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SITE F BURLEIGH FALLS DAM AT LOCK 28 AND PERRY'S CREEK DAM 1

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1 GENERAL

1.1 Introduction

Investigation works were performed during the fall 2017 and winter 2018 at Site F Burleigh Falls dam at Lock 28 and Perry's Creek Dam 1. The site is located approximately 30 kilometers north of the city of Peterborough Ontario between the Lower Buckhorn Lake on its upstream side and the Stoney Lake located on its downstream side.

The main objective of this investigation is to characterize subsurface conditions at the Burleigh Falls dam and Perry's Creek Dam 1 and their surrounding area. The information will be used to support the detailed design during development phase of the project.

The field work program conducted on the river and at both abutments, consisted of surveys (topographic, bathymetric and geophysical), boreholes and coreholes drilling.

1.2 Scope of work

This investigation program consisted of geotechnical, geological and surveying works performed at the Burleigh Falls / Perry's Creek Dams which includes in addition to the field works results, laboratory test results, geophysics, bathymetric and topographic surveys results.

The geological context of the project site is described in the section 2 entitled "Regional Geology". The details of the investigation program carried out at the Burleigh Falls / Perry's Creek Dams sites as well as the methods used, the laboratory testing of materials with the standards followed are presented in the section 3. The investigation results are listed in the tables of the section 4.

Location plan of the investigation works is presented in Appendix A. Boreholes logs, packer test results and rock cores structural logging and the corresponding core photos are included in the Appendix B. Laboratory test results are presented in Appendix C and geophysical, bathymetric and topographical surveys reports by subcontractors are presented in Appendix D.

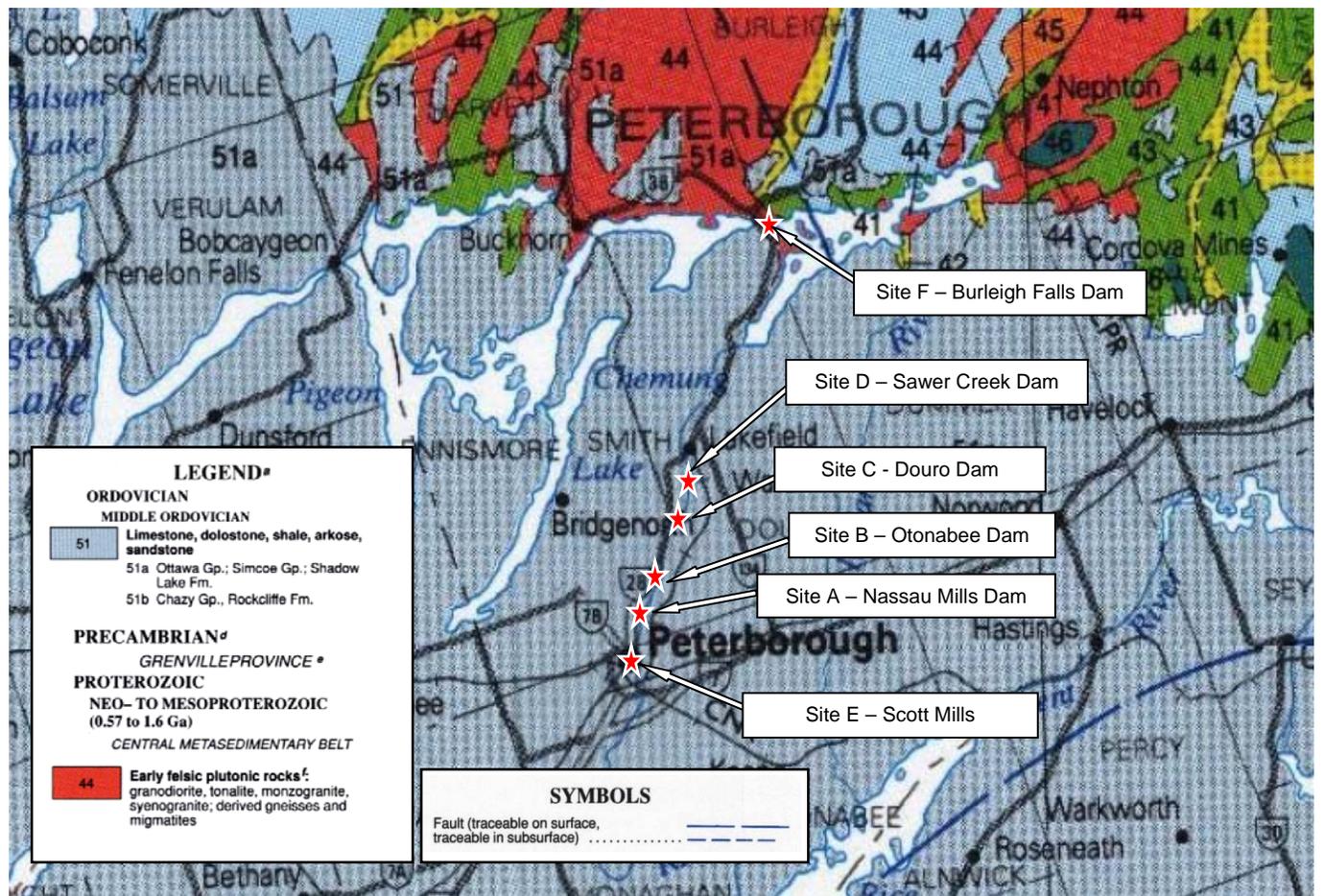
2 REGIONAL GEOLOGY

Site F – Burleigh Falls is the only Central Bundle site not located in the Ordovician rocks. It is rather located in the Precambrian Grenville Province rocks (0.6 to 1 Ga years of age). These older rocks are composed of felsic plutonic rocks (granodiorite, tonalite, monzogranite and derived gneiss). Some faults are indicated in this area. The Bedrock geology of the area is presented in Figure 2-1.

The actual landscape and surface deposits result of the action of the last glaciation epoch during the Pleistocene 20 000 to 10 000 years ago approximately. The Burleigh Falls area is characterized by the presence of Precambrian outcrops with very little overburden. Today the isostatic rebound is still effective. The Quaternary geology of the area is presented in Figure 2-2.

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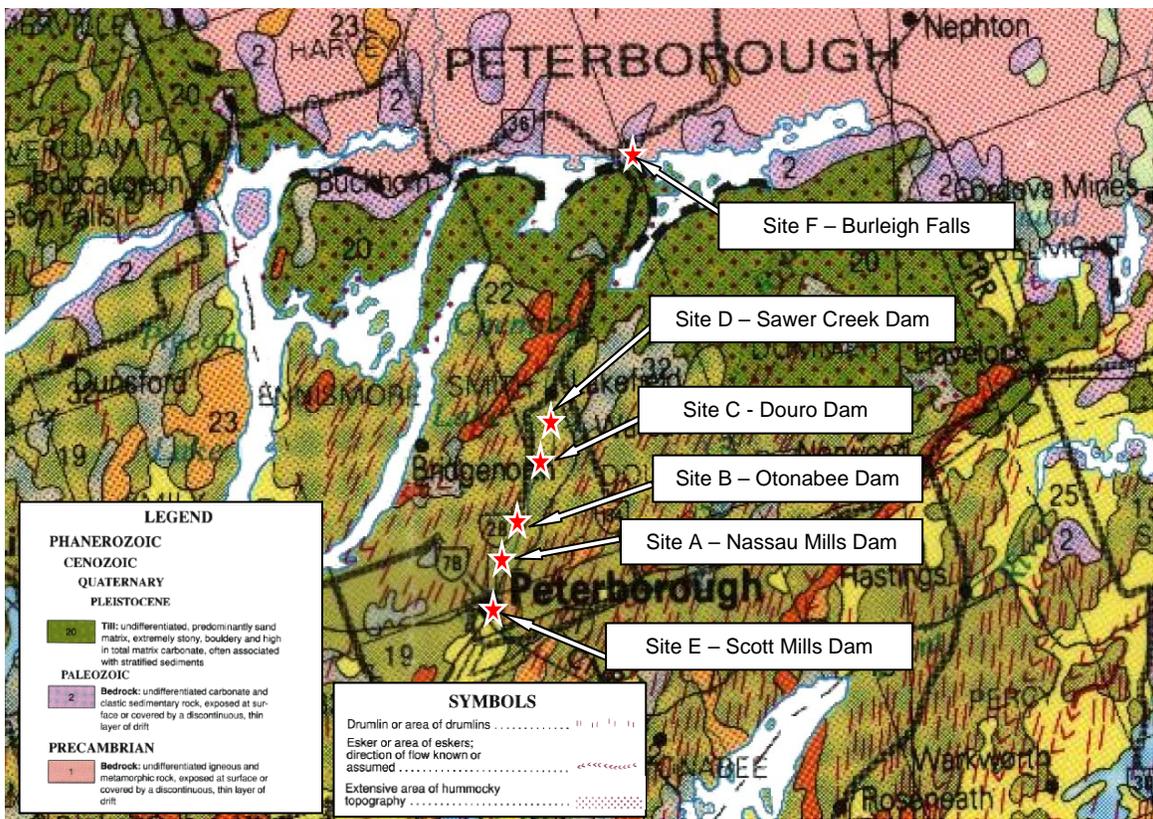


Ontario Geological Survey 1991. Bedrock geology of Ontario, southern sheet; Ontario Geological Survey, Map 2544, scale 1:1 000 000.

Figure 2-1 : Bedrock Geology in Central Bundle Dam Sites

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Barnett, P.J., Cowan, W.R. and Henry, A.P. 1991. Quaternary geology of Ontario, southern sheet; Ontario Geological Survey, Map 2556, scale 1:1 000 000.

Figure 2-2 : Quaternary Geology in Central Bundle Dam Sites

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3 SITE WORK

3.1 Field Logistic

The geotechnical investigation consisted of boreholes, coreholes, geophysical, bathymetric and topographic surveys.

Borehole and corehole drilling was carried out by Marathon Drilling Co. Ltd. hired by Maple CDB (Construction Manager) and under direct technical guidance from SNCL field representatives. Drilling and coring were advanced using one CME 55, one CME 75 and one CME 850 diamond drills; these machines are all manufactured by Central Mine Equipment Company. In addition, one Hilti DD 250 and one termite portable diamond core drills were used. The drilling operations were supervised by SNCL personnel (technicians and engineer).

The geophysical and bathymetric surveys were executed by Geophysics GPR International Inc hired by SNCL. The topographic survey was executed by GD Jewell Engineering under the supervision of Geophysics GPR International Inc.

3.2 Boreholes

Boreholes were advanced to penetrate through the sediments by means of 150 mm diameter hollow stem auger. Concrete and bedrock were cored using diamond bit with diameter of 76 mm (NQ) or 96 mm (HQ) and the samples were retrieved for further identification and classification. Soil or backfill materials were sampled using a split spoon sampler which is driven down by a drop hammer (SPT-Standard Penetration Tests – ASTM D1586). The SPT tests were performed with a 60 cm long split spoon at every 150 cm. Blow counts were recorded for successive 15 cm penetrations of the sampler and values for the second and third 15 cm intervals lengths are summed to represent the SPT N blow counts which are indicated on the borehole logs.

The following table summarizes the boreholes and corehole performed during the 2017 investigation works.

Table 3-1 : List of Boreholes and Corehole

Borehole	Northing (m)	Easting (m)	Ground Elevation (m)	Final Depth (m)	Machine	Orientation	Date started	Date completed
BH17-01	721810.5	4937437.2	242.3	5.00	HILTI DD 250	Vertical	2017/12/04	2017/12/06
BH17-02	721799.0	4937528.0	237.1	5.50	CME 75	Vertical (In water)	2017/12/07	2017/12/07
BH17-03	721770.1	4937665.8	242.0	4.97	HILTI DD 250	Vertical	2017/12/19	2017/12/20
BH17-04	721836.6	4937446.8	243.6	7.12	HILTI DD 250	Vertical	2017/11/30	2017/12/01

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Borehole	Northing (m)	Easting (m)	Ground Elevation (m)	Final Depth (m)	Machine	Orientation	Date started	Date completed
BH17-05	721831.4	4937475.4	243.6	11.20	HILTI DD 250	Vertical	2017/11/27	2017/11/28
BH17-06	721864.0	4937443.8	242.0	6.41	HILTI DD 250	Vertical	2017/11/15	2017/11/21
BH17-07	721848.9	4937535.0	235.0	4.88	HILTI DD 250	Vertical (In water)	2018/05/28	2018/05/30
BH17-08	721834.6	4937616.8	240.3	9.14	CME 850	Vertical	2017/12/12	2017/12/12
BH17-09	721898.2	4937434.4	243.6	4.98	HILTI DD 250	Vertical	2017/11/22	2017/11/24
BH17-11	721851.4	4937635.5	240.9	9.91	CME 55	Vertical	2018/04/12	2018/04/12
BH17-12	721547.5	4937720.4	242.4	8.82	CME 55	Vertical	2018/05/23	2018/05/24
BH17-101	721824.9	4937489.6	240.8	8.53	CME 55	Vertical (In water)	2017/12/11	2017/12/11
BH17-102	721823.3	4937498.9	241.8	9.93	CME 55	Vertical (In water)	2017/12/05	2017/12/05
BH17-103	721821.3	4937509.6	241.9	9.93	CME 55	Vertical (In water)	2018/03/20	2018/03/20
BH17-104	721819.5	4937517.5	242.9	12.67	HILTI DD 250	Vertical (In water)	2018/03/20	2018/03/20
BH17-105	721818.2	4937525.4	242.8	16.00	HILTI DD 250	Vertical (In water)	2018/03/21	2018/03/21
BH17-106	721837.6	4937513.1	241.1	9.78	HILTI DD 250	Vertical (In water)	2018/03/21	2018/03/21
BH17-107	721835.8	4937521.0	241.5	9.68	CME 850	Vertical (In water)	2018/03/22	2018/03/22
BH17-108	721834.5	4937528.9	237.1	5.21	CME 55	Vertical (In water)	2018/04/11	2018/04/11
CH17-01	721582.7	4937726.9	242.7	11.10	CME 55	Vertical	2017/11/28	2017/11/30
CH17-02	721588.7	4937727.6	242.7	10.26	CME 55	Vertical	2017/11/30	2017/11/30
CH17-101	721822.3	4937542.4	244.0	12.50	Termite	Vertical	2018/01/25	2018/01/25
CH17-102	721817.7	4937565.4	244.0	13.36	Termite	Vertical	2018/01/23	2018/01/23
CH17-103	721810.0	4937605.0	244.0	12.04	Termite	Vertical	2018/01/11	2018/01/11
CH17-104	721804.6	4937605.7	244.0	11.07	HILTI DD 250	Vertical	2018/01/10	2018/01/17
CH17-105	721803.7	4937610.6	244.0	9.50	HILTI DD 250	Vertical	2018/01/22	2018/01/24
ENV17-01	721813.2	4937605.3	244.0	0.35	HILTI DD 250	Vertical	2017/12/21	2017/12/21
ENV17-02	721814.3	4937597.1	244.0	0.35	HILTI DD 250	Vertical	2017/12/21	2017/12/21
ENV17-03	721829.3	4937511.9	244.0	0.35	HILTI DD 250	Vertical	2017/12/21	2017/12/21

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Boreholes BH17-08 and BH17-107 were drilled using a CME 850 diamond drill track mounted and boreholes BH17-11, BH17-12, BH17-101, BH17-102, BH17-103, BH17-108, CH17-01, CH17-02 were drilled using a CME 55 diamond drill truck mounted. Borehole BH17-02 was drilled using a CME 75 diamond drill track mounted and CH17-101, CH17-102 and CH17-103 were drilled using a termite portable diamond core drill. Finally, BH17-01, BH17-03, BH17-04, BH17-05, BH17-06, BH17-07, BH17-09, BH17-104, BH17-105, BH17-106, CH17-104, CH17-105, ENV17-01, ENV17-02 and ENV17-03 were drilled using a Hilti DD 250 portable diamond core drill. The samples obtained from ENV17-01, ENV17-02 and ENV17-30 were sent to the Environment services. The in water holes were drilled on a barge. After completion all holes were filled with grout except those one drilled in water where they were left open.

The locations of the boreholes/corehole are presented on drawing 644198-003F-4GDD-0550-PA in Appendix A.

Details of drilling, sampling and testing, types of overburden, concrete and rock core recovered are presented in the logs presented in Appendix B.

Core recovery was measured and calculated for every run performed in concrete or bedrock while the Rock Quality Designation (RQD) index was measured and calculated for every run performed in bedrock only.

A structural description was carried out on every rock core sample and the general concrete condition was described. Photos of concrete and bedrock samples were taken and can be found in Appendix B.

3.2.1 Packer Test

Twenty nine (29) packer tests were carried out in various boreholes following ASTM D4630. A wireline double packer was used for the packer test performed at the concrete/bedrock interface and a single packer (wireline) was used for the packer tests performed in bedrock only. Complete results are presented in Appendix B and Lugeon values obtained are summarized in Table 4-6.

3.3 Geophysical Surveys

Five seismic refraction lines totaling approximately 808 meters were surveyed on the Burleigh Falls Dam site: on the left shore, downstream and upstream of the dam across the river.

The purpose of seismic refraction survey was to determine subsurface units and bedrock contact. The survey was supplemented by 4 MASW (multichannel analysis of surface waves) surveys along the selected portions of the seismic lines to enhance data collection and interpretation.

The seismic refraction lines are shown on drawing 644198-003F-4GDD-0550-PA. The details and methods are elaborated in the GPR Geophysical Report annexed in Appendix D.

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3.4 Bathymetry Survey

One bathymetry survey was carried out upstream the Burleigh Falls dam in the Lower Buckhorn Lake on an approximated area of 68,700 m². The survey was conducted by Geophysics GPR International Inc. in order to measure the depth of the river and map the ground feature of riverbed.

The bathymetry survey location is shown on drawing 644198-003F-4GDD-0550-PA and included in Appendix A and the complete bathymetry survey report is presented in Appendix D.

3.5 Topographic Survey

A topographical land survey verification program was carried out over the left and right embankments of the Burleigh Falls dam and near Perry's Creek dam. A few random points surveyed in the past were re-surveyed in 2017 for verification and confirmation of their accuracy.

The area covered by the topographical survey and results are shown on drawing 644198-003F-4GDD-0550-PA included in Appendix A.

In addition, existing benchmarks, boreholes and seismic lines were surveyed and incorporated on the same drawing.

The complete topographical survey report is included in Appendix D.

3.6 Laboratory Tests

Following the fieldwork, rock and concrete samples were selected for laboratory tests. Compression strength testing (rock and concrete) were performed in the SNCL Vaughan Laboratory. Rock and bedrock/concrete interface direct shear testing was performed by the Queen University Rock Mechanics Laboratory. No soil testing was performed. The testing included:

- Rock Testing

- Compressive Strength and Elastic Moduli of Intact Rock Core Specimens (ASTM D7012);
- Direct Shear Test (ASTM D5607);

- Concrete Testing

- Direct Shear Test at concrete/bedrock interface (ASTM D5607);
- Compressive Strength Test (CSA A23.2-14C or ASTM C39);

All laboratory tests results are compiled and included in Appendix C.

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4 RESULTS OF INVESTIGATION

4.1 Stratigraphy

4.1.1 Fill

Very little overburden material was found at Burleigh Falls/Perry's Creek dams sites. Fill material composed of brown gravelly sand with some silt was found in boreholes BH17-08 and BH17-11 on thickness of 0.6 m. This fill has a relative density classified as compact to dense based on the SPT blow counts.

Under this gravelly sand fill found in borehole BH17-08 and BH17-11 and under a 0.15 m asphalt layer in BH17-12, boulders and cobbles fragments with some sand were found on thickness varying between 2.9 to 3.9 m.

4.1.2 Sediments

Marine sediment composed of clay with some pieces of broken cobbles was observed in BH17-02 on a thickness of 0.5 m just above bedrock. Based on the SPT blow counts, the clay consistency is hard.

4.1.3 Boulders and Cobbles

In borehole BH17-106, boulders and cobbles were observed in the river bed, just above bedrock, on a thickness of 0.4 m.

4.1.4 Concrete

Concrete was intersected in BH17-03, BH17-04, BH17-05, CH17-01, CH17-02, CH17-101 to CH17-105 and ENV17-01 to ENV17-03. BH17-03 was drilled on a retaining wall located on the left bank. BH17-04 and BH17-05 were drilled on the South concrete dam and CH17-01 and CH17-02 were performed on Perry's Creek dam. CH17-101 to CH17-105 and ENV17-01 to ENV17-03 were drilled on the main Burleigh Falls dam.

- Retaining Wall: Fresh and sound concrete was found in BH17-03 on a thickness of 0.4 m.
- South concrete dam: Moderately to slightly fractured concrete with large aggregate (max aggregate diameter: 370 mm) was found in BH17-04 and BH17-05 on thickness varying from 1.9 to 6.2 m.
- Perry's Creek dam: Moderately fractured (in the upper part of CH17-01) to slightly fractured concrete with maximum aggregate diameter of 50 mm was found in CH17-01 and CH17-02 on thickness varying from 5.0 to 5.7 m.

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- Burleigh Falls main dam: Moderately to highly fractured concrete with maximum aggregate diameter of 185 mm was found in the boreholes performed on the Burleigh Falls main dam.

Table 4-1 summarizes the concrete bedrock interface found in the various boreholes.

Table 4-1 : Concrete/bedrock interface

Borehole	Length (m)	Concrete/bedrock Interface
BH17-03	0.4	Open
BH17-04	1.9	Closed not sealed
BH17-05	6.2	Closed not sealed
CH17-01	5.7	Open
CH17-02	5.0	Closed
CH17-101	7.5	Open
CH17-102	8.1	Open
CH17-103	7.2	Closed not sealed
CH17-104	6.4	Open
CH17-105	4.6	Open
ENV17-01	0.4	No interface
ENV17-02	0.4	No interface
ENV17-03	0.4	No interface

Unconfined compressive strength tests were performed on selected concrete samples. The results are shown in the Table 4-2:

Table 4-2 : Unconfined Compressive Strength (Concrete)

Borehole	Depth (m)		Compressive strength
	From	To	MPa
BH17-05	2.77	3.00	16.9
BH17-05	4.57	4.78	15.9
CH17-102	0.19	0.43	44.6
CH17-103	1.32	1.50	31.3
CH17-105	0.00	0.30	39.0
CH17-01	1.98	2.29	14.6
CH17-02	1.50	1.80	27.5

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Photographs of the concrete core samples are shown in Appendix B.

4.1.5 Bedrock

The bedrock underlies the overburden materials or the concrete structure or directly under water in the riverbed. It is composed of dark to light gray to pink, very strong, fresh to slightly weathered, granodiorite and gabbro gneiss, moderately fractured and moderately foliated.

The RQD of the rock core samples are summarized in Table 4-3.

Table 4-3 : RQD Values

Borehole	Sample	Depth (m)		RQD	Borehole	Sample	Depth (m)		RQD
		From	To				From	To	
BH17-01	RC1	0.00	0.43	100	BH17-12	RC1	2.90	3.18	0
	RC2	0.43	1.12	63		RC2	3.18	4.22	100
	RC3	1.12	1.75	79		RC3	4.22	5.77	97
	RC4	1.75	2.24	100		RC4	5.77	7.19	89
	RC5	2.24	2.54	100		RC5	7.19	8.82	94
	RC6	2.54	3.15	63	BH-17-101	RC1	2.85	4.27	88
	RC7	3.15	3.45	42		RC2	4.27	5.79	100
	RC8	3.45	3.78	38		RC3	5.79	7.40	99
	RC9	3.78	4.24	61		RC4	7.40	8.54	100
	RC10	4.24	5.00	73	BH17-102	RC1	3.83	5.35	97
BH17-02	RC1	6.60	7.41	94		RC2	5.35	6.02	80
	RC2	7.42	9.07	92		RC3	6.02	6.91	92
	RC3	9.07	10.54	100		RC4	6.91	8.38	87
	RC4	10.54	12.12	100		RC5	8.38	9.90	97
BH17-03	RC1	0.41	0.74	100	BH17-103	RC1	4.11	5.28	88
	RC2	0.74	0.89	75		RC2	5.28	6.99	100
	RC3	0.89	1.02	100		RC3	6.99	8.49	99
	RC4	1.02	1.3	100		RC4	8.49	9.93	100
	RC5	1.3	1.7	88	BH17-104	RC1	2.85	4.27	88
	RC6	1.7	2.4	100		RC2	4.27	5.79	100
	RC7	2.4	2.7	100		RC3	5.79	7.40	99
	RC8	2.7	3.0	40		RC4	7.40	8.54	100
	RC9	3.0	3.43	86	BH17-105	RC1	3.83	5.36	97
	RC10	3.43	3.86	65		RC2	5.36	6.05	80
	RC11	3.86	4.14	40		RC3	6.05	6.93	92

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Borehole	Sample	Depth (m)		RQD	Borehole	Sample	Depth (m)		RQD
		From	To				From	To	
BH17-03	RC12	4.14	4.52	100	BH17-105	RC4	6.93	8.41	87
	RC13	4.52	4.75	72		RC5	8.41	9.93	97
	RC14	4.75	4.97	100	CH17-01	RC1	5.66	6.05	93
BH17-04	RC1	1.93	2.67	93		RC2	6.05	7.11	62
	RC2	2.67	4.19	73		RC3	7.11	8.64	53
	RC3	4.19	4.37	100		RC4	8.64	10.08	91
	RC4	4.37	4.78	90		RC5	10.08	11.10	100
	RC5	4.78	6.36	87	CH17-02	RC1	5.03	5.66	100
RC6	6.36	7.12	100	RC2		5.66	7.24	90	
BH17-05	RC1	6.20	6.58	53		RC3	7.24	8.74	100
	RC2	6.58	7.6	63	RC4	8.74	10.26	100	
	RC3	7.6	8.5	100	CH-01	RC1	7.47	8.15	38
	RC4	8.5	9.2	100		RC2	8.15	9.65	81
	RC5	9.2	10.4	90		RC3	9.65	10.21	100
RC6	10.4	11.21	100	RC4		10.21	11.43	94	
RC1	0.0	1.47	0	RC5		11.43	12.50	100	
BH17-06	RC2	1.47	1.95	79	CH-02	RC1	8.10	9.20	95
	RC3	1.95	2.21	50		RC2	9.20	9.76	100
	RC4	2.21	2.85	70		RC3	9.76	11.23	92
	RC5	2.85	3.89	85		RC4	11.23	12.60	100
	RC6	3.89	4.50	81		RC5	12.60	13.36	90
	RC7	4.50	5.14	100	CH-03	RC1	7.16	8.23	61
	RC8	5.14	6.41	100		RC2	8.23	9.22	77
BH17-07	RC1	1.78	2.57	74		RC3	9.22	10.21	95
	RC2	2.57	3.02	94		RC4	10.21	11.25	76
	RC3	3.02	3.35	92	RC5	11.25	12.04	68	
	RC4	3.35	3.89	100	CH-04	RC1	6.38	7.09	54
	RC5	3.89	4.88	97		RC2	7.09	7.85	37
BH17-08	RC1	0.61	1.52	0		RC3	7.85	8.43	70
	RC2	1.52	2.13	0		RC4	8.43	8.84	56
	RC3	3.51	4.57	86		RC5	8.84	9.42	61
	RC4	4.57	6.1	90		RC6	9.42	9.75	92
	RC5	6.1	7.65	93		RC7	9.75	10.72	86
	RC6	7.65	9.15	100		RC8	10.72	11.08	100
BH17-09	RC1	0.00	0.81	75	CH-05	RC1	4.55	5.46	65

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**2017 INVESTIGATION ASSESSMENT REPORT
SITE F BURLEIGH FALLS DAM AT LOCK 28
AND PERRY'S CREEK DAM 1**

Borehole	Sample	Depth (m)		RQD	Borehole	Sample	Depth (m)		RQD
		From	To				From	To	
BH17-09	RC2	0.81	1.30	95	CH-05	RC2	5.46	6.25	94
	RC3	1.30	2.41	91		RC3	6.25	7.47	73
	RC4	2.41	3.58	100		RC4	7.47	8.03	73
	RC5	3.58	4.70	100		RC5	8.03	8.79	83
	RC6	4.70	4.98	100		RC6	8.79	9.50	43
BH17-11	RC1	0.61	1.52	0					
	RC2	1.52	3.66	0					
	RC3	3.66	4.52	0					
	RC4	4.52	6.02	78					
	RC5	6.02	7.62	83					
	RC6	7.62	9.14	97					
	RC7	9.14	9.91	100					

Based on the RQD (Rock Quality Designation) values, the rock quality over the site is more often good to excellent with exceptional RQD values below 50% (poor to very poor quality).

Unconfined compressive strength tests were performed on selected rock samples. The results are shown in the Table 4-4:

Table 4-4 : Unconfined Compressive Strength (Rock)

Borehole	Depth (m)		Compressive strength
	From	To	MPa
BH17-05	7.59	7.77	97.2
CH17-101	7.67	7.90	101.7
CH17-103	7.98	8.23	79.9
CH17-01	7.11	7.37	78.7
CH17-02	5.21	5.51	98.3

Based on the compressive strength test results, rock strengths vary from strong to very strong.

Three residual direct shear strength tests were performed on selected concrete/bedrock interface samples and the results are shown in Table 4-5.

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SITE F BURLEIGH FALLS DAM AT LOCK 28
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Table 4-5 : Direct Shear Strength (Rock)

Borehole-Sample (depth)	Intact		Residual		
	Normal Stress (Mpa)	Shear Stress (Mpa)	Apparent Cohesion (kPa)	Internal Friction Angle (°)	Coefficient of Multiple Correlation (R ²)
Site F-CH17-103 (6.88-7.16 m) (interface)	n/a	n/a	606	36.3	0.993
Site F-CH17-104 (6.32-6.43 m) (interface)	n/a	n/a	926	27.3	0.995
Site F-CH17-02 (no footage) (interface)	n/a	n/a	1020	33.1	0.995

Packer tests were carried out in all 14 boreholes. Table 4-6 summarizes the results of these in-situ hydraulic conductivity tests.

Table 4-6 : Packer Tests

Corehole	Depth (m)		Material	Lugeon value	Corehole	Depth (m)		Material	Lugeon value
	Top	End				Top	End		
BH17-01	1.68	5.01	Bedrock	31	CH17-01	4.88	11.11	Interface + Bedrock	9
BH17-02	6.61	12.12	Bedrock	37	CH17-01	5.79	11.13	Bedrock	7
BH17-03	1.89	4.96	Bedrock	33	CH17-02	4.70	5.31	Interface	1
BH17-04	1.96	7.11	Bedrock	20	CH17-02	5.31	10.26	Bedrock	17
BH17-05	6.21	11.20	Bedrock	29	CH17-101	8.23	12.50	Bedrock	73
BH17-06	2.26	6.40	Bedrock	0	CH17-101	7.29	7.70	Interface	0
BH17-08	5.18	9.14	Bedrock	31	CH17-102	7.77	13.36	Bedrock	48
BH17-09	1.58	4.99	Bedrock	7	CH17-102	7.77	8.18	Interface	504
BH17-11	6.10	9.91	Bedrock	0	CH17-103	7.62	12.04	Bedrock	45
BH17-12	3.35	8.81	Bedrock	17	CH17-103	6.80	7.21	Interface	250
BH17-101	5.36	8.53	Bedrock	45	CH17-104	6.38	11.08	Bedrock	8
BH17-102	5.51	9.93	Bedrock	18	CH17-104	6.17	6.57	Interface	38
BH17-103	6.10	9.93	Bedrock	40	CH17-105	4.35	4.75	Interface	7

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**2017 INVESTIGATION ASSESSMENT REPORT
SITE F BURLEIGH FALLS DAM AT LOCK 28
AND PERRY'S CREEK DAM 1**

Corehole	Depth (m)		Material	Lugeon value	Corehole	Depth (m)		Material	Lugeon value
	Top	End				Top	End		
BH17-104	8.86	12.67	Bedrock	30	CH17-105	4.55	9.50	Bedrock	18
BH17-105	10.36	16.00	Bedrock	29					

As shown in Table 4-6, the Lugeon values in bedrock vary from 0 to 73 which correspond to very low to high water absorption with a median value of 29. At the concrete/bedrock interface, the Lugeon values vary from 0 to 504 which correspond to very low to high water absorption. The values measured at the interface in CH17-102 and CH17-103 show that the interface is very permeable with Lugeon values of 504 and 250 respectively.

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**2017 INVESTIGATION ASSESSMENT REPORT
 SITE F BURLEIGH FALLS DAM AT LOCK 28
 AND PERRY'S CREEK DAM 1**

APPENDIX A – LOCATION PLAN

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 millimetres



Contract No.	Drawing Code	Serial	Rev.
644198	003F	4GDD	0550 00

- NOTES:**
- ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
 - ALL ELEVATIONS ARE BASED ON CANADIAN GEODETIC VERTICAL DATUM CGVD1928-1978.
 - ALL COORDINATES ARE BASED ON UTM NAD83 (CSRS).
 - GEOTECHNICAL INFORMATION ARE OBTAINED FROM GEOTECHNICAL SITE INVESTIGATION REPORTS BY SNCL (2017).
 - BATHYMETRIC CONTOUR LINE PROVIDED BY LVM (2016) AND GPR (2017).
 - TOPOGRAPHIC CONTOUR LINE PROVIDED BY IBI GROUP (2007) AND GPR (2017).

- LEGEND:**
- BH17-XX / CH17-XX (2017 BOREHOLE / COREHOLE BY SNCL)
 - ENV17-XXX (2017 BY SNCL)
 - GEOPHYSICAL SURVEY LINE (GPR 2017)

NOT FOR CONSTRUCTION

No.	Description	Dwn.By Des.Par	Date
1	FINAL ISSUANCE	LT	10/05/2018

Do not scale drawings.
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A	A Detail number Numéro du détail
B	B Location dwg. number Numéro sur dessin

Professional Stamp

Project title / Titre du projet
**TRENT-SEVERN WATERWAY
DAM AT LOCK 28 - BURLEIGH FALLS
RECONSTRUCTION**

Drawing title / Titre du dessin
**2017 INVESTIGATIONS
PLAN**

Drawn by / Dessiné par L. TCHEKIKEN	Designed by / Conçu par S. VIAU P.Eng.
Verified by / Vérifié par A. TOURNIER P.Geo.	Approved by / Approuvé par A. MARTINIELLO P.Eng.
Drawing Date / Date du dessin 09/09/2018	Drawing Number / Numéro du Dessin 550
Project Number / Numéro du projet R.076951.700	Sheet Feuille 1 of 1

DERNIERE SAUVEGARDE: 2018/10/03 - 11:18am
CHEMIN: \\sll-mtl-ccc-pro\644198\T Dam Burleigh Falls 2018\preliminary\500_Geotechnical\Burleigh Falls Dam at Lock 28 - 550 - 100 per.dwg

PLAN
1:500

0 5 10 15 20 25
1:500

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**2017 INVESTIGATION ASSESSMENT REPORT
 SITE F BURLEIGH FALLS DAM AT LOCK 28
 AND PERRY'S CREEK DAM 1**

APPENDIX B – BOREHOLE LOGS



The following document presents a summary of the field data collected during the site investigation and the laboratory testing results for each borehole, this is a detailed legend of the log reports form.

DEPTH

This column presents a scale of the depth in m. Note that the depth is either a vertical or an inclined length.

ELEVATION

The column elevation shows the elevation and the depth of each strata found in the hole.

MATERIAL DESCRIPTION

The overburden description presented in this column come from a visual identification of the sample recovered by the drilling and from the lab results. Each soil layer is described in regards to a classification (ref: Field compendium for visual description of soil and for investigation reporting, SNC-Lavalin, July 2007). The classification and terminology of some soils are presented below:

Classification of soils according to grain size

Classification	ASTM (mm)
Boulder	300 and above
Cobble	75-300
Gravel	4.75-75
Sand	0.42-4.75
Silt	0.0002-0.42
Clay	0.0002 and below

Field estimation of soils strength

Soil type	Term
Sands, gravel	Loose
	Dense
	Slightly cemented
Silt	Soft or loose
	Firm or dense
Clay	Very soft
	Soft or loose
	Firm
	Stiff
	Very stiff

Soils proportion terminology

Terminology	Percent
Trace	less than 10%
Some	10-20%
Adj. -y, ey	20-35%
And	35-50%

The bedrock description presented in this column is a summary of the structural description of the rock core recovered by the diamond drilling and/or sonic drilling. Note that the abbreviation "c.a." means core axis.

N OR RQD

This column shows the penetration index "N" determined during Standard Penetration Tests (SPT) in soils or the Rock Quality Designation (RQD) of a rock core.

The "N" index represents the number of blows required to penetrate into the soils at a depth of 0.305 m (1 feet). The SPTs done followed the ASTM D1586-99 norm. Note that sometimes, the letter 'R' replace the N value which means that refusal is reach (more than 50 blows/ft).

The RQD index is determined by the percentage of rock core length higher than 0.10 m (4 inches).

Compaction	'N" index (blows/ft)
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	50 and more *

Rock quality	RQD (%)
Very poor quality	0 to 25
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Very good quality	90 to 100

K (cm/s)

This column locates and presents the results of permeability tests done in a borehole.

1.1 TESTS & RESULTS

In this column, all the tests realized in a borehole are written, including
Percent of fines (Fines%);
Water content (W);
Vane test (V) with depth or sample number in parenthesis and with the results of the shear strength undisturbed (Cu) and remolded (Cur);
Atterberg limits (LL: liquid limit; PL: plastic limit);

1.2 WATER CONTENT AND SPT

The last column presents in graphs, the standard penetration tests (▲) and water content (●) measured at different depths for a borehole.



SNC • LAVALIN

**STRUCTURAL LOG
LEGENDS AND DETAILS**

The following few pages present the detailed legend of the rock core description being part of the structural log.

ROCK CORE SAMPLE

Sample Number

This column refers to the number of the rock core run.

Depth

These columns present the depth of the run in meter. Note that the depth is either a vertical or an inclined length.

Recovery (Rec.)

This column presents the percentage of recovery of a run.

Water Return

These columns give an indication of the percent and the color of the drilling water that comes out of the hole during coring (see below for the color abbreviations).

ROCK CORE DESCRIPTION

Petrography-Alteration / Particular features

The type of bedrock, mineral composition, alteration and the presence of geologic features are indicated (see below for the description of the different abbreviations used).

RWI (Rock Weathering Index)

This index gives an idea of the rock weathering.

- FR:** fresh rock
- FRsJ:** fresh rock stained joints
- SW:** slightly weathered
- MW:** moderately weathered
- HW:** highly weathered
- CW:** completely weathered

ROCK STRUCTURAL DESCRIPTION

Joints per meter

This column gives the number of joints present per meter for the given run.

Jn, Jr, Ja, JRC : Rock mass classification parameters

- a) The Jn, Jr, Ja parameters enter in the calculation of the Q index (Barton et al., 1974).

Jn: Joint Set Number that represents the number of joint sets in the rock mass.

Jr: Joint Roughness Number that represents the roughness of the structural features in the rock mass.

Ja: Joint Alteration Number that represents the condition or degree of alteration of the structures in the rock mass.

Joint Set Number		Jn
A	Massive rock mass with no or few joints	0.5-1.0
B	1 joint set	2
C	1 joint set and some erratic joints	3
D	2 joints sets	4
E	2 joints sets and some erratic joints	6
F	3 joints sets	9
G	3 joints sets and some erratic joints	12
H	4 joints sets or more, erratic joints, high fracturation	15
J	Crushed or disaggregated rock	20

Joint Roughness Number		Jr
Rock wall contact and Rock wall contact before <10 cm shear		
A	Discontinuous joints	4
B	Rough or irregular, undulating	3
C	Smooth, undulating	2
D	Slickensided, undulating	1.5
E	Rough or irregular, planar	1.5
F	Smooth, planar	1.0
G	Slickensided, planar	0.5

Joint Alteration Number		Ja
Rock wall contact		
A	Tightly healed, hard, non-softening, impermeable filling i.e. quartz or epidote	0.75
B	Unaltered joint walls, surface staining only	1.0
C	Slightly altered joint walls. Non-softening mineral coatings, sandy particles, clay-free disintegrated rock etc.	2.0
D	Silty- or sandy-clay coating, small clay fraction (non-softening)	3.0
E	Softening or low friction clay mineral coatings, i.e. kaolinite or mica. Also chlorite, talc, gypsum, graphite, etc. and small quantities of swelling clays.	4.0

The Joint Roughness Coefficient **JRC** is a numerical number that can be estimated by comparing the appearance of a discontinuity surface with standard profiles as shown below.

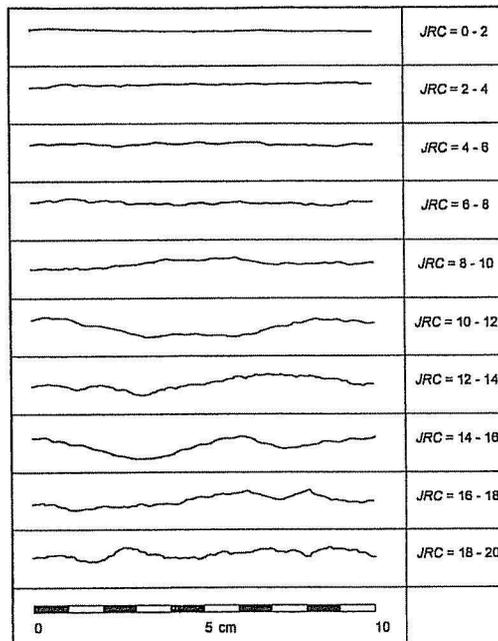


Figure 1: Roughness profiles and corresponding JRC values (after Barton and Choubey 1977).

RQD

This column shows the Rock Quality Designation (RQD) of a rock core. The RQD index is determined by the percentage of the recovered rock core length higher than 0.100 m (4 inches).

Rock quality	RQD (%)
Very poor quality	0 to 25
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Very good quality	90 to 100

Depth

This column presents the localisation of the structure (joint, lithologic contact, shear, vein, etc.) in meter. Note that the depth is either a vertical or an inclined length.

Type

This column indicates the type of the structure. The different abbreviations are described below:

- J:** primary joint
- F:** foliation joint
- L:** lithologic contact
- S:** shear
- V:** vein

Angle

This column indicates the angle of the geological structure with the core axis.

Opening

This column indicated the state of the geological structure. The different abbreviations are described below:

- t:** tight
- o:** open: in mm when measurable;
- c:** completely closed and healed

Filling

The type and the color of the filling material into the geological structures are described when observable. The different abbreviations are presented below:

Type:	Color:
A: allophane	bl: black
B: biotite	br: brown
C: calcite (carbonate)	g: green
E: epidote	gy: grey
K: chlorite	o: orange
KA: kaolinite	r: red
F: feldspar	w: white
FM: ferro-magn	y: yellow
M: silt and/or clay	d: dark
MG: magnetite	
O: oxydation	
P: pyrite	
PO: pyrrhotite	
Q: quartz	
R: rust	
S: sand	

OTHER ABBREVIATIONS

- sl:** slightly
- st:** strongly
- tr:** traces
- m.g.:** medium grained
- c.g.:** coarse grained
- f.g.:** fine grained
- str:** striation
- prob:** probably
- gg:** gouge

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-01 - Dry rock cores



Site F – Burleigh Falls – BH17-01 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-01	Vertical
------------------	----------

Logged by	S. Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1		0	0.43	100	100	2	From 0 to 5.00 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation		1 Jnt, oxydised	2	1.5	1.5	8
RC2		0.43	1.12	104	89	4		Estimation	3 Jnts	3	1.5-3	1-1.5	8-14
RC3		1.12	1.75	88	80	5		Estimation	3 Jnts	3	1.5	1-1.5	8
RC4		1.75	2.24	100	100	0			No joint				
RC5		2.24	2.54	100	100	0			No joint				
RC6		2.54	3.15	108	65	10		Estimation	6 Jnts	3	1.5-2	1-1.5	8-14
RC7		3.15	3.45	100	100	7		Estimation	2 Jnts	2	1.5	1.0	10
RC8		3.45	3.78	100	38	6		Estimation	2 Jnts	2	1.5	1.0	10
RC9		3.78	4.24	103	67	4		Estimation	2 Jnts	2	1.5	1-1.5	10
RC10		4.24	5.00	100	68	5		Estimation	4 Jnts	3	1.5-2	1-1.5	8-12
END							End of hole 5.00 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-01	
Collar Elev. m:		
Test section, m:	From: 1.68	To: 5.01
Date of test:	6-Dec-17	
Start time:	3:55 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m:	0.31
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Shubra PK
End time:	4:35 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	11.540	-	-
	1	11.551	0.011	0.011
	2	11.562	0.011	0.022
	3	11.573	0.011	0.033
	4	11.584	0.011	0.044
	5	11.595	0.011	0.055
	6			
	7			
	8			
	9			
10				

Pressure Gauge 0.069
Total 0.072

Lugeon 46

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.954	-	-
	1	11.970	0.016	0.016
	2	11.986	0.016	0.032
	3	12.002	0.016	0.048
	4	12.018	0.016	0.064
	5	12.034	0.016	0.080
	6	12.050	0.016	0.096
	7			
	8			
	9			
10				

Pressure Gauge 0.138
Total 0.141

Lugeon 34

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.610	-	-
	1	11.627	0.017	0.017
	2	11.644	0.017	0.034
	3	11.661	0.017	0.051
	4	11.678	0.017	0.068
	5	11.685	0.007	0.075
	6			
	7			
	8			
	9			
10				

Pressure Gauge 0.138
Total 0.141

Lugeon 36

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.061	-	-
	1	12.072	0.011	0.011
	2	12.082	0.010	0.010
	3	12.092	0.010	0.010
	4	12.102	0.010	0.010
	5	12.112	0.010	0.010
	6			
	7			
	8			
	9			
10				

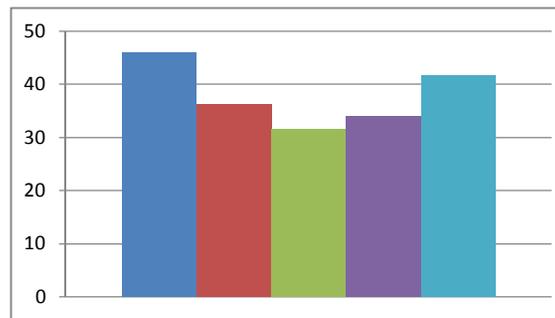
Pressure Gauge 0.069
Total 0.072

Lugeon 42

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	11.716	-	-
	1	11.739	0.023	0.023
	2	11.760	0.021	0.044
	3	11.782	0.022	0.066
	4	11.805	0.023	0.089
	5	11.827	0.022	0.111
	6	11.848	0.021	0.132
	7	11.870	0.022	0.154
	8	11.892	0.022	0.176
	9	11.914	0.022	0.198
10	11.936	0.022	0.220	

Pressure Gauge 0.207
Total 0.210

Lugeon 31



Lugeon 31

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-02 - Dry rock cores



Site F – Burleigh Falls – BH17-02 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-02	Vertical
------------------	----------

Logged by	S. Viau
Date	2018/01/25

Core Description							Lithological Description Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
RC1		6.60	7.42	100	97	6	From 6.60 to 7.42 m	6.81	1 Jnt, closed 70°	2	1.5	0.75	6
							5 joints Granitic gneiss and gabbro with pegmatite light foliation	6.83	1 Jnt, closed 70°	2	1.5	0.75	6
								7.09	1 Jnt, closed 25°	2	1.5	0.75	6
								7.21	1 Jnt, closed 85°	2	1.5	0.75	8
RC2		7.42	9.07	98	84	4	From 7.42 to 9.07 m	8.38	1 Jnt, closed 45°	2	1.5	0.75	6
							6 joints Granitic gneiss From 8.64 to 8.69 m broken rock	8.43	1 Jnt, closed 15°	2	1.5	0.75	6
								8.48	1 Jnt, closed 85°	2	1.5	0.75	6
								8.74	1 Jnt, open 90°	2	3	0.75	12
RC3		9.07	10.54	100	100	1	From 9.07 to 10.54 m	9.70	1 Jnt, closed 75°	2	1.5	0.75	6
							2 joints Granitic gneiss	9.88	1 Jnt, open 80°	2	1.5	0.75	6
RC4		10.54	12.12	100	100	2	From 10.54 m to 12.12 m	10.64	1 Jnt, closed 80°	2	1.5	0.75	10
							3 joints Granitic gneiss	10.77	1 Jnt, closed 90°	2	1.5	0.75	6
								11.10	1 Jnt, closed 80°	2	1.5	0.75	8
END							End of hole 12.12 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-02	
Collar Elev. m:		
Test section, m:	From: 6.61	To: 12.12
Date of test:	6-Dec-17	
Start time:	2:30 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.81
Collar stickup above ground, m	6.61
Section tested:	Bedrock
Test by:	A.Reza Khabbazi
End time:	3:30 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	36.070	-	-
	1	36.095	0.025	0.025
	2	36.120	0.025	0.050
	3	36.145	0.025	0.075
	4	36.170	0.025	0.100
	5	36.185	0.015	0.115
	6	36.210	0.025	0.140
	7	36.230	0.020	0.160
	8	36.250	0.020	0.180
	9	36.270	0.020	0.200
10	36.290	0.020	0.220	

Pressure Gauge 0.069
Total 0.077

Lugeon 47

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	37.200	-	-
	1	37.230	0.030	0.030
	2	37.261	0.031	0.061
	3	37.290	0.029	0.090
	4	37.320	0.030	0.120
	5	37.350	0.030	0.150
	6	37.381	0.031	0.181
	7	37.412	0.031	0.212
	8	37.442	0.030	0.242
	9	37.472	0.030	0.272
10	37.500	0.028	0.300	

Pressure Gauge 0.138
Total 0.146

Lugeon 39

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	36.310	-	-
	1	36.340	0.030	0.030
	2	36.370	0.030	0.060
	3	36.401	0.031	0.091
	4	36.431	0.030	0.121
	5	36.463	0.032	0.153
	6	36.493	0.030	0.183
	7	36.524	0.031	0.214
	8	36.554	0.030	0.244
	9	36.585	0.031	0.275
10	36.616	0.031	0.306	

Pressure Gauge 0.138
Total 0.146

Lugeon 40

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	37.600	-	-
	1	37.618	0.018	0.018
	2	37.640	0.022	0.022
	3	37.660	0.020	0.020
	4	37.680	0.020	0.020
	5	37.700	0.020	0.020
		37.720	0.020	0.020
		37.740	0.020	0.020
		37.761	0.021	0.021
		37.781	0.020	0.020
	37.800	0.019	0.019	

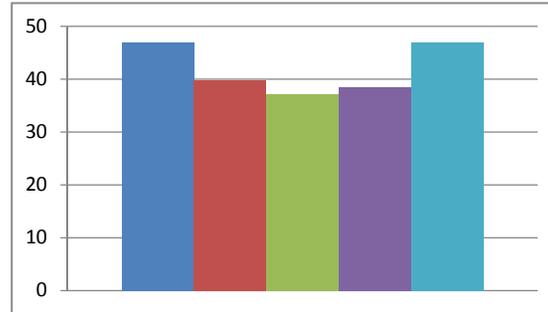
Pressure Gauge 0.069
Total 0.077

Lugeon 47

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	36.750	-	-
	1	36.792	0.042	0.042
	2	36.835	0.043	0.085
	3	36.877	0.042	0.127
	4	36.920	0.043	0.170
	5	36.964	0.044	0.214
	6	37.008	0.044	0.258
	7	37.052	0.044	0.302
	8	37.096	0.044	0.346
	9	37.140	0.044	0.390
10	37.185	0.045	0.435	

Pressure Gauge 0.207
Total 0.215

Lugeon 37



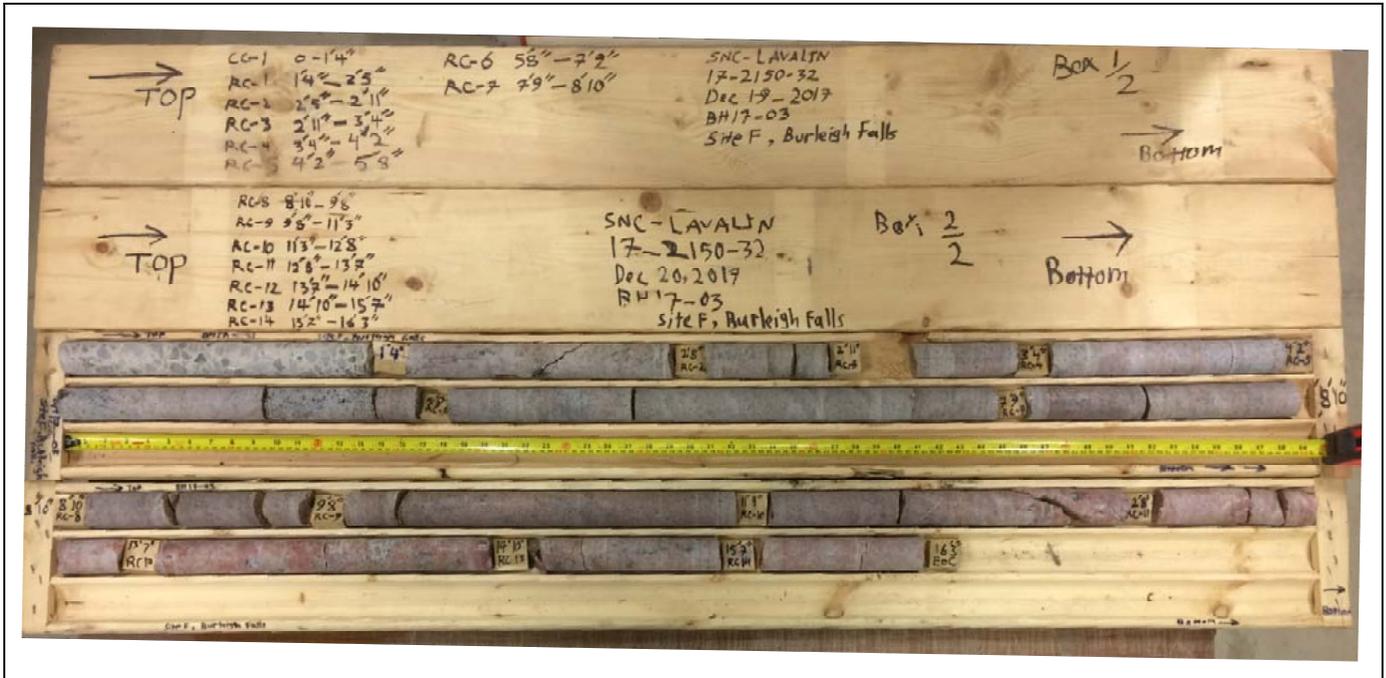
Lugeon 37

RECORD OF BOREHOLE No. **BH17-03**

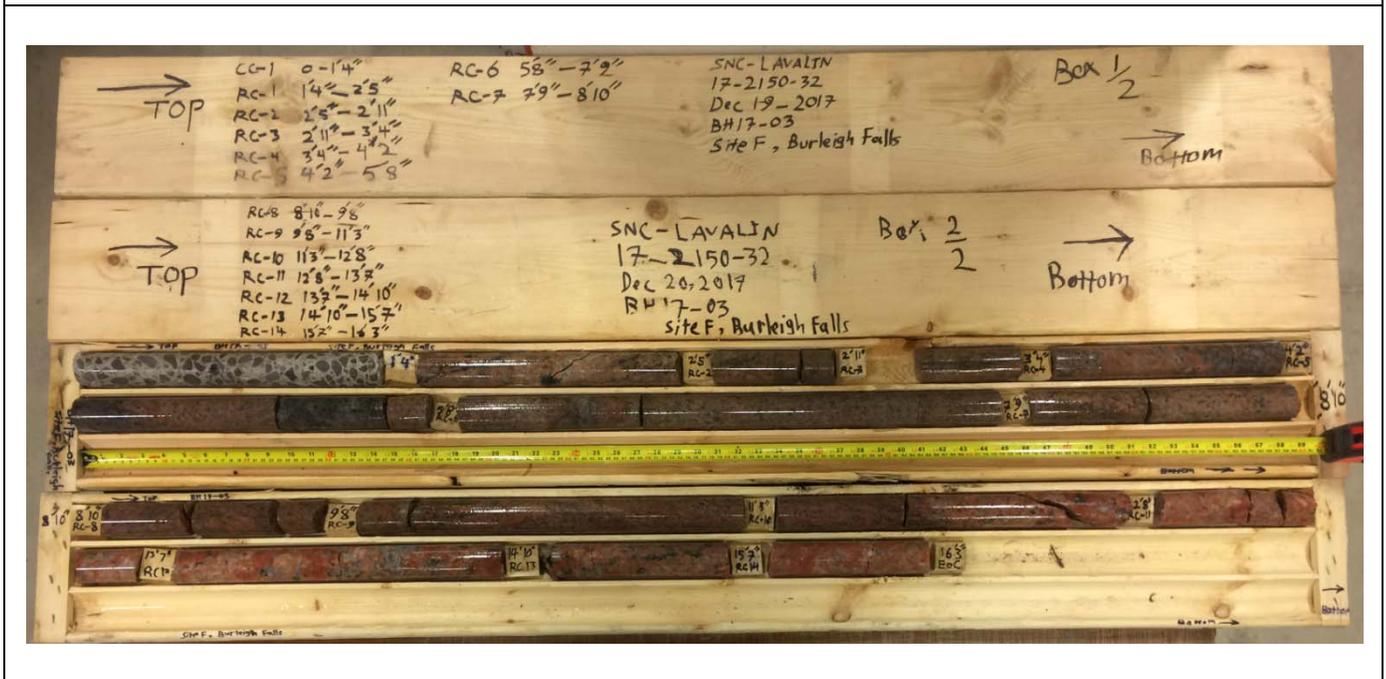
Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RA**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **HILTI DD 250** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Dec 19, 2017** Date Completed: **Dec 20, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	EASTING: 721770.1 NORTHING: 4937665.8	COMMENTS
		DESCRIPTION	Sample Type	Sample Number	Recovery (%)							
	Local Ground Surface Elevation: 242.00 m											
++	CONCRETE Light grey, strong, CONCRETE, fresh, no fractures	CC	1	90							RQD = 100%, SCR = 100%	
++	Concrete/bedrock interface open	RC	1	100								
++	BEDROCK	RC	2	100							RQD = 75%, SCR = 100%	
++	Dark to light gray to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, excellent to poor rock quality	RC	3	100		1	241				RQD = 100%, SCR = 100%	
++		RC	4	100							RQD = 100%, SCR = 100%	
++		RC	5	93							RQD = 88%, SCR = 93%	
++		RC	6	98		2	240				RQD = 100%, SCR = 100% From 1.89 to 4.96 m: 28 Lu	
++		RC	7	94							RQD = 100%, SCR = 94%	
++		RC	8	100							RQD = 40%, SCR = 96%	
++		RC	9	89		3	239				RQD = 86%, SCR = 98%	
++		RC	10	113							RQD = 65%, SCR = 100%	
++		RC	11	89		4	238				RQD = 40%, SCR = 89%	
++		RC	12	100							RQD = 100%, SCR = 100%	
++		RC	13	100							RQD = 72%, SCR = 100%	
++	END OF BOREHOLE	RC	14	91							RQD = 100%, SCR = 91%	
	Notes: 1. Borehole was found to be open and no free standing water upon completion.										Note: RQD: Rock quality designation SCR: Solid core recovery	

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-03 - Dry rock cores



Site F – Burleigh Falls – BH17-03 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-03	Vertical
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Logged by	S.Viau
Date	2018/04/02

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
CC1	NQ	0	0.41	91			From 0 to 0.41 m : Sound concrete At 0.41 m Concrete / Bedrock contact		No Fr				
								0.41	Contact not tight and not sealed				
RC1	NQ	0.41	0.74	100	46	3	From 0.41 to 4.95 m : Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	1 Jnt	2	3	1.0	14
RC2	NQ	0.74	0.89	100	67	7		Estimation	1 Jnt	2	2	1.0	10
RC3	NQ	0.89	1.02	100	100	0		No Jnt					
RC4	NQ	1.02	1.27	110	100	0		No Jnt					
RC5	NQ	1.27	1.73	94	83	4		Estimation	2 Jnts	2	1.5	1.0	10
RC6	NQ	1.73	2.18	144	100	4		Estimation	2 Jnts	2	1.5	1.0	10
RC7	NQ	2.18	2.69	63	63	2		Estimation	1 Jnt	2	1.5	1.0	10
RC8	NQ	2.69	2.95	100	80	12		Estimation	3 Jnts	2	1.5	1.0	10
RC9	NQ	2.95	3.43	97	84	2		Estimation	1 Jnt	2	1.5	1.0	10
RC10	NQ	3.43	3.86	100	71	5		Estimation	2 Jnts	3	1.5-3	1.0	10-16
RC11	NQ	3.86	4.14	91	36	14		Estimation	4 Jnts	3	1.5-3	1.0	10-16
RC12	NQ	4.14	4.52	107	100	3		Estimation	1 Jnt	2	1.5-3	1.0	10-16
RC13	NQ	4.52	4.75	100	67	13		Estimation	3 Jnt	2	1.5-3	1.0	10-16
RC14	NQ	4.75	4.95	100	56	5		END OF HOLE 4.95 m	Estimation	1 Jnt	2	1.5-3	1.0

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-03		
Collar Elev. m:			
Test section, m:	From: 1.89	To: 4.96	
Date of test:	20-Dec-17		
Start time:	4:23 PM		

Packer Size (PQ/HQ/NQ):	BTW
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.10
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Reza Araghi
End time:	4:55 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.022	-	-
	1	12.031	0.009	0.009
	2	12.040	0.009	0.018
	3	12.048	0.008	0.026
	4	12.057	0.009	0.035
	5	12.068	0.011	0.046
	6	12.077	0.009	0.055
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 51

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.425	-	-
	1	12.439	0.014	0.014
	2	12.455	0.016	0.030
	3	12.469	0.014	0.044
	4	12.484	0.015	0.059
	5	12.499	0.015	0.074
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 35

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.195	-	-
	1	12.210	0.015	0.015
	2	12.223	0.013	0.028
	3	12.237	0.014	0.042
	4	12.251	0.014	0.056
	5	12.266	0.015	0.071
	6	12.281	0.015	0.086
	7	12.296	0.015	0.101
	8			
	9			
10				

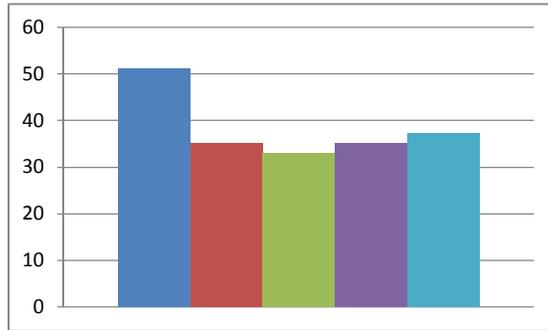
Pressure Gauge
Total
Lugeon 35

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.505	-	-
	1	12.513	0.008	0.008
	2	12.521	0.008	0.008
	3	12.529	0.008	0.008
	4	12.537	0.008	0.008
	5	12.545	0.008	0.008
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 37

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	12.310	-	-
	1	12.329	0.019	0.019
	2	12.348	0.019	0.038
	3	12.367	0.019	0.057
	4	12.386	0.019	0.076
	5	12.407	0.021	0.097
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 33



Lugeon 33

RECORD OF BOREHOLE No. **BH17-04**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RA**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **HILTI DD 250** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Nov 30, 2017** Date Completed: **Dec 1, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721836.6 NORTHING: 4937446.8	
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p W _L	COMMENTS					
	Local Ground Surface Elevation: 243.60 m														
	CONCRETE Light grey, strong, CONCRETE with large aggregate, moderately to slightly fractured. Max aggregate diameter: 370 mm	CC	1	100		243									
	Concrete/bedrock interface open					241.7									
++	BEDROCK Dark to light grey to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, fair to excellent rock quality Becomes moderately foliated	RC	1	100		1.9								RQD = 93%, SCR = 93% From 1.96 to 9.07 m: 30 Lu	
++						241								RQD = 73%, SCR = 73%	
++		RC	2	100		240									
++						239								RQD = 100%, SCR = 100% RQD = 90%, SCR = 90%	
++	Becomes slightly fractured, thickly foliated	RC	3	100										RQD = 87%, SCR = 87%	
++						238									
++		RC	4	100											
++	Becomes fresh					237								RQD = 100%, SCR = 100%	
++		RC	5	101											
++						236.5									
++	END OF BOREHOLE					7.1									
	Notes: 1. Borehole was found to be open and no free standing water upon completion.													Note: RQD: Rock quality designation SCR: Solid core recovery	

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-04 - Dry rock cores



Site F – Burleigh Falls – BH17-04 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-04	Vertical
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Logged by	S. Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
CC1		0	1.93				From 0 to 1.93 m		15 Fr				
							Good to fair quality concrete Max Ø aggregate 370 mm						
RC1		1.93	2.67	100	91	8	From 1.93 to 7.11 m	Estimation	6 Jnts	3	1.5	1.0	8-10
							Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation						
RC2		2.67	4.19	101	87	7		Estimation	10 Jnts	4	1.5	1.0	8-10
RC3		4.19	4.37	114	0	39	From 4.20 to 4.37 m	Estimation	7 Jnts	ind.	1.5	1.0	8-10
							Broken zone		Oxidized				
RC4		4.37	4.78	100	28	12	From 4.37 to 4.78 m	Estimation	5 Jnts	2	1.5-1	1-2	8-10
							Green weathering on joints						
RC5		4.78	6.35	100	88	3		Estimation	5 Jnts	3	1-1.5	1.0	8-10
RC6		6.35	7.11	97	97	0			No joint				
END							End of hole 7.11 m						

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-04		
Collar Elev. m:			
Test section, m:	From: 1.96	To: 7.11	
Date of test:	5-Dec-17		
Start time:	12:50 PM		

Packer Size (PQ/HQ/NQ):	BTW
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.09
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Reza Araghi
End time:	1:22 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	10.990	-	-
	1	11.002	0.012	0.012
	2	11.013	0.011	0.023
	3	11.024	0.011	0.034
	4	11.036	0.012	0.046
	5	11.048	0.012	0.058
	6	11.060	0.012	0.070
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
Total 0.070

Lugeon 33

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.300	-	-
	1	11.316	0.016	0.016
	2	11.332	0.016	0.032
	3	11.348	0.016	0.048
	4	11.364	0.016	0.064
	5	11.380	0.016	0.080
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.138
Total 0.139

Lugeon 22

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.070	-	-
	1	11.087	0.017	0.017
	2	11.103	0.016	0.033
	3	11.120	0.017	0.050
	4	11.136	0.016	0.066
	5	11.152	0.016	0.082
	6	11.168	0.016	0.098
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.138
Total 0.139

Lugeon 22

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	11.390	-	-
	1	11.400	0.010	0.010
	2	11.411	0.011	0.011
	3	11.422	0.011	0.011
	4	11.433	0.011	0.011
	5	11.444	0.011	0.011

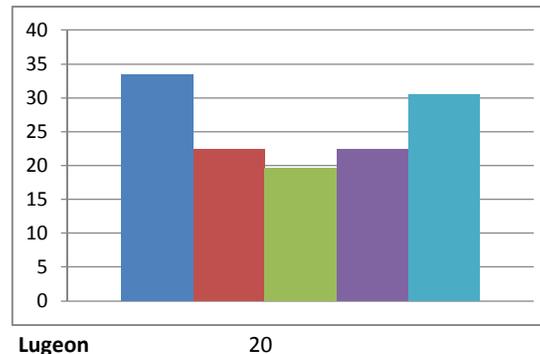
Pressure Gauge (Mpa) 0.069
Total 0.070

Lugeon 31

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	11.990	-	-
	1	12.011	0.021	0.021
	2	12.033	0.022	0.043
	3	12.053	0.020	0.063
	4	12.074	0.021	0.084
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.207
Total 0.208

Lugeon 20



RECORD OF BOREHOLE No. **BH17-05**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RA**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **HILTI DD 250** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Nov 27, 2017** Date Completed: **Nov 28, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721831.4 NORTHING: 4937475.4			
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L 20 40 60 80 W _p	COMMENTS							
	Local Ground Surface Elevation: 243.60 m																
<p>CONCRETE Light grey, strong, CONCRETE with large aggregate, moderately to slightly fractured. Max aggregate diameter: 180 mm</p>	CC	01	96		1	243											
	CC	02	65		2	242											
	CC	03	195		3	241										UCS = 16.9 MPa	
	CC	04	100		4	240											
	CC	05	100		5	239										UCS = 15.9 MPa	
	Concrete/bedrock interface partly closed, not sealed 237.4				6	238											
<p>BEDROCK Dark to light gray to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, moderately to thickly foliated, fair to excellent rock quality</p>	RC	01	100		7	237										RQD = 53%, SCR = 53% From 6.21 to 11.20 m: 43 Lu RQD = 63%, SCR = 63%	
	RC	02	101		8	236											UCS = 97.2 MPa RQD = 100%, SCR = 100%
	RC	03	99		9	235											RQD = 100%, SCR = 100%
	RC	04	100		10	234											RQD = 90%, SCR = 90%
	RC	05	101		11	233											RQD = 100%, SCR = 100%
	RC	06	100			232.4											
END OF BOREHOLE 11.2																Note: RQD: Rock quality designation SCR: Solid core recovery	

SNC-LAVALIN
 1801 McGill College Avenue
 12th Floor
 Montreal, Quebec H3A 2N4
 Tel: 514-393-1000

∇ No freestanding groundwater measured in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Notes to Record of Boreholes'.

Scale: 1 : 63
Page: 1 of 2

RECORD OF BOREHOLE No. **BH17-05**

Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

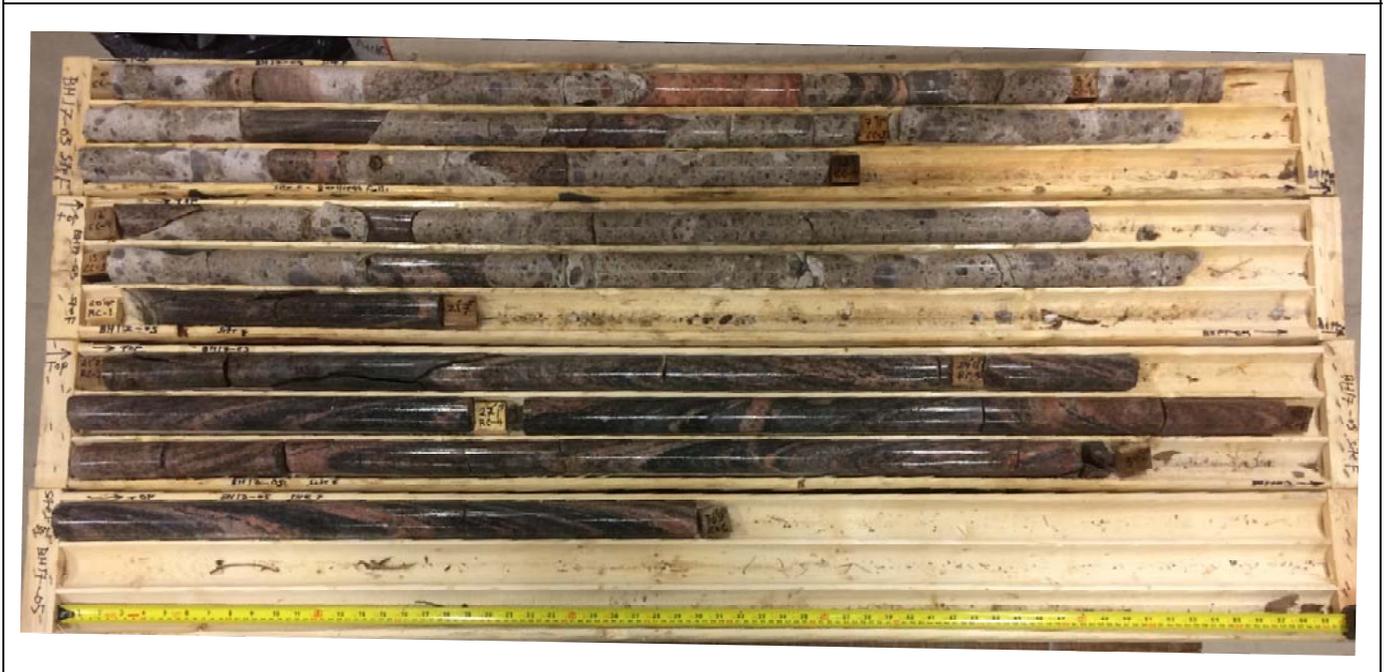
Logged by: **RA**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L W _P 20 40 60 80					
	<p>Notes:</p> <p>1. Borehole was found to be open and no free standing water upon completion.</p>													

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-05 - Dry rock cores



Site F – Burleigh Falls – BH17-05 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-05	Vertical
------------------	----------

Logged by	S. Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
CC1		0	1.27	94			From 0 to 1.27 m Fair quality concrete Max Ø aggregate 180 mm	7 Fr					
CC2		1.27	2.41	98			From 1.27 to 2.41 m Fair quality concrete Max Ø aggregate 175 mm	10 Fr					
CC3		2.41	3.66	102			From 2.41 to 3.66 m Fair quality concrete Max Ø aggregate 125 mm	7 Fr					
CC4		3.66	4.85	100			From 3.66 to 4.85 m Fair quality concrete Max Ø aggregate 95 mm	6 Fr					
CC5		4.85	6.20	99			From 4.85 to 6.20 m Fair quality concrete Max Ø aggregate 140 mm Broken pieces at 5.44 m and from 5.69 to 5.72 m CONCRETE	9 Fr					
							BEDROCK	6.20	Contact Concrete/Bedrock 45°				
								6.20	Contact Concrete/Bedrock not sealed				
RC1		6.20	6.58	100	47	16	From 6.20 to 11.20 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	6 Jnts	3	1.5-3	1-1.5	8-14
RC2		6.58	7.59	101	53	7		Estimation	7 Jnts	3	1.5-3	1-1.5	8-14



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-05	Vertical
------------------	----------

Logged by	S. Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC3		7.59	8.26	100	100	2	From 6.20 to 11.20 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	1 Jnt	2	1.5	1.0	8
RC4		8.26	9.17	100	96	3		Estimation	3 Jnts	3	1.5	1.0	8-12
RC5		9.17	10.41	100	91	6	From 10.36 to 11.41 m Broken zone	Estimation	7 Jnts	3	1.5-3	1-1.5	8-14
RC6		10.41	11.20	97	97	1		Estimation	1 Jnt	2	1.5	1.0	10
END							End of hole 11.20 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-05	
Collar Elev. m:		
Test section, m:	From: 6.21	To: 11.20
Date of test:	29-Nov-17	
Start time:	1:30 PM	

Packer Size (PQ/HQ/NQ):	BTW
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.09
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Reza Araghi
End time:	2:00 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	8.820	-	-
	1	8.836	0.016	0.016
	2	8.851	0.015	0.031
	3	8.866	0.015	0.046
	4	8.881	0.015	0.061
	5	8.896	0.015	0.076
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
43

(Mpa)
0.069
0.070

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.250	-	-
	1	9.272	0.022	0.022
	2	9.294	0.022	0.044
	3	9.316	0.022	0.066
	4	9.338	0.022	0.088
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
32

(Mpa)
0.138
0.139

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	8.970	-	-
	1	8.993	0.023	0.023
	2	9.014	0.021	0.044
	3	9.034	0.020	0.064
	4	9.055	0.021	0.085
	5	9.076	0.021	0.106
	6	9.097	0.021	0.127
	7			
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
30

(Mpa)
0.138
0.139

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.390	-	-
	1	9.406	0.016	0.016
	2	9.422	0.016	0.016
	3	9.438	0.016	0.016
	4	9.454	0.016	0.016
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
46

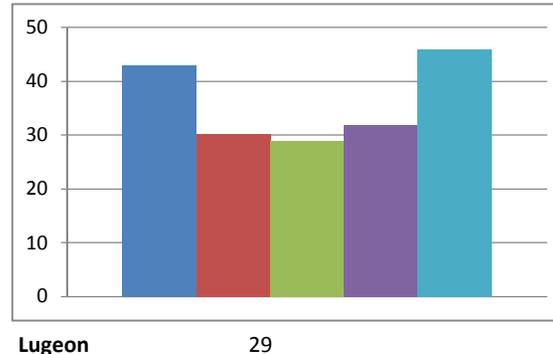
(Mpa)
0.069
0.070

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	9.155	-	-
	1	9.185	0.030	0.030
	2	9.215	0.030	0.060
	3	9.245	0.030	0.090
	4	9.275	0.030	0.120
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
29

(Mpa)
0.207
0.208



**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-06 - Dry rock cores



Site F – Burleigh Falls – BH17-06 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-06	Vertical
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Logged by	S. Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1		0	1.47	43	0		From 0 to 1.47 m Broken to fragmented gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation						
RC2		1.47	1.96	95	63	10		Estimation	5 Jnts	3	1.5	1-1.5	8-10
RC3		1.96	2.21	110	90	8		Estimation	2 Jnts	3	1.5-3	1-1.5	8-16
RC4		2.21	2.84	100	72	11		Estimation	7 Jnts	3	1.5-3	1-1.5	8-14
RC5		2.84	3.89	98	72	8		Estimation	8 Jnts	3	1.5-3	1-1.5	8-14
RC6		3.89	4.57	102	85	7		Estimation	5 Jnts	2	1.5	1-2	8-10
RC7		3.15	4.50	98	85	3		Estimation	4 Jnts	2	1.5	1-1.5	8-10
RC8		4.50	5.13	104	96	2		Estimation	1 Jnt	2	1.5	1.0	8
RC9		5.13	6.40	92	84	2		Estimation	2 Jnts	2	1.5	1.0	8
END								End of hole 6.40 m					

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-06		
Collar Elev. m:			
Test section, m:	From: 2.26	To: 6.40	
Date of test:	29-Nov-17		
Start time:	1:30 PM		

Packer Size (PQ/HQ/NQ):	BTW
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.09
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Reza Araghi
End time:	2:00 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	8.630	-	-
	1	8.630		
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
 Total 0.070
 Lugeon 0

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.000
 Total 0.001
 Lugeon 0

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.000
 Total 0.001
 Lugeon 0

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
	0			
	1			
	2			
	3			
	4			
	5			

Pressure Gauge (Mpa) 0.000
 Total 0.001
 Lugeon 0

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.000
 Total 0.001
 Lugeon 0

Tried with 10 to 45 PSI but did not take any water
 Highest capacity of the pump was 45 PSI

RECORD OF BOREHOLE No. **BH17-07**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **HILTI DD 250** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **May 28, 2018** Date Completed: **May 30, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721848.9 NORTHING: 4937535		
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L ■ W _P ● W _U 20 40 60 80				COMMENTS	
		Local Ground Surface Elevation: 236.78 m													
	WATER From top of the boat						236								
	235.0 1.8 BEDROCK Dark to light gray to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, fair to excellent rock quality	RC	1	87		2	235							RQD = 74%	
		RC	2	102		3	234							RQD = 94%	
		RC	3	100		4	233							RQD = 92%	
		RC	4	98		5	232							RQD = 100%	
	231.9 4.9 END OF BOREHOLE	RC	5	100		6	232							RQD = 97%	
														Note: RQD: Rock quality designation SCR: Solid core recovery	

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-07 - Dry rock cores



Site F – Burleigh Falls – BH17-07 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-07	Vertical
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Logged by	S.Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	1.78	2.57	100	71		From 1.78 to 4.88 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	6 Jnts	2	2	1	8
RC2	NQ	2.57	3.02	100	72			Estimation	3 Jnts	2	2	1	8
RC3	NQ	3.02	3.35	100	69			Estimation	2 Jnts	2	2	1	6
RC4	NQ	3.35	3.89	100	100			Estimation	2 Jnts	2	2	0.75	6
RC5	NQ	3.89	4.88	100	87			Estimation	5 Jnts	2	2	1	7
END							End of hole 4.88 m						

RECORD OF BOREHOLE No. **BH17-08**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Hollow Stem Augering & Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 850 Track Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Dec 12, 2017** Date Completed: **Dec 12, 2017** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721834.6 NORTHING: 4937616.8	
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing		★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p W _L				COMMENTS
		Local Ground Surface Elevation: 240.30 m												
	FILL Brown, compact, GRAVELLY SAND, some silt, moist	SS	01	38	21		240	○						
	Becomes BOULDERS and COBBLES with some sand and some gravel	RC	01	45		1	239							RQD = 0%, SCR = 0%
		SS	02	0		2	238							
						3	237							
						4	236							RQD = 86%, SCR = 95%
						5	235							RQD = 90%, SCR = 97%
						6	234							From 5.18 to 9.14 m: 50 Lu
						7	233							RQD = 93%, SCR = 100%
						8	232							RQD = 100%, SCR = 100%
						9								
	END OF BOREHOLE													
	Notes: 1. Borehole was found to be open and no free standing water upon completion.													Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-08 - Dry rock cores



Site F – Burleigh Falls – BH17-08 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-08	Vertical
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Logged by	S.Viau
Date	2018/04/02

Core Description							Lithological Description	Structural Description						
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock	
		From	To											
RC1	NQ	0.61	3.51	16	0		From 0.61 to 3.51 m Concrete : Moderately broken Recovery of 0.38 m concrete and of 0,08 m limestone At 3.51 m : Concrete / Bedrock contact not visible							
RC2														
								3.51	Contact zone not tight not sealed					
RC3	NQ	3.51	4.57	93	19	6	From 3.51 to 9.14 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	6 Jnts	4	1.5	1.0	8	
RC4	NQ	4.57	6.10	105	30	6		Estimation	9 Jnts	4	1-1.5	1.0	8	
								4.70 to 4.72 broken zone						
RC5	NQ	6.10	7.65	95	87	3		Estimation	5 Jnts	3	1-1.5	1.0	10	
RC6	NQ	7.65	9.14	102	100	1		Estimation	2 Jnts	2	1.5	1.0	8	
END							End of hole 9.14 m							

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-08	
Collar Elev. m:		
Test section, m:	From: 5.18	To: 9.14
Date of test:	13-Dec-17	
Start time:	2:10 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs:	7.01
Height gauge above ground (H2), m:	0.78
Collar stickup above ground, m	0.20
Section tested:	Bedrock
Test by:	A.Reza Khabbaznic
End time:	3:10 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	37.440	-	-
	1	37.460	0.020	0.020
	2	37.475	0.015	0.035
	3	37.490	0.015	0.050
	4	37.507	0.017	0.067
	5	37.522	0.015	0.082
	6	37.538	0.016	0.098
	7	37.555	0.017	0.115
	8	37.572	0.017	0.132
	9	37.588	0.016	0.148
10	37.605	0.017	0.165	

Pressure Gauge 0.069
Total 0.147

Lugeon 26

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	38.360	-	-
	1	38.385	0.025	0.025
	2	38.410	0.025	0.050
	3	38.440	0.030	0.080
	4	38.470	0.030	0.110
	5	38.500	0.030	0.140
	6	38.530	0.030	0.170
	7	38.560	0.030	0.200
	8	38.590	0.030	0.230
	9	38.620	0.030	0.260
10	38.650	0.030	0.290	

Pressure Gauge 0.138
Total 0.216

Lugeon 35

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	37.620	-	-
	1	37.650	0.030	0.030
	2	37.675	0.025	0.055
	3	37.705	0.030	0.085
	4	37.730	0.025	0.110
	5	37.760	0.030	0.140
	6	37.790	0.030	0.170
	7	37.810	0.020	0.190
	8	37.830	0.020	0.210
	9	37.850	0.020	0.230
10	37.870	0.020	0.250	

Pressure Gauge 0.138
Total 0.216

Lugeon 35

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	38.700	-	-
	1	38.720	0.020	0.020
	2	38.740	0.020	0.020
	3	38.765	0.025	0.025
	4	38.770	0.005	0.005
	5	38.785	0.015	0.015
	6	38.800	0.015	0.015
	7	38.815	0.015	0.015
	8	38.830	0.015	0.015
	9	38.845	0.015	0.015
10	38.860	0.015	0.015	

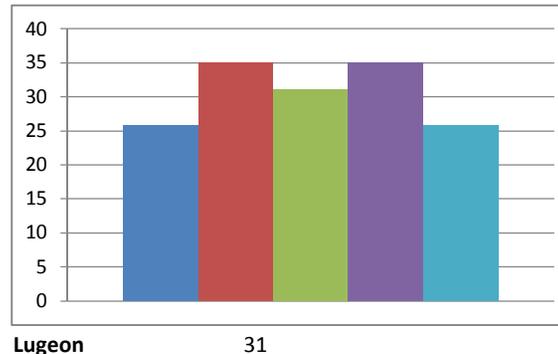
Pressure Gauge 0.069
Total 0.147

Lugeon 26

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	38.000	-	-
	1	38.035	0.035	0.035
	2	38.075	0.040	0.075
	3	38.110	0.035	0.110
	4	38.140	0.030	0.140
	5	38.175	0.035	0.175
	6	38.210	0.035	0.210
	7	38.245	0.035	0.245
	8	38.280	0.035	0.280
	9	38.315	0.035	0.315
10	38.350	0.035	0.350	

Pressure Gauge 0.207
Total 0.285

Lugeon 31



**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-09 - Dry rock cores



Site F – Burleigh Falls – BH17-09 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-09	Vertical
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Logged by	S.Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1		0	0.81	95	70	6	From 0 to 4.98 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	5 Jnts	3	1.5-3	1-1.5	10-16
RC2		0.81	1.30	95	89	4		Estimation	2 Jnts	2	1.5	1.0	8-10
RC3		1.30	2.41	101	80	11	From 2.31 to 2.41 m Pegmatite	Estimation	12 Jnts	3	1.5-3	1-2	8-16
RC4		2.41	3.58	101	80	5	From 2.41 to 2.59 m Pegmatite	Estimation	6 Jnts	3	1.5	1.0	8-12
RC5		3.58	4.70	101	98	4		Estimation	4 Jnts	2	1.5	1.0	8-10
RC6		4.70	4.98	91	77	4		Estimation	1 Jnt	1	3	1.0	16
END							End of hole 4.98 m						

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-09		
Collar Elev. m:			
Test section, m:	From: 1.58	To: 4.99	
Date of test:	24-Nov-17		
Start time:	10:02 PM		

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	-0.51
Collar stickup above ground, m	0.10
Section tested:	Bedrock
Test by:	Shubra PK
End time:	10:50 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	8.670	-	-
	1	8.672	0.002	0.002
	2	8.673	0.002	0.003
	3	8.674	0.001	0.004
	4	8.675	0.001	0.005
	5	8.677	0.002	0.007
	6	8.678	0.002	0.008
	7	8.680	0.002	0.010
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
 Total 0.064
 Lugeon 7

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	8.750	-	-
	1	8.753	0.003	0.003
	2	8.756	0.003	0.006
	3	8.760	0.004	0.010
	4	8.763	0.003	0.013
	5	8.767	0.004	0.017
	6	8.770	0.003	0.020
	7	8.773	0.003	0.023
	8	8.776	0.003	0.026
	9			
10				

Pressure Gauge (Mpa) 0.138
 Total 0.133
 Lugeon 7

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	8.682	-	-
	1	8.685	0.003	0.003
	2	8.688	0.003	0.006
	3	8.691	0.002	0.008
	4	8.693	0.002	0.011
	5	8.696	0.003	0.014
	6	8.699	0.003	0.017
	7	8.702	0.003	0.020
	8	8.705	0.003	0.023
	9			
10				

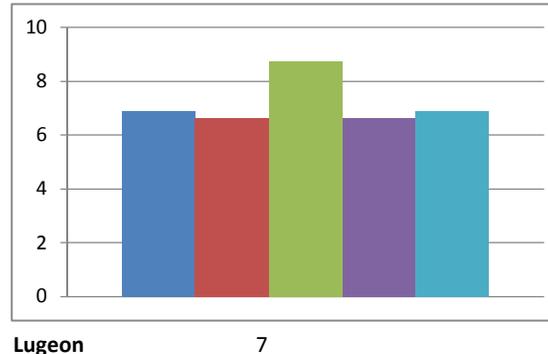
Pressure Gauge (Mpa) 0.138
 Total 0.133
 Lugeon 7

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	8.779	-	-
	1	8.780	0.001	0.001
	2	8.782	0.002	0.002
	3	8.783	0.002	0.002
	4	8.785	0.002	0.002
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
 Total 0.064
 Lugeon 7

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	8.711	-	-
	1	8.716	0.005	0.005
	2	8.721	0.005	0.010
	3	8.726	0.005	0.015
	4	8.731	0.005	0.020
	5	8.737	0.006	0.026
	6	8.742	0.005	0.031
	7	8.747	0.005	0.036
	8			
	9			
10				

Pressure Gauge (Mpa) 0.207
 Total 0.202
 Lugeon 9



RECORD OF BOREHOLE No. BH17-11

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **SPK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Hollow Stem Augering & Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 850 Track Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Dec 11, 2017** Date Completed: **Dec 11, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721851.4 NORTHING: 4937635.5		
	DESCRIPTION	Local Ground Surface Elevation: 240.90 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p ■ W _L ● W _u 20 40 60 80	COMMENTS					
	FILL Brown, dense, GRAVELLY SAND, moist	240.3	SS	01	62	48										
	BOULDERS Grey, moderately strong, BOULDERS and COBBLES, some sand, some gravel, highly weathered	0.6	RC	01	0		1	240								RQD = 0%, SCR = 0%
			RC	02	25		2	239								RQD = 0%, SCR = 0%
			SS	02	67		3	238								
			RC	03	0		4	237								RQD = 0%, SCR = 0%
		236.4														
	++ BEDROCK Dark to light gray to pink, moderately strong, faintly weathered, highly fractured, GRANODIORITE and GABBRO gneiss, thickly fractured. Good to excellent rock quality.	4.5	RC	04	100		5	236								RQD = 78%, SCR = 78%
	++ Becomes slightly fractured						6	235								RQD = 83%, SCR = 83% Joints between 5.5 m and 7.0 m From 6.10 to 9.91 m: 0 Lu
			RC	05	100		7	234								
							8	233								RQD = 97%, SCR = 97% Joints between 7.5 m and 8.5 m
			RC	06	100											
							9	232								RQD = 100%, SCR = 100%
		231.0														
	END OF BOREHOLE Notes: 1. Borehole was found to be open and no free standing water upon completion.	9.9						231								Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-11 - Dry rock cores



Site F – Burleigh Falls – BH17-11 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-11	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		1.52	3.05				From 1.52 to 3.05 m Limestone fragments with brown silt & sand						
RC1		4.52	6.02	103	54	9	From 4.52 to 9.91 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	13 Jnts	3	1.5-3	1-1.5	8-12
RC2		6.02	7.62	100	80	6	From 6.02 to 6.20 m Broken zone	Estimation	10 Jnts	3	1.5	1.0	8-12
RC3		7.62	9.14	101	92	5		Estimation	7 Jnts	2	1.5	1.0	8-12
RC4		9.14	9.91	103	95	3		Estimation	2 Jnts	2	1.5	1.0	8-12
END							End of hole 9.91 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-11	
Collar Elev. m:		
Test section, m:	From: 6.10	To: 9.91
Date of test:	12-Dec-17	
Start time:	8:10 AM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	1.07
Collar stickup above ground, m	0.13
Section tested:	Bedrock
Test by:	Shubra PK
End time:	8:40 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa)
0.069
Total 0.080

Lugeon
0

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa)
0.276
Total 0.286

Lugeon
0

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa)
0.138
Total 0.149

Lugeon
0

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
50	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa)
0.345
Total 0.355

Lugeon
0

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa)
0.207
Total 0.218

Lugeon
0

10: Did not take any water
20: Moving a little can be considered 0.0005 m³/min
30: Moving a little can be considered 0.00075 m³/min
40: Moving a little can be considered 0.0005 m³/min

RECORD OF BOREHOLE No. BH17-12

Project Number: **644198** Drilling Location: **Site F: Perry's Creek** Logged by: **SPK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Hollow Stem Augering & Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Truck Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Dec 5, 2017** Date Completed: **Dec 5, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721547.5 NORTHING: 4937720.4	
	DESCRIPTION	DEPTH (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p ■ W _L ● W _u	COMMENTS					
	Local Ground Surface Elevation: 242.40 m														
	Asphalt ~0.15 m BOULDERS Grey, moderately strong, BOULDERS and COBBLES, highly weathered	242.3 0.2					242								
			SS	01	0		1								
							241								
							2								
			SS	02	0		240								
							3								
		239.2	RC	01	48		239								RQD = 0%, SCR = 0%
++	BEDROCK Dark to light gray to pink, very strong, slightly weathered, GRANODIORITE and GABBRO gneiss, moderately fractured, moderately foliated. Good to excellent rock quality. Becomes slightly fractured	3.2					4								RQD = 100%, SCR = 100% From 3.35 to 8.81 m: 31 Lu
++			RC	02	100		3								
++							238								RQD = 97%, SCR = 97% Joints at ~4.27 m and 5.48 m
++			RC	03	100		5								
++							237								
++							6								RQD = 89%, SCR = 89% Joint at ~6.25 m
++			RC	04	100		236								
++							7								
++	Becomes fresh						235								RQD = 94%, SCR = 94% Joints between 7.47 m and 7.92 m
++							8								
++			RC	05	100		234								
++		233.6													
++	END OF BOREHOLE Notes: 1. Borehole was found to be open and no free standing water upon completion.	8.8													Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F PERRY'S CREEK**



Site F – Perry's Creek – BH17-12 - Dry rock cores



Site F – Perry's Creek – BH17-12 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Perry's Creek
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-12	Vertical
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Logged by	S.Viau
Date	2018/04/02

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
RC1	NQ	1.37	3.18	39			From 1.37 to 3.18 m Rock fragments composed of allochthonous material (granite,gabbro and limestone)						
RC2	NQ	3.18	4.22	76	31	2	From 3.18 to 8.81 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	2 Jnts	2	1.5	1.0	10
RC3	NQ	4.22	5.77	100	93	5		Estimation	8 Jnts	3	1.5-2	1.0	10
RC4	NQ	5.77	7.19	102	85	6		Estimation	8 Jnts	2	1.5-2	1.0	10-12
RC5	NQ	7.19	8.81	105	77	6	From 7.52 to 7.70 m Fractured zone and weathered rock	Estimation	9 Jnts	3	1.5-2	1-2	10-12
END							End of hole 8.81 m						

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-12		
Collar Elev. m:			
Test section, m:	From: 3.35	To: 8.81	
Date of test:	6-Dec-17		
Start time:	10:25 AM		

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.15
Collar stickup above ground, m	0.10
Section tested:	Bedrock
Test by:	Shubra PK
End time:	11:30 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.060	-	-
	1	9.067	0.007	0.007
	2	9.073	0.006	0.013
	3	9.079	0.006	0.019
	4	9.085	0.006	0.025
	5	9.092	0.007	0.032
	6	9.099	0.007	0.039
	7	9.106	0.007	0.046
	8	9.113	0.007	0.053
	9	9.120	0.007	0.060
10	9.127	0.007	0.067	

Pressure Gauge
Total
0.069
0.070

Lugeon
18

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.551	-	-
	1	9.567	0.016	0.016
	2	9.583	0.016	0.032
	3	9.599	0.016	0.048
	4	9.615	0.016	0.064
	5	9.631	0.016	0.080
	6	9.641	0.010	0.090
	7			
	8			
	9			
10				

Pressure Gauge
Total
0.138
0.139

Lugeon
13

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.139	-	-
	1	9.153	0.014	0.014
	2	9.166	0.013	0.027
	3	9.180	0.014	0.041
	4	9.194	0.014	0.055
	5	9.208	0.014	0.069
	6	9.223	0.015	0.084
	7	9.237	0.014	0.098
	8	9.251	0.014	0.112
	9	9.265	0.014	0.126
10	9.279	0.014	0.140	

Pressure Gauge
Total
0.138
0.139

Lugeon
18

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.668	-	-
	1	9.676	0.008	0.008
	2	9.683	0.007	0.015
	3	9.691	0.008	0.023
	4	9.699	0.008	0.031
	5	9.706	0.007	0.038
	6	9.714	0.008	0.046
	7	9.723	0.009	0.055
	8	9.731	0.008	0.063
	9	9.739	0.008	0.071
10	9.746	0.007	0.078	

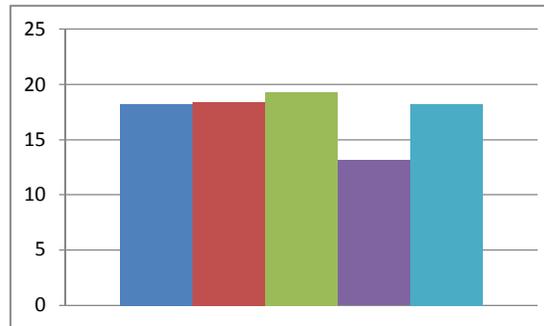
Pressure Gauge
Total
0.069
0.070

Lugeon
18

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	9.319	-	-
	1	9.340	0.021	0.021
	2	9.362	0.022	0.043
	3	9.383	0.021	0.064
	4	9.404	0.021	0.085
	5	9.426	0.022	0.107
	6	9.447	0.021	0.128
	7	9.469	0.022	0.150
	8	9.490		
	9	9.512		
10	9.534			

Pressure Gauge
Total
0.207
0.208

Lugeon
19



Lugeon 17

RECORD OF BOREHOLE No. BH17-101

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Track Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Mar 20, 2018** Date Completed: **Mar 20, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721824.9 NORTHING: 4937489.6
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p ■ W _L ● W _u 20 40 60 80	COMMENTS			
	Local Ground Surface Elevation: 240.84 m												
	WATER From top of the boat					1	240						
						2	239						
						3	238						RQD = 88%, SCR = 92%
++	BEDROCK Dark to light gray to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, good to excellent rock quality	RC	01	96		4	237						
++	Becomes fresh					5	236						RQD = 100%, SCR = 100%
++		RC	02	100		6	235						From 5.36 to 8.53 m: 50 Lu
++	Becomes dark grey to pink					7	234						RQD = 99%, SCR = 99%
++						8	233						RQD = 100%, SCR = 100%
++		RC	04	100									
	END OF BOREHOLE												Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-101 - Dry rock cores



Site F – Burleigh Falls – BH17-101 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-101	Vertical
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Logged by	S.Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	2.84	4.27	98	88		From 2.84 to 8.53 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	6 Jnts	2	2	0.75	14
RC2	NQ	4.27	5.79	100	100			Estimation	1 Jnt	2	1.5	0.75	10
RC3	NQ	5.79	7.39	98	86			Estimation	5 Jnts	2	2	0.75	10
RC4	NQ	7.39	8.53	100	100			Estimation	1 Jnt	2	1.5	0.75	8
END							End of hole 8.53 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-101	
Collar Elev. m:		
Test section:	From: 5.36	To: 8.53
Date of test:	20-Mar-18	
Start time:	12:40 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.75
Collar stickup above ground, m:	1.04
Section tested:	Bedrock
Test by:	Reza Khabbaznia
End time:	1:45 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.773	-	-
	1	9.774	0.001	0.001
	2	9.774	0.000	0.001
	3	9.774	0.000	0.001
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.138
 Total 0.145
 Lugeon 0

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
50	0	10.200	-	-
	1	10.245	0.045	0.045
	2	10.294	0.049	0.094
	3	10.340	0.046	0.140
	4	10.386	0.046	0.186
	5	10.432	0.046	0.232
	6	10.478	0.046	0.278
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.345
 Total 0.352
 Lugeon 41

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	9.775	-	-
	1	9.780	0.005	0.005
	2	9.785	0.005	0.010
	3	9.791	0.006	0.016
	4	9.797	0.006	0.022
	5	9.802	0.005	0.027
	6	9.805	0.003	0.030
	7	9.810	0.005	0.035
	8	9.813	0.003	0.038
	9	9.816	0.003	0.041
10	9.819	0.003	0.044	

Pressure Gauge (Mpa) 0.207
 Total 0.214
 Lugeon 7

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0	10.500	-	-
	1	10.540	0.040	0.040
	2	10.580	0.040	0.080
	3	10.630	0.050	0.130
	4	10.665	0.035	0.165
	5	10.705	0.040	0.205
	6	10.745	0.040	0.245
	7	10.785	0.040	0.285
	8	10.835	0.050	0.335
	9			
10				

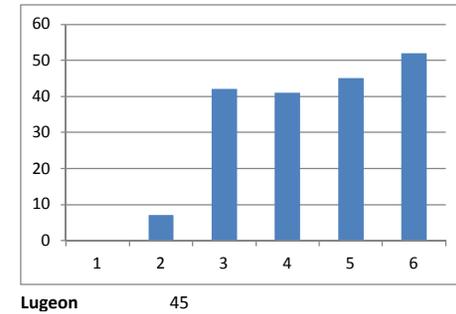
Pressure Gauge (Mpa) 0.276
 Total 0.283
 Lugeon 45

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0	9.870	-	-
	1	9.910	0.040	0.040
	2	9.952	0.042	0.042
	3	9.990	0.038	0.038
	4	10.032	0.042	0.042
	5	10.070	0.038	0.038
	6	10.108	0.038	0.038
	7	10.146	0.038	0.038
	8	10.184	0.038	0.038
	9			
10				

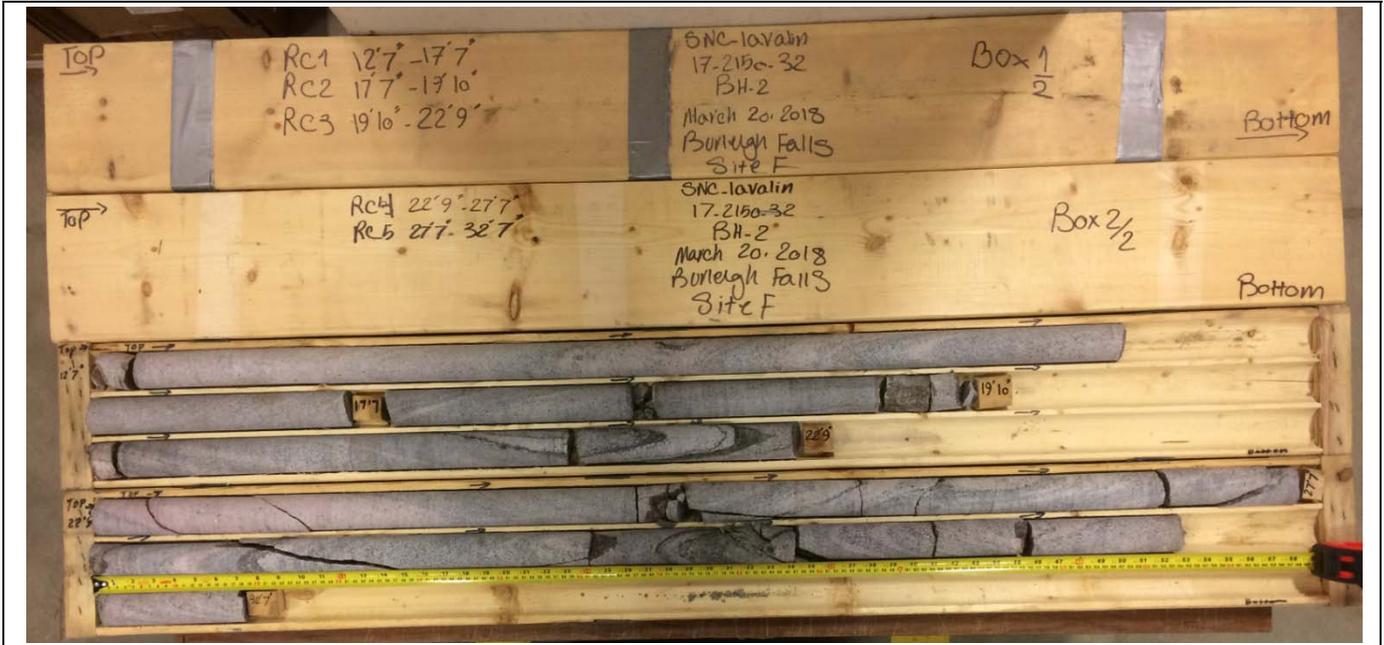
Pressure Gauge (Mpa) 0.276
 Total 0.283
 Lugeon 42

H ₃	Stage 6 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	10.870	-	-
	1	10.905	0.035	0.035
	2	10.940	0.035	0.070
	3	10.975	0.035	0.105
	4	11.010	0.035	0.140
	5	11.045	0.035	0.175
	6	11.080	0.035	0.210
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.207
 Total 0.214
 Lugeon 52



**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-102 - Dry rock cores



Site F – Burleigh Falls – BH17-102 - Wet rock cores

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	BH17-102		
Collar Elev. m:			
Test section, m:	From: 5.51	To:	9.93
Date of test:	20-Mar-18		
Start time:	5:50 PM		

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.75
Collar stickup above ground, r	0.60
Section tested:	Bedrock
Test by:	Reza Khabbazi
End time:	5:45 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	11.130	-	-
	1	11.142	0.012	0.012
	2	11.155	0.013	0.025
	3	11.168	0.013	0.038
	4	11.180	0.012	0.050
	5	11.192	0.012	0.062
	6	11.204	0.012	0.074
	7	11.216	0.012	0.086
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 36

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.420	-	-
	1	11.433	0.013	0.013
	2	11.446	0.013	0.026
	3	11.459	0.013	0.039
	4	11.472	0.013	0.052
	5	11.482	0.010	0.062
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 20

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.210	-	-
	1	11.228	0.018	0.018
	2	11.245	0.017	0.035
	3	11.262	0.017	0.052
	4	11.279	0.017	0.069
	5	11.296	0.017	0.086
	6			
	7			
	8			
	9			
10				

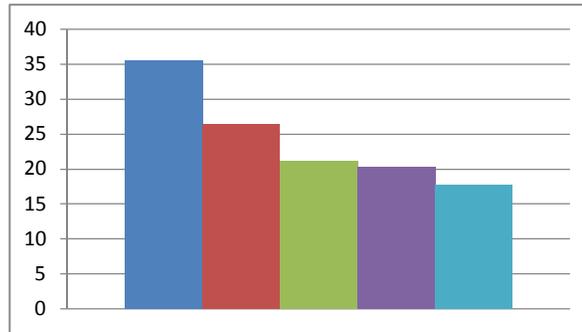
Pressure Gauge
Total
Lugeon 26

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	11.500	-	-
	1	11.507	0.007	0.007
	2	11.513	0.006	0.013
	3	11.519	0.006	0.019
	4	11.525	0.006	0.025
	5	11.531	0.006	0.031
	6	11.537	0.006	0.037
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 18

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	11.310	-	-
	1	11.332	0.022	0.022
	2	11.352	0.020	0.020
	3	11.372	0.020	0.020
	4	11.392	0.020	0.020
	5	11.412	0.020	0.020
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 21



Lugeon 18

RECORD OF BOREHOLE No. **BH17-103**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Track Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Mar 21, 2018** Date Completed: **Mar 21, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721821.3 NORTHING: 4937509.6		
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p W _L	COMMENTS					
	Local Ground Surface Elevation: 241.91 m														
	WATER From top of the boat					1	241								
						2	240								
						3	239								
						4	238								
++	BEDROCK Dark to light gray to pink, very strong, faintly weathered, GRANODIORITE and GABBRO gneiss, good to excellent rock quality	RC	01	97		5	237							RQD = 88%, SCR = 92%	
++						6	236							RQD = 100%, SCR = 100%	
++		RC	02	92		7	235							From 6.10 to 9.93 m: 47 Lu	
++						8	234							RQD = 99%, SCR = 99%	
++	Becomes slightly weathered					9	233							RQD = 100%, SCR = 100%	
	END OF BOREHOLE						232							Note: RQD: Rock quality designation SCR: Solid core recovery	

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-103 - Dry rock cores



Site F – Burleigh Falls – BH17-103 - Wet rock cores

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-103	
Collar Elev. m:		
Test section, m:	From: 6.10	To: 9.93
Date of test:	21-Mar-18	
Start time:	11:10 AM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.77
Collar stickup above ground, r	0.28
Section tested:	Bedrock
Test by:	Reza Khabbazi
End time:	12:00 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	11.700	-	-
	1	11.715	0.015	0.015
	2	11.730	0.015	0.030
	3	11.746	0.016	0.046
	4	11.762	0.016	0.062
	5	11.788	0.026	0.088
	6	11.804	0.016	0.104
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 55

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.200	-	-
	1	12.225	0.025	0.025
	2	12.250	0.025	0.050
	3	12.275	0.025	0.075
	4	12.300	0.025	0.100
	5	12.325	0.025	0.125
	6	12.350	0.025	0.150
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.138
Total 0.146

Lugeon 45

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	11.810	-	-
	1	11.836	0.026	0.026
	2	11.860	0.024	0.050
	3	11.885	0.025	0.075
	4	11.910	0.025	0.100
	5	11.935	0.025	0.125
	6	11.960	0.025	0.150
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.138
Total 0.146

Lugeon 45

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.360	-	-
	1	12.374	0.014	0.014
	2	12.388	0.014	0.028
	3	12.402	0.014	0.042
	4	12.416	0.014	0.056
	5	12.430	0.014	0.070
	6	12.444	0.014	0.084
	7			
	8			
	9			

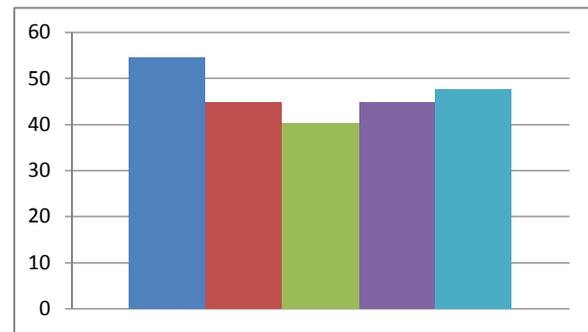
Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 48

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	11.980	-	-
	1	12.014	0.034	0.034
	2	12.047	0.033	0.067
	3	12.080	0.033	0.100
	4	12.113	0.033	0.133
	5	12.146	0.033	0.166
	6	12.179	0.033	0.199
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.207
Total 0.215

Lugeon 40



Lugeon 40

RECORD OF BOREHOLE No. **BH17-104**

Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

Logged by: **RK**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing		Soil Vapour Reading parts per million (ppm)			
									○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) W _L W _P W _L				
++ ++ ++ ++		230.2												
	END OF BOREHOLE	12.7												Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-104 - Dry rock cores



Site F – Burleigh Falls – BH17-104 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-104	Vertical
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Logged by	S.Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	6.88	8.15	100	70		From 6.88 to 12.67 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	9 Jnts	3	2	0.75	11
RC2	NQ	8.15	9.75	89	44			Estimation	14 Jnts	3	2	0.75	11
RC3	NQ	9.75	11.20	95	89			Estimation	4 Jnts	3	2	0.75	11
RC4	NQ	11.20	12.67	100	66			Estimation	14 Jnts	3	2	0.75	11
END							End of hole 12.67 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-104	
Collar Elev. m:		
Test section, m:	From: 8.86	To: 12.67
Date of test:	21-Mar-18	
Start time:	2:50 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.78
Collar stickup above ground, r	0.51
Section tested:	Bedrock
Test by:	Reza Khabbazi
End time:	3:45 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
15	0	12.450	-	-
	1	12.460	0.010	0.010
	2	12.470	0.010	0.020
	3	12.480	0.010	0.030
	4	12.490	0.010	0.040
	5	12.500	0.010	0.050
	6			
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.103
 Total 0.111
 Lugeon 24

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
25	0	12.800	-	-
	1	12.827	0.027	0.027
	2	12.854	0.027	0.054
	3	12.880	0.026	0.080
	4	12.906	0.026	0.106
	5	12.932	0.026	0.132
	6	12.958	0.026	0.158
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.172
 Total 0.180
 Lugeon 38

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
25	0	12.510	-	-
	1	12.525	0.015	0.015
	2	12.540	0.015	0.030
	3	12.565	0.025	0.055
	4	12.580	0.015	0.070
	5	12.595	0.015	0.085
	6	12.610	0.015	0.100
	7			
	8			
	9			

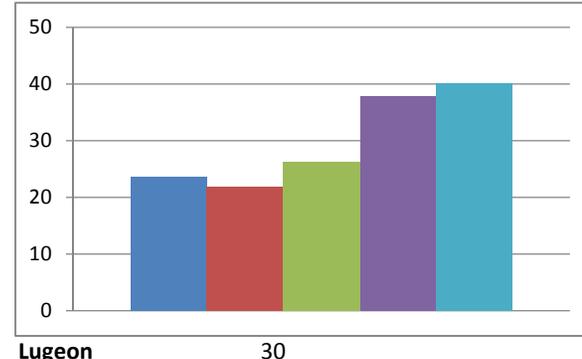
Pressure Gauge (Mpa) 0.172
 Total 0.180
 Lugeon 22

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
15	0	12.970	-	-
	1	12.988	0.018	0.018
	2	13.005	0.017	0.035
	3	13.022	0.017	0.052
	4	13.039	0.017	0.069
	5	13.056	0.017	0.086
	6	13.063	0.007	0.093
	7	13.080	0.017	0.110
	8			
	9			

Pressure Gauge (Mpa) 0.103
 Total 0.111
 Lugeon 40

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
35	0	12.620	-	-
	1	12.645	0.025	0.025
	2	12.670	0.025	0.025
	3	12.695	0.025	0.025
	4	12.720	0.025	0.025
	5	12.745	0.025	0.025
	6	12.770	0.025	0.025
	7			
	8			
	9			

Pressure Gauge (Mpa) 0.241
 Total 0.249
 Lugeon 26



RECORD OF BOREHOLE No. **BH17-105**

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Track Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Mar 22, 2018** Date Completed: **Mar 22, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721818.2 NORTHING: 4937525.4	
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p ■ W _L				COMMENTS
		Local Ground Surface Elevation: 242.84 m												
	WATER From top of the boat					1	242							
						2	241							
						3	240							
						4	239							
						5	238							
						6	237							
						7	236							
						8	235							
						9	234							RQD = 97%, SCR = 97%
++	234.0 8.8 BEDROCK Dark to light gray to pink, very strong, slightly weathered, GRANODIORITE and GABBRO gneiss. Good to excellent rock quality.	RC	01	125		10	233							RQD = 80%, SCR = 93%
++						11	232							From 10.36 to 16.00 m: 50 Lu
++		RC	02	43		12	231							RQD = 92%, SCR = 92%



SNC-LAVALIN
 1801 McGill College Avenue
 12th Floor
 Montreal, Quebec H3A 2N4
 Tel: 514-393-1000

∇ No freestanding groundwater measured in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Notes to Record of Boreholes'.

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Page: 1 of 2

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-105 - Dry rock cores



Site F – Burleigh Falls – BH17-105 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-105	Vertical
-------------------	----------

Logged by	S.Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	8.84	10.06	44	10		From 8.84 to 16.00 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation						
							From 8.84 to 10.06 m: Various gneiss fragments						
RC2	NQ	10.06	11.61	100	52			Estimation	18 Jnts	3	2	0.75	10
RC3	NQ	11.61	13.03	100	91			Estimation	6 Jnts	3	2	0.75	11
RC4	NQ	13.03	14.63	100	92			Estimation	9 Jnts	3	2	1	11
RC5	NQ	14.63	16.00	100	80			Estimation	10 Jnts	3	2	1	11
END							End of hole 16.00 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	BH17-105	
Collar Elev. m:		
Test section, m:	From: 10.36	To: 16.00
Date of test:	22-Mar-18	
Start time:	10:35 AM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.76
Collar stickup above ground, r	0.18
Section tested:	Bedrock
Test by:	Reza Khabbazi
End time:	11:20 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.200	-	-
	1	13.215	0.015	0.015
	2	13.230	0.015	0.030
	3	13.244	0.014	0.044
	4	13.258	0.014	0.058
	5	13.272	0.014	0.072
	6	13.286	0.014	0.086
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 32

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.720	-	-
	1	13.745	0.025	0.025
	2	13.770	0.025	0.050
	3	13.795	0.025	0.075
	4	13.820	0.025	0.100
	5	13.845	0.025	0.125
	6	13.870	0.025	0.150
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 30

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.300	-	-
	1	13.326	0.026	0.026
	2	13.351	0.025	0.051
	3	13.376	0.025	0.076
	4	13.401	0.025	0.101
	5	13.426	0.025	0.126
	6	13.451	0.025	0.151
	7			
	8			
	9			

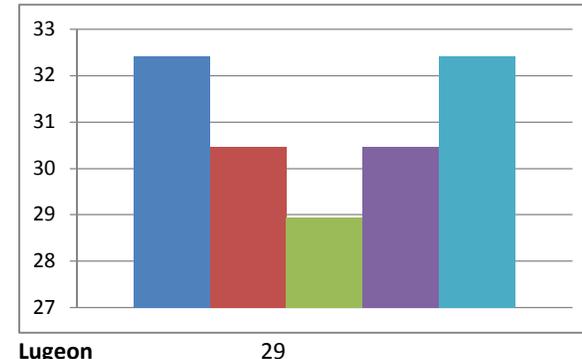
Pressure Gauge
Total
Lugeon 30

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.900	-	-
	1	13.914	0.014	0.014
	2	13.928	0.014	0.028
	3	13.942	0.014	0.042
	4	13.956	0.014	0.056
	5	13.970	0.014	0.070
	6	13.984	0.014	0.084
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 32

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	13.470	-	-
	1	13.505	0.035	0.035
	2	13.540	0.035	0.070
	3	13.575	0.035	0.105
	4	13.605	0.030	0.135
	5	13.640	0.035	0.170
	6	13.675	0.035	0.205
	7	13.710	0.035	0.240
	8			
	9			

Pressure Gauge
Total
Lugeon 29



Lugeon 29

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-106 - Dry rock cores



Site F – Burleigh Falls – BH17-106 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-106	Vertical
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Logged by	S.Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	6.10	6.45	71	0		From 6.10 to 9.78 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation, heavily fractured						
RC2	NQ	6.45	7.04	100	0		From 8.84 to 10.06 m: Various gneiss fragments	Estimation	18 Jnts	3	2	0.75	10
RC3	NQ	7.04	7.67	100	0			Estimation	6 Jnts	3	2	0.75	11
RC4	NQ	7.67	7.98	100	67			Estimation	9 Jnts	3	2	1	11
RC5	NQ	7.98	8.18	88	0			Estimation	10 Jnts	3	2	1	11
RC6	NQ	8.18	9.78	87	30								
END							End of hole 9.78 m						

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-107 - Dry rock cores



Site F – Burleigh Falls – BH17-107 - Wet rock cores

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – BH17-108 - Dry rock cores



Site F – Burleigh Falls – BH17-108 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE BH17-108	Vertical
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Logged by	S. Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1	NQ	2.13	2.31	71	0		From 2.13 to 5.21 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	No joint				
RC2	NQ	2.31	2.77	100	28			Estimation	7 Jnts	3	2	0.75	10
RC3	NQ	2.77	3.05	100	0			Estimation	5 Jnts	3	1.5	0.75	8
RC4	NQ	2.13	2.31	71	0			Estimation	3 Jnts	3	1.5	0.75	7
RC5	NQ	3.48	4.37	71	66			Estimation	2 Jnts	3	1.5	0.75	8
RC6	NQ	4.37	5.11	86	100			Estimation	1 Jnt	1	1.5	0.75	7
RC7	NQ	5.11	5.21	87	0			Estimation	No joint				
END								End of hole 5.21 m					

RECORD OF COREHOLE No. CH17-01

Project Number: **644198** Drilling Location: **Site F: Perry's Creek** Logged by: **SPK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Hollow Stem Augering & Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Truck Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Nov 28, 2017** Date Completed: **Nov 30, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721582.7 NORTHING: 4937726.9		
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p W _L					COMMENTS		
	Local Ground Surface Elevation: 242.70 m															
	CONCRETE Light grey, strong, CONCRETE, slightly weathered, smooth surface Maximum visible aggregate size ~50 mm A mix of rock was observed with the concrete	CC	01	100		242										
		CC	02	100		241										UCS = 14.6 MPa
		CC	03	100		240										
		CC	04	100		239										
	Concrete/bedrock interface open 237.0					238										From 4.88 to 11.11 m: 14 Lu
	++ BEDROCK 5.7 Dark to light gray to pink, very strong, slightly weathered, GRANODIORITE and GABBRO gneiss, moderately fractured, moderately foliated	RC	01	92		237										RQD = 93%, SCR = 93%
		RC	02	101		236										RQD = 62%, SCR = 62% Joints between 6.1 m and 7.16 m
		RC	03	99		235										RQD = 53%, SCR = 53% Joint at ~8.6 m UCS = 78.7 MPa
		RC	04	101		234										RQD = 91%, SCR = 91% Joint at ~9.14 m
		RC	05	100		233										RQD = 100%, SCR = 100% Joint at ~10.97 m
	END OF BOREHOLE 231.6					232										Note: RQD: Rock quality designation SCR: Solid core recovery
						231										



SNC-LAVALIN
 1801 McGill College Avenue
 12th Floor
 Montreal, Quebec H3A 2N4
 Tel: 514-393-1000

∇ No freestanding groundwater measured in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Notes to Record of Boreholes'.

Scale: 1 : 63
Page: 1 of 2

RECORD OF COREHOLE No. CH17-01

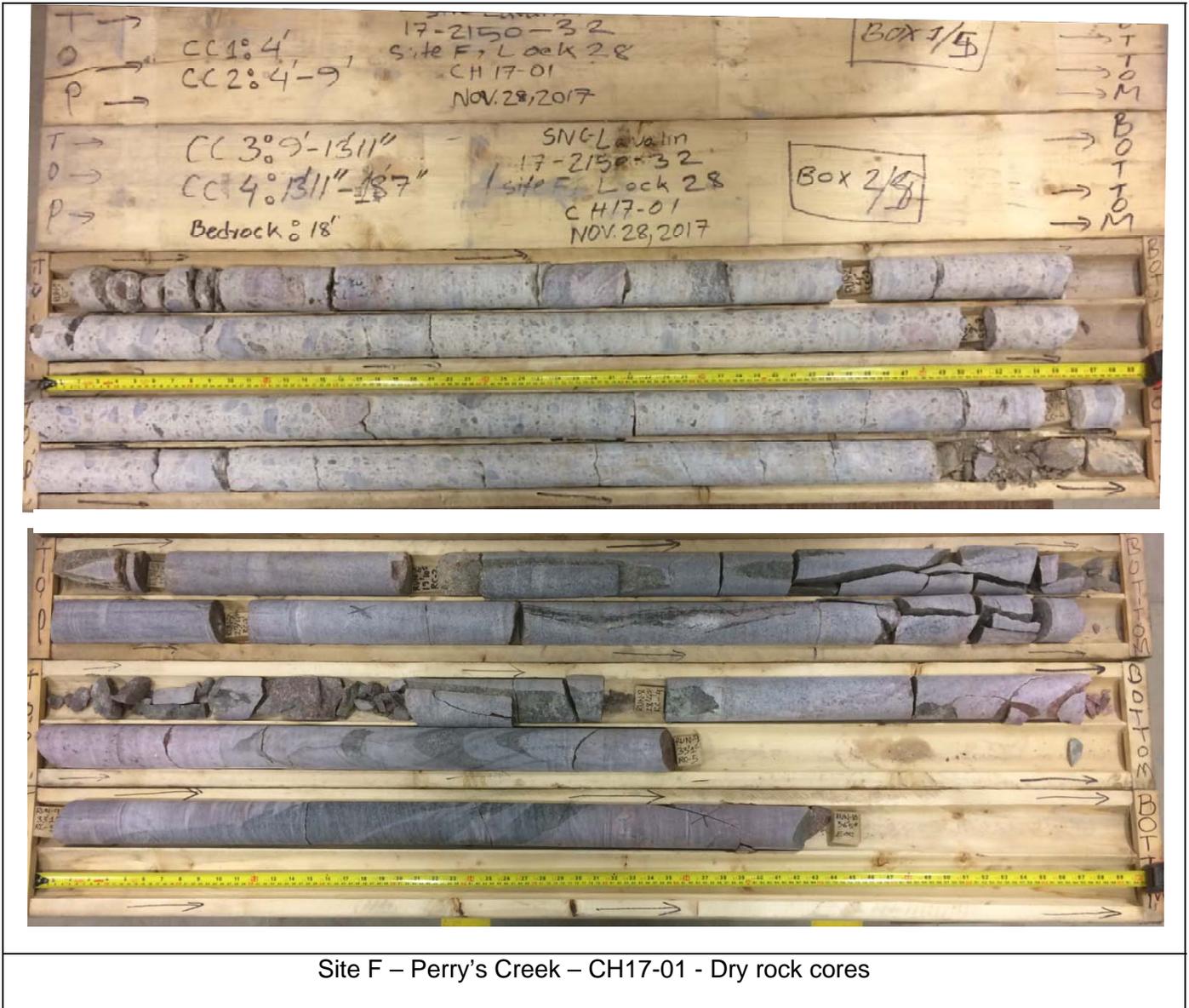
Project Number: **644198**

Drilling Location: **Site F: Perry's Creek**

Logged by: **SPK**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT	★ Rinse pH Values 2 4 6 8 10 12	Soil Vapour Reading parts per million (ppm) 100 200 300 400	▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%)		
	Notes:													
	1. Borehole was found to be open and no free standing water upon completion.													

**CORE PHOTOS –
 SITE F PERRY'S CREEK**



Site F – Perry's Creek – CH17-01 - Dry rock cores

**CORE PHOTOS –
 SITE F PERRY'S CREEK**



Site F – Perry's Creek – CH17-01 - Wet rock cores

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-01	
Collar Elev. m:		
Test section, m:	From: 4.88	To: 11.11
Date of test:	30-Nov-17	
Start time:	10:20 AM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs:	
Height gauge above ground (H2), m:	0.08
Collar stickup above ground, m	0.03
Section tested:	Concrete and bedrock
Test by:	Shubra PK
End time:	11:15 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.981	-	-
	1	9.986	0.005	0.005
	2	9.991	0.005	0.010
	3	9.996	0.005	0.015
	4	10.000	0.004	0.019
	5	10.005	0.005	0.024
	6	10.010	0.005	0.029
	7	10.015	0.005	0.034
	8	10.019		
	9	10.024		
10	10.029			

Pressure Gauge
Total

Lugeon
12

(Mpa)
0.069
0.070

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	10.201	-	-
	1	10.209	0.008	0.008
	2	10.216	0.007	0.015
	3	10.222	0.006	0.021
	4	10.229	0.007	0.028
	5	10.236	0.007	0.035
	6	10.243	0.007	0.042
	7	10.250	0.007	0.049
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
8

(Mpa)
0.138
0.139

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	10.037	-	-
	1	10.045	0.008	0.008
	2	10.052	0.007	0.015
	3	10.059	0.007	0.022
	4	10.069	0.010	0.032
	5	10.073	0.004	0.036
	6	10.080	0.007	0.043
	7	10.087	0.007	0.050
	8	10.097	0.010	0.060
	9			
10				

Pressure Gauge
Total

Lugeon
5

(Mpa)
0.138
0.139

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	10.253	-	-
	1	10.257	0.004	0.004
	2	10.261	0.004	0.004
	3	10.266	0.005	0.005
	4	10.270	0.004	0.004
	5	10.275	0.005	0.005
	6	10.279	0.004	0.004
	7	10.284	0.005	0.005
	8			
	9			
10				

Pressure Gauge
Total

Lugeon
12

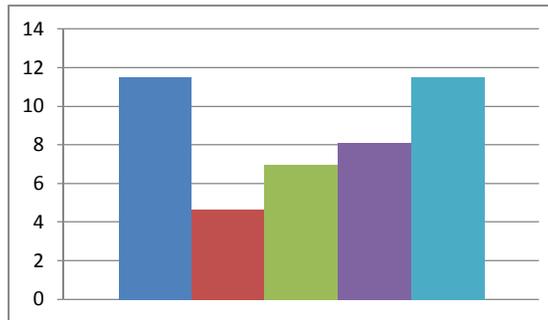
(Mpa)
0.069
0.070

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	10.105	-	-
	1	10.115	0.010	0.010
	2	10.124	0.009	0.019
	3	10.134	0.010	0.029
	4	10.143	0.009	0.038
	5	10.152	0.009	0.047
	6	10.162	0.010	0.057
	7	10.171	0.009	0.066
	8	10.184	0.013	0.079
	9	10.190	0.006	0.085
10	10.200	0.010	0.095	

Pressure Gauge
Total

Lugeon
7

(Mpa)
0.207
0.208



Lugeon 9

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	CH17-01		
Collar Elev. m:			
Test section, m:	From: 5.79	To:	11.11
Date of test:	30-Nov-17		
Start time:	9:15 AM		

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.08
Collar stickup above ground, r	0.03
Section tested:	Bedrock
Test by:	Shubra PK
End time:	10:10 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.460	-	-
	1	9.464	0.004	0.004
	2	9.468	0.004	0.008
	3	9.472	0.004	0.012
	4	9.475	0.003	0.015
	5	9.479	0.004	0.019
	6	9.482	0.003	0.022
	7	9.486	0.004	0.026
	8	9.489	0.003	0.029
	9	9.492	0.003	0.032
10	9.495	0.003	0.035	

Pressure Gauge (Mpa) 0.069
Total 0.070

Lugeon 11

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.750	-	-
	1	9.757	0.007	0.007
	2	9.764	0.007	0.014
	3	9.770	0.006	0.020
	4	9.776	0.006	0.026
	5	9.782	0.006	0.032
	6	9.788	0.006	0.038
	7	9.793	0.005	0.043
	8	9.799	0.006	0.049
	9	9.804	0.005	0.054
10	9.810	0.006	0.060	

Pressure Gauge (Mpa) 0.138
Total 0.139

Lugeon 8

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	9.560	-	-
	1	9.565	0.005	0.005
	2	9.570	0.005	0.010
	3	9.576	0.006	0.016
	4	9.582	0.006	0.022
	5	9.588	0.006	0.028
	6	9.593	0.005	0.033
	7	9.598	0.005	0.038
	8	9.604	0.006	0.044
	9	9.610	0.006	0.050
10	9.615	0.005	0.055	

Pressure Gauge (Mpa) 0.138
Total 0.139

Lugeon 8

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	9.820	-	-
	1	9.824	0.004	0.004
	2	9.828	0.004	0.004
	3	9.831	0.003	0.003
	4	9.835	0.004	0.004
	5	9.839	0.004	0.004
	6	9.842	0.003	0.003
	7	9.846	0.004	0.004
	8	9.850	0.004	0.004
	9	9.853	0.003	0.003
10	9.857	0.004	0.004	

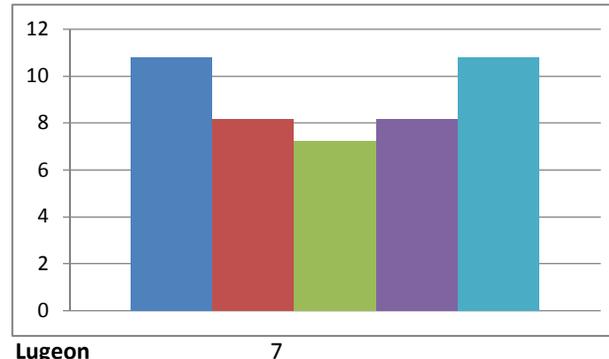
Pressure Gauge (Mpa) 0.069
Total 0.070

Lugeon 11

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	9.650	-	-
	1	9.666	0.016	0.016
	2	9.674	0.008	0.024
	3	9.682	0.008	0.032
	4	9.689	0.007	0.039
	5	9.697	0.008	0.047
	6	9.697	0.000	0.047
	7	9.704	0.007	0.054
	8	9.711	0.007	0.061
	9	9.718	0.007	0.068
10	9.725	0.007	0.075	

Pressure Gauge (Mpa) 0.207
Total 0.208

Lugeon 7



RECORD OF COREHOLE No. CH17-02

Project Number: **644198** Drilling Location: **Site F: Perry's Creek** Logged by: **SPK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Hollow Stem Augering & Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **CME 55 Truck Mounted** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Nov 30, 2017** Date Completed: **Nov 30, 2017** Revision No.: **0**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721588.7 NORTHING: 4937727.6	
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p W _L 20 40 60 80	COMMENTS					
	Local Ground Surface Elevation: 242.70 m														
	CONCRETE Light grey, strong, CONCRETE, slightly weathered Maximum visible aggregate size ~50 mm A mix of rock was observed with the concrete Fractures at the rock and concrete joints	CC	01	100		242									UCS = 27.5 MPa
		CC	02	100		241									
						240									
		CC	03	100		239									
						238									
	Concrete/bedrock interface closed, not sealed 237.7	CC	04	101		238									
	++ BEDROCK Dark to light gray to pink, very strong, slightly weathered, GRANODIORITE and GABBRO gneiss, moderately fractured, moderately foliated. Excellent rock quality. 5.0	RC	01	100		237									RQD = 100%, SCR = 100% UCS = 98.3 MPa
						236									RQD = 90%, SCR = 90% From 5.79 to 11.13 m: 10 Lu
		RC	02	100		236									Joint at ~6.4 m
						235									RQD = 100%, SCR = 100%
		RC	03	100		235									Joints at ~7.62 m and 8.53 m
						234									Three joints between 8.5 m to 10 m
		RC	04	100		234									RQD = 100%, SCR = 100%
						233									
						232.4									
	END OF BOREHOLE Notes: 1. Borehole was found to be open and no free standing water upon completion.					10.3									Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F PERRY'S CREEK**



Site F – Perry's Creek – CH17-02 - Dry rock cores



Site F – Perry's Creek – CH17-02 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-02	Vertical
------------------	----------

Logged by	S. Viau
Date	2018/08/08

Core Description							Lithological Description	Structural Description						
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock	
RC1	NQ	0.08	1.12	100	0		From 0.08 to 5.00 m Concrete, fair to good quality Aggregate max diameter: 150 mm		7 Jnts					
RC2	NQ	1.12	2.62	100	0				6 Jnts					
RC3	NQ	2.62	4.14	100	0				6 Jnts					
RC4	NQ	4.14	5.66	96	100			Concrete/bedrock interface closed but not sealed	Estimation	2 Jnts	2	1.5	1	8
RC5	NQ	5.66	7.24	100	65			From 5.00 to 10.26 m Gneissic granodiorite and tonalite, veins of pegmatite coarse-grained quartzofeldspathic material, light to moderate foliation	Estimation	9 Jnts	3	2	1	12
RC6	NQ	7.24	8.74	100	88				Estimation	5 Jnts	3	1.5	1	9
RC7	NQ	8.74	10.26	98	86				Estimation	5 Jnts	3	2	1.5	12
END							End of hole 11.10 m							

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-02	
Collar Elev. m:		
Test section, m:	From: 4.70	To: 5.31
Date of test:	1-Dec-17	
Start time:	10:40 AM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.08
Collar stickup above ground, r	0.03
Section tested:	Concrete/Bedrock interface
Test by:	Shubra PK
End time:	11:25 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0	9.037	-	-
	1	9.038	0.000	0.000
	2	9.038	0.001	0.001
	3	9.039	0.001	0.002
	4	9.039	0.000	0.002
	5	9.040	0.001	0.002

Pressure Gauge (Mpa) 0.276
 Total 0.277
 Lugeon 3

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
50	0	9.046	-	-
	1	9.047	0.001	0.001
	2	9.047	0.001	0.001
	3	9.048	0.000	0.002
	4	9.048	0.001	0.002
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.345
 Total 0.345
 Lugeon 0

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
50	0	9.040	-	-
	1	9.041	0.001	0.001
	2	9.041	0.001	0.001
	3	9.042	0.000	0.002
	4	9.042	0.001	0.002
	5			
	6			
	7			
	8			
	9			
10				

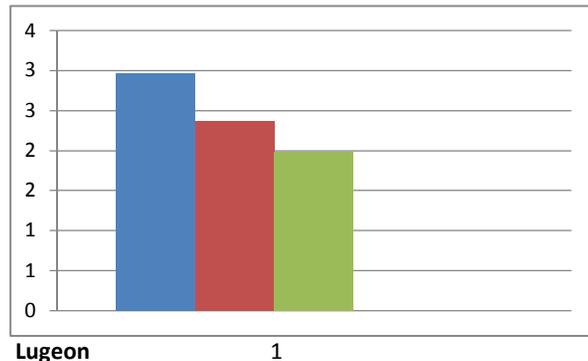
Pressure Gauge (Mpa) 0.345
 Total 0.345
 Lugeon 2

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0	No water		
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.276
 Total 0.277
 Lugeon 0

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
60	0	9.043	-	-
	1	9.044	0.001	0.001
	2	9.044	0.001	0.001
	3	9.045	0.000	0.002
	4	9.045	0.001	0.002
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.414
 Total 0.414
 Lugeon 2



Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-02	
Collar Elev. m:		
Test section, m:	From: 5.31	To: 10.26
Date of test:	1-Dec-17	
Start time:	7:45 AM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.91
Collar stickup above ground, r	0.03
Section tested:	Bedrock
Test by:	Shubra PK
End time:	8:45 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	10.330	-	-
	1	10.338	0.008	0.008
	2	10.346	0.008	0.016
	3	10.354	0.008	0.024
	4	10.361	0.007	0.031
	5	10.369	0.008	0.039
	6	10.376	0.007	0.046
	7	10.383	0.007	0.053
	8	10.391	0.008	0.061
	9	10.399	0.008	0.069
	10	10.406	0.007	0.076

Pressure Gauge (Mpa) 0.069
 Total 0.078
 Lugeon 21

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	10.735	-	-
	1	10.746	0.011	0.011
	2	10.756	0.010	0.021
	3	10.768	0.012	0.033
	4	10.779	0.011	0.044
	5	10.790	0.011	0.055
	6	10.800	0.010	0.065
	7	10.812	0.012	0.077
	8	10.823	0.011	0.088
	9	10.835	0.012	0.100
	10	10.846	0.011	0.111

Pressure Gauge (Mpa) 0.138
 Total 0.147
 Lugeon 14

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	10.417	-	-
	1	10.431	0.014	0.014
	2	10.443	0.012	0.026
	3	10.456	0.013	0.039
	4	10.469	0.013	0.052
	5	10.481	0.012	0.064
	6	10.493	0.012	0.076
	7	10.506	0.013	0.089
	8	10.519	0.013	0.102
	9	10.531	0.012	0.114
	10	10.544	0.013	0.127

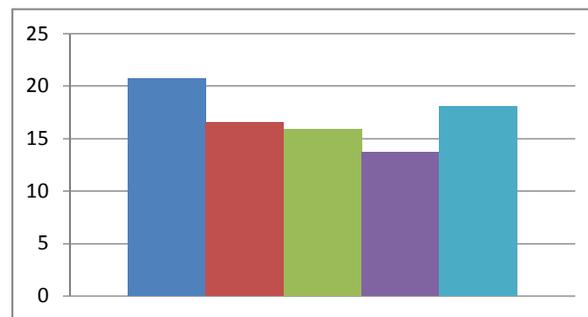
Pressure Gauge (Mpa) 0.138
 Total 0.147
 Lugeon 16

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	10.850	-	-
	1	10.856	0.006	0.006
	2	10.862	0.006	0.006
	3	10.868	0.006	0.006
	4	10.874	0.006	0.006
	5	10.881	0.007	0.007
	6	10.888	0.007	0.007
	7	10.894	0.006	0.006
	8	10.901	0.007	0.007
	9	10.908	0.007	0.007
	10	10.915	0.007	0.007

Pressure Gauge (Mpa) 0.069
 Total 0.078
 Lugeon 18

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	10.559	-	-
	1	10.575	0.016	0.016
	2	10.592	0.017	0.033
	3	10.609	0.017	0.050
	4	10.626	0.017	0.067
	5	10.643	0.017	0.084
	6	10.659	0.016	0.100
	7	10.675	0.016	0.116
	8	10.691	0.016	0.132
	9	10.707	0.016	0.148
	10	10.725	0.018	0.166

Pressure Gauge (Mpa) 0.207
 Total 0.216
 Lugeon 16



Lugeon 17

RECORD OF COREHOLE No. CH17-101

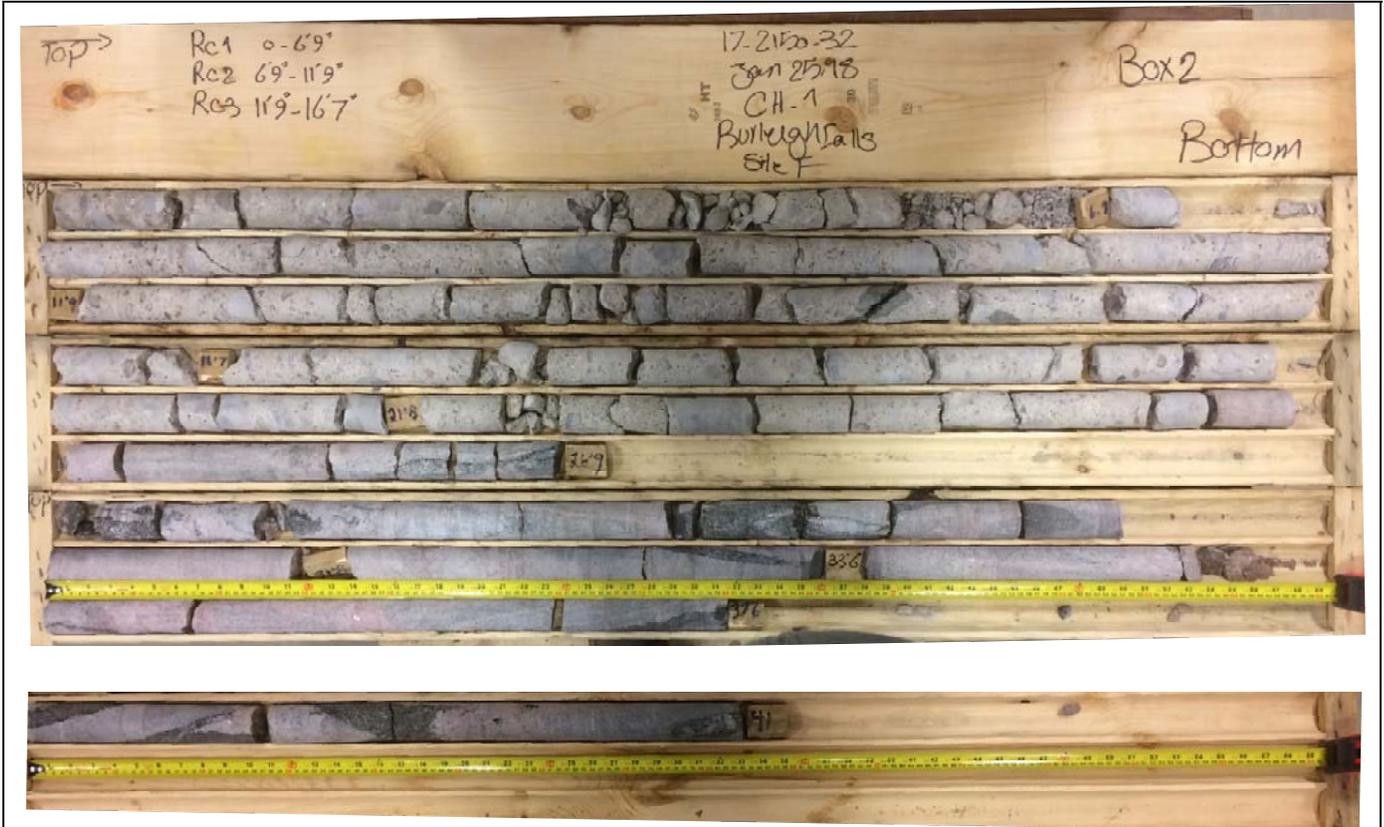
Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

Logged by: **RK**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS		
	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing		★ Rinse pH Values					
++ ++ ++			RC	05	100				Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L W _P W _U 20 40 60 80					
	END OF BOREHOLE	231.5 12.5														
	Notes: 1. Borehole was found to be open and no free standing water upon completion.														Note: RQD: Rock quality designation SCR: Solid core recovery	

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – CH17-101 - Dry rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-101	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
CC1		0	2.06	58			From 0 to 2.06 m Concrete: Fair to very poor quality Max Ø aggregate 45 mm Fragmented from 0.66 to 0.84		13 Fr				
CC2		2.06	3.58	100			From 2.06 to 3.58 m Concrete: Fair quality Max Ø aggregate 75 mm		11 Fr				
CC3		3.58	5.05	107			From 3.58 to 5.05 m Concrete: Fair to poor quality Max Ø aggregate 65 mm		18 Fr				
CC4		5.05	6.60	103			From 5.05 to 6.60 m Concrete: Fair to poor quality Max Ø aggregate 70 mm		15 Fr				
CC5		6.60	8.15	102			From 6.60 to 7.54 m Concrete: 100% Recovery, fair quality Max Ø aggregate 105 mm		11 Fr				
		7.54	8.15	104	38	10	From 7.54 to 12.50 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	7.54	Contact Concrete/Bedrock				
								Estimation	6 Jnts	2	1.5	1.0	8
RC1		8.15	9.65	99	82	7		Estimation	11 Jnts	3	1.5-3	1.0	8-14
RC2		9.65	10.21	98	98	2		Estimation	1 Jnt	2	1.5	1.0	8



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-101	Vertical
-------------------	----------

Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock
		From	To										
RC3		10.21	11.43	98	95	3	From 7.54 to 12.50 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	4 Jnts	3	1.5-3	1.0	8-12
RC4		11.43	12.50	79	79	2		Estimation	2 Jnts	2	2-3	1.0	8-14
END							End of hole 12.50 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-101	
Collar Elev. m:		
Test section, m:	From: 8.23	To: 12.50
Date of test:	29-Jan-18	
Start time:	1:35 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	3.60
Height gauge above ground (H2), m	0.80
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Shubra PK
End time:	2:00 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
4	0	43.085	-	-
	1	43.110	0.025	0.025
	2	43.134	0.024	0.049
	3	43.157	0.023	0.072
	4	43.182	0.025	0.097
	5	43.207	0.025	0.122
	6	43.232	0.025	0.147

Pressure Gauge 0.028
Total 0.072

Lugeon 82

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
8	0	43.640	-	-
	1	43.670	0.030	0.030
	2	43.690	0.020	0.050
	3	43.720	0.030	0.080
	4	43.750	0.030	0.110
	5	43.780	0.030	0.140
	6			
	7			
	8			
	9			
10				

Pressure Gauge 0.055
Total 0.099

Lugeon 71

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
8	0	43.265	-	-
	1	43.294	0.029	0.029
	2	43.322	0.028	0.057
	3	43.351	0.029	0.086
	4	43.380	0.029	0.115
	5	43.409	0.029	0.144
	6			
	7			
	8			
	9			
10				

Pressure Gauge 0.055
Total 0.099

Lugeon 68

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
4	0	43.820	-	-
	1	43.846	0.026	0.026
	2	43.872	0.026	0.052
	3	43.898	0.026	0.078
	4	43.924	0.026	0.104
	5			
	6			
	7			
	8			
	9			
10				

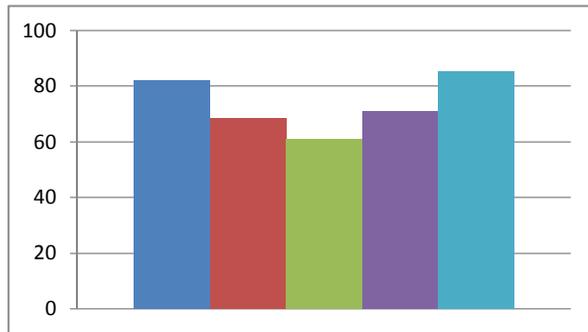
Pressure Gauge 0.028
Total 0.072

Lugeon 85

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
12	0	43.435	-	-
	1	43.468	0.033	0.033
	2	43.501	0.033	0.066
	3	43.534	0.033	0.099
	4	43.567	0.033	0.132
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge 0.083
Total 0.127

Lugeon 61



Lugeon 73

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-101	
Collar Elev. m:		
Test section, m:	From: 7.29	To: 7.70
Date of test:	29-Jan-18	
Start time:	12:52 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	3.60
Height gauge above ground (H2), m	0.80
Collar stickup above ground, r	0.00
Section tested:	Concrete/Bedrock interface
Test by:	Shubra PK
End time:	1:00 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0			
	1			
	2			
	3			
	4			
	5			

Pressure Gauge (Mpa)
0.069
Total 0.113

Lugeon
0

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
40	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			

Pressure Gauge (Mpa)
0.276
Total 0.320

Lugeon
0

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			

Pressure Gauge (Mpa)
0.138
Total 0.182

Lugeon
0

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
50	0	No water		
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			

Pressure Gauge (Mpa)
0.345
Total 0.389

Lugeon
0

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			

Pressure Gauge (Mpa)
0.207
Total 0.251

Lugeon
0

Did not take any water

RECORD OF COREHOLE No. CH17-102

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **Termite** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Jan 23, 2018** Date Completed: **Jan 23, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721817.7 NORTHING: 4937565.4
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _p ■ W _L ● W _u 20 40 60 80			COMMENTS
		Local Ground Surface Elevation: 244.00 m											
	CONCRETE Moderately to highly fractured concrete (max aggregate diameter: 75 mm)	CC	01			1	243						UCS = 44.6 MPa
		CC	02			2	242						
		CC	03			3	241						
		CC	04			4	240						
		CC	05			5	239						
		CC	06			6	238						
	Concrete/bedrock interface open 235.9					7	237						
	8.1					8	236						From 7.77 to 8.18 m: 71 Lu From 7.77 to 13.37 m: 85 Lu RQD = 95%, SCR = 95%
++	BEDROCK Dark to light gray to pink, very strong, slightly weathered. GRANODIORITE and GABBRO gneiss. Excellent rock quality.	RC	01	95		9	235						RQD = 100%, SCR = 100%
++		RC	02	104		10	234						RQD = 92%, SCR = 99%
++		RC	03	99		11	233						RQD = 100%, SCR = 100%
++		RC	04	100		12	232						



SNC-LAVALIN
 1801 McGill College Avenue
 12th Floor
 Montreal, Quebec H3A 2N4
 Tel: 514-393-1000

∇ No freestanding groundwater measured in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying Notes to Record of Boreholes.

Scale: 1 : 63
Page: 1 of 2

RECORD OF COREHOLE No. CH17-102

Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

Logged by: **RK**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L W _P	W _L W _P				
++ ++ ++ ++ ++ ++ ++	BEDROCK Dark to light gray to pink, very strong, slightly weathered, GRANODIORITE and GABBRO gneiss. Excellent rock quality.	RC	05	100	13	231								RQD = 90%, SCR = 100%
	END OF BOREHOLE Notes: 1. Borehole was found to be open and no free standing water upon completion.													Note: RQD: Rock quality designation SCR: Solid core recovery



Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying Notes to Record of Boreholes.

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – CH17-102 - Dry rock cores



Site F – Burleigh Falls – CH17-102 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-102	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
CC1		0	1.75	67			From 0 to 0.58 m Concrete: Good to fair quality						
							From 0.58 to 1.75 m Fragmented concrete Max Ø aggregate 65 mm						
CC2		1.75	2.24	76			From 1.75 to 2.24 m Concrete: Good to fair quality Max Ø aggregate 65 mm		2 Fr				
CC3		2.24	3.66	106			From 2.24 to 3.66 m Concrete: Fair quality Max Ø aggregate 62 mm		15 Fr				
CC4		3.66	5.16	103			From 3.66 to 5.16 m Concrete: Fair quality Max Ø aggregate 75 mm		12 Fr				
CC5		5.16	6.68	99			From 5.16 to 6.68 m Concrete: Fair quality Max Ø aggregate 72 mm		13 Fr				
CC6		6.68	8.10	102			From 6.68 to 8.03 m Concrete: Fair to poor quality Max Ø aggregate 75 mm		18 Fr				
								8.03	Contact Concrete/Bedrock				
							From 8.03 to 13.36 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation						



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-102	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC1		8.10	9.19	100	95	5	From 8.03 to 13.36 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation From 8.10 to 8.15 m Broken zone	Estimation	5 Jnts	1	1.5	1.0	8-12
RC2		9.19	9.73	100	100	2		Estimation	1 Jnt	2	1.5	1.0	8
RC3		9.73	11.23	100	90	5		Estimation	7 Jnts	3	1.5-3	1-1.5	8-12
RC4		11.23	12.60	100	100	1		Estimation	1 Jnt	2	1.5	1.0	8
RC5		12.60	13.36	97	87	7		Estimation	5 Jnts	3	1.5	1-1.5	8-10
END							End of hole 13.36 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-102	
Collar Elev. m:		
Test section, m:	From: 7.77	To: 13.36
Date of test:	24-Jan-18	
Start time:	3:10 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.78
Collar stickup above ground, m	
Section tested:	Bedrock
Test by:	Reza Khababznic
End time:	4:10 AM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	41.440	-	-
	1	41.460	0.020	0.020
	2	41.480	0.020	0.040
	3	41.501	0.021	0.061
	4	41.521	0.020	0.081
	5	41.541	0.020	0.101
	6	41.561	0.020	0.121
	7	41.581	0.020	0.141
	8	41.601	0.020	0.161
	9	41.621	0.020	0.181
10	41.641	0.020	0.201	

Pressure Gauge (Mpa) 0.034
Total 0.042

Lugeon 85

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	42.100	-	-
	1	42.125	0.025	0.025
	2	42.150	0.025	0.050
	3	42.175	0.025	0.075
	4	42.200	0.025	0.100
	5	42.225	0.025	0.125
	6	42.250	0.025	0.150
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 58

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	41.680	-	-
	1	41.705	0.025	0.025
	2	41.730	0.025	0.050
	3	41.756	0.026	0.076
	4	41.781	0.025	0.101
	5	41.806	0.025	0.126
	6	41.831	0.025	0.151
	7	41.856	0.025	0.176
	8			
	9			
10				

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 58

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	42.275	-	-
	1	42.295	0.020	0.020
	2	42.319	0.024	0.024
	3	42.339	0.020	0.020
	4	42.359	0.020	0.020
	5	42.379	0.020	0.020
	6	42.399	0.020	0.020
	7	42.419	0.020	0.020
	8			
	9			
10				

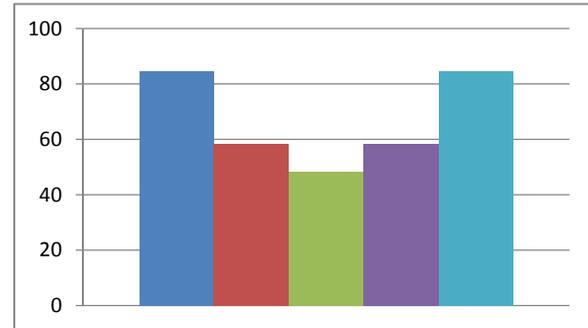
Pressure Gauge (Mpa) 0.034
Total 0.042

Lugeon 85

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
15	0	41.910	-	-
	1	41.940	0.030	0.030
	2	41.970	0.030	0.060
	3	42.000	0.030	0.090
	4	42.030	0.030	0.120
	5	42.060	0.030	0.150
	6	42.090	0.030	0.180
	7			
	8			
	9			
10				

Pressure Gauge (Mpa) 0.103
Total 0.111

Lugeon 48



Lugeon 48

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-102	
Collar Elev. m:		
Test section, m:	From: 7.77	To: 8.18
Date of test:	24-Jan-18	
Start time:	1:40 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.78
Collar stickup above ground, r	
Section tested:	Concrete/Bedrock interface
Test by:	Reza Khababznic
End time:	2:50 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	40.100	-	-
	1	40.120	0.020	0.020
	2	40.140	0.020	0.040
	3	40.160	0.020	0.060
	4	40.182	0.022	0.082
	5	40.204	0.022	0.104
	6	40.224	0.020	0.124
	7	40.244	0.020	0.144
	8	40.264	0.020	0.164
	9	40.284	0.020	0.184
10	40.304	0.020	0.204	

Pressure Gauge (Mpa) 0.034
Total 0.042

Lugeon 1269

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	40.800	-	-
	1	40.821	0.021	0.021
	2	40.842	0.021	0.042
	3	40.861	0.019	0.061
	4	40.881	0.020	0.081
	5	40.901	0.020	0.101
	6	40.920	0.019	0.120
	7	40.940	0.020	0.140
	8	40.960	0.020	0.160
	9	40.980	0.020	0.180
10	41.001	0.021	0.201	

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 636

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	40.310	-	-
	1	40.330	0.020	0.020
	2	40.350	0.020	0.040
	3	40.372	0.022	0.062
	4	40.392	0.020	0.082
	5	40.412	0.020	0.102
	6	40.434	0.022	0.124
	7	40.454	0.020	0.144
	8	40.474	0.020	0.164
	9	40.494	0.020	0.184
10	40.514	0.020	0.204	

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 636

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	40.110	-	-
	1	40.125	0.015	0.015
	2	40.140	0.015	0.015
	3	40.165	0.025	0.025
	4	40.175	0.010	0.010
	5	40.190	0.015	0.015
	6	40.210	0.020	0.020
	7	40.225	0.015	0.015
	8	40.240	0.015	0.015
	9	40.265	0.025	0.025
10	40.280	0.015	0.015	

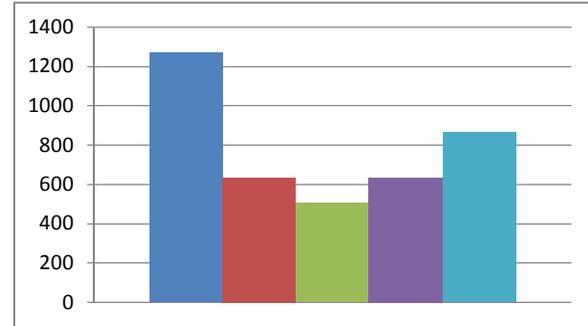
Pressure Gauge (Mpa) 0.034
Total 0.042

Lugeon 865

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
15	0	40.540	-	-
	1	40.565	0.025	0.025
	2	40.588	0.023	0.048
	3	40.610	0.022	0.070
	4	40.632	0.022	0.092
	5	40.655	0.023	0.115
	6	40.680	0.025	0.140
	7	40.705	0.025	0.165
	8	40.730	0.025	0.190
	9	40.755	0.025	0.215
10	40.780	0.025	0.240	

Pressure Gauge (Mpa) 0.103
Total 0.111

Lugeon 504



Lugeon 504

RECORD OF COREHOLE No. CH17-103

Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RK**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **Termite** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Jan 11, 2018** Date Completed: **Jan 11, 2018** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721810 NORTHING: 4937605
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L 20 40 60 80 W _p			COMMENTS
		Local Ground Surface Elevation: 244.00 m											
	CONCRETE Moderately fractured concrete (max aggregate diameter: 105 mm)	CC	01			1	243						UCS = 31.3 MPa
	Rebar	CC	02			4	240						
		CC	03			5	239						
		CC	04			6	238						
	Concrete/bedrock interface partly open, not sealed 236.8					7	237						From 6.80 to 7.21 m: 34 Lu RQD = 61%, SCR = 98%
	++ BEDROCK 7.2 Dark to light gray to pink, very strong, slightly weathered. GRANODIORITE and GABBRO gneiss. Fair to excellent rock quality.	RC	01	97		8	236						From 7.62 to 12.04 m: 62 Lu RQD = 77%, SCR = 97%
		RC	02	98		9	235						RQD = 95%, SCR = 74%
		RC	03	100		10	234						RQD = 76%, SCR = 100%
		RC	04	100		11	233						RQD = 68%, SCR = 98%
		RC	05	99		12	232						



SNC-LAVALIN
 1801 McGill College Avenue
 12th Floor
 Montreal, Quebec H3A 2N4
 Tel: 514-393-1000

∇ No freestanding groundwater measured in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying Notes to Record of Boreholes.

Scale: 1 : 63
Page: 1 of 2

RECORD OF COREHOLE No. CH17-103

Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

Logged by: **RK**

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value			MTO Vane*	Nilcon Vane*	Penetration Testing	Soil Vapour Reading parts per million (ppm)	Moisture Content (%)	Atterberg Limits	Lower Explosive Limit (LEL)	Passing 75 um (%)		
	<p>END OF BOREHOLE</p> <p>Notes:</p> <p>1. Borehole was found to be open and no free standing water upon completion.</p>							Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L W _P W _L								Note: RQD: Rock quality designation SCR: Solid core recovery

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – CH17-103 - Dry rock cores



Site F – Burleigh Falls – CH17-103 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-103	Vertical
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Logged by	S.Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
CC1		2.03	3.71	? 100			From 2.03 to 3.71 m Concrete: Fair quality; fractured Max Ø aggregate 105 mm		22 Fr				
CC2		3.71	4.27	114			From 3.71 to 4.27 m Concrete: Fair to poor quality Max Ø aggregate 65 mm	4.14	metal piece				
CC3		4.27	5.79	85			From 4.27 to 5.79 m Concrete: Fair to poor quality Max Ø aggregate 50 mm						
CC4		5.79	7.16	111			From 5.79 to 7.06 m Concrete: Fair quality Max Ø aggregate 50 mm						
								7.06	Contact Concrete/Bedrock partly tight				
							From 7.06 to 12.04 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation						
RC1		7.16	8.23	95	60	7		Estimation	8 Jnts	3	1.5	1.0	8-10
RC2		8.23	9.22	97	97	4		Estimation	4 Jnts	3	1.5	1.0	8-10
RC3		9.22	10.21	105	59	10		Estimation	10 Jnts	3	1.5	1.0	8-10
							From 9.45 to 9.47 m Broken zone Pseudo-vertical joint from 9.68 to 9.93						



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-103	Vertical
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Logged by	S.Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC4		10.21	11.25	105	88	5	From 7.06 to 12.04 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	5 Jnts	3	1.5	1.0	8-10
RC5		11.25	12.04	98	63	6		Estimation	5 Jnts	3	1.5	1.0	8-10
END							End of hole 12.04 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-103	
Collar Elev. m:		
Test section, m:	From: 7.62	To: 12.04
Date of test:	22-Jan-18	
Start time:	1:35 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.78
Collar stickup above ground, r	
Section tested:	Bedrock
Test by:	Reza Khababznic
End time:	2:40 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	39.600	-	-
	1	39.611	0.011	0.011
	2	39.622	0.011	0.022
	3	39.644	0.022	0.044
	4	39.655	0.011	0.055
	5	39.666	0.011	0.066
	6			
	7			
	8			
	9			

Pressure Gauge Total 0.034 0.042
Lugeon 59

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	40.050	-	-
	1	40.068	0.018	0.018
	2	40.085	0.017	0.035
	3	40.100	0.015	0.050
	4	40.115	0.015	0.065
	5	40.130	0.015	0.080
	6	40.145	0.015	0.095
	7			
	8			
	9			

Pressure Gauge Total 0.069 0.077
Lugeon 44

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	39.700	-	-
	1	39.720	0.020	0.020
	2	39.741	0.021	0.041
	3	39.761	0.020	0.061
	4	39.781	0.020	0.081
	5	39.800	0.019	0.100
	6	39.820	0.020	0.120
	7	39.841	0.021	0.141
	8	39.861	0.020	0.161
	9	39.881	0.020	0.181

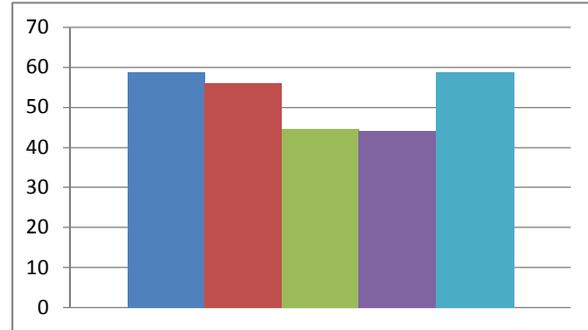
Pressure Gauge Total 0.069 0.077
Lugeon 56

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
5	0	40.200	-	-
	1	40.213	0.013	0.013
	2	40.225	0.012	0.025
	3	40.236	0.011	0.036
	4	40.247	0.011	0.047
	5	40.258	0.011	0.058
	6	40.269	0.011	0.069
	7	40.280	0.011	0.080
	8			
	9			

Pressure Gauge Total 0.034 0.042
Lugeon 59

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
15	0	39.920	-	-
	1	39.942	0.022	0.022
	2	39.964	0.022	0.044
	3	39.986	0.022	0.066
	4	40.008	0.022	0.088
	5	40.030	0.022	0.110
	6			
	7			
	8			
	9			

Pressure Gauge Total 0.103 0.111
Lugeon 45



Lugeon 45

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-103	
Collar Elev. m:		
Test section, m:	From: 6.80	To: 7.21
Date of test:	18-Jan-18	
Start time:	11:50 PM	

Packer Size (PQ/HQ/NQ):	PQ
Depth of stable WL in hole (H1), mbgs	
Height gauge above ground (H2), m	0.78
Collar stickup above ground, r	
Section tested:	Concrete/bedrock interface
Test by:	Reza Khabbazi
End time:	1:15 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	38.610	-	-
	1	38.623	0.013	0.013
	2	38.640	0.017	0.030
	3	38.652	0.012	0.042
	4	38.670	0.018	0.060
	5	38.682	0.012	0.072
	6	38.698	0.016	0.088
	7	38.712	0.014	0.102
	8	38.726	0.014	0.116
	9	38.740	0.014	0.130
10				

Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 381

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	39.120	-	-
	1	39.140	0.020	0.020
	2	39.162	0.022	0.042
	3	39.181	0.019	0.061
	4	39.200	0.019	0.080
	5	39.219	0.019	0.099
	6	39.238	0.019	0.118
	7	39.258	0.020	0.138
	8	39.278	0.020	0.158
	9	39.298	0.020	0.178
10	39.318	0.020	0.198	

Pressure Gauge (Mpa) 0.138
Total 0.146

Lugeon 318

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	38.750	-	-
	1	38.770	0.020	0.020
	2	38.790	0.020	0.040
	3	38.810	0.020	0.060
	4	38.830	0.020	0.080
	5	38.850	0.020	0.100
	6	38.870	0.020	0.120
	7	38.890	0.020	0.140
	8			
	9			
10				

Pressure Gauge (Mpa) 0.138
Total 0.146

Lugeon 335

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	39.350	-	-
	1	39.367	0.017	0.017
	2	39.380	0.013	0.030
	3	39.400	0.020	0.050
	4	39.418	0.018	0.068
	5	39.436	0.018	0.086
	6	39.466	0.030	0.116
	7	39.486	0.020	0.136
	8	39.506	0.020	0.156
	9	39.526	0.020	0.176
10	39.546	0.020	0.196	

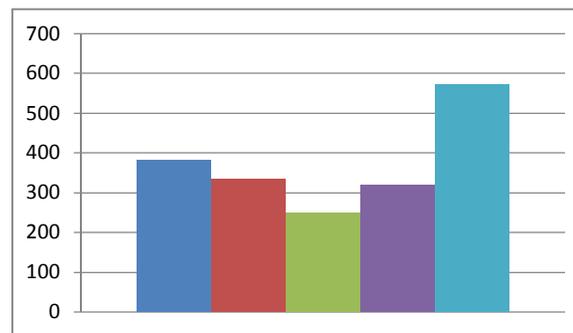
Pressure Gauge (Mpa) 0.069
Total 0.077

Lugeon 572

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	38.900	-	-
	1	38.922	0.022	0.022
	2	38.948	0.026	0.048
	3	38.970	0.022	0.070
	4	38.990	0.020	0.090
	5	39.012	0.022	0.112
	6	39.036	0.024	0.136
	7	39.060	0.024	0.160
	8	39.084	0.024	0.184
	9	39.108	0.024	0.208
10				

Pressure Gauge (Mpa) 0.207
Total 0.215

Lugeon 250



Lugeon 250

RECORD OF COREHOLE No. CH17-104

Project Number: **644198**

Drilling Location: **Site F: Burleigh Falls**

Logged by: **RA**

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS
	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing		Soil Vapour Reading parts per million (ppm)		Moisture Content (%)			
	Notes:															
	1. Borehole was found to be open and no free standing water upon completion.															

**CORE PHOTOS –
SITE F BURLEIGH FALLS**



Site F – Burleigh Falls – CH17-104 - Dry rock cores



Site F – Burleigh Falls – CH17-104 - Wet rock cores



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-104	Vertical
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Logged by	S.Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
CC1		1.80	2.87	133			From 1.80 to 2.87 m Fractured concrete Max Ø aggregate 65 mm						
CC2		2.87	4.29	102			From 2.87 to 4.29 m Concrete: Fair to good quality Max Ø aggregate 110 mm		12 Fr				
CC3		4.29	5.49	102			From 4.29 to 5.49 m Concrete: Fair to good quality Max Ø aggregate 31 mm		11 Fr				
CC4		5.49	6.38	100			From 5.49 to 6.38 m Concrete: Fair to good quality Max Ø aggregate 185 mm		3 Fr				
								6.38	Contact Concrete/Bedrock not sealed				
RC1		6.38	7.09	104	71	11	From 6.38 to 11.07 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	8 Jnts	3	1.5	1.0	8-10
RC2		7.09	7.85	103	55	14		Estimation	11 Jnts	3	1-1.5	1.0	8-10
RC3		7.85	7.92	100	na	0			No Jnt				
RC4		7.92	8.43	115	75	6		Estimation	3 Jnts	3	1-1.5	1.0	8-10
RC5		8.43	8.84	100	81	12		Estimation	5 Jnts	3	1-1.5	1.0	8-10



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-104	Vertical
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Logged by	S.Viau
Date	2018/03/06

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter	Concrete & rock condition: petrography, alteration, soundness, other observations etc.	Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
		From	To										
RC6		8.84	9.41	104	100	3	From 6.38 to 11.07 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	2 Jnts	1	1.5	1.0	8-10
RC7		9.41	9.75	100	100	0		No Jnt					
RC8		9.75	10.72	99	86	5		At 10.39: Epidote alteration	Estimation	5 Jnts	1	1.5	1.0
RC9		10.72	11.07	107	100	3	Estimation		1 Jnt	1	1	1.0	6-8
END							End of hole 11.07 m						

Constant Head Packer Test

Project No.:	17-2150-32		
Location:	Burleigh Falls, Site F		
BH No.:	CH17-104		
Collar Elev. m:			
Test section, m:	From: 6.38	To:	11.08
Date of test:	18-Jan-18		
Start time:	1:30 PM		

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	3.00
Height gauge above ground (H2), m	0.13
Collar stickup above ground, r	0.00
Section tested:	Bedrock
Test by:	Reza Aragh
End time:	1:55 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.665	-	-
	1	12.673	0.008	0.008
	2	12.681	0.008	0.016
	3	12.689	0.008	0.024
	4	12.697	0.008	0.032
	5	12.705	0.008	0.040
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon
17

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.821	-	-
	1	12.831	0.010	0.010
	2	12.841	0.010	0.020
	3	12.851	0.010	0.030
	4	12.861	0.010	0.040
	5			
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon
13

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.715	-	-
	1	12.723	0.008	0.008
	2	12.731	0.008	0.016
	3	12.739	0.008	0.024
	4	12.749	0.010	0.034
	5			
	6			
	7			
	8			
	9			

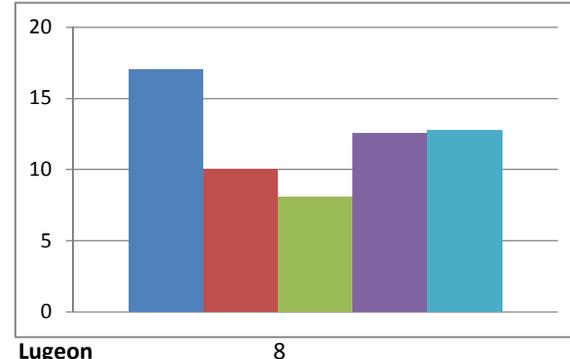
Pressure Gauge
Total
Lugeon
10

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.861	-	-
	1	12.867	0.006	0.006
	2	12.873	0.006	0.006
	3	12.879	0.006	0.006
	4	12.885	0.006	0.006
	5			
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon
13

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	12.260	-	-
	1	12.269	0.009	0.009
	2	12.278	0.009	0.018
	3	12.287	0.009	0.027
	4	12.294	0.007	0.034
	5			
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon
8



Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-104	
Collar Elev. m:		
Test section, m:	From: 6.17	To: 6.57
Date of test:	18-Jan-18	
Start time:	12:09 PM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	3.00
Height gauge above ground (H2), m	0.13
Collar stickup above ground, r	0.00
Section tested:	Concrete/bedrock interface
Test by:	Reza Aragh
End time:	12:40 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.560	-	-
	1	12.562	0.002	0.002
	2	12.564	0.002	0.004
	3	12.566	0.002	0.006
	4	12.568	0.002	0.008
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 50

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.617	-	-
	1	12.620	0.003	0.003
	2	12.623	0.003	0.006
	3	12.626	0.003	0.009
	4	12.629	0.003	0.012
	5	12.632	0.003	0.015
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 44

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	12.574	-	-
	1	12.577	0.003	0.003
	2	12.580	0.003	0.006
	3	12.583	0.003	0.009
	4	12.586	0.003	0.012
	5	12.589	0.003	0.015
	6			
	7			
	8			
	9			
10				

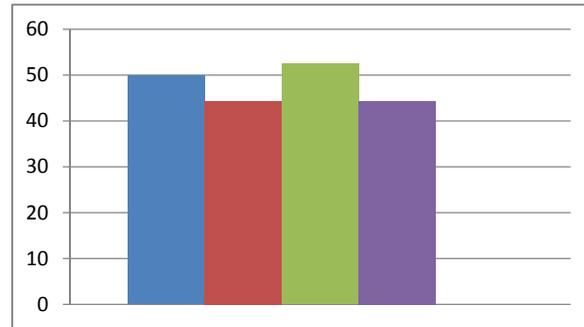
Pressure Gauge
Total
Lugeon 44

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	12.633	-	-
	1	12.633	0.000	0.000
	2	12.633	0.000	0.000
	3	12.634	0.001	0.001
	4	12.634	0.000	0.000
	5	12.634	0.000	0.000
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 0

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	12.591	-	-
	1	12.596	0.005	0.005
	2	12.601	0.005	0.010
	3	12.606	0.005	0.015
	4	12.611	0.005	0.020
	5	12.616	0.005	0.025
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
Lugeon 52



Lugeon 38



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-105	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joints per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
CC1		0	0.71	104			From 0 to 0.71 m Concrete: Fair to poor quality Max Ø aggregate 45 mm Fragmented fro 0.51 to 0.71	10 Fr					
CC2		0.71	1.65	97			From 0.71 to 1.65 m Concrete: Good to fair quality Max Ø aggregate 55 mm	10 Fr					
CC3		1.65	3.20	102			From 1.65 to 3.20 m Concrete: Good quality. Weathering 3.15 to 3.25 Max Ø aggregate 45 mm	11 Fr					
CC4		3.20	4.19	103			From 3.20 to 4.19 m Concrete: Good to fair quality Max Ø aggregate 160 mm	6 Fr					
CC5		4.19	4.55	100			From 4.19 to 4.55 m Concrete: Good to fair quality Max Ø aggregate 75 mm	1 Fr					
								4.55	Contact Concrete/Bedrock not sealed				
RC1		4.55	4.67	110	0	8	From 4.55 to 9.50 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	1 Jnt	2	3	1.0	14
RC2		4.67	5.46	94	52	9		Estimation	7 Jnts	3	1.5	1-1.5	8-12
RC3		5.46	6.25	106	94	6		Estimation	5 Jnts	3	1.5-3	1-1.5	8-14



Project	TSW CENTRAL BUNDLE
Site	Site F
Location	Burleigh Falls
Total length in concrete (m)	
Total length in bedrock (m)	

BOREHOLE CH17-105	Vertical
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Logged by	S.Viau
Date	2018/03/07

Core Description							Lithological Description	Structural Description					
Run number	Core size	Run depth (m)		Recov %	RQD %	Joins per meter		Fracture depth (m)	Fracture type & filling	Jn rock	Jr rock	Ja rock	JRC rock
RC4		6.25	7.47	102	71	7	From 4.55 to 9.50 m Gneissic granodiorite and tonalite, veins of pegmatite, light to moderate foliation	Estimation	9 Jnts	3	1.5-3	1-1.5	8-12
RC5		7.47	8.03	102	80	9		Fragments from 7.72 to 7.80	Estimation	5 Jnts	3	1.5	1.0
RC6		8.03	8.79	100	83	5	Estimation		4 Jnts	2	1.5	1-1.5	8-10
RC7		8.79	9.50	100	39	8	Estimation	6 Jnts	3	1.5-3	1-1.5	8-16	
END							End of hole 9.50 m						

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-105	
Collar Elev. m:		
Test section, m:	From: 4.55	To: 9.50
Date of test:	24-Jan-18	
Start time:	3:50 AM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	3.12
Height gauge above ground (H2), m	0.15
Collar stickup above ground, m	0.00
Section tested:	Bedrock
Test by:	Reza Aragh
End time:	4:25 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.328	-	-
	1	13.340	0.012	0.012
	2	13.352	0.012	0.024
	3	13.364	0.012	0.036
	4	13.376	0.012	0.048
	5			
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 24

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.610	-	-
	1	13.628	0.018	0.018
	2	13.647	0.019	0.037
	3	13.664	0.017	0.054
	4	13.681	0.017	0.071
	5	13.698	0.017	0.088
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 20

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.385	-	-
	1	13.402	0.017	0.017
	2	13.419	0.017	0.034
	3	13.436	0.017	0.051
	4	13.453	0.017	0.068
	5	13.470	0.017	0.085
	6			
	7			
	8			
	9			

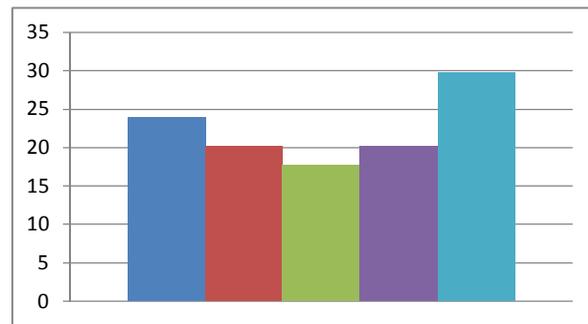
Pressure Gauge
Total
Lugeon 20

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.710	-	-
	1	13.724	0.014	0.014
	2	13.739	0.015	0.015
	3	13.754	0.015	0.015
	4	13.769	0.015	0.015
	5	13.784	0.015	0.015
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 30

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	13.490	-	-
	1	13.511	0.021	0.021
	2	13.533	0.022	0.043
	3	13.554	0.021	0.064
	4	13.575	0.021	0.085
	5	13.596	0.021	0.106
	6			
	7			
	8			
	9			

Pressure Gauge
Total
Lugeon 18



Lugeon 18

Constant Head Packer Test

Project No.:	17-2150-32	
Location:	Burleigh Falls, Site F	
BH No.:	CH17-105	
Collar Elev. m:		
Test section, m:	From: 4.34	To: 4.75
Date of test:	22-Jan-18	
Start time:	3:05 AM	

Packer Size (PQ/HQ/NQ):	NQ
Depth of stable WL in hole (H1), mbgs	3.12
Height gauge above ground (H2), m	0.13
Collar stickup above ground, r	0.00
Section tested:	Concrete/bedrock interface
Test by:	Reza Aragh
End time:	3:25 PM

H ₁	Stage 1 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.024	-	-
	1	13.025	0.001	0.001
	2	13.025	0.000	0.001
	3	13.025	0.001	0.001
	4	13.026	0.000	0.002
	5			
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
0.069
0.101

Lugeon
0

H ₁	Stage 4 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.036	-	-
	1	13.037	0.001	0.001
	2	13.037	0.001	0.001
	3	13.038	0.000	0.002
	4	13.038	0.001	0.002
	5	13.039	0.001	0.003
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
0.138
0.170

Lugeon
7

H ₂	Stage 2 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
20	0	13.027	-	-
	1	13.028	0.001	0.001
	2	13.028	0.001	0.001
	3	13.029	0.000	0.002
	4	13.029	0.001	0.002
	5	13.030	0.001	0.003
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
0.138
0.170

Lugeon
7

H ₂	Stage 5 – PRESSURE DECREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
10	0	13.040	-	-
	1	13.040	0.000	0.000
	2	13.040	0.000	0.000
	3	13.041	0.001	0.001
	4	13.041	0.000	0.000
	5	13.041	0.001	0.001
	6			
	7			
	8			
	9			
10				

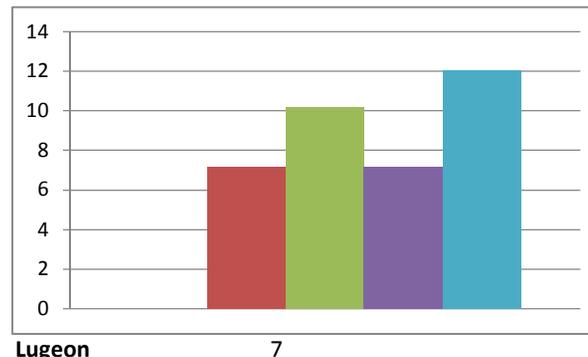
Pressure Gauge
Total
0.069
0.101

Lugeon
12

H ₃	Stage 3 – PRESSURE INCREASING			
Applied Pressure (PSI)	Time (min)	Meter (m ³)	Δ Take (m ³)	Σ Take (m ³)
30	0	13.030	-	-
	1	13.031	0.001	0.001
	2	13.032	0.001	0.002
	3	13.033	0.001	0.003
	4	13.034	0.001	0.004
	5	13.035	0.001	0.005
	6			
	7			
	8			
	9			
10				

Pressure Gauge
Total
0.207
0.239

Lugeon
10



RECORD OF COREHOLE No. ENV17-01

Project Number: 644198 Drilling Location: Site F: Burleigh Falls Logged by: RA
 Client: Public Services and Procurement Canada Drilling Method: Diamond Coring Compiled by: SPK
 Project Name: TSW Central Bundle Drilling Machine: HILTI DD 250 Reviewed by: AS
 Location: Site F- Burleigh Falls Dam at Lock 28 Date Started: Dec 21, 2017 Date Completed: Dec 21, 2017 Revision No.: 0

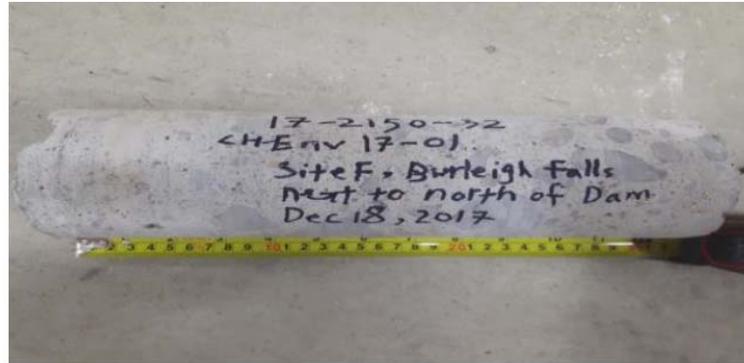
LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721813.2 NORTHING: 4937605.3	COMMENTS
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L ■ W _p ● W _u 20 40 60 80					
	Local Ground Surface Elevation: 244.00 m													
	CONCRETE, sound													
	243.7													
	0.4													

RECORD OF COREHOLE No. ENV17-02

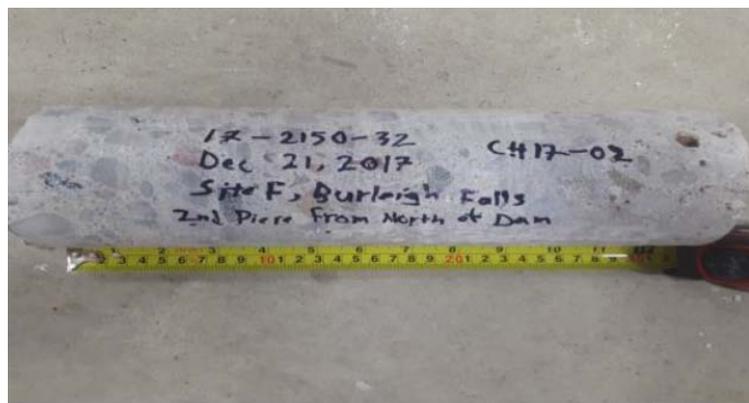
Project Number: **644198** Drilling Location: **Site F: Burleigh Falls** Logged by: **RA**
 Client: **Public Services and Procurement Canada** Drilling Method: **Diamond Coring** Compiled by: **SPK**
 Project Name: **TSW Central Bundle** Drilling Machine: **HILTI DD 250** Reviewed by: **AS**
 Location: **Site F- Burleigh Falls Dam at Lock 28** Date Started: **Dec 21, 2017** Date Completed: **Dec 21, 2017** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721814.3 NORTHING: 4937597.1
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L ■ W _p ● W _u 20 40 60 80	COMMENTS			
		Local Ground Surface Elevation: 244.00 m											
	CONCRETE, sound												
	243.7												
	0.4												

**CORE PHOTOS –
SITE F PERRY'S CREEK**



Site F – Burleigh Falls – EN17-01



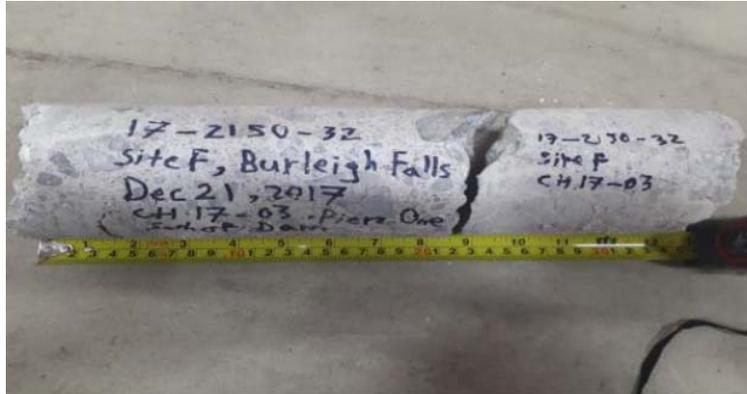
Site F – Burleigh Falls – EN17-02

RECORD OF COREHOLE No. ENV17-03

Project Number: 644198 Drilling Location: Site F: Burleigh Falls Logged by: RA
 Client: Public Services and Procurement Canada Drilling Method: Diamond Coring Compiled by: SPK
 Project Name: TSW Central Bundle Drilling Machine: HILTI DD 250 Reviewed by: AS
 Location: Site F- Burleigh Falls Dam at Lock 28 Date Started: Dec 21, 2017 Date Completed: Dec 21, 2017 Revision No.: 0

LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				INSTRUMENTATION INSTALLATION	EASTING: 721829.3 NORTHING: 4937511.9	
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 △ Soil Vapour Reading parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) * Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits W _L ■ W _p ● W _u 20 40 60 80	COMMENTS				
	Local Ground Surface Elevation: 244.00 m													
	CONCRETE, sound													
	243.7													
	0.4													

**CORE PHOTOS –
SITE F PERRY'S CREEK**



Site F – Burleigh Falls – EN17-03

	Document No.	Revision		Page
		No.	Date	
	644198-003F-4GER-0001	00	2018-10-02	

**2017 INVESTIGATION ASSESSMENT REPORT
 SITE F BURLEIGH FALLS DAM AT LOCK 28
 AND PERRY'S CREEK DAM 1**

APPENDIX C – LABORATORY TEST REPORTS



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SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
☎ 905.851.0090 📠 905.851.0091

COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1493

Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
 Sample Location/Structure: BH17 - 05 (Concrete).

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	6	Thickness/Height in mm	83.2
Diameter in (mm)	41.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	16.9	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1494

Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
 Sample Location/Structure: BH17 - 05 (Concrete).

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	7	Thickness/Height in mm	83.2
Diameter in (mm)	41.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	15.9	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.



Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1495

Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
 Sample Location/Structure: BH17 - 05 (Rock).

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	8	Thickness/Height in mm	83.2
Diameter in (mm)	41.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	97.2	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1496
 Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
 Sample Location/Structure: CH17-101 (Rock)
 Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	9	Thickness/Height in mm	89.6
Diameter in (mm)	44.8	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	101.7	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

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Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
Lab No: 1497
Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
Sample Location/Structure: CH17-102 (Concrete)

Sample Type: Drilled Hardened Core.
Date Sampled: 5th ~ 9th March, 2018
Date Received : March 13, 2018
Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	10	Thickness/Height in mm	169.2
Diameter in (mm)	84.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	44.6	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
Lab No: 1498
Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
Sample Location/Structure: CH17-103 (Concrete)

Sample Type: Drilled Hardened Core.
Date Sampled: 5th ~ 9th March, 2018
Date Received : March 13, 2018
Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	11	Thickness/Height in mm	122.9
Diameter in (mm)	84.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	31.3	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1499

Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
 Sample Location/Structure: CH17-103 (Rock)

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	12	Thickness/Height in mm	89.6
Diameter in (mm)	44.8	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	79.9	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
Lab No: 1500
Project Name: Hydro Dam Project - Peterbrough. Site F - Burleigh Falls
Sample Location/Structure: CH17-105 (Concrete)

Sample Type: Drilled Hardened Core.
Date Sampled: 5th ~ 9th March, 2018
Date Received : March 13, 2018
Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	13	Thickness/Height in mm	162
Diameter in (mm)	84.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	39.0	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1502

Project Name: Hydro Dam Project - Peterbrough. Site F - Perry's Creek
 Sample Location/Structure: CH17 - 01 (Rock).

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	15	Thickness/Height in mm	121.2
Diameter in (mm)	60.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	79.7	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 **Date:** March 20, 2018
Lab No: 1503
Project Name: Hydro Dam Project - Peterbrough. **Site F - Perry's Creek**
Sample Location/Structure: CH17 - 02 (Concrete).

Sample Type: Drilled Hardened Core.
Date Sampled: 5th ~ 9th March, 2018
Date Received : March 13, 2018
Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	16	Thickness/Height in mm	121.2
Diameter in (mm)	60.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	27.5	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





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COMPRESSIVE STRENGTH TESTING OF CORES

Procedure CSA -A23.2-14C

Project No: 17 - 2150 - 32 Date: March 20, 2018
 Lab No: 1504

Project Name: Hydro Dam Project - Peterbrough. Site F - Perry's Creek
 Sample Location/Structure: CH17 - 02 (Rock).

Sample Type: Drilled Hardened Core.
 Date Sampled: 5th ~ 9th March, 2018
 Date Received : March 13, 2018
 Date Tested: March 19, 2018

Core Data for Compressive Strength Testing			
Core No.	17	Thickness/Height in mm	121.2
Diameter in (mm)	60.6	Conditioning	Dry
Compressive Strength with Corr. Factor in (Mpa)	98.3	Specified Strength (after 28 days) in MPa	N/A
Date Of Pouring	N/A	Test Age (in Days)	N/A

Remarks: The cores were extracted by Sebastien Viau. Information gathered on site / lab.has been reported.

Nasir Siddiqui B.E.(C.E.T.)rcji
Concrete Lab. Supervisor

Tested By: Luis





DEPARTMENT OF
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Goodwin Hall
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Fax 613 533-6597

March 30, 2018

Mr. Abid Sahi
Geotechnical Project Manager
SNC-Lavalin
401 Hanlan Road
Woodbridge, ON L4L 3T1

Re: Core Testing – South and Central Bundle Projects (Projects #17-2150-33 and 17-2150-32)

Mr. Sahi:

A total of seven (7) rock core specimens were delivered to Queen's University during December, 2016 in a single batch (Set 1) for the purpose of conducting rock and concrete/rock ("interface") direct shear strength tests. In late February, 2018, an additional set of thirteen (13) core samples (Set 2) was received for similar direct shear strength testing. Both Set 1 and Set 2 samples were identified as being sourced for the South Bundle Project (Project Number 17-2150-33).

A third set of seven (7) core specimens (Set 3) was received in mid-March and was identified as being received from the Central Bundle Project (Project Number 17-2150-32).

For Set 1, of the seven received samples, only six direct shear tests, with three along pre-failed "interface" concrete/rock or rock joint surfaces and three along intact rock or "interface" concrete/rock core materials, were able to be conducted. One intact sample shear test was unable to be completed due to multiple seam failure occurrences during the testing process, from which no usable data could be obtained.

For Set 2, the majority of samples were tested through rock with two being tested through "interface" concrete/rock surfaces. For this set, two specimens were only able to be tested for residual shear strength due to breakage of weak material along the orientated failure surface prior to testing. A third sample was able to be failed only once in the intact state and, due to excessive failure surface damage that resulted during the intact sample failure test process, no residual failure testing could be accommodated.

For Set 3, three samples (all identified as "interface" samples having as-received and pre-failed shear surfaces) were subjected only to residual shear strength determination. Four remaining core specimens (identified as intact "rock" core) were to be tested both in the intact and residual state. For one of these samples, and due to breakage of weak material along the oriented failure surface prior to testing, only residual shear strength parameters were able to be determined. Additionally, no data was able to be determined for any of the three remaining intact specimens due to availability of only short sample lengths and multiple failure occurrences that developed during the initial intact sample shearing tests that obviated determination of both intact and residual failure shear strength parameters for these tests.

Views of the post-test direct shear sample specimens are shown in the separate direct shear sample photo listing that will be sent to you.

Additional testing for determination of unconfined compression strength (UCS) parameters is also planned for separate shipments of core material from these project sites, when they become available.

All tests for these samples have been or will be performed in accordance with ASTM Test Standards, these being ASTM D7012-14 (for unconfined and confined strength determination) and ASTM D5607-08 (for direct shear strength determination).

For each successfully tested unconfined strength test specimen, stress/strain data output will be recorded and will be appended to future reports as electronic attachments. For each direct shear test trial, force/displacement and resultant shear/normal stress plot data have also been reported.

Each sample that will be subjected to unconfined compression failure testing will be subjected to a process of preparation that includes:

- diamond sawing to prepare cylindrical samples having nearly parallel end faces at length-to-diameter aspect ratios approximating 2.5-to-1, depending on core lengths delivered
- diamond lathing, to prepare sample faces parallel to within ± 0.025 mm
- testing to failure within a Materials Testing System (MTS) Model 815 servo-controlled, electrohydraulic compression testing frame

All compression tests will be performed under axial strain control at rates approximating 10^{-5} s^{-1} . For the unconfined compression tests, simultaneous recordings of axial force, axial deformation and circumferential deformation (through use of an integral load cell and applied strain gauges) will be performed from which determination of standard failure parameters (UCS, Young's Modulus and Poisson's ratio) will be made.

A summary of direct shear strength test results is tabled and included. When performed, separate electronic files that illustrate the stress/strain responses of each unconfined compression test specimen will be e-mailed to you. Photo images of these test UCS specimens, both prior to and following failure testing, as well as of post-test direct shear specimens, will be appended to written reports for your information. Electronic plots of direct shear test data will also be forwarded to you separately following submission of this report.

Yours sincerely,

J. F. Archibald, Ph.D., P. Eng., FCIM

Summary Failure Test Results (January-March, 2018)
South and Central Bundle Kingston Project – Projects #17-2150-32 & #17-2150-33

SUMMARY of DIRECT SHEAR STRENGTH TESTS PERFORMED

Site/Sample (depth, m)					Direct Shear Data
SET 1 SAMPLES (South Bundle)					
Site B-CH09 (7.96-8.11 m) (interface)					* (residual only)
Site B-CH10 (8.77-9.05 m) (interface)					* (residual only)
Site B-CH10 (10.64-10.90 m) (rock)					* (intact+residual)
Site B-CH01 (7.55-7.82 m) (interface)					* (residual only)
Site B-CH05 (8.64-8.90 m) (interface)					* (intact+residual)
Site B-CH06 (10.39-10.60 m) (rock)					* (intact+residual)
Site B-CH08 (10.75-11.06 m) (rock)	No test	results	obtained	(sample fail)	NO TEST
SET 2 SAMPLES (South Bundle)					
Site A-BH17-04 (7.29-7.42 m) (rock)					*(residual only)
Site A-BH17-05 (6.45-6.68 m) (rock)					*(intact+residual)
Site A-BH17-11 (7.37-7.57 m) (rock)					*intact+residual
Site C-BH17-01 (6.40-6.63 m) (rock)					*(intact+residual)
Site C-CH03 (7.34-7.65 m) (interface)					*(intact+residual)
Site D-CH01 (10°10"-11°8") (rock)					*(intact+residual)
Site D-CH03 (10.50-10.70 m) (rock)					*(intact+residual)
Site D-CH03 (8.74-9.08 m) (interface)					*(residual only)
Site E-BH17-01 (16.28-16.51 m) (rock)					*(intact+residual)
Site E-CH01 (12.32-12.60 m) (rock)					*(intact+residual)
Site E-CH03 (8.81-8.99 m) (rock)					*(intact only)
Site G-BH17-01 (6.93-7.24 m) (rock)					*(intact+residual)
Site G-BH17-03 (7.49-7.72 m) (rock)					*(intact+residual)
SET 3 SAMPLES (Central Bundle)					
Site C-BH17-10 (10.39-10.57 m) (rock)					*(residual only)
Site F-BH17-05 (9.02-9.17 m) (rock)	No test	results	obtained	(sample fail)	NO TEST
Site F-CH03 (6.88-7.16 m) (interface)					*(residual only)
Site F-CH03 (9.22-9.47 m) (rock)	No test	results	obtained	(sample fail)	NO TEST
Site F-CH04 (6.32-6.43 m) (interface)					*(residual only)
Site F-CH17-01 (5.66-6.05 m) (rock)	No test	results	obtained	(sample fail)	NO TEST
Site F-CH17-02 (no footage) (interface)					*(residual only)

(*) – summary direct shear test data presented in separate table to follow

Summary of Intact Specimen Direct Shear Strength Test Results

Borehole-Sample (depth)	Normal Stress (MPa)	Shear Stress (MPa)
SET 1 SAMPLES (South Bundle)		
Site B-CH05 (8.64-8.90 m) (interface)	0.191	1.490
Site B-CH06 (10.39-10.60 m) (rock)	0.344	3.065
Site B-CH10 (10.64-10.90 m) (rock)	0.365	1.937
SET 2 SAMPLES (South Bundle)		
Site A-BH17-05 (6.45-6.68 m) (rock)	0.191	0.553
Site C-CH03 (7.34-7.65 m) (interface)	0.129	0.374
Site A-17-11 (7.37-7.57) (rock)	0.230	3.649
Site D-CH01 (10'10"-11'8") (rock)	0.270	1.095
Site C-BH17-01 (6.40-6.63) (rock)	0.349	3.950
Site D-CH03 (10.50-10.70) (rock)	0.309	5.482
Site E-BH17-01 (16.28-16.51) (rock)	0.248	4.451
Site E-CH01 (12.32-12.60) (rock)	0.338	3.193
Site E-CH03 (8.81-8.99) (rock)	0.392	4.615
Site G-BH17-01 (6.93-7.24) (rock)	0.237	1.076
Site G-BH17-03 (7.49-7.72) (rock)	0.327	1.633
SET 3 SAMPLES (Central Bundle)		
Site C-BH17-10 (10.39-10.57 m) (rock)	No Test Results	No Test Results
Site F-BH17-05 (9.02-9.17 m) (rock)	No Test Results	No Test Results
Site F-CH03 (9.22-9.47 m) (rock)	No Test Results	No Test Results
Site F-CH17-01 (5.66-6.05 m) (rock)	No Test Results	No Test Results

Summary of Residual Direct Shear Strength Test Results

Borehole-Sample (depth)	Apparent Cohesion (kPa)	Internal Friction Angle (°)	Coefficient of Multiple Correlation (R ²)
SET 1 SAMPLES (South Bundle)			
Site B-CH01 (7.55-7.82 m) (interface)	658	18.7	0.980
Site B-CH05 (8.64-8.90 m) (interface)	533	28.2	0.995
Site B-CH06 (10.39-10.60 m) (rock)	1154	34.8	0.996
Site B-CH08 (10.75-11.06 m) (rock)	No test data	-major sample failure	during shear test procedure
Site B-CH09 (7.96-8.11 m) (interface)	130	20.0	0.991
Site B-CH10 (8.77-9.05 m) (interface)	626	16.3	0.966
Site B-CH10 (10.64-10.90 m) (rock)	973	41.0	0.997
SET 2 SAMPLES (South Bundle)			
Site A-BH17-04 (7.29-7.42 m) (rock)	174	29.9	0.975
Site A-BH17-05 (6.45-6.68 m) (rock)	379	37.7	0.984
Site A-BH17-11 (7.37-7.57 m) (rock)	1385	51.4	0.987
Site C-BH17-01 (6.40-6.63 m) (rock)	872	38.1	0.996
Site C-CH03 (7.34-7.65 m) (interface)	468	38.2	0.996
Site D-CH01 (10°10'3"-11°8'") (rock)	732	36.3	0.998
Site D-CH03 (10.50-10.70 m) (rock)	818	36.0	0.996
Site D-CH03 (8.74-9.08 m) (interface)	237	32.7	0.974
Site E-BH17-01 (16.28-16.51 m) (rock)	1030	28.9	0.995
Site E-CH01 (12.32-12.60 m) (rock)	555	31.5	0.991
Site E-CH03 (8.81-8.99 m) (rock)	---	---	---
Site G-BH17-01 (6.93-7.24 m) (rock)	647	23.8	0.982
Site G-BH17-03 (7.49-7.72 m) (rock)	322	31.8	0.998

Direct Shear Test Results – Intact (where applicable) and Residual Strength Sample Tests

SET 1 SAMPLE DATA (SOUTH BUNDLE)

Intact and Residual Shear Strength Data – Site B-CH05 (8.64-8.90 m)

Intact shear strength: Normal stress = 0.191 MPa Shear stress = 1.490 MPa

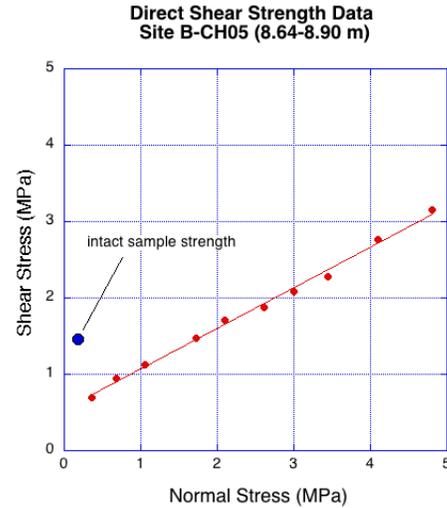
Residual shear strength:

Apparent Cohesion = 533 kPa

Internal Friction Angle = 28.2°

R² = 0.995

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.366	.693
2	.688	.949
3	1.058	1.129
4	1.719	1.471
5	2.101	1.708
6	2.613	1.879
7	2.998	2.088
8	3.446	2.278
9	4.093	2.771
10	4.811	3.151



Intact and Residual Shear Strength Data – Site B-CH06 (10.39-10.60 m)

(Intact and residual strength tests on saw cut rock on grout interface)

Intact shear strength: Normal stress = 0.344 MPa Shear stress = 3.065 MPa

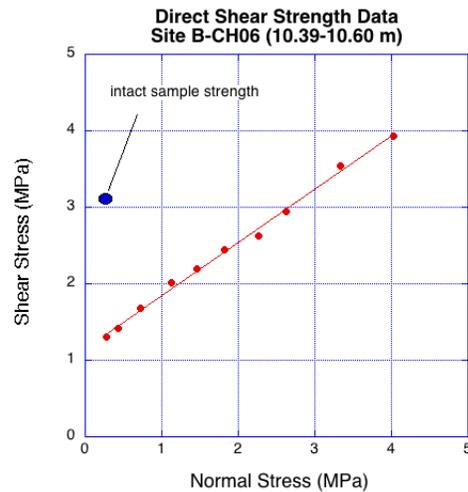
Residual shear strength:

Apparent Cohesion = 1154 kPa

Internal Friction Angle = 34.8°

R² = 0.996

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.277	1.310
2	.430	1.423
3	.721	1.680
4	1.125	2.012
5	1.454	2.192
6	1.820	2.439
7	2.265	2.619
8	2.624	2.942
9	3.334	3.540
10	4.033	3.938



Intact and Residual Shear Strength Data – Site B-CH10 (10.64-10.90 m)

(Intact and residual strength tests on saw cut rock on grout interface)

Intact shear strength: Normal stress = 0.365 MPa Shear stress = 1.937 MPa

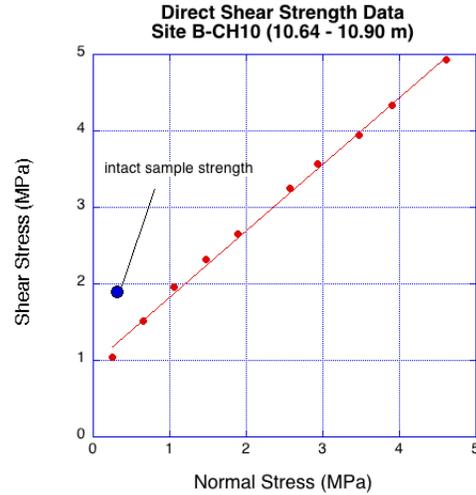
Residual shear strength:

Apparent Cohesion = 973 kPa

Internal Friction Angle = 41.0°

R² = 0.997

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.246	1.047
2	.651	1.515
3	1.063	1.965
4	1.468	2.323
5	1.888	2.653
6	2.568	3.250
7	2.936	3.572
8	3.475	3.939
9	3.902	4.334
10	4.607	4.930



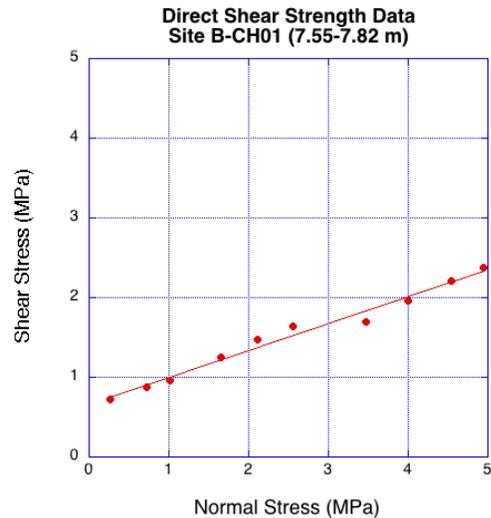
Residual Shear Strength Data – Site B- CH01 (7.55-7.82 m)

Apparent Cohesion = 658 kPa

Internal Friction Angle = 18.7°

R² = 0.980

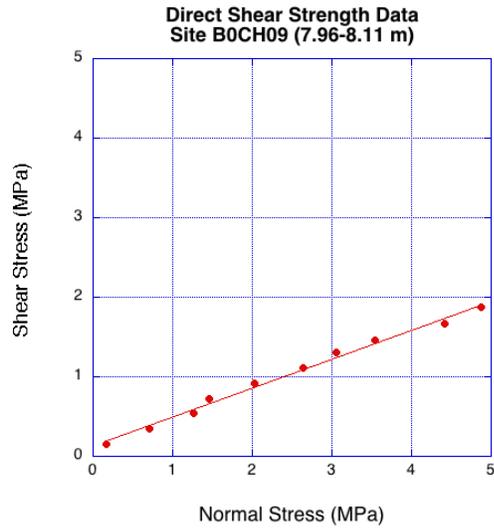
Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.271	.725
2	.727	.881
3	1.020	.964
4	1.653	1.249
5	2.116	1.469
6	2.560	1.643
7	3.472	1.689
8	4.000	1.965
9	4.539	2.204
10	4.944	2.378



Residual Shear Strength Data – Site B-CH09 (7.96-8.11)

Apparent Cohesion = 130 kPa
 Internal Friction Angle = 20.0°
 $R^2 = 0.991$

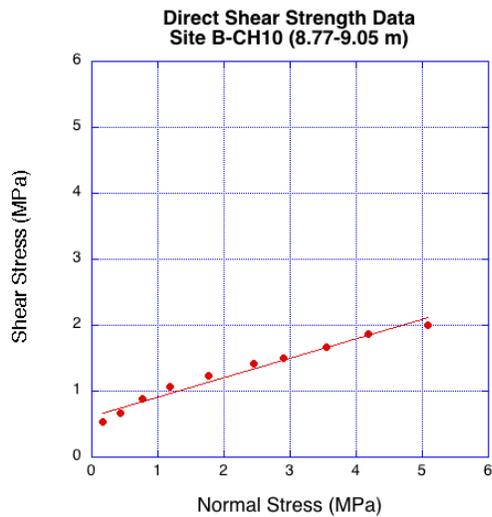
Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.164	.152
2	.714	.351
3	1.267	.541
4	1.465	.721
5	2.033	.921
6	2.639	1.110
7	3.058	1.300
8	3.536	1.461
9	4.422	1.670
10	4.871	1.870



Residual Shear Strength Data – Site B-CH10 (8.77-9.05 m)

Apparent Cohesion = 626 kPa
 Internal Friction Angle = 16.3°
 $R^2 = 0.966$

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.161	.531
2	.437	.664
3	.763	.883
4	1.181	1.072
5	1.768	1.234
6	2.452	1.414
7	2.893	1.509
8	3.544	1.670
9	4.190	1.860
10	5.080	2.002



SET 2 SAMPLE DATA (SOUTH BUNDLE)

Intact and Residual Shear Strength Data – Site A- BH17-04 (7.29-7.42 m)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa (**residual strength data only**)

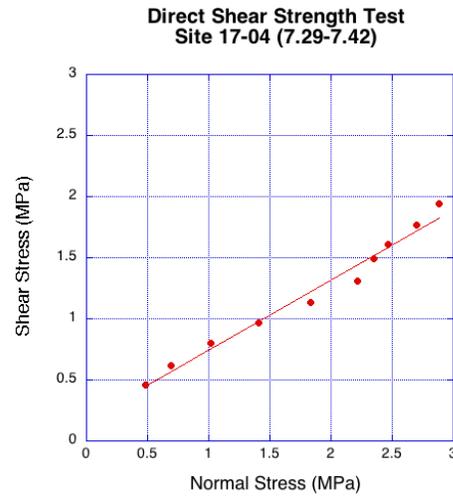
Residual shear strength:

Apparent Cohesion = 174 kPa

Internal Friction Angle = 29.9°

R² = 0.975

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.48	.46
2	.69	.62
3	1.02	.80
4	1.41	.97
5	1.83	1.13
6	2.22	1.31
7	2.35	1.49
8	2.47	1.61
9	2.70	1.77
10	2.88	1.94



Intact and Residual Shear Strength Data – Site A- BH17-05 (6.45-6.68 m)

Intact shear strength: Normal stress = 0.19 MPa Shear stress = 0.55 MPa

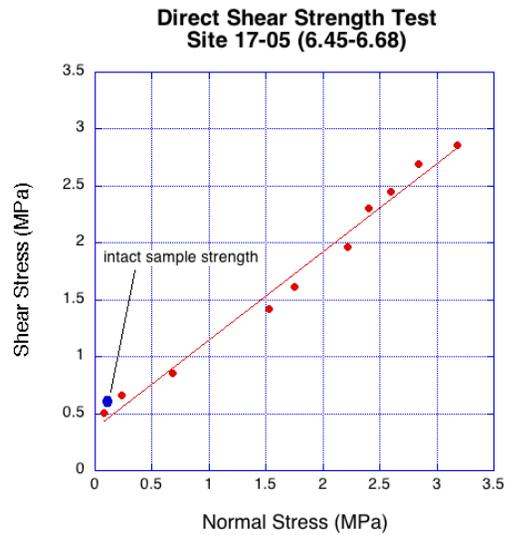
Residual shear strength:

Apparent Cohesion = 379 kPa

Internal Friction Angle = 37.7°

R² = 0.984

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.08	.51
2	.23	.66
3	.68	.86
4	1.53	1.42
5	1.75	1.61
6	2.22	1.96
7	2.40	2.30
8	2.60	2.45
9	2.84	2.69
10	3.18	2.86



Intact and Residual Shear Strength Data – Site A- BH17-11 (7.37-7.57 m)

Intact shear strength: Normal stress = 0.230 MPa

Shear stress = 3.649 MPa

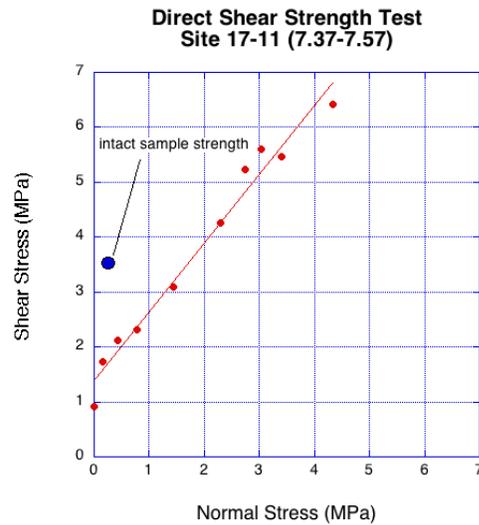
Residual shear strength:

Apparent Cohesion = 1385 kPa

Internal Friction Angle = 51.4°

R² = 0.987

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.01	.91
2	.16	1.73
3	.42	2.13
4	.77	2.32
5	1.44	3.09
6	2.29	4.26
7	2.75	5.24
8	3.04	5.61
9	3.40	5.47
10	4.33	6.41



Intact and Residual Shear Strength Data – Site C- BH17-01 (6.40-6.63 m)

Intact shear strength: Normal stress = 0.349 MPa

Shear stress = 3.950 MPa

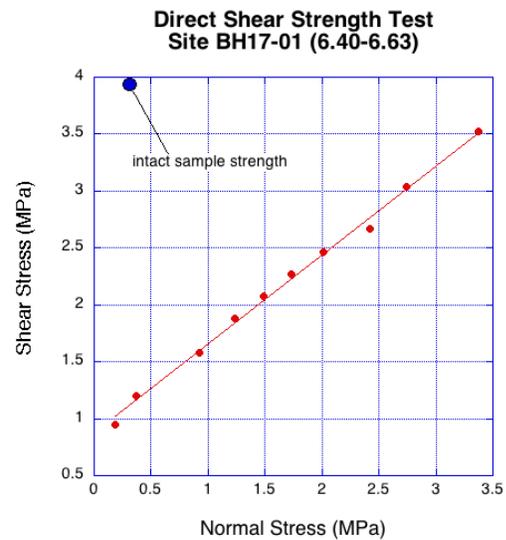
Residual shear strength:

Apparent Cohesion = 872 kPa

Internal Friction Angle = 38.1°

R² = 0.996

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.19	.95
2	.37	1.20
3	.92	1.58
4	1.24	1.88
5	1.49	2.08
6	1.73	2.27
7	2.01	2.46
8	2.42	2.67
9	2.74	3.04
10	3.37	3.52



Intact and Residual Shear Strength Data – Site C- CH-03 (7.34-7.65 m)

Intact shear strength: Normal stress = 0.129 MPa

Shear stress = 0.374 MPa

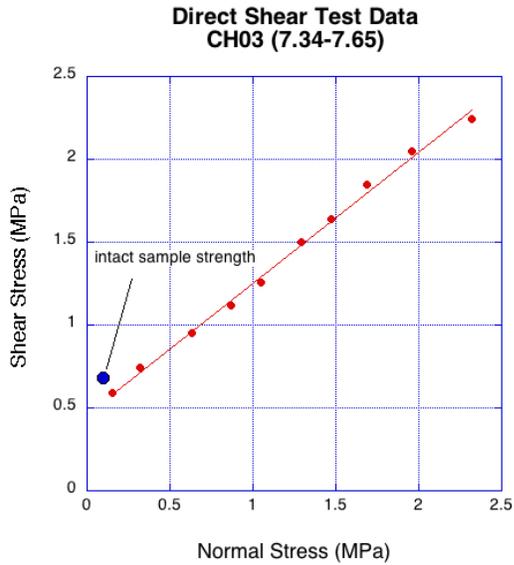
Residual shear strength:

Apparent Cohesion = 468 kPa

Internal Friction Angle = 38.2°

R² = 0.996

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.15	.59
2	.32	.74
3	.63	.95
4	.87	1.12
5	1.05	1.26
6	1.29	1.50
7	1.47	1.64
8	1.69	1.85
9	1.96	2.05
10	2.32	2.24



Intact and Residual Shear Strength Data – Site D- CH-01 (10'10"-11'8")

Intact shear strength: Normal stress = 0.271 MPa

Shear stress = 1.095 MPa

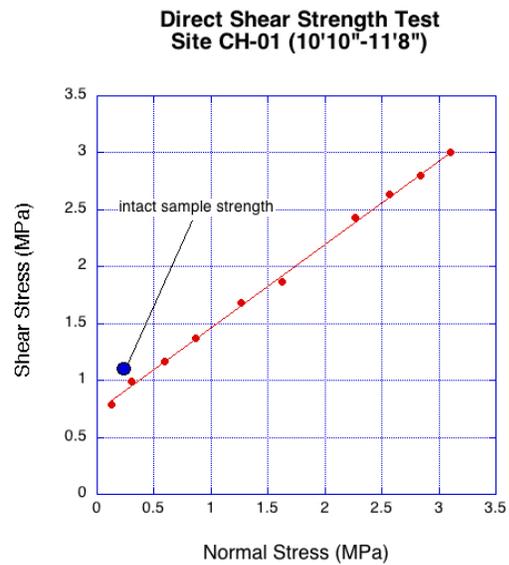
Residual shear strength:

Apparent Cohesion = 732 kPa

Internal Friction Angle = 36.3°

R² = 0.998

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.13	.79
2	.30	.99
3	.59	1.17
4	.87	1.37
5	1.26	1.68
6	1.62	1.87
7	2.27	2.43
8	2.57	2.64
9	2.84	2.80
10	3.10	3.00



Intact and Residual Shear Strength Data – Site D- CH-03 (10.50-10.70 m)

Intact shear strength: Normal stress = 0.309 MPa

Shear stress = 5.482 MPa

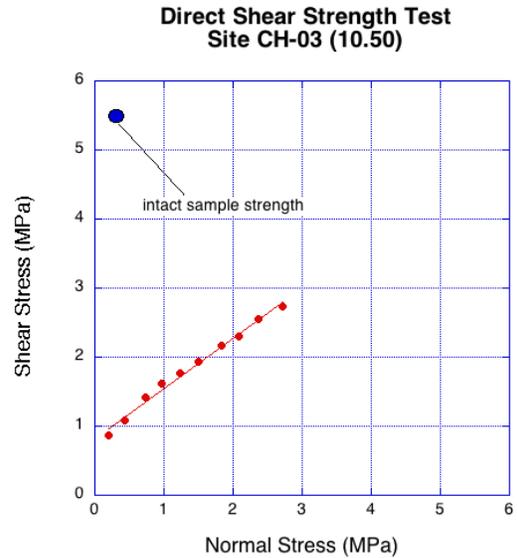
Residual shear strength:

Apparent Cohesion = 818 kPa

Internal Friction Angle = 36.0°

R² = 0.996

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.20	.86
2	.43	1.09
3	.74	1.41
4	.97	1.61
5	1.24	1.77
6	1.50	1.93
7	1.84	2.16
8	2.09	2.30
9	2.37	2.55
10	2.72	2.74



Intact and Residual Shear Strength Data – Site D- CH-03 (8.74-9.08 m) (residual strength data only)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa

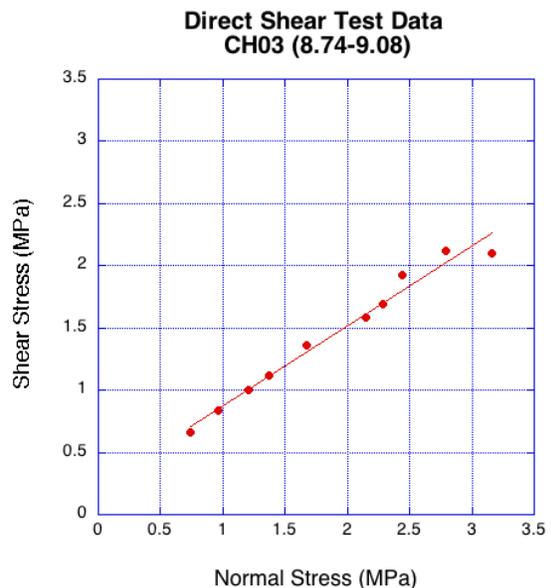
Residual shear strength:

Apparent Cohesion = 237 kPa

Internal Friction Angle = 32.7°

R² = 0.974

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.74	.66
2	.96	.84
3	1.21	1.00
4	1.37	1.12
5	1.67	1.36
6	2.15	1.59
7	2.29	1.69
8	2.44	1.93
9	2.79	2.12
10	3.16	2.10



Intact and Residual Shear Strength Data – Site E- BH17-01 (16.28-16.51 m)

Intact shear strength: Normal stress = 0.248 MPa

Shear stress = 4.451 MPa

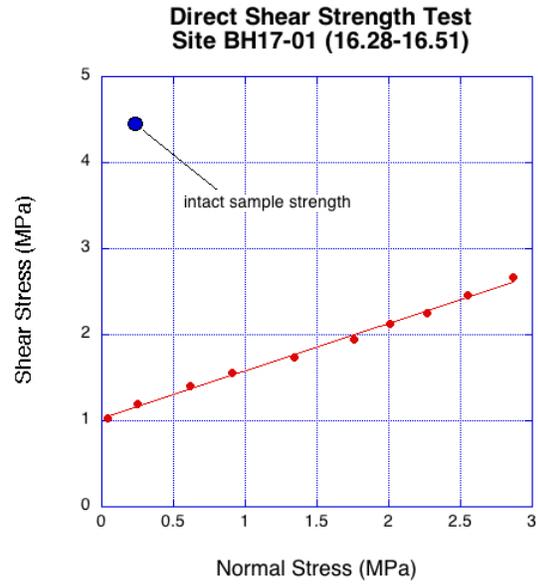
Residual shear strength:

Apparent Cohesion = 1030 kPa

Internal Friction Angle = 28.9°

R² = 0.995

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.04	1.03
2	.25	1.20
3	.62	1.41
4	.91	1.55
5	1.34	1.74
6	1.76	1.94
7	2.01	2.12
8	2.27	2.25
9	2.55	2.46
10	2.87	2.67



Intact and Residual Shear Strength Data – Site E- CH-01 (12.32-12.60 m)

Intact shear strength: Normal stress = 0.338 MPa

Shear stress = 3.193 MPa

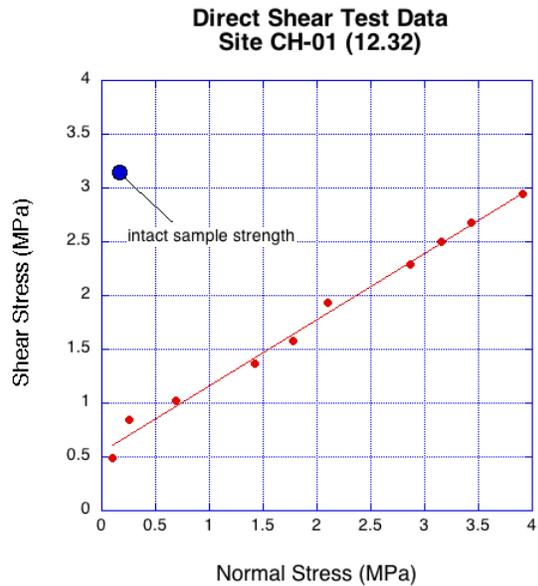
Residual shear strength:

Apparent Cohesion = 555 kPa

Internal Friction Angle = 31.5°

R² = 0.991

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.10	.49
2	.26	.85
3	.69	1.02
4	1.42	1.37
5	1.78	1.58
6	2.10	1.93
7	2.87	2.29
8	3.16	2.50
9	3.43	2.68
10	3.91	2.95



Intact and Residual Shear Strength Data – Site E- CH-03 (8.81-8.99 m)

Intact shear strength: Normal stress = 0.392 MPa Shear stress = 4.615 MPa

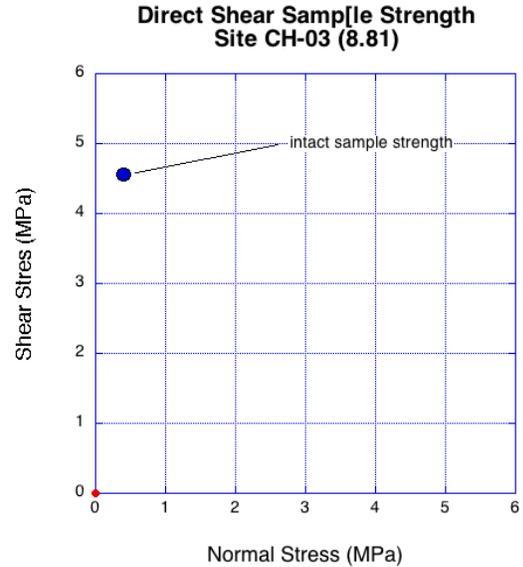
Residual shear strength:

Apparent Cohesion = --- kPa **(no sample residual strength test results due to failure)**

Internal Friction Angle = ---°

R² = ---

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---
6	---	---
7	---	---
8	---	---
9	---	---
10	---	---



Intact and Residual Shear Strength Data – Site G- BH17-01 (6.93-7.24 m)

Intact shear strength: Normal stress = 0.237 MPa Shear stress = 1.076 MPa

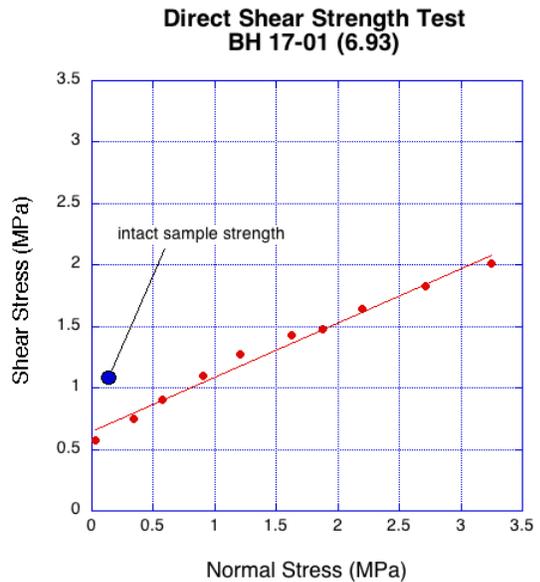
Residual shear strength:

Apparent Cohesion = 647 kPa

Internal Friction Angle = 23.8°

R² = 0.982

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.03	.57
2	.34	.75
3	.57	.90
4	.90	1.10
5	1.21	1.27
6	1.62	1.43
7	1.88	1.48
8	2.20	1.64
9	2.71	1.83
10	3.25	2.01



Intact and Residual Shear Strength Data – Site G- BH17-03 (7.49-7.72 m)

Intact shear strength: Normal stress = 0.327 MPa Shear stress = 1.633 MPa

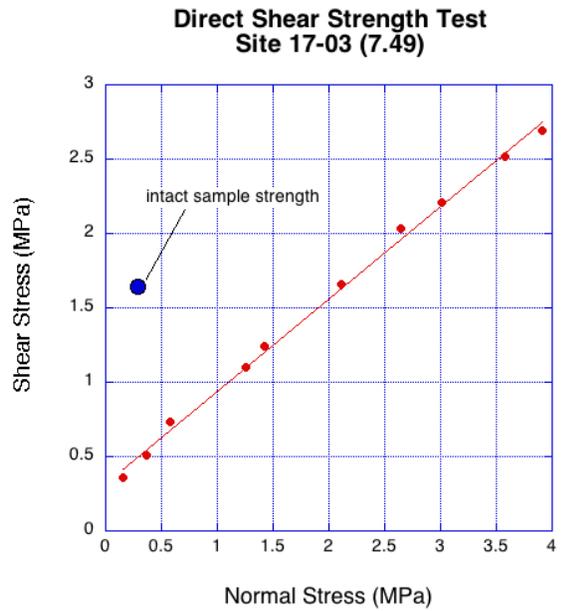
Residual shear strength:

Apparent Cohesion = 322 kPa

Internal Friction Angle = 31.8°

R² = 0.998

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	.16	.36
2	.37	.51
3	.58	.73
4	1.26	1.10
5	1.42	1.24
6	2.11	1.66
7	2.65	2.03
8	3.01	2.21
9	3.58	2.52
10	3.91	2.69



SET 3 SAMPLE DATA (CENTRAL BUNDLE)

Intact and Residual Shear Strength Data – Site C – BH17-10 (10.39-10.57 m)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa (*sample failure before test*)

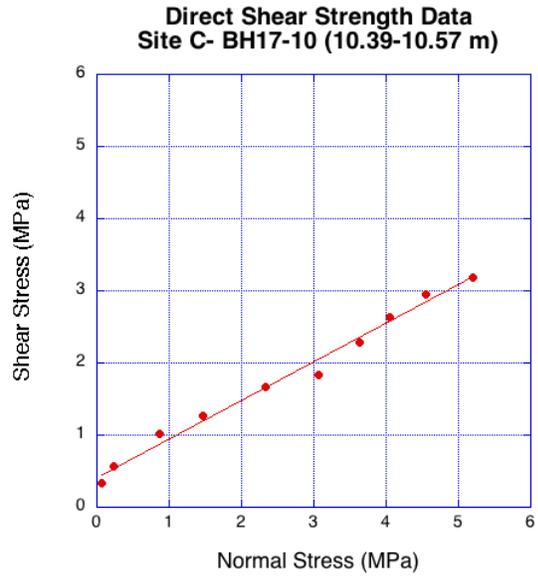
Residual shear strength:

Apparent Cohesion = 416 kPa

Internal Friction Angle = 28.1°

R² = 0.987

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	0.07	0.34
2	0.23	0.57
3	0.87	1.01
4	1.46	1.27
5	2.33	1.67
6	3.06	1.84
7	3.63	2.29
8	4.05	2.63
9	4.55	2.95
10	5.20	3.19



Intact and Residual Shear Strength Data – Site F-BH17-05 (9.02-9.17 m)

Intact shear strength: Normal stress = MPa Shear stress = MPa

Residual shear strength:

Apparent Cohesion = kPa

Internal Friction Angle = °

R² =

NO TEST DATA DUE TO SAMPLE FAILURE

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Residual Shear Strength Data – Site F-CH03 (6.88-7.16 m)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa

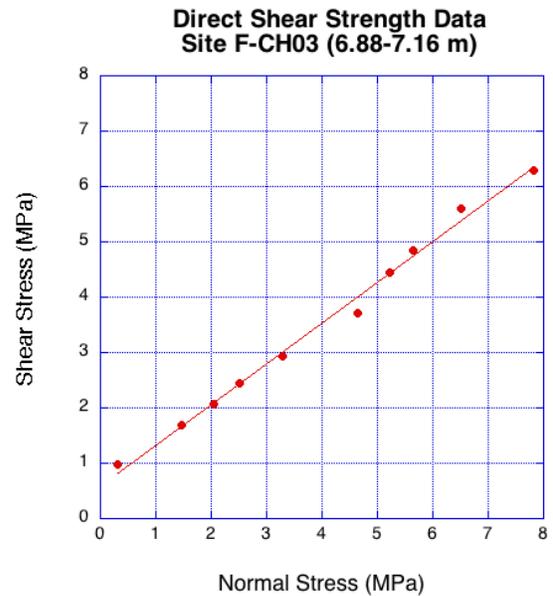
Residual shear strength:

Apparent Cohesion = 606 kPa

Internal Friction Angle = 36.3°

R² = 0.993

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	0.31	0.97
2	1.47	1.68
3	2.04	2.07
4	2.51	2.45
5	3.29	2.93
6	4.64	3.71
7	5.23	4.45
8	5.64	4.85
9	6.51	5.61
10	7.83	6.30



Intact and Residual Shear Strength Data – Site F-CH03 (9.22-9.47 m)

Intact shear strength: Normal stress = MPa Shear stress = MPa

Residual shear strength:

Apparent Cohesion = kPa

Internal Friction Angle = °

R² =

NO TEST DATA DUE TO SAMPLE FAILURE

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Residual Shear Strength Data – Site F-CH04 (6.32-6.43 m)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa

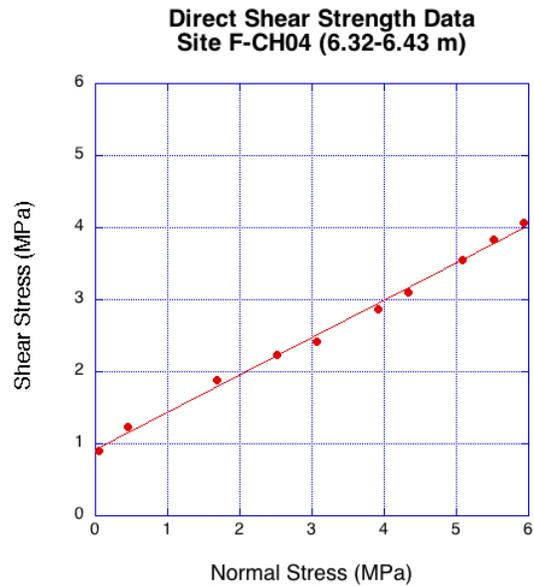
Residual shear strength:

Apparent Cohesion = 926 kPa

Internal Friction Angle = 27.3°

R² = 0.995

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	0.05	0.90
2	0.45	1.23
3	1.69	1.89
4	2.51	2.24
5	3.06	2.42
6	3.92	2.86
7	4.33	3.10
8	5.09	3.55
9	5.52	3.83
10	5.93	4.07



Intact and Residual Shear Strength Data – Site F-CH17-01 (5.66-6.05 m)

Intact shear strength: Normal stress = MPa Shear stress = MPa

Residual shear strength:

Apparent Cohesion = kPa

Internal Friction Angle = °

R² =

NO TEST DATA DUE TO SAMPLE FAILURE

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Residual Shear Strength Data – Site F-CH17-02 (no footage)

Intact shear strength: Normal stress = --- MPa Shear stress = --- MPa

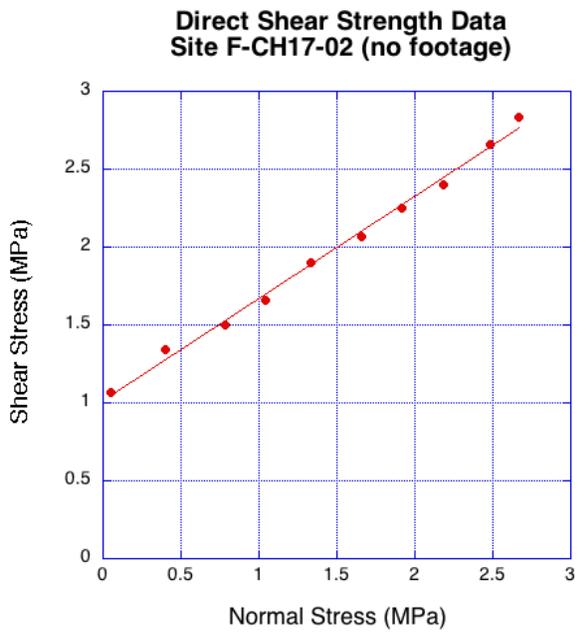
Residual shear strength:

Apparent Cohesion = 1020 kPa

Internal Friction Angle = 33.1°

$R^2 = 0.995$

Residual stage	Normal Stress (MPa)	Shear Stress (MPa)
1	0.05	1.07
2	0.40	1.34
3	0.78	1.50
4	1.04	1.66
5	1.33	1.90
6	1.66	2.07
7	1.92	2.25
8	2.18	2.40
9	2.48	2.66
10	2.67	2.83



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**2017 INVESTIGATION ASSESSMENT REPORT
 SITE F BURLEIGH FALLS DAM AT LOCK 28
 AND PERRY'S CREEK DAM 1**

**APPENDIX D – GEOPHYSIC, TOPOGRAPHIC AND BATHYMETRY SURVEYS
 REPORT**



GEOPHYSICS GPR INTERNATIONAL INC.

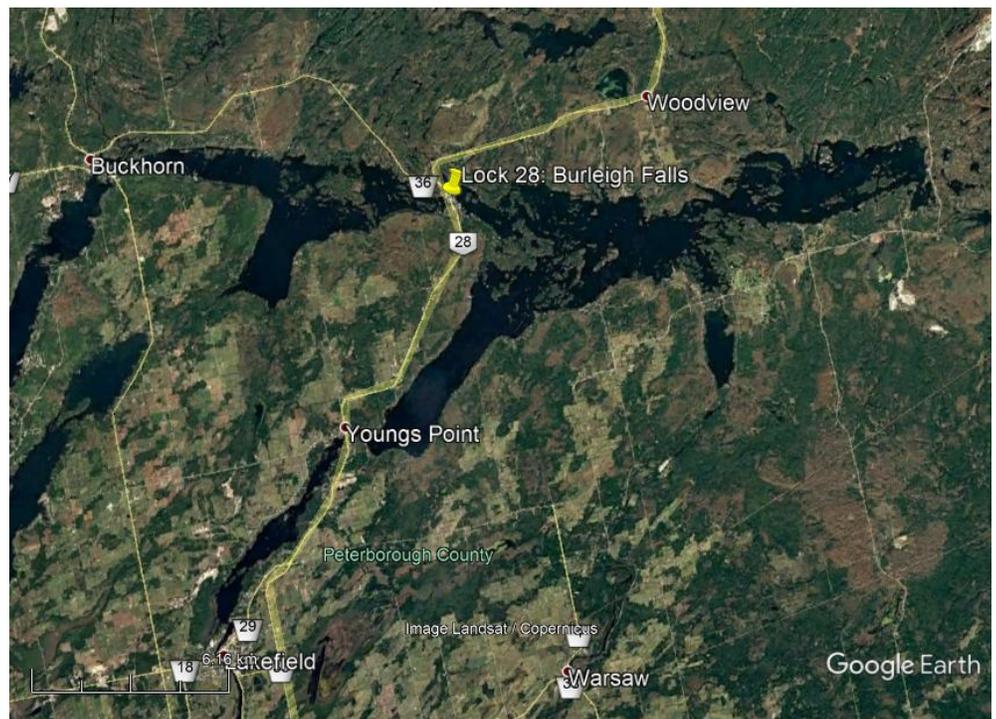
**GEOPHYSICAL SURVEYS WITHIN THE TRENT-SEVERN WATERWAY,
CENTRAL BUNDLE
SITE F: LOCK 28 – BURLEIGH FALLS,
PETERBOROUGH COUNTY**

PROJECT NO. 644198

Presented to :



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MAY 2018 T-17089

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APPENDICES

Appendix A: Seismic Methodology Fact Sheets

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1 INTRODUCTION

Geophysics GPR International Inc. (GPR) was requested by SNC-Lavalin Inc. (SNC) to execute geophysical, bathymetric and topographic surveys in the vicinity of select dams along the Trent-Severn Waterway as a component of a geotechnical investigation.

This report presents the results of the geophysical measurements relating to Central Bundle, Site F - Lock 28 – Burleigh Falls, County of Peterborough, Ontario (Figure 1).

The results of the topographic measurements and bathymetric surveys (if mandated) are presented in separate reports.

The purpose of the geophysical investigation was to characterize the overburden and bedrock conditions based on the seismic velocities along several alignments.

The results, in combination with geotechnical, topographical and bathymetric data will be used to assess the local geologic site conditions relating to dam rehabilitation/reconstruction.

The goals of the investigation were as follows:

- Assess the thickness and nature of overburden/sediment
- Identification of any major discontinuities within the bedrock. This would include faults, shears, zones of fractured rock or any other potentially high permeability zones

Surficial seismic methods were applied to measure the depth to bedrock and assess the soil/rock quality including identifying potential fracture or shear zones. Georadar was applied to characterize the bottom sediments and potential bedrock features.

The following report describes the various aspects of the survey including field techniques, survey design, interpretation techniques, and finally an interpretation in the form of bedrock elevation profiles.



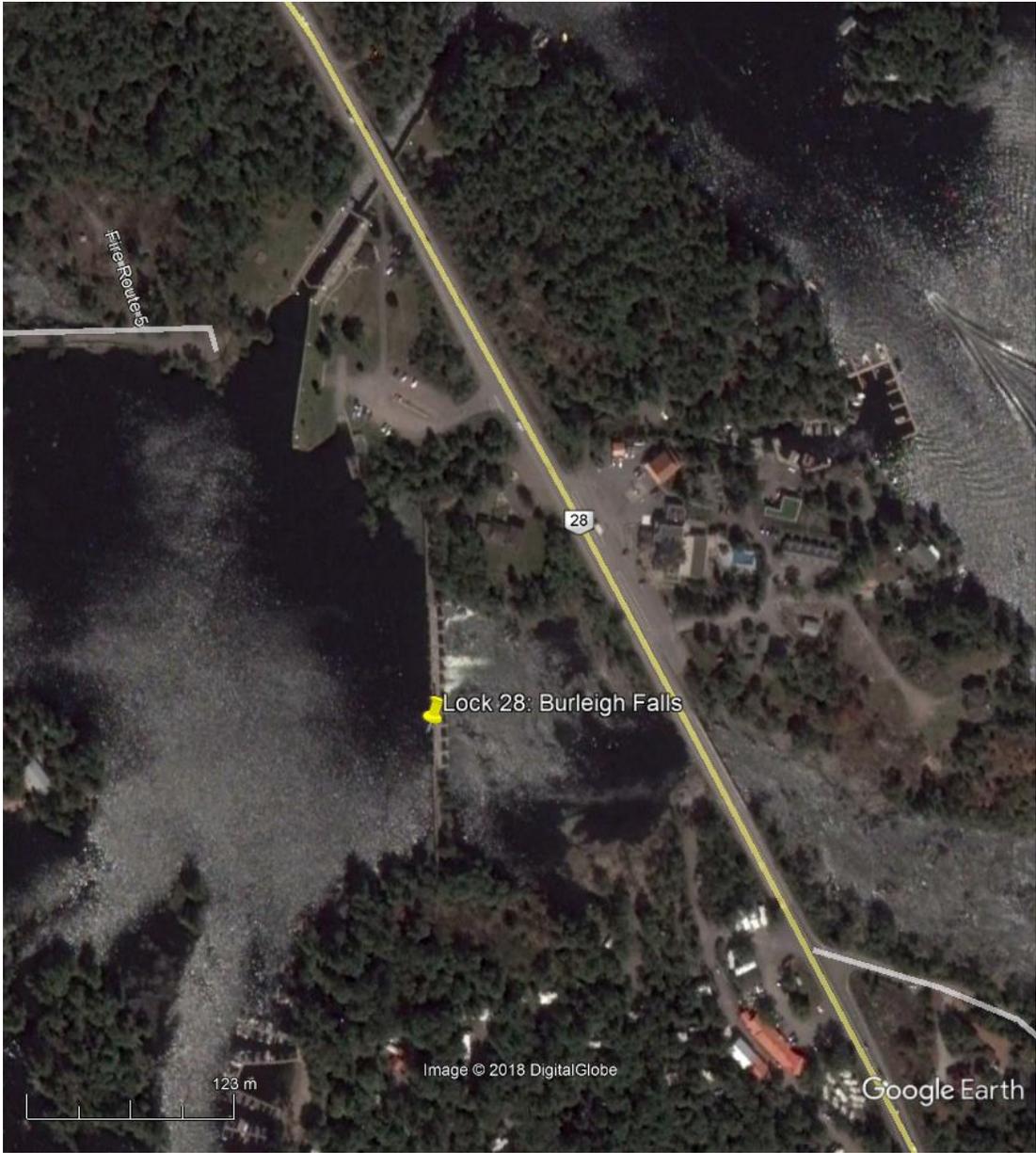


Figure 1: Site Location: Site F: Lock 28, Burleigh Falls, County of Peterborough, Ontario



2 METHODOLOGY

2.1 Personnel

The GPR personnel involved with the geophysical field work and the dates on-site are outlined in Table 1.

Table 1: GPR Personnel

Name	Role	Dates On-Site
Cameron Coatsworth	Field Manager	December 8, 10-11, 13, 2017
Tomas Westerblom	Snr. Technician	December 8, 10-11, 13, 2017
Ilia Gusakov	Geophysicist	December 8, 10-11, 13, 2017
Gilbert Desharnais	Snr. Technician	December 8, 10-11, 13, 2017
Alexis Marchand	Jnr. Geophysicist	December 13-14, 2017
Stephanie Beaudoin	Helper	December 13-14, 2017
Mauritz Van Zyl	Jnr. Geophysicist	December 14, 2017
Paul Lin	Helper	December 13, 2017

2.2 Positioning, Topography and Units of Measurement

Positioning and topographic measurements were provided by G.D. Jewell Engineering Inc. (GDJE) for the land portion of the survey. The reader is referred to the accompanying report for the discussion of the land surveying component.

The coordinate system used on this project was UTM Zone 17N, NAD 83 CSRS. The vertical datum reference for the survey is CGVD2013.

The geophysical surveys were referenced to stakes placed in the ground by the GDJE survey crew at the start, end and at set intervals along the alignments.

In some cases the locations of the seismic profiles were positioned or repositioned by GPR for logistical reasons. For these situations, the new profile locations were referenced to the surveyed stakes or post-surveyed by GDJE.

The geophone positioning (x, y and z) along the land seismic profiles is estimated to be on the order of +/- 0.5 m.

Positioning on the water was recorded by GPR with a Hemisphere R120 DGPS system with Omnistar VBS corrections. The accuracy of the DGPS measurements are typically sub-metre. The overall accuracy of the positioning of the marine lines with consideration for GPS accuracy, and boat/hydrophone offset is estimated to be on the order of +/- 1 to 2 m.

All geophysical measurements were collected in SI units.



2.3 Seismic Methods

Seismic methods for geologic mapping involve recording the response of vibration or pressure sensors. Multiple techniques and methodologies are available for analysis of the data depending on the ultimate goal of the investigation. For this investigation, two essentially independent techniques were used; namely, seismic refraction and MASW.

2.3.1 Seismic Refraction

Basic Theory

The seismic refraction method relies on measuring the transit time of the wave that takes the shortest time to travel from the shot-point to each geophone. The fastest seismic waves are the compressional (P) or acoustic waves, where displaced particles oscillate in the direction of wave propagation. The energy that follows this first arrival, such as reflected waves, transverse (S) waves and resonance, is not considered under routine seismic refraction interpretation.

Survey Design – Land surveys

A seismic spread typically consists of 12 to 24 vibration monitoring devices (geophones) connected in line (spread) to a seismograph (ABEM Terraloc Mark 6) by connector cables. Spacing between geophones ranged from 3 m to 7.5 m depending on spread length.

The seismic energy source for the land profiles was a “buffalo” source or sledge hammer. Typically, seven or more shots are executed per seismic spread: three to five shots within the profile to obtain the lateral velocity variation in the overburden and two shots on either side of the spread to provide the true velocity of the bedrock surface.

Survey Design – Marine surveys

One of two methodologies (stationary spreads or reverse shooting) were employed for river crossings depending on current flow and profile length.

Stationary spreads are similar to the land spreads with the exception of using hydrophones as opposed to geophone receivers. A stationary marine seismic spread typically consists of 12 to 24 pressure sensing devices (hydrophones) connected in line (spread) to a seismograph (ABEM Terraloc Mark 6) by connector cables. Stationary spreads were employed in areas of relatively low current. The spacing between hydrophones was 5 m.

Reverse shooting spreads essentially swap the locations of the hydrophones and shot locations. Shots and receivers are, by theory, interchangeable in seismic refraction surveys. This allows one to reverse the standard refraction setup and replace each sensor (hydrophone/geophone) with a shot and each shot with a sensor. Seismic shots are done in the water at set intervals with the sensors (geophones/hydrophones) and seismographs (linked by radio) installed on/near both shores. The water must be navigable such that shots can be floated into place at set intervals across the length of the river.

The seismic energy source for the marine profiles was an air gun or “buffalo” source. Typically, seven or more shots are executed per stationary seismic spread: three to five shots within the



profile to obtain the lateral velocity variation in the overburden and two shots on either side of the spread to provide the true velocity of the bedrock surface.

Interpretation Method and Accuracy of Results

Interpretation of the seismic data was done using the Hawkins' method and cross-checked with the critical distance method. The Hawkins' method allows the computation of the rock depth to every geophone/hydrophone. This method provides information on the thickness of the various overburden layers, depth to bedrock and rock quality including fracture or shear zones that could provide potential seepage paths within the bedrock. It is based on the closure times of the inner shots. It can calculate the true velocities of the rock using the apparent velocities, measured with information provided by the outer shots. Brief descriptions of the seismic refraction method and equipment specifications are presented in Appendix A. A further description of the Hawkins' method can be found in the article *Seismic Refraction Surveys for Civil Engineering* by L. Hawkins (1961).

The seismic refraction method typically allows the determination of the bedrock profile with a precision of 10% or better for depths greater than 10 m and a precision of 1 m for depths less than 10 m. The precision in the determination of rock velocities is plus or minus 3%. The vertical contacts (lateral velocity change), usually associated with faults and deep valleys, are generally accurate to within 5 m in width; although, this is somewhat site specific.

The two most significant problem areas for refraction mapping are the "hidden" layer and effect of velocity inversions.

The likelihood of velocity inversions at this particular site is low. There is always the potential for "hidden" layers.

A "hidden" layer or "blind zone" is a stratigraphic layer that is not possible to discern from the arrival time data due to insufficient velocity variation or thickness. The unknown presence of a hidden layer has the effect of making the interpreted bedrock depth too shallow. The presence of a "hidden" layer is typically revealed through borehole or test-pit data and calculations can be made to compensate for the presence of such a layer. Without borehole or secondary bedrock depth information, it is not possible to predict the presence of a hidden layer.

Velocity inversions occur when the velocity does not increase with depth. The velocity inversion can result from the presence of a low or high velocity layer. Refractions from low-velocity layers cannot be determined from the arrival time data. The unknown presence of a low velocity layer has the effect of making the interpreted depths deeper than actual depths.

Along with hidden layers and velocity inversions, other inherent limitations of the seismic refraction method are approached as the depth to bedrock decreases. This is especially apparent with higher velocity overburden material. Identification and interpretation of vertical and lateral velocity variations and the time spent in each layer is critical to accurate interpretations. Irregularities in the bedrock surface and weathered bedrock at shallow depths, such as at this site, will also have a more pronounced effect on accuracy than irregularities at greater depths.



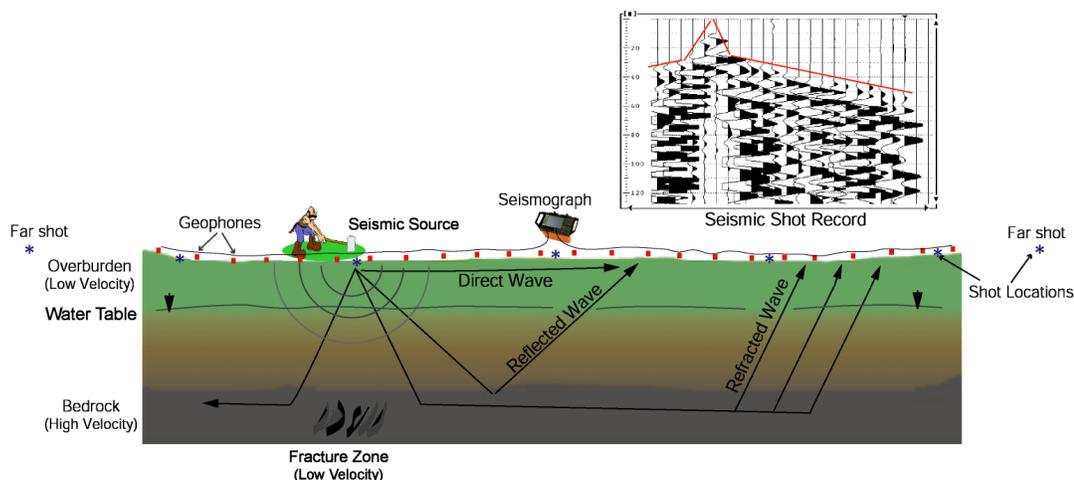


Figure 2: Seismic Refraction Operating Principle

2.3.2 Surface Wave Analysis (MASW)

Basic Theory

The Multi-channel Analysis of Surface Waves (MASW) and the Micro-tremor Array Measurements (MAM) are seismic methods used to evaluate the shear-wave velocities of subsurface materials through the analysis of the dispersion properties of Rayleigh surface waves (“ground roll”). The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves (Figure 3). Inversion of the Rayleigh wave dispersion curve yields a shear-wave (V_s) velocity depth profile (sounding). A more detailed description of the method can be found in the paper Multi-channel Analysis of Surface Waves, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); P. 800–808.

Survey Design

The geometry of an MASW survey is similar to that of a seismic refraction investigation (i.e. 12 to 24 geophones/hydrophones in a linear array). The fundamental principle involves intentionally generating an acoustic/pressure wave at the surface and digitally recording the surface waves from the moment of source impact with a linear series of geophones/hydrophones. This is referred to as an “active source” method. An air-gun, “buffalo” source or sledge hammer were used as the energy sources for the MASW soundings.

Unlike the refraction method, which produces a data point beneath each geophone, the shear-wave depth profile is the average of the bulk area within the middle third of the geophone spread.

The theoretical maximum depth of penetration is half of the maximum seismic array length, in practice the maximum depth of penetration is often influenced by the geology.

Interpretation Method and Accuracy of Results

The main processing sequence involved plotting, picking, and 1-D inversion of the MASW shot records using the SeisimagerSW™ software package (Figure 4). The results of the inversion process are inherently non-unique and the final model must be judged to be geologically realistic. The inversion modelling also assumes that all layering is flat/horizontal and laterally uniform.

The 1D MASW sounding are presented as a shear-wave velocity versus depth chart representative of a bulk area/volume of material beneath the seismic spread.

A table of typical shear-wave (S-wave) velocities for various overburden materials is enclosed in Appendix A.

Typically the accuracy of the shear-wave velocities modelled from the MASW method is on the order of +/- 10 to 15% for overburden material. The estimated error is typically higher (and underestimated) for shear-wave velocities within rock formations.

The depth to bedrock as measured from the MASW method is typically accurate to +/- 10 to 15%; however, weathered layers and/or dense tills overlying bedrock can increase this error.

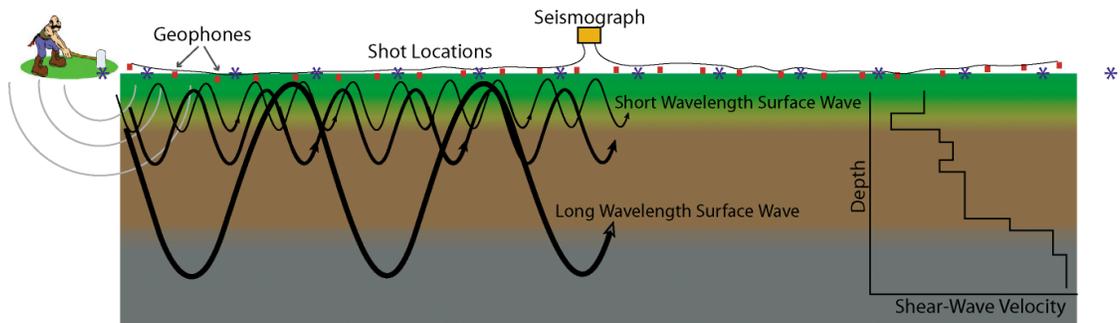


Figure 3: 1-D MASW Operating Principle

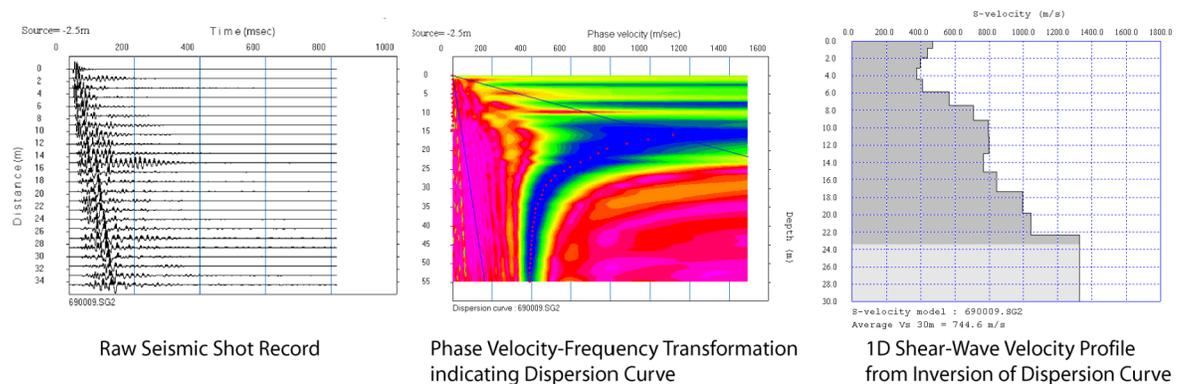


Figure 4: MASW Processing Work Flow – Raw shot record, phase velocity/frequency curve and resulting 1d shear wave velocity model



2.4 Georadar

Basic Theory

Georadar utilises radar technology to obtain a near-continuous profile of the subsurface. The basic principle is to emit an electromagnetic impulse into the ground at a predetermined frequency rate (typically 10 to 80 scans/second). This pulse will travel through the sub-surface and reflect off boundaries of differing dielectric constants (contrasts of EM impedances). The reflected pulse returns to the surface and is recorded by a receiver and displayed in real-time as a cross-sectional image. Only by moving the antennas along a profile directly over the targets can the locations and depths be determined. Examples of radar reflecting boundaries included air/water (water table); water/earth (bathymetry); earth/metal, PVC, or concrete (pipe locating); and differing earth materials (stratigraphic profiles, including bedrock profiles).

The depth of investigation is controlled by the frequency and power of the antenna limited by attenuation and diffraction of the radar signal. Lower frequency antennas provide greater depth penetration at the expense of resolution. The radar signal is attenuated by conductive ground materials (e.g. clays, dissolved salts etc.). The radar signal is diffracted by irregular shaped material (e.g. boulders, debris etc...) that prevents the clear return of the reflected pulse. More information on the georadar equipment can be found in Appendix A.

Survey Design

The georadar data were collected with a GSSI SIR-4000 system and a 350 MHz HS digital antenna. The 350 MHz antenna was utilized for this particular project in order to obtain more detailed data near surface as well as reaching the required depths of penetration for this area of investigation. The 350 MHz antenna is usually the most appropriate for shallow to intermediate depth penetration and resolution of stratigraphic layers, utilities, USTs and voids.

Positioning for the georadar survey was controlled by the DGPS system.

Prior to data collection, test profiles were collected to determine the optimal time window and gain settings for the given subsurface conditions.

Interpretation Method

Processing of the radar images involved basic filtering, distance normalization and gain control settings.

The vertical scale on all radar images is a two-way time scale representing the time taken for a radar pulse to transmit to a reflector and back to the receiver. In order to convert the time scale to a depth scale a signal velocity must be applied. The velocity with which the pulse travels through the given material is determined by the dielectric constant. This dielectric will vary with the type of material.



Calculating a velocity can be done in many ways but the most reliable method is with a test pit or borehole as the real rock contact can be exposed. Baring in-situ measurements or borehole data, the dielectric value can be approximated based on the expect material type. Appendix A contains a table of relative dielectric values for commonly encountered materials. Based on the table the dielectric values for saturated sediments can range from 8 to 30 depending on the clay-silt-sand ratios. At this particular site, the large concentration of cobbles and boulders may serve to lower the bulk dielectric value.

The radar images presented in the drawings are plotted with a dielectric of 81 (representing the water column). Any sub-bottom targets will be deeper than plotted as the dielectric will be lower for the bottom material.

Interpretation of the data is based primarily on the qualitative analysis of three characteristics of radar reflections: continuity, amplitude and shape. The interpreter then identifies reflectors and textures within the radar records that represent subsurface contacts, objects or zones. The true nature of the interpreted features can only be assumed without corroborating evidence.



3 RESULTS

The results of the geophysical survey are presented in Drawing T-17089_Central_F1: Lock 28 – Burleigh Falls.

The basemaps were provided by SNC supplemented with data from GDJE and GPR. The base images are presented for reference purposes only. The reader is referred to the topography report and the digital topographic maps provided by GDJE.

The borehole data were provided by SNC-Lavalin and are presented for reference purposes only.

Bathymetry data were extracted from the georadar data and/or bathymetry data sets collected by GPR.

Table 2 outlines the coordinates of the seismic profiles as collected.

Table 2: Seismic Line Coordinates (see Drawing T-17089_Central F1: Lock 28 – Burleigh Falls)

Seismic Line	Start		End		Length (m)
	Easting	Northing	Easting	Northing	
GP-01	721 807.6	4 937 445.3	721 773.1	4 937 659.5	217
GP-02	721 865.9	4 937 452.0	721 842.9	4 937 549.3	193
GP-03	721 896.2	4 937 447.6	721 857.5	4 937 610.6	168
GP-04	721 808.5	4 937 612.0	721 897.1	4 937 627.9	90
GP-05	721 759.7	4 937 667.0	721 889.7	4 937 625.1	140



The following paragraphs provide a discussion of the results of the geophysical investigation for each profile line.

GP-01

Seismic profile GP-01 was collected approximately 30 m upstream (west) of the dam at Burleigh Falls.

The seismic profile was approximately 217 m in length and was composed of one hydrophone spread and reverse shooting.

The interpreted competent bedrock elevation ranges from approximately 232.4 m to 240.5 m. The depth to interpreted competent bedrock ranged from less than 1.0 m to approximately 8.7 m below survey grade. There is the potential for weathered bedrock surface at shallower depths that was not well resolved with the seismic data.

The seismic compression-wave (P-wave) velocities suggest two layers. The upper layer for the river crossing has a velocity on the order of 1450 m/s. This velocity is typical for the water column and saturated sediments to heavily weathered bedrock.

The P-wave velocity of the competent bedrock was measured as 5150 m/s to 5350 m/s. This velocity is typical for competent bedrock. No indications of fractured or shear-zones were observed in the seismic refraction data.

The model shear-wave velocities from the MASW data sets indicate an S-wave velocity on the order of 2040 m/s to 2200 m/s for the bedrock.

Georadar data were collected across the length of the marine profile. The bathymetry data were interpreted from the georadar data and echosounder data. The maximum water depth at the time of the survey was on the order of 6.7 m corresponding to a bottom elevation of approximately 234.0 m. Areas of increased boulder concentration and potentially exposed bedrock are indicated on the drawing.

There is a noted difference between the georadar and echosounder bathymetry. This suggests that the bottom elevation could be changing significantly in the area adjacent to the seismic profile.

Two boreholes were located along, or in close proximity to, the seismic profile (BH17-02 and BH17-03). The boreholes were in good agreement with the seismic data.



GP-02

Seismic profile GP-02 was collected approximately 18 m downstream (east) of the dam at Burleigh Falls.

The seismic profile was approximately 193 m in length and was composed of two hydrophone spreads. A gap between the two spreads was necessary due to the strong current in that area.

The interpreted competent bedrock elevation ranges from approximately 230.5 m to 238.0 m. The depth to interpreted competent bedrock ranged from less than 1.0 m to approximately 8.2 m below survey grade. There is the potential for weathered bedrock surface at shallower depths that was not well resolved with the seismic data.

The seismic compression-wave (P-wave) velocities suggest two layers. The upper layer for the river crossing has a velocity on the order of 1450 m/s. This velocity is typical for the water column and saturated sediments to heavily weathered bedrock.

The P-wave velocity of the competent bedrock was measured as 4850 m/s to 4200 m/s. This velocity is typical for competent bedrock. No indications of fractured or shear-zones were observed in the seismic refraction data.

The model shear-wave velocities from the MASW data sets indicate an S-wave velocity on the order of 2160 m/s to 2300 m/s for the bedrock.

Georadar data were collected across the length of the marine profile excluding a segment where the current was too strong. The bathymetry data were interpreted from the georadar data and echosounder data. The maximum water depth at the time of the survey was on the order of 7.1 m corresponding to a bottom elevation of approximately 231.5 m. Areas of increased boulder concentration and potentially exposed bedrock are indicated on the drawing.

Borehole data for one borehole (BH17-08) was available at the north end of the profile. The borehole was in good agreement with the seismic data.



GP-03

Seismic profile GP-03 was collected approximately 45 m downstream (east) of the dam at Burleigh Falls.

The seismic profile was approximately 168 m in length and was composed of two hydrophone spreads. A gap between the two spreads was necessary due to the strong current in that area.

The interpreted competent bedrock elevation ranges from approximately 232.5 m to 237.3 m. The depth to interpreted competent bedrock ranged from less than 1.5 m to approximately 6.0 m below survey grade. There is the potential for weathered bedrock surface at shallower depths that was not well resolved with the seismic data.

The seismic compression-wave (P-wave) velocities suggest two layers. The upper layer for the river crossing has a velocity on the order of 1450 m/s. This velocity is typical for the water column and saturated sediments to heavily weathered bedrock.

The P-wave velocity of the competent bedrock was measured as 5550 m/s to 5600 m/s. This velocity is typical for competent bedrock. No indications of fractured or shear-zones were observed in the seismic refraction data.

The model shear-wave velocities from the MASW data sets indicate an S-wave velocity on the order of 1840 m/s to 2200 m/s for the bedrock.

Georadar data were collected across the length of the marine profile excluding a segment where the current was too strong. The bathymetry data were interpreted from the georadar data and echosounder data. The maximum water depth at the time of the survey was on the order of 4.7 m corresponding to a bottom elevation of approximately 234.0 m. Areas of increased boulder concentration and potentially exposed bedrock are indicated on the drawing.

Borehole data were not available along this profile.



GP-04

Seismic profile GP-04 was collected running east to west on the north side of the river.

The seismic profile was approximately 90 m in length. Bedrock depths could not be interpreted along the entire length of the profile due to lack of space for off-end (far) shots.

The interpreted bedrock elevation ranges from approximately 235.7 m to 237.0 m. The depth to interpreted bedrock ranged from approximately 2.9 m to 4.3 m below survey grade.

The seismic compression-wave (P-wave) velocities suggest two layers. The uppermost layer, with a velocity on the order of 650 m/s, is interpreted as stiff/compact to hard/dense overburden with potential boulders.

The P-wave velocity of the bedrock was measured as 4900 m/s. This velocity is typical for competent bedrock. No indications of fractured or shear-zones were observed in the seismic refraction data.

The shear-wave velocities from the MASW and refraction data sets indicate an S-wave velocity on the order of 2000 m/s to 2300 m/s for the bedrock.

The S-wave velocity of the overburden material is on the order 240 m/s. This range is typical for loose/soft to overburden material.

One borehole was located along the seismic profile (BH17-08). The borehole was in good agreement with the seismic data.



GP-05

Seismic profile GP-05 was collected running northwest to southeast on the north side of the river.

The seismic profile was approximately 140 m in length.

The interpreted bedrock elevation ranges from approximately 235.7 m to 239.4 m. The depth to interpreted bedrock ranged from less than one metre to approximately 4.6 m below survey grade.

The seismic compression-wave (P-wave) velocities suggest two layers. The uppermost layer, with a velocity on the order of 1350 m/s, is interpreted as hard/dense overburden with boulders.

The P-wave velocity of the bedrock was measured as 4550 m/s to 5000 m/s. This velocity is typical for competent bedrock. No indications of fractured or shear-zones were observed in the seismic refraction data.

The shear-wave velocity of the bedrock was measured as 2600 m/s from the refraction data. A clear MASW dispersion was not evident.

Two boreholes were located along, or in close proximity to, the seismic profile (BH17-03 and BH17-11). The boreholes were in good agreement with the seismic data.



4 CONCLUSIONS

A geophysical investigation involving seismic and ground radar surveys was carried out on the upstream and downstream sides and both banks of the Central Bundle Site F: Lock 28 – Burleigh Falls in the County of Peterborough, Ontario.

The results of the geophysical investigation are presented in drawing T-17089_Central_F1: Lock 28 – Burleigh Falls. Digital CAD files of the drawings have also been provided.

A total of approximately 808 m of seismic data were interpreted.

Topographic data were collected by G.D. Jewell Engineering Inc., the results of which are presented in accompanying reports, drawings and digital files.

Borehole data was provided by the client to aid in the interpretation of the seismic data. The borehole data was in good agreement with the seismic data.

Bathymetry data were collected by GPR, the results of which are presented in accompanying reports, drawings and digital files.

The seismic refraction method was applied to map the depth to bedrock and assess the rock quality including identifying potential fracture or shear zones that could provide seepage paths within the bedrock.

Bedrock P-wave velocities ranged from 4200 to 5600 m/s. This range is typical for competent rock. There was no evidence of low velocities zones within the bedrock that could indicate the presence of fault, shear, or fracture zones. The vertical contacts (lateral velocity change), usually associated with faults and deep valleys, are generally accurate to within 5 m in width; although, this is somewhat site specific. Small joints must be sufficient in size, number or velocity contrast to create a bulk drop in rock velocity in order to be detected.

The shear-wave velocity models indicate competent bedrock S-wave velocities on the order of 1840 m/s to 2600 m/s.

The overburden/sediment S-wave velocities were not well defined predominately due to the thinness. Seismic line GP-04 had modelled S-wave velocities on the order of 200 m/s for the overburden.

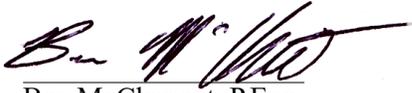
The georadar data provided supplemental information regarding bottom characteristics; however, its use as a sub-bottom profiler at this particular site was limited due to signal diffraction from the cobble and boulder bottom material. The interpreted radar data are plotted on the seismic profiles of the drawings.

Interpretation of the data was carried out by Ilia Gusakov and Ben McClement.

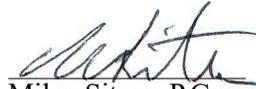
Geophysics GPR would like to acknowledge Parks Canada and SNC-Lavalin personnel for their assistance and cooperation in the safety and logistics of the geophysical surveys.



This report has been written by Ben McClement, P.Eng. and reviewed by Milan Situm, P.Geo.



Ben McClement, P.Eng.
Geophysicist



Milan Situm, P.Geo.
Manager



APPENDIX A

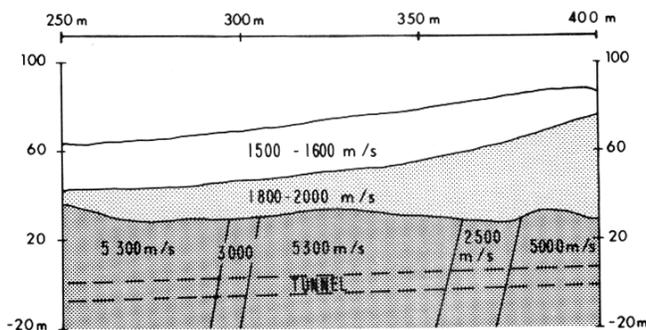
Seismic Methodology Fact Sheets



AREAS OF APPLICATION

Civil Engineering/Mining Exploration - Exploitation/Petroleum and Gas Sectors/ Geotechnology/Geology/ Hydrology.

- Identification of faults, fractures, shear zones.
- Detection of rock differences (veins, dykes, cavities, etc.).
- Determination of rock topography.
- Evaluation of volume of soil present or to be excavated.
- Excellent complement to geological mapping.
- Recognition of geophysical anomalies such as VLF, gravimetry, etc.
- Drill site selection, better target identification.
- Evaluation of the size, thickness and condition of surface shafts (mining exploitation).
- Mass Rock Quality Determination (MRQD).
- Detection of rock irregularities and breaks.
- Hydrogeology (detection of water tables, veins, reservoirs).
- Excellent complement to any geological analysis.



Interpretation results of a seismic profile

ADDITIONAL REMARKS

Geophysics GPR International Inc. has been recognized for the past fifteen years as a leader in both the application and the development of seismic methods. Seismic refraction is currently used in both civil and mining engineering; the use of lighter high-performance equipment and better tomographical interpretation of the results have contributed to its growing popularity.



GEOPHYSICS G P R INTERNATIONAL INC.



TERRALOC MK6 FEATURES



The Terraloc mark 6 is a high resolution multi-channel seismograph with an 18-bit A/D converter and 3-bit instantaneous floating point (IFP) amplifier. Overall resolution is thus 21 bits. Its dynamic range, 126 dB, eliminates all gain setting hassles and satisfies the most stringent shallow reflection requirements.

Technical Specifications for the Terraloc

- Number of channels (smaller unit)..... 4-24 in steps of 4
- Number of channels (larger unit)..... 4-48 in steps of 4
- Additional channels..... Easily obtained by linking two or more units together
- Up-hole channel..... Yes
- Sampling rate (selectable)..... 25, 50, 100, 200, 500,1000 & 2000 μ s
- Record length (selectable)..... 128, 256, 512, 1024, 2048,4096, 8192 or 16384 samples per trace equivalent to: 3.2 ms - 32.7 s
- Pre-trig record (selectable)..... 0-100 % of record length
- Pre stack correlation..... Yes, cross correlation with reference or any other channel
- Delay time Related to sampling rate May be set (for example) from: 0-0.8 s at 25 ps ,sampling rate 0-131 s at 2 ms sampling rate
- Stacking..... 32 bits, up to 999 impacts
- Unstack..... Remove last shot from stack
- First-arrivals picking..... Automatic or manual. Times can be saved with record
- Trigger inputs..... Trigger coil, make/brake, geophone, TTL
- A/D converter resolution..... 21 bits (18 bits plus 3-bit IFP)
- Dynamic range (theoretical/measured)..... 126 / 114 dB
- Max input signal..... 500 mV p-p
- Frequency range..... 1 - 4000 Hz (at 25 ps sampling rate)
- Total harmonic distortion..... - 80 dB
- Crosstalk..... - 86 dB
- Input impedance..... 3 k
- Noise monitor..... Amplitude or full waveform display available on-line

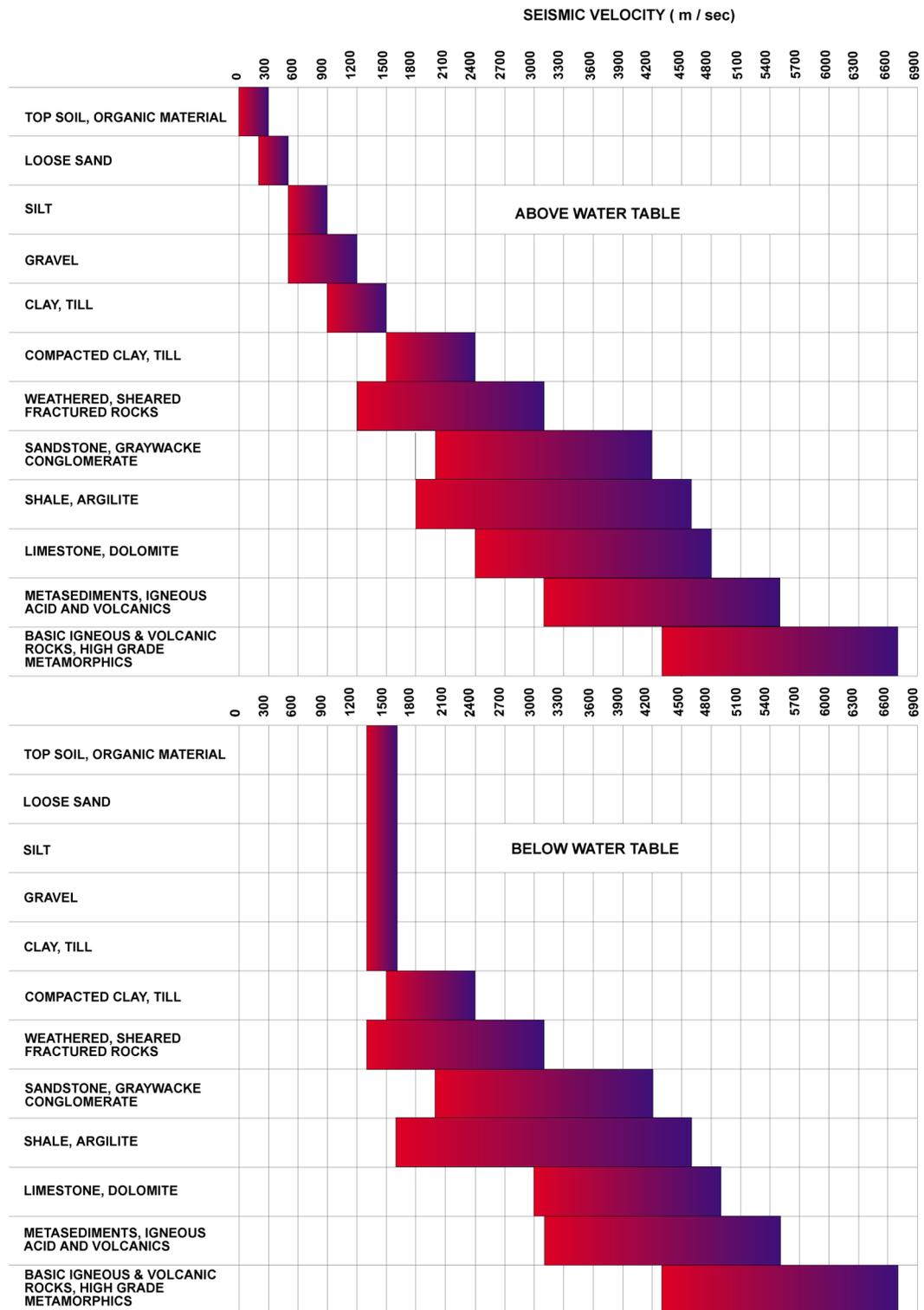
Analog filters

- Low cut (selectable)..... 12 or 24 dB/octave 16 steps from 12 to 240 Hz
- Notch..... 50 or 60 Hz specify when ordering
- Anti-aliasing..... set automatically based on sampling rate

Digital filters

- Bandpass, low-cut, high-cut, bandreject, alpha-beta and remove DC offset Spectrum analysis..... Any single trace

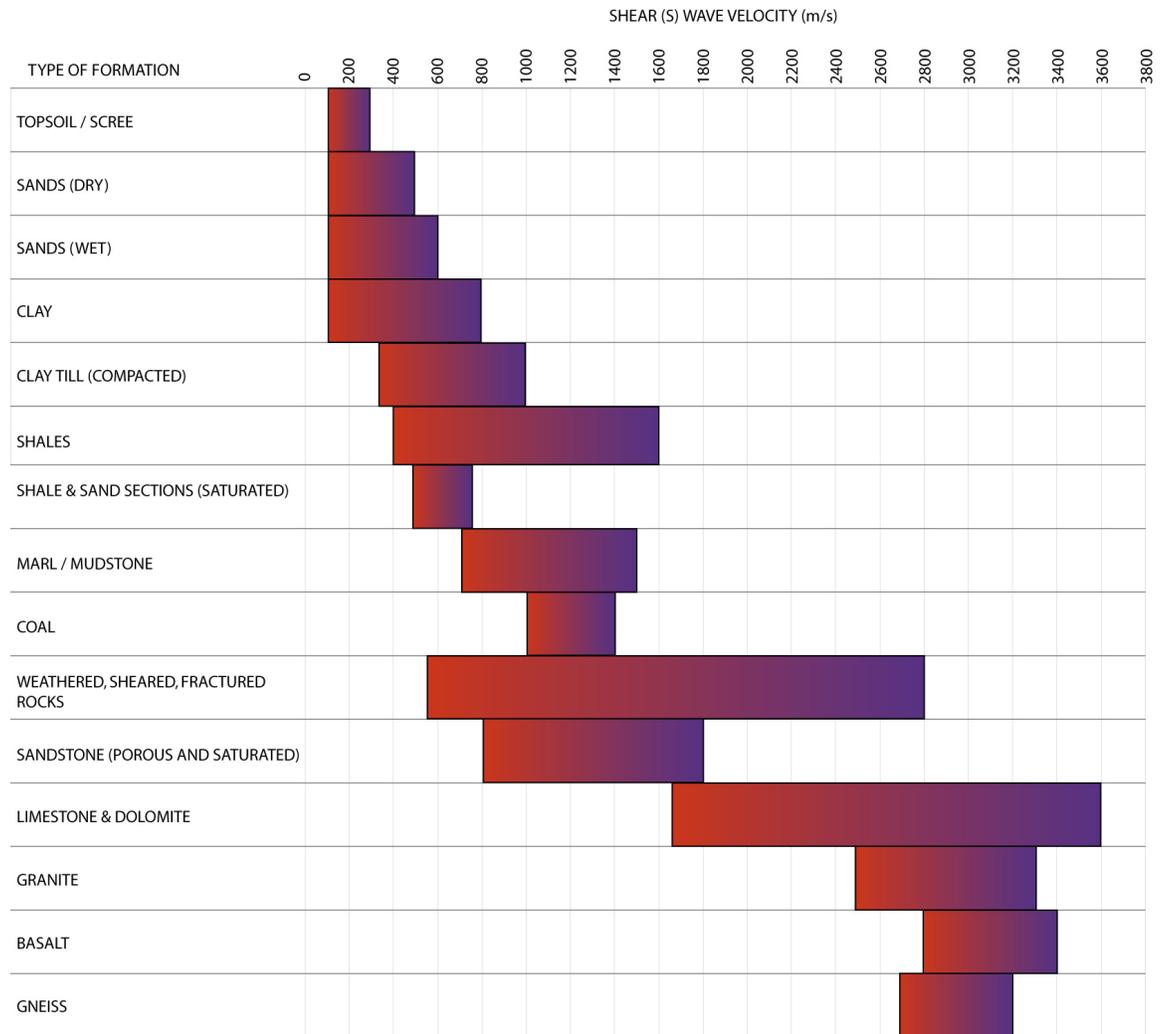




**SOIL AND ROCK CLASSIFICATION
BASED ON SEISMIC VELOCITIES**

Table of P-wave velocities for given materials





Typical rock velocities, Based on Bourbie, Coussy and Zinszner, Acoustics of Porous Media, 1987 with modifications by Geophysics GPR. Rev A.1 July 2011

Table of S-wave velocities for given materials





GSSI SIR-4000 – High Performance GPR Data Acquisition System

System

Antennas: Compatible with all GSSI antennas
Number of Channels: Records data from 1 single-frequency antenna or 1 dual-frequency antenna
Data Storage: 32 GB Flash, 1 GB RAM
Display: Enhanced 10.4" LED display with internal high brightness, Active matrix 1024 x 768 resolution and 32-bit color
GPS: Data logged internally
Display Modes: Linescan, Linescan plus O-scope, Wiggle trace Full 3D, 256 color bins are used to represent the amplitude and polarity of the signal
Environmental Rating: IP65

Data Acquisition

Data Format: RADAN® (dzt)
Output Data Format: 32-bit
Scan Interval: User-selectable, up to 400 scans/sec
Samples per Scan: 256, 512, 1024, 2048, 4096, 8192, 16384
Operating Modes: Continuous (time) or survey wheel (distance triggered) or point mode
Time Range: 0-20,000 nanoseconds full scale, user-selectable Gain: manual adjustment from -42 to +126 dB Number of segments in gain curve is user-selectable from 1 to 8
Standard Real-Time Filters: Infinite Impulse Response (IIR) - Low and High Pass, vertical and horizontal - Finite Impulse Response (FIR): Low and High Pass, vertical and horizontal
Advanced Real-Time Filters: Migration, Surface Position Tracking, Signal Noise Floor Tracking, Adaptive Background Removal
Automatic System Setups: Storage of an unlimited number of system setup files for different survey conditions and/or antenna deployment configurations

Operating

Operating Temperature -20°C to 40°C external (-4°F to 104°F)
Battery Inspired Energy Ni2040ED, 3 hour runtime (battery life dependent on level of display brightness)
Transmit Rate Up to 800 KHz (International) US/Canada and CE rates depend on antenna model

Input/Output

Available Ports: Antenna inputs analog and digital (one at a time), DC power input, Serial RS232 (GPS port), Accessory connector, HDMI video output, Ethernet to PC, USB 2.0 port, mini USB Ethernet RJ45 100BT Ethernet USB Host USB host with external keyboard support, USB flash drive support and USB HUB support

Mechanical

Dimensions 14x10x2.75 in (36x25x7 cm)
Weight 10 lbs (4.53 kg) including battery
Relative Humidity <95% non-condensing
Storage Temperature -40°C to 60°C (-40°F to 140°F)



Dielectric Values For Common Materials

Material	Dielectric	Velocity (mm/ns)
Air	1	300
Water (fresh)	81	33
Water (sea)	81	33
Polar snow	1.4 to 3	194 to 252
Polar ice	3 to 3.15	168
Temperate ice	3.2	167
Pure ice	3.2	167
Freshwater Lake ice	4	150
Sea Ice	2.5 to 8	78 to 157
Permafrost	1 to 8	106 to 300
Coastal sand (dry)	10	95
Sand (dry)	3 to 6	120 to 170
Sand (wet)	25 to 30	55 to 60
Silt (wet)	10	95
Clay (wet)	8 to 15	86 to 110
Clay soil (dry)	3 to 3.15	173
Marsh	12	86 to 110
Agricultural land	15	77
Pastoral land	13	83
“Average” soil	16	75
Granite	5 to 8	106 to 120
Limestone	7 to 9	100 to 113
Dolomite	6.8 to 8	106 to 115
Basalt (wet)	8 to 15	106 to 115
Shale (wet)	7 to 9	113
Sandstone (wet)	6.8 to 8	112
Coal	4 to 5	134 to 150
Quartz	4.3	145
Concrete	5 to 8	106 to 120
Asphalt	3 to 5	134 to 173
PVC	3	173

From Reynolds, John M. 1997, An Introduction to Applied And Environmental Geophysics, John Wiley & Sons, New York

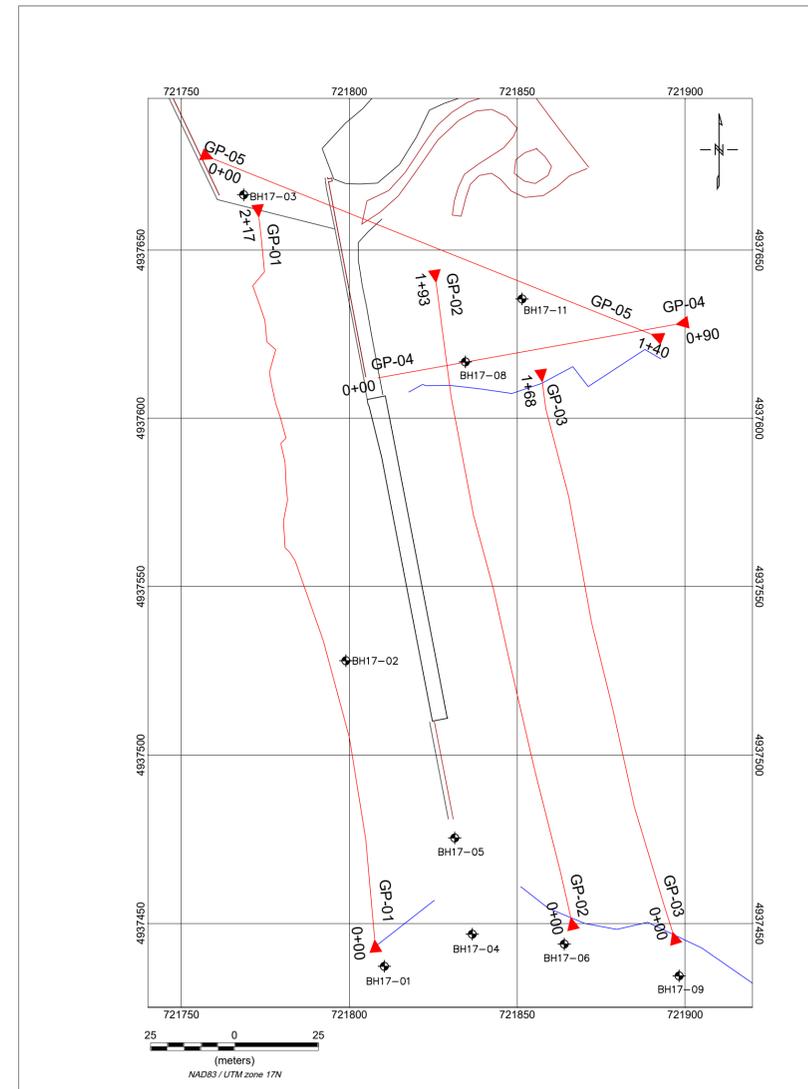
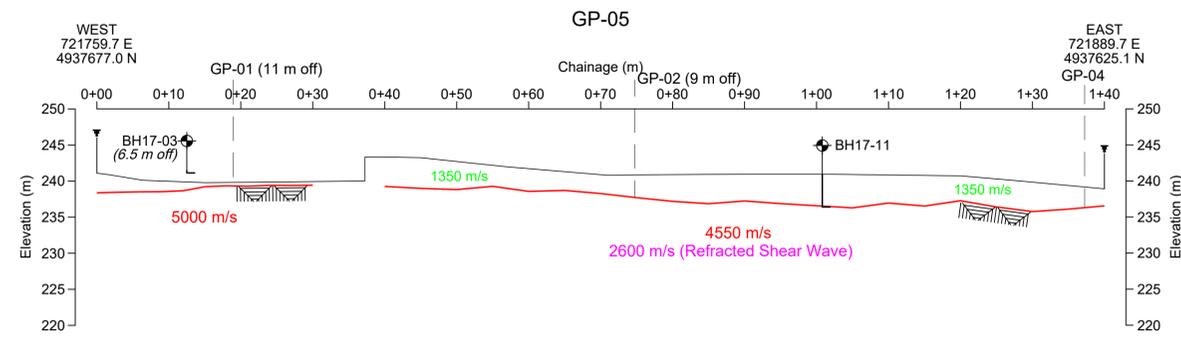
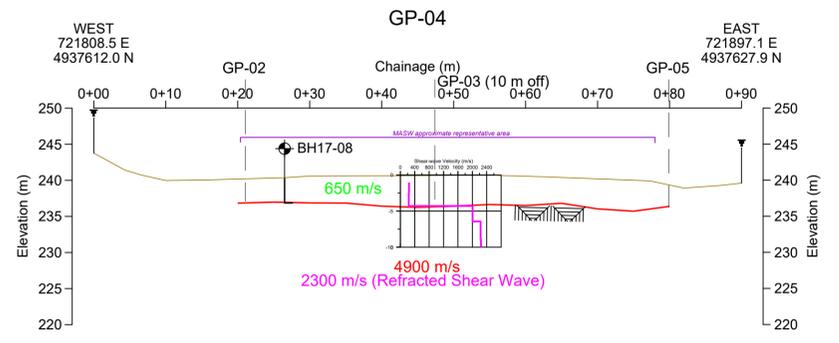
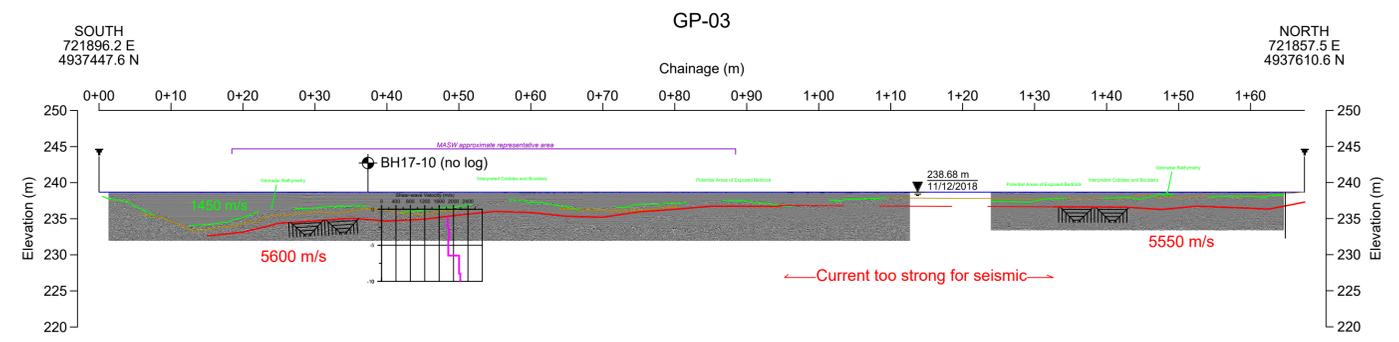
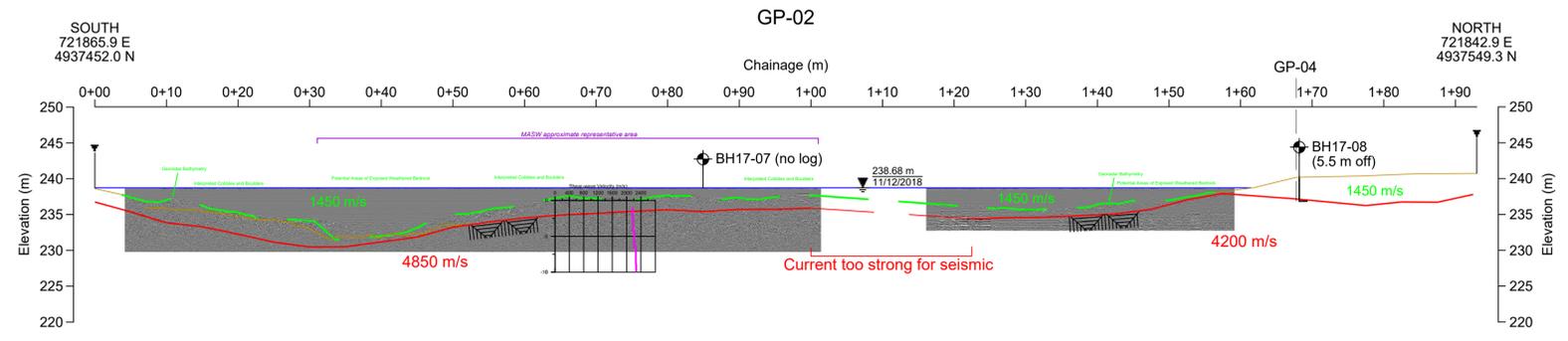
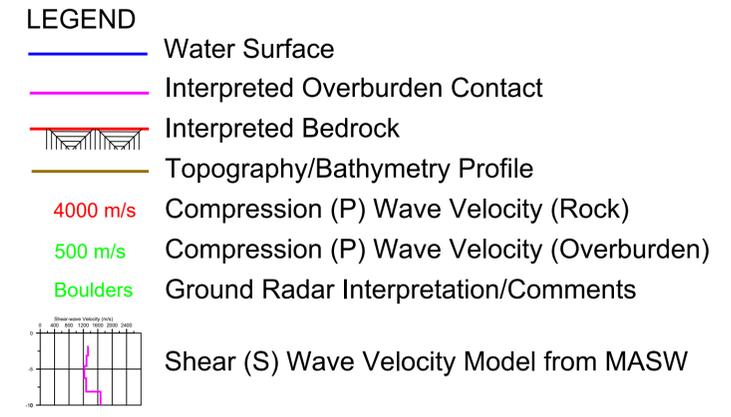
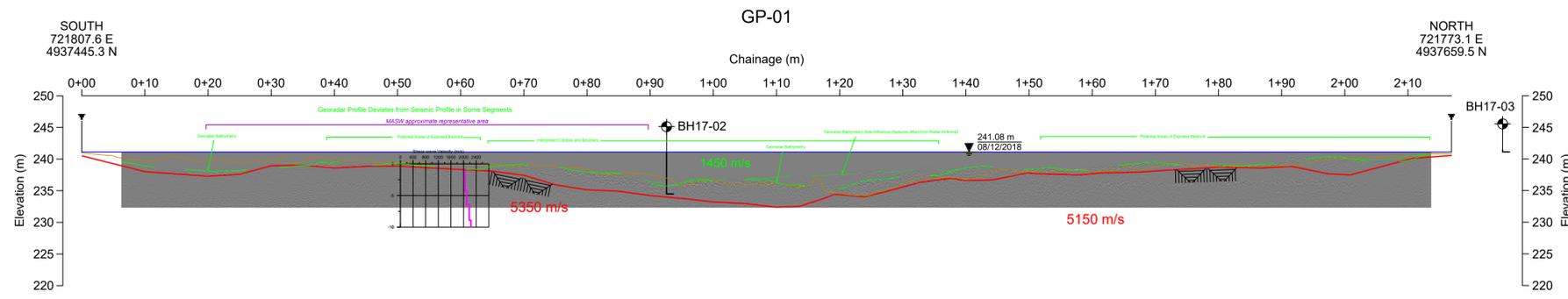


APPENDIX B

Drawing

T-17089_Central_F1: Lock 28 – Burleigh Falls

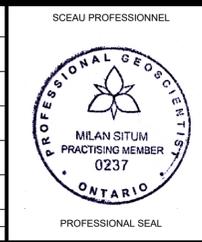




NOT VALID FOR CONSTRUCTION

1	THE SEISMIC SURVEY WAS EXECUTED BY GEOPHYSICS GPR INTERNATIONAL INC. DECEMBER 2017
2	COORDINATE SYSTEM: UTM ZONE 17 (NAD83)
3	TOPOGRAPHY DATA PROVIDED BY THE CLIENT AND PRESENTED FOR REFERENCE PURPOSES ONLY
4	BOREHOLE DATA PROVIDED BY THE CLIENT AND PRESENTED FOR REFERENCE PURPOSES ONLY
5	REFER TO FULL REPORT FOR DISCUSSION OF METHODOLOGIES, RESULTS AND LIMITATIONS
6	
No	NOTES

DRAFT - revised 25/05/18				
No	DATE	MODIFICATIONS	GPR	APP.



GEOPHYSICS GPR INTERNATIONAL INC.	
DESSINÉ PAR / DRAWN BY	IG
VERIFIÉ PAR / CHECKED BY	RBM
APPROUVÉ PAR / APPROVED BY	Milan Situm, P.Geo.
# CONTRACT / CONTRACT #	T-17089 / 644198-S-9401
DATE	MAY 2018
ÉCHELLE / SCALE	AS SHOWN
# DESSIN / DRAWING #	T17089_Central_F1

CLIENT	SNC LAVALIN INC.		CLIENT
PROJET	TRENT-SEVERN WATERWAY		PROJECT
GEOPHYSICAL AND TOPOGRAPHIC SURVEY			
CENTRAL BUNDLE			
TITRE	LOCK 28 - BURLEIGH FALLS DAM		TITLE
SEISMIC PROFILES			



GEOPHYSICS GPR INTERNATIONAL INC.

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June 20, 2018

GPR file: T17089

SNC Lavalin Inc.
195 The West Mall
Toronto, ON
M9C 5K1

**Bathymetric and Side Scan Sonar Surveys Within The Trent-Severn Waterway
Central Bundle Site F: Lock 28 – Burleigh Falls, Ontario
Project No. 644198**

Geophysics GPR International Inc. (GPR) was requested by SNC-Lavalin Inc. (SNC) to execute geophysical, bathymetric and topographic surveys in the vicinity of select dams along the Trent-Severn Waterway as a component of a geotechnical investigation.

G.D. Jewell Engineering Inc. (GDJE) was sub-contracted by GPR to carry-out the topographic survey and benchmark verification.

This report presents an outline of the bathymetric and side scan sonar measurements carried out by GPR relating to Central Bundle Site F - Lock 28 – Burleigh Falls, Ontario.

The results of the seismic and topographic surveys (if mandated) are presented in separate reports.

The results, in combination with geotechnical, topographical and seismic data will be used to assess the local geologic site conditions relating to dam rehabilitation/reconstruction.

Personnel

The GPR personnel involved with the field work and the dates on-site are outlined in Table 1.

Table 1: GPR Personnel

Name	Role	Dates On-Site
Christian Chatel	Operator, Snr. Technician	May 21, 2018
Mauritz Van Zyl	Geophysicist-in-training	May 21, 2018
Lucas Roy Chatel	Safety/Support Boat Operator	May 21, 2018

Equipment

The following equipment and software were used for the marine surveys measurements and processing:



Boats:

- Princecraft 16feet with Mercury 50HP engine (survey vessel)
- Princecraft 16feet with Mercury 25HP engine (support vessel)

Swath bathymetry and side scan sonar system:

- Edgetech 6205 Topside (console)
- Edgetech 6205 Sonar Head
- Coda Octopus Inertial Motion Unit (IMU) F175
- Trimble R8-3 Kinematic GPS receiver with Trimble Survey Controller (TSC3)
- Hypack Hysweep 2017 survey software
- HP laptop
- Samsung laptop
- 1500w Honda generator

Processing software:

- Hypack Hysweep
- Geosoft Oasis Montaj
- SonarWiz 6.0

Coordinate System

The bathymetry and side scan sonar plots are presented in the NAD83 CSRS UTM zone 17N coordinate system.

The elevation data are CGVD 2013.

Survey Details

The total area surveyed was approximately 68,700 m² upstream of the dam. The data have been contoured on a 0.2 m grid.

The side scan sonar data have been merged into plan-view mosaic images. Based on the side scan sonar images, remnants of infrastructure, areas of suspected exposed bedrock, zones of increased boulder material and bottom debris can be observed.

Data coverage was good, with most of the survey area being navigable for swath bathymetry. The area directly downstream of the dam was deemed too shallow/rough for collection of side scan sonar data.

The data collection and processing followed GPR's QA/QC procedures. The precision of the readings is estimated to be on the order of +/- 0.2 m or better.



Deliverables

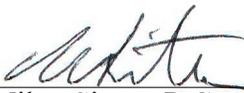
The marine survey results are presented in drawing T17089_Marine_Central_F1, provided to the client in AutoCAD and PDF formats.

The side scan sonar mosaic images and bathymetry colour contoured images have also been provided as Google Earth KMZ files.

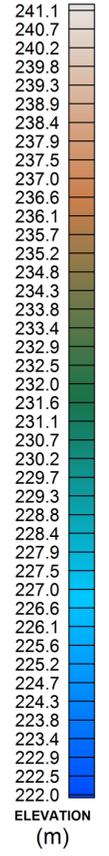
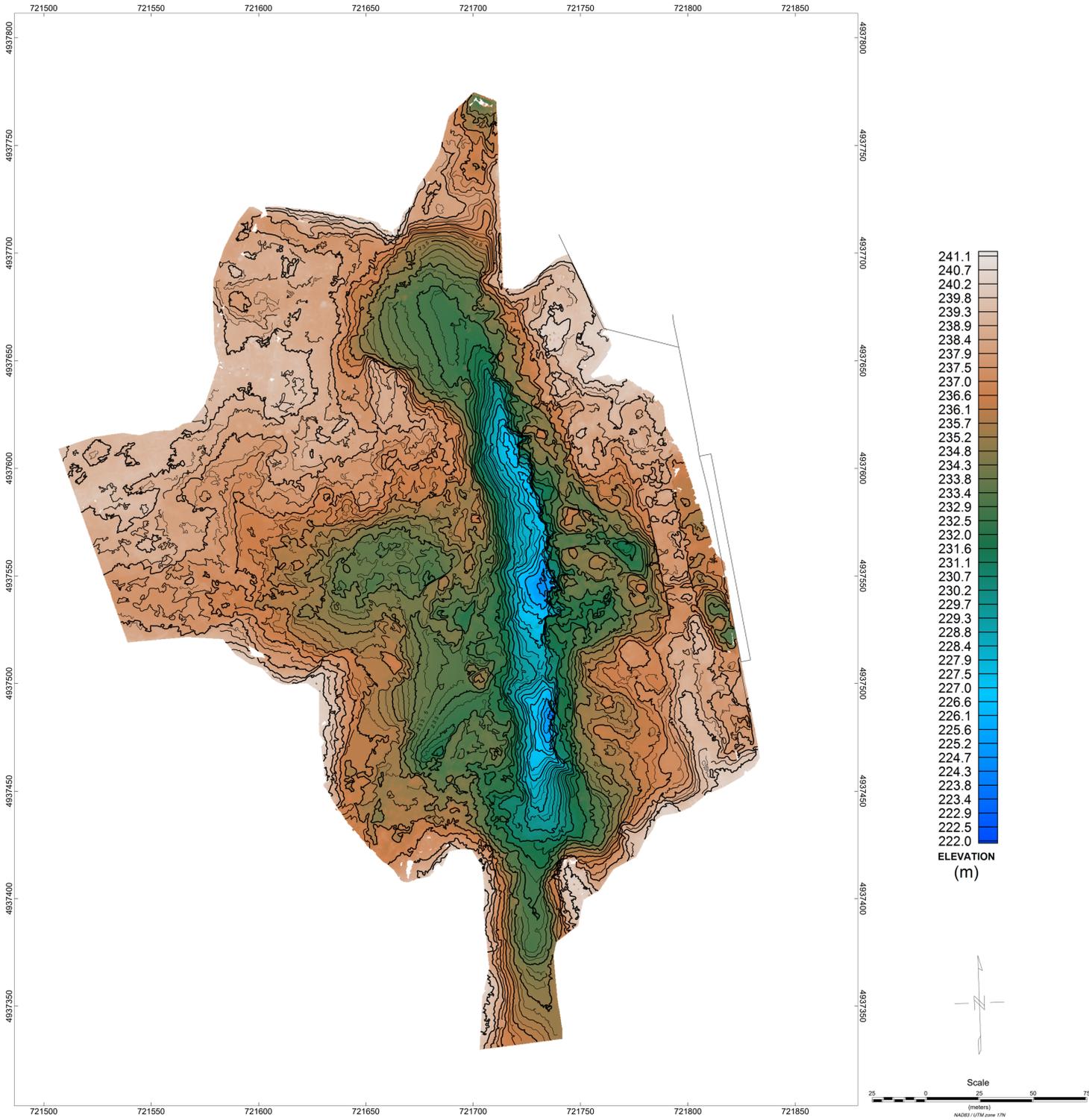
The bathymetry data have been incorporated into Civil 3D digital terrain models prepared by GDJE.

The bathymetry and side scan sonar drawings were prepared by Christian Chatel, Snr. Tech and Ben McClement, P.Eng.

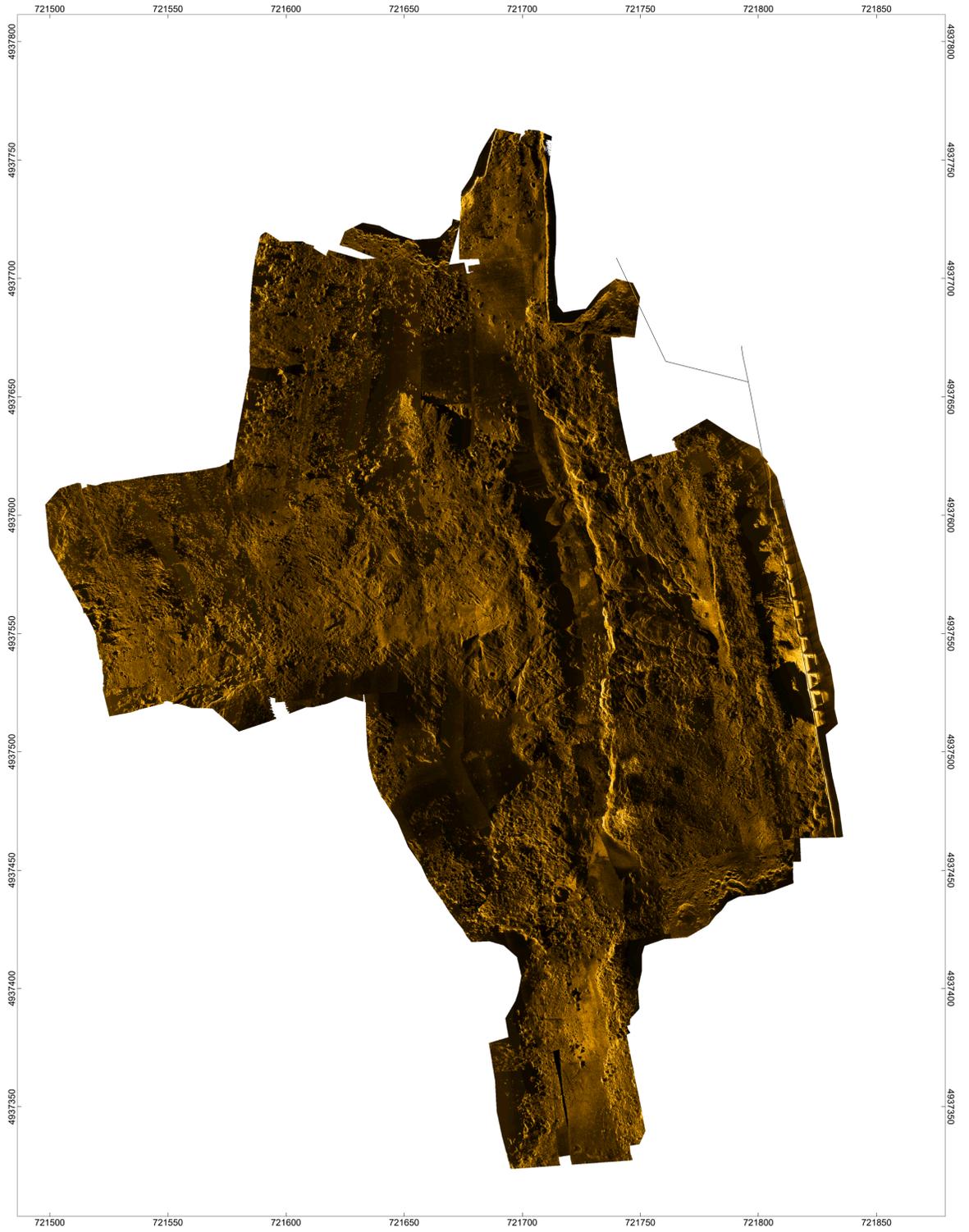
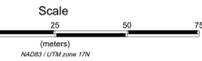
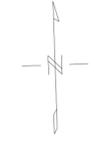
This report has been prepared by Ben McClement, P.Eng and Milan Situm, P.Geo.


Milan Situm, P.Geo.





ELEVATION (m)



Bathymetric Contour Map

Side Scan Sonar Mosaic

NOT VALID FOR NAVIGATION
NOT VALID FOR CONSTRUCTION

1	THE BATHYMETRY SURVEY WAS EXECUTED BY GEOPHYSICS GPR INTERNATIONAL INC. MAY 2018
2	COORDINATE SYSTEM: UTM ZONE 17 (NAD83), CGVD 2013
3	BASE IMAGE PRESENTED FOR REFERENCE PURPOSES ONLY
4	REFER TO FULL REPORT FOR DISCUSSION OF METHODOLOGIES, RESULTS AND LIMITATIONS
5	
6	
No	NOTES

No	DATE	MODIFICATIONS	GPR	APP.



GEOPHYSICS GPR INTERNATIONAL INC.	
OPERATEUR DE SONDAGE SURVEY OPERATOR	Christian Chatel, Tech. Sr.
DESSINÉ PAR DRAWN BY	Robert McClement, P.Eng.
APPROUVÉ PAR APPROVED BY	Milan Situm, P.Geo.
# CONTRAT CONTRACT #	T-17089 644198-S-9401
ÉCHELLE SCALE	AS SHOWN
DATE	JUNE 2018
# DESSIN DRAWING #	T17089_Marine_Central_F1

CLIENT	SNC LAVALIN INC.		CLIENT
PROJET	TRENT-SEVERN WATERWAY	PROJECT	
GEOPHYSICAL AND TOPOGRAPHIC SURVEY CENTRAL BUNDLE			
TITRE	LOCK 28 - BURLEIGH FALLS BATHYMETRY & SIDESCAN SONAR		TITLE



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May 25, 2018

GPR file: T17089

SNC Lavalin Inc.
195 The West Mall
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M9C 5K1

**Topographic Surveys Within The Trent-Severn Waterway
Central Bundle Site F: Lock 28 – Burleigh Falls, County of Peterborough, Ontario
Project No. 644197**

Geophysics GPR International Inc. (GPR) was requested by SNC-Lavalin Inc. (SNC) to execute geophysical, bathymetric and topographic surveys in the vicinity of select dams along the Trent-Severn Waterway as a component of a geotechnical investigation.

G.D. Jewell Engineering Inc. (GDJE) was sub-contracted by GPR to carry-out the topographic survey and benchmark verification.

This report presents an outline of the topographic measurements carried out by GDJE relating to Central Bundle Site F - Lock 19 – Burleigh Falls, County of Peterborough, Ontario.

The results of the seismic and bathymetric surveys (if mandated) are presented in separate reports.

The results, in combination with geotechnical, topographical and bathymetric data will be used to assess the local geologic site conditions relating to dam rehabilitation/reconstruction.

Personnel

The GDJE personnel involved with the field work and the dates on-site are outlined in Table 1. Additionally, some borehole and test pit coordinates were surveyed in April 2018.

Table 1: GDJE Personnel

Name	Role	Dates On-Site
Mark McConnell	Survey Crew Chief	November 29, December 19, 2017
Chad McCormick	Survey Technician	November 29, December 19, 2017

Equipment

The following equipment was used for the topographic measurements:

- Trimble R6 GPS RTK GSM
- Trimble S6 Robotic Total Station
- Trimble TSC3 Data Collector



Benchmark

Benchmark 32U558S was located and verified. The coordinates of the benchmark are outlined in Table 2

Table 2: Benchmark verification

Benchmark	32U558S
Northing	4 937 724.169
Easting	721 666.955
Elevation (CGVD2013)	243.414
Elevation (CGVD28)	243.729
Coordinate system	NAD83 Zone 17

Topography Points

A total of 761 topography points were recorded within the survey area.

The data collection and processing followed GDJE's QA/QC procedures. The precision of the readings is on the order of +/- 1 cm or better.

Deliverables

The results of the topography survey are provided to the client in digital format as ASCII files, AutoCAD and Civil 3D digital terrain models.

The topography fieldwork, drawings and results were prepared by G.D. Jewell Engineering under the supervision of Bryon Keene, P.Eng.

This report has been prepared by Milan Situm, P.Geo.



Milan Situm, P.Geo.

