creek are shown in Table 5.

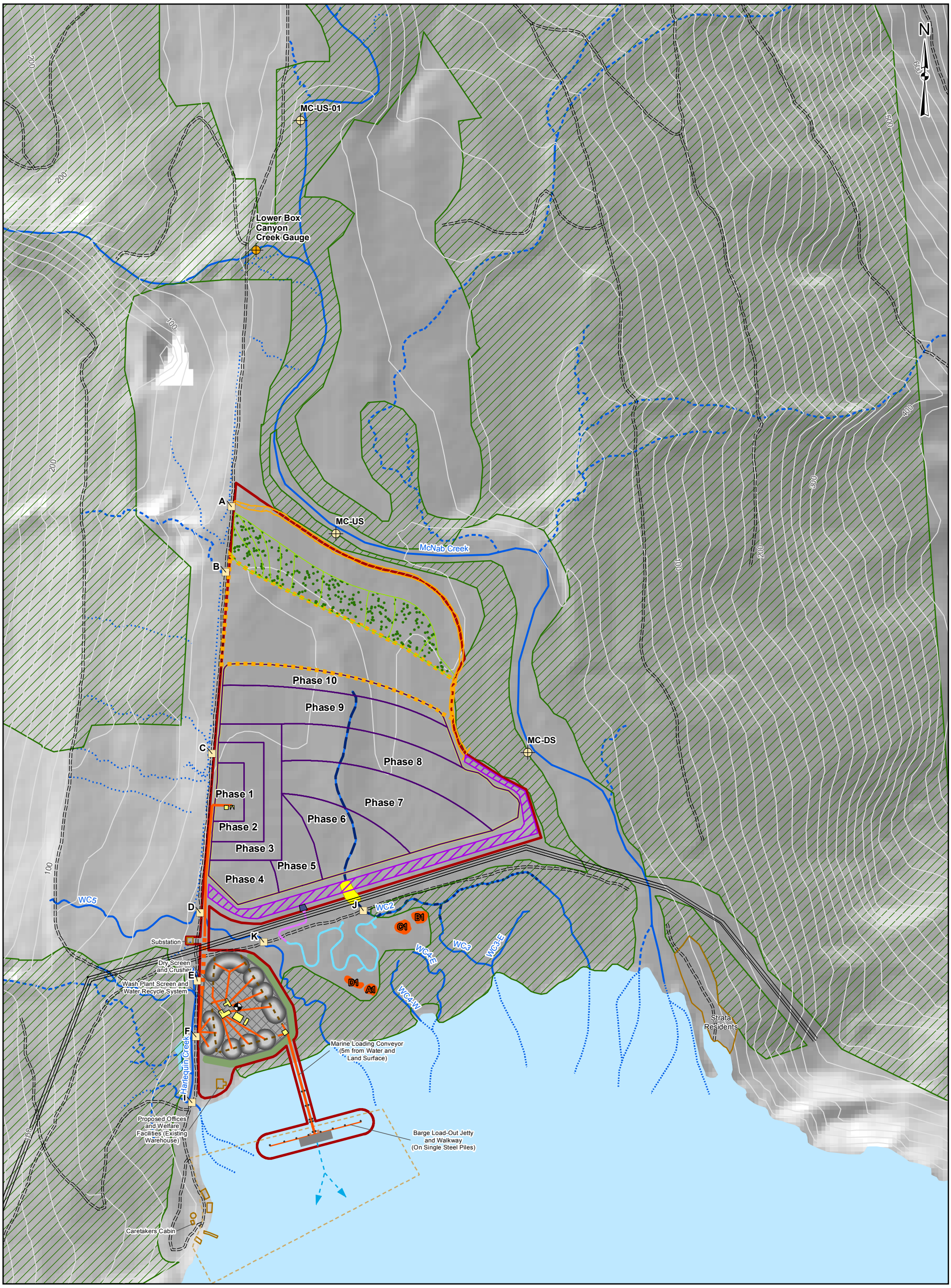
Table 5: Estimated losses along McNab Creek to Valley Fill Sediments

Date	A	B	C=A+B	D	E=C-D	
	MC-US-01 discharge (m^3/s)	Box Canyon discharge (m^3/s)[a]	Box Canyon + MC-US-01 discharge (m^3/s)	MC-DS discharge (m^3/s)	McNab Creek Loss	
					(m^3/s)	(m^3/day)
7/9/2012	7.43	1.53	8.97	8.82	0.15	13,000
7/13/2012	5.96	1.11	7.07	6.30	0.77	66,000
7/17/2012	4.55	0.79	5.34	5.69	-0.35[b]	-30,000
9/7/2012	0.18	0.01	0.19	0.03	0.16	14,000
9/14/2012	0.26	0.03	0.29	0.12	0.17	15,000

Notes:

a) Flow data from Lower Box Canyon provided by Box Canyon Hydro Corporation

b) Negative loss indicates a gain of flow between the confluence of McNab Creek and Box Canyon and station MC-DS



LEGEND

PROJECT COMPONENTS

- Project Area
- Proposed Aggregate Pit Phases
- McNab Creek Flood Protection Dyke
- Pit Lake Containment Berm
- Soil Deposit Area (Salvaged Soil Stockpiles)
- Fines Storage Area
- Processing Area
- Elevated Conveyor
- Underground Conveyor
- Below Pile Conveyor
- Barge Route
- Proposed Groundwater Use Well
- Existing Culvert
- Existing Feature
- Chanel Infill (WC 2 Plug) Riprap and Filter Zone
- WC 2 Extension - Year 1 Construction
- WC 2 Extension - Closure Construction
- Outlet Structure with Spillway and Low-level Outlet
- Final Pit Lake Boundary
- Amphibian Compensation Pond
- Product Stockpiles
- Possible Processing Infrastructure Configuration
- Processing Area Berm

BASEMAP DATA (TRIM / McElhanney)

- Mature Forest
- Existing Road
- Existing Log Tenure Area
- Existing Transmission Lines
- Contour (20m)
- Permanent /Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse
- Ephemeral Watercourse
- Constructed Watercourse Phase 1 (1985)
- Constructed Watercourse Phase 2 (1996)
- Constructed Watercourse Phase 3 (2001-2003)

Monitoring Locations

- Box Canyon Hydro Corporation Monitoring Location
- Surface Water Monitoring Location

REFERENCE

DEM from Geobas. Base data from the Province of British Columbia. Contours from TRIM positional data. Additional detailed site features provided by McElhanney. Projection: UTM Zone 10 Datum: NAD 83

300 0 300

SCALE 1:9,000 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

HYDROMETRIC MONITORING STATIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	7 Mar. 2017	SCALE AS SHOWN	REV. 0
GIS	JP	4 Apr. 2017	FIGURE 1	
CHECK	KZ	4 Apr. 2017		
REVIEW	CC	4 Apr. 2017		

Path: Y:\Vancouver\Spatial Data\Project Data\BC\McNab\Figures\MXD\Surface WaterTech_Memo\Figure_01_Hydrometric_Monitoring_Stations.mxd

McNab Creek at station MC-US-01

Station setup after installation

Pressure transducer sensor

PROJECT

BURNCO AGGREGATE PROJECT

TITLE

SURFACE WATER STATION MC-US-01 SETUPS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	2MAR17	SCALE NTS	REV.
CADD	---	---	**FIGURE 2**	
CHECK	SN	2MAR17		
REVIEW	CC	4APR17		

Station setup after installation

Station MC-US location

Looking downstream from section MC-US

PROJECT

BURNCO AGGREGATE PROJECT

TITLE

SURFACE WATER STATION MC-US SETUPS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	2MAR17	SCALE NTS	REV.
CADD	---	---	**FIGURE 3**	
CHECK	SN	2MAR17		
REVIEW	CC	4APR17		

Flow measurement downstream of station MC-DS

Looking downstream from section MC-DS

Station setup after installation

PROJECT

BURNCO AGGREGATE PROJECT

TITLE

SURFACE WATER STATION MC-DS SETUPS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150		
DESIGN	SN	2MAR17	SCALE NTS		REV.
CADD	---	---	**FIGURE 4**		
CHECK	SN	2MAR17			
REVIEW	CC	4APR17			

Lower Box Canyon Creek gauge looking upstream

Lower Box Canyon Creek gauge looking downstream

Note: Photos from Knight Piesold 2012 report

PROJECT

BURNCO AGGREGATE PROJECT

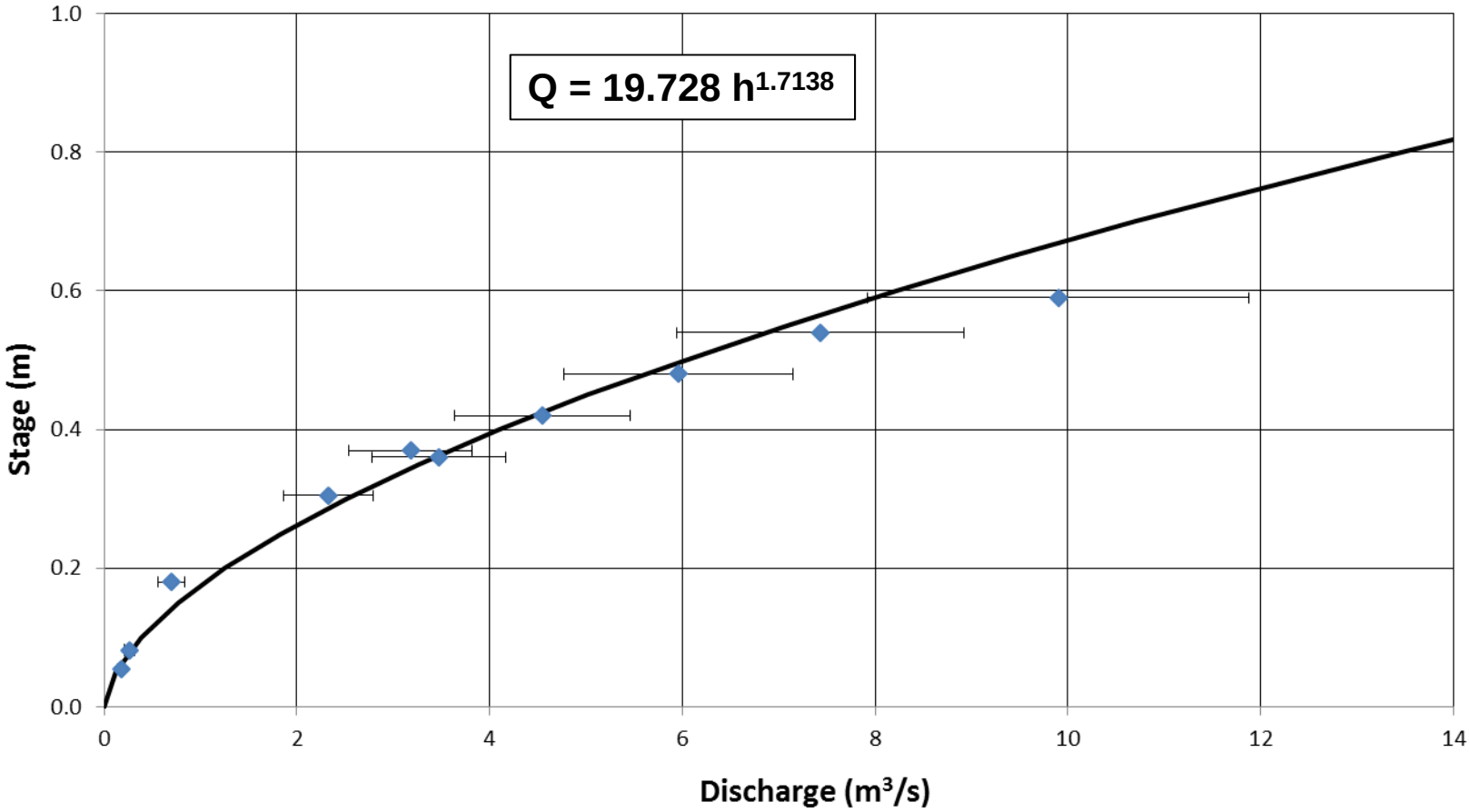
TITLE

SURFACE WATER STATION MC-DS SETUPS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	2MAR17	SCALE NTS	REV.
CADD	---	---		
CHECK	SN	2MAR17		
REVIEW	CC	4APR17		

FIGURE 5



PROJECT

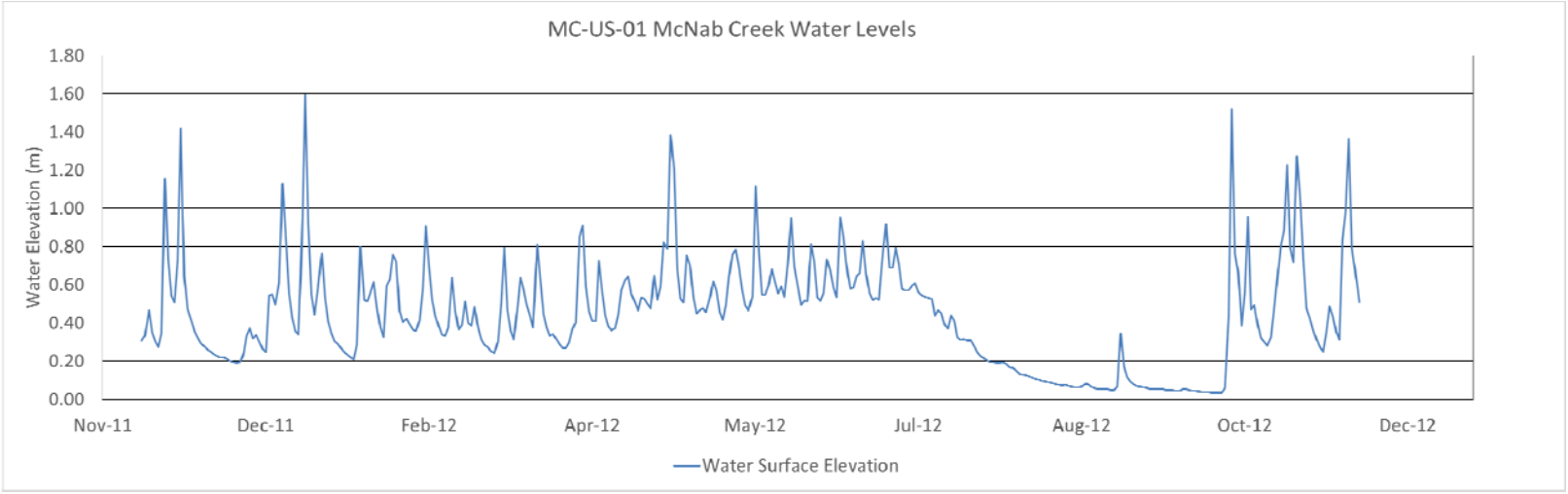
BURNCO AGGREGATE PROJECT

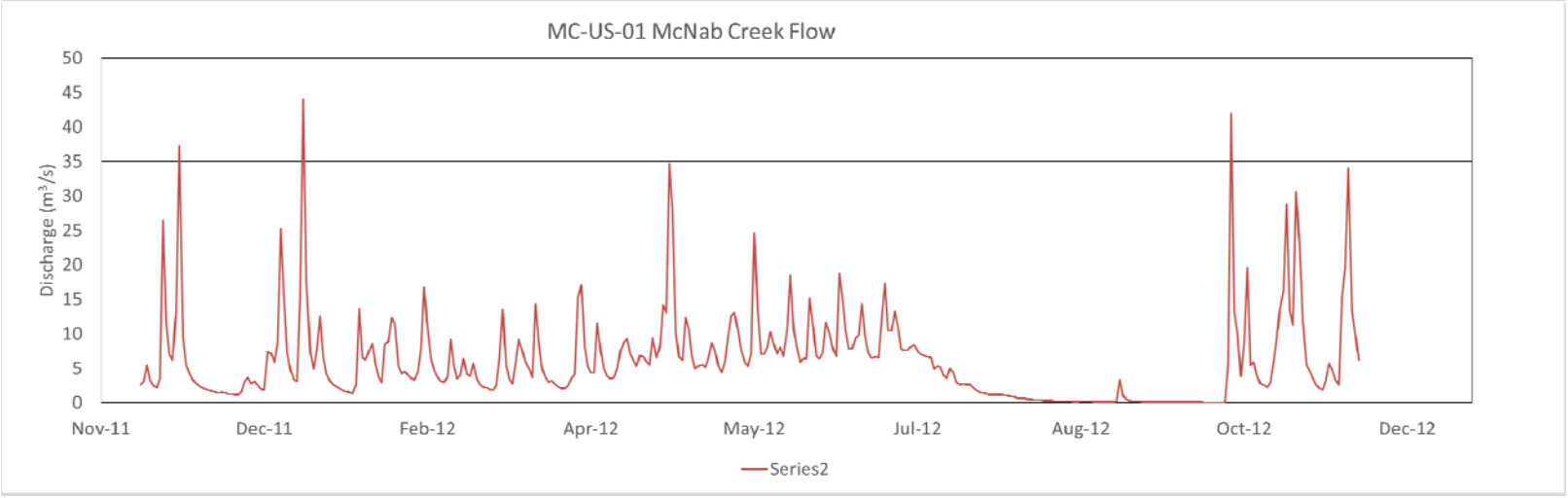
TITLE

SURFACE WATER STATION MC-US-01
RATING CURVE

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	2MAR17	SCALE NTS	REV.
CADD	---	---	**FIGURE 6**	
CHECK	SN	2MAR17		
REVIEW	CC	4APR17		





Note: Flow rates based on site specific rating curve

PROJECT
BURNCO AGGREGATE PROJECT

TITLE
MCNAB CREEK MC-US-01
AVERAGE DAILY WATER LEVELS AND FLOWS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150	
DESIGN	SN	2MAR17	SCALE NTS	REV.
CADD	---	---		
CHECK	SN	2MAR17	**FIGURE 7**	
REVIEW	CC	4APR17		

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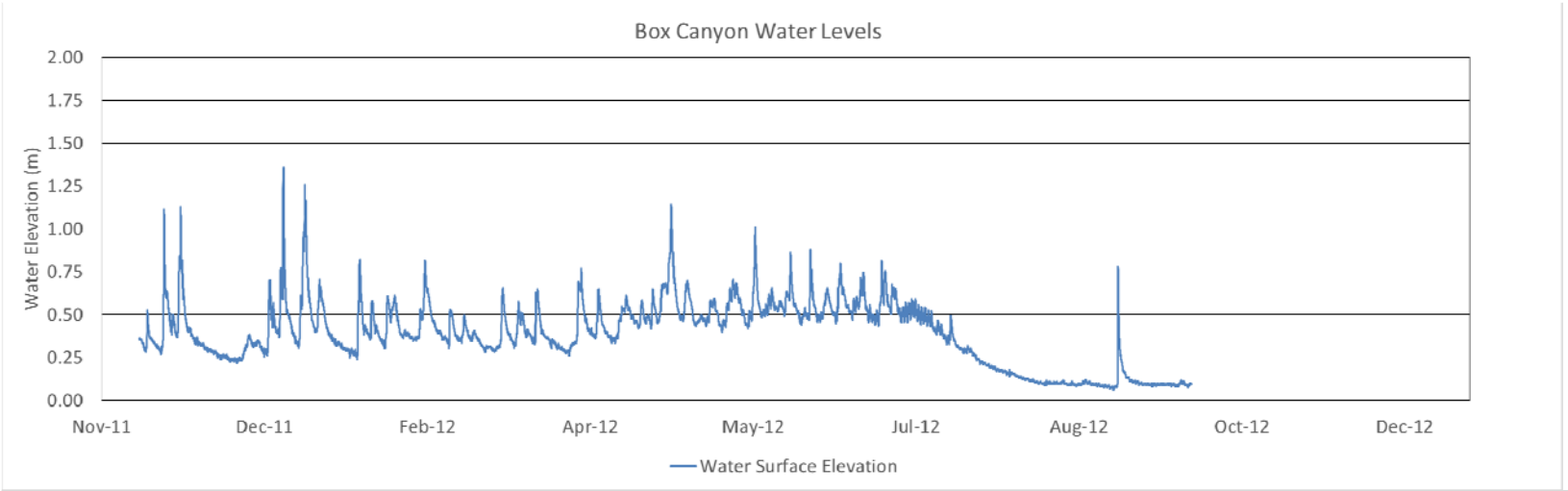

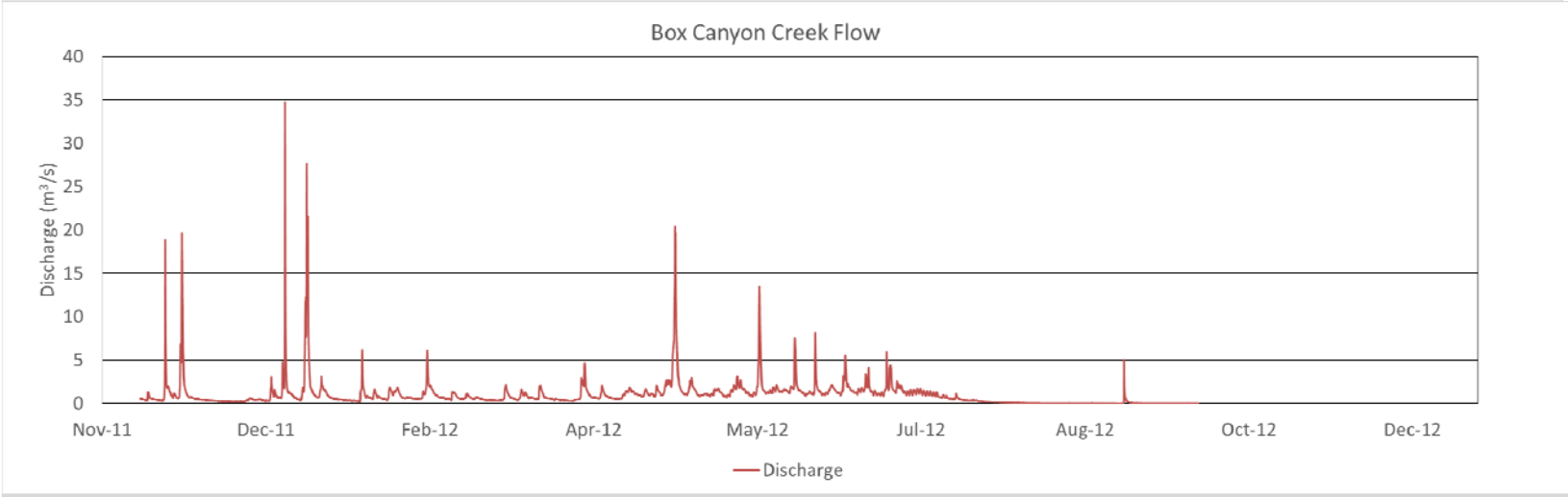

Note: Flow rates from Lower Box Canyon provided by Box Canyon Hydro Corporation

PROJECT
BURNCO AGGREGATE PROJECT

TITLE
BOX CANYON
AVERAGE DAILY WATER LEVELS AND FLOWS

Golder Associates

PROJECT No. 11-1422-0046			PHASE No. 1150
DESIGN	SN	2MAR17	SCALE AS SHOWN REV.
CADD	---	---	
CHECK	SN	2MAR17	**FIGURE 8**
REVIEW	CC	4APR17	

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6.0 CLOSURE

This document should be read in conjunction with the Study Limitations presented at the end of the technical memorandum. The reader's attention is specifically drawn to this information, as it is essential that it be followed for the proper use and interpretation of this document.

We trust that the information provided in this report meets your present needs. Should you have any questions or require additional information, please feel free to contact the undersigned.

GOLDER ASSOCIATES LTD.

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KZ/SN/CC/RM/asd

Attachment: Study Limitations

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7.0 REFERENCES

Dakin, A. 2017. Inter-office Memorandum. Comments and suggestions for information to be requested from BURNCO. Submitted to Marina Wright, DFO. Dated February 6, 2017. Project No: 151.

DFO 2017. Proposed BURNCO Aggregate Mine – Additional information requests. Submitted to Rob Haju, CEAA Project Manager. Dated February 14, 2017. File 09-HPAC-PA1-00024.

Golder 2013. BURNCO Aggregate Project, Howe Sound, BC, Project Description. December 12, 2013. Submitted to BC Environmental Assessment Office, Victoria, BC. 17p. Appendices, A, B and C.

Knight Piesold 2012. Box Canyon Hydro Corporation, Box Canyon Hydro Project, Diversion Section Hydrology and Hydraulics Impacts, March 12, 2012.

STUDY LIMITATIONS

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