FINAL REPORT

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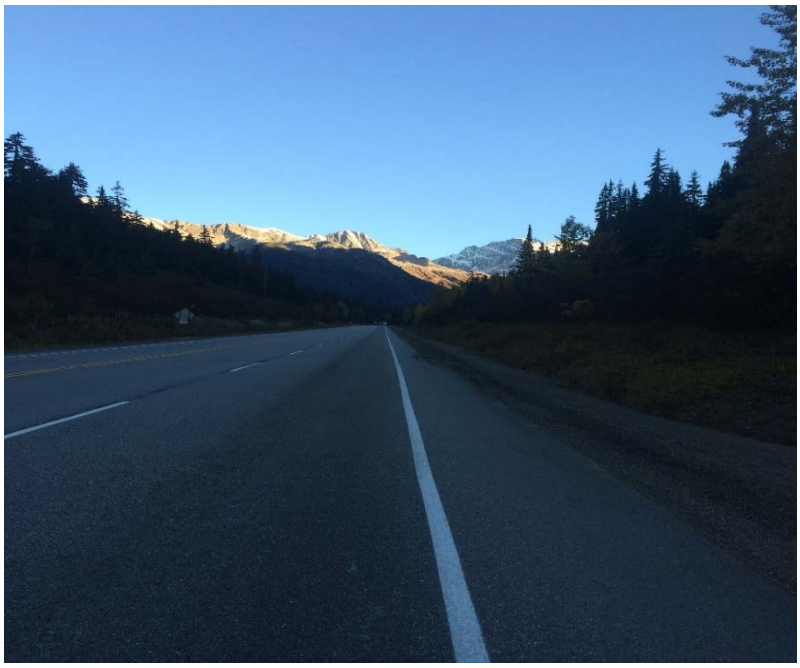
FINAL GEOTECHNICAL REPORT

TransCanada Highway - Illecillewaet Curve/Summit Ponding at Roger's Pass Glacier National Park British Columbia

Submitted to:
Mr. Gilles Lussier
Highway Engineering Services
Parks Canada
Box 900 C.P. 900
Banff, AB T1L 1K2



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1.0 INTRODUCTION

This report has been prepared as part of Call Up No.11, dated April 21, 2016 under Standing Offer and Call-up Authority No. 5P420-15-5004/001 between Golder Associates (Golder) and Parks Canada Agency (PCA) for the TransCanada Highway, Illecillewaet Curve/Summit Ponding project at Rogers Pass. The site is located on a 7.65 km long section of the Trans-Canada #1 Highway (TCH) that extends from km 20.65 and km 28.3 (i.e. Station 20+065 to 28+300) between Golden and Revelstoke, in Glacier National Park British Columbia (the Project site, see Figure 1). This report provides geotechnical design input for the highway widening project along the Project site.

Golder conducted an initial geotechnical investigation between km 22.2 to km 27.9 between September 29 and October 1, 2015, and submitted a preliminary geotechnical report dated June 02, 2016. Additional geotechnical field investigation was conducted between km 20.6 and km 28.3 between June 8 and June 17, 2016. This report presents the results of the field investigations conducted to date and is based on the updated project design information (received May 2016) provided by the prime consultant, McElhanney Consulting Services Ltd. (McElhanney).

The factual data, interpretations and recommendations provided in this report pertain to a specific project as described in the report and are not applicable to any other project or site location.

Use of this report is subject to the conditions outlined in the *Important Information and Limitations of this Report* that follows the main text and forms an integral part of this document. The readers' attention is specifically drawn to this information, as it is essential for the proper use and interpretation of the report.

2.0 PROJECT UNDERSTANDING

The project involves the addition of a westbound travelling lane on the Trans-Canada Highway 1 (TCH) in the Rogers Pass Summit and Illecillewaet Curve area with provision for a median barrier in four lane section and standard shoulder widths for safety reasons; creation of a ponding area near the Roger's Pass Visitor Information Centre (NW quadrant) and formalization of access road from the TCH westbound lanes. The project site extends from km 20.65 and km 28.3 (in generally a northeast to southwest direction along the alignment).

The widening of the existing highway will occur mainly on the westbound side, with some widening along the eastbound side to minimize cuts into the adjacent steep slopes. Project work will generally include asphalt removal, vegetation clearing and grubbing, earthwork, ditching, culvert extension/installation, base course and paving, retaining wall construction, signage, guardrail/barrier installation, intersection treatments, parking area expansion/relocation and utility relocation (electrical/communications).

Design and construction of the project is proposed to be carried out in two phases. It is understood that Phase 1, extending from km 24.1 to km 28.3, is planned to be constructed in 2016/2017 construction season, and Phase 2, extending from km 20.6 to km 24.1 is planned to be constructed in 2017/2018 construction season.

The purposes of the geotechnical investigation and assessment is to provide input for the design and construction of the proposed widening project. The Issued for Tender drawings for Phase 1, dated May 13, 2016 and 90% Review drawing package (used for Phase 2), dated February 26, 2016, provided by McElhanney have been used as a basis of information for this report.

3.0 GEOTECHNICAL INVESTIGATION

3.1 Field Investigation

The initial field investigation was carried out between September 29 and October 1, 2015, (2015 investigation) and included completion of 12 boreholes that were advanced to depths between 5.0 m and 6.1 m below ground surface (mbgs) using a B80 truck mounted drill rig owned and operated by Geotech Drilling. The boreholes were advanced utilizing solid stem auger and odex (i.e., percussion) drilling techniques.

Additional field investigation was carried out between June 8 and June 17, 2016 (June 2016 investigation) and included completion of 14 boreholes, 6 test pits and 23 hand augers. Boreholes were advanced to depths between 6.0 mbgs and 26.0 mbgs using two B80 truck mounted drill rigs owned and operated by Earth Drilling Co. Ltd. Borehole BH16-06B was advanced with odex drilling to 2.7 mbgs and advanced with hand augers to the termination depth of 6.1 mbgs. Test pits were advanced to depths between 2.2 m to 4.0 mbgs using a track mounted excavator. Hand auger holes were advanced up to 3.6 mbgs and completed by a two person Golder crew to further assess shallow subsurface conditions at select locations.

Prior to commencing the field investigation, underground utility locates were carried out at the selected borehole and test pit locations utilizing a private utility locator subcontracted by Golder.

The field investigation was completed under the full-time supervision of Golder geotechnical field supervisors who visually observed and logged the subsurface soil and groundwater conditions encountered at the test locations. Samples were identified in the field, placed in labelled containers and transported to Golder's laboratory for further examination and laboratory testing. Golder's Soil Classification System, which is based on a modified Unified Soil Classification System (USCS), was used for soil description and classification purposes and is presented along with a list of abbreviations and symbols and the Record of Borehole and Test Pit Sheets in Appendix A.

The borehole locations for the 2015 investigation were selected to cover a broader portion of the original study area between km 22.1 to km 27.9 and were generally positioned along the shoulder of the west and east bound lanes of the highway as permitted by environmental and site constraints at the time of the investigation (see Borehole and Test Pit Location Plan, Figures 2-1 to 2-6).

The borehole, test pit and hand auger hole locations completed for the June 2016 investigation were selected based on the proposed design including areas with major fill (e.g. more than 2 m of fill on slopes higher than about 5 m), major cut (e.g. cut slopes higher than about 3 m), and proposed retaining. Boreholes were generally positioned along the shoulder or driving lane of the west bound and east bound lanes of the highway except borehole BH16-10 which was positioned at the traffic pull-over area near km 26.0. Test pits were generally positioned about 3 m to 6 m outside the paved road, on both sides of the highway. Prior to the test pit investigation, bird sweeps, amphibian studies, and identification of nearby water bodies were conducted per PCA's National Best Management Practice for Geotechnical Investigations. Test pit TP16-04 was not excavated as it was too close to a water body. Hand auger holes were completed on existing road embankment slopes and within areas identified as potential peat areas.

An abandoned Telus telephone line was encountered during the excavation of Test pit TP16-06. An Telus representative that was on site at the time of the investigation confirmed that the telephone line was an abandoned line and no repair would be required, and the test pit was advanced to the termination depth and backfilled.

A member of Golder's geotechnical engineering field staff located the boreholes and test pits in the field, using a hand held GPS unit at the time of drilling. The completed borehole locations were subsequently surveyed by McElhanney.

A summary of the approximate location of boreholes and test pits are presented in Tables 1 and 2 respectively.

Table 1: Borehole Locations

Borehole Number	Station	Northing[(a)]	Easting[(a)]	Elevation[(a)] (masl)	Borehole Depth (m)
2015 Investigation					
AH15-01	27+840	5679425	463718	1158.8	5.2
AH15-02	27+427	5679605	464093	1175.1	5.2
AH15-03	27+010	5679794	464450	1190.9	6.1
AH15-04	25+930	5680415	464531	1241.9	5.2
AH15-05	25+658	5680677	464451	1258.2	5.2
AH15-06	24+915	5681368	464176	1304.3	5.2
AH15-07	24+450	5681831	464209	1326.1	5.2
AH15-08	24+120	5682146	464112	1325.6	5.1
AH15-09	23+370	5682854	463853	1316.0	5.2
AH15-10	22+975	5683238	463768	1313.7	5.0
AH15-11[2]	22+840	5683688	463743	1311.7	5.5
AH15-12	22+522	5684042	463790	1306.5	5.6
June 2016 Investigation					
BH16-01	21+100	5684896	464364	1286.5	9.6
BH16-02	21+850	5684317	463934	1298.5	11.1
BH16-03	22+100	5684102	463822	1304.5	6.6
BH16-04	23+260	5682976	463822	1316.3	6.6
BH16-05	23+520	5682701	463911	1318.4	8.1
BH16-06A	23+700	5682535	463975	1320.3	8.1
BH16-06B	22+710	5682544	463972	1320.5	6.1
BH16-07	25+200	5681102	464284	1286.6	9.8
BH16-08	25+800	5680542	464494	1249.7	11.6
BH16-09	25+900	5680447	464530	1243.8	6.1
BH16-10	25+980	5680360	464560	1238.7	9.6
BH16-11	27+150	5679755	464278	1185.2	26.0
BH16-12	27+700	5679491	463845	1164.9	15.2
BH16-13	28+060	5679363	463521	1153.8	21.8
BH16-14	28+120	5679336	463454	1152.4	20.3

Notes:

(a) Location information based on as-drilled survey data provided by McElhanney.
(b) AH15-11 was located along Rogers Pass Summit Rd.

Table 2: Test Pit Locations

Test Pit Number	Station	Northing[(a)]	Easting[(a)]	Elevation[(a)] (masl)	Test Pit Depth (m)
TP16-01	21+400	5684688	464125	1290.0	2.2
TP16-02	23+250	5682988	463806	1315.5	4.0
TP16-03	23+400	5682822	463862	1316.2	4.0
TP16-04	Not Completed				
TP16-05	24+400	5681874	464170	1325.8	4.0
TP16-06	24+640	5681653	464214	1320.0	3.5
TP16-07	25+450	5680869	464385	1270.2	4.0

Note:

[(a)] Location information based on as-drilled survey data provided by McElhanney.

The groundwater levels encountered in the boreholes, and test pits at time of drilling are summarized in Section 4.2.8 and reported in the Record of Borehole sheets and Record of Test Pits attached in Appendix A. Standpipe piezometers were installed in boreholes BH16-02, BH16-12 and BH16-13. Water level readings from the standpipes were recorded after installation and on June 19, 2016, and are summarised in Table 5 of Section 4.2.8.

Boreholes without standpipes were backfilled using soil cuttings and bentonite chips at surface upon completion of drilling. Where boreholes were advanced through the existing asphalt, the surface was backfilled with cold mix asphalt. Boreholes with standpipe piezometers were backfilled with cuttings, sand and bentonite with a flush mount road box at surface.

Test pits were backfilled with spoil and bucket packed. At test pit locations, organic material was placed last over the final surface. Test pit locations within Phase 2 area were seeded with Mount Revelstoke Glacier (MRG) field unit approved seed mix.

In Borehole BH16-10, a hydrocarbon odour was noted below 8 mbgs and the borehole was terminated at 9.6 mbgs due to suspected contamination and MRG field unit was notified. Upon receipt of PCA and MRG field unit's approval, the borehole was backfilled with sand and bentonite to surface. A MRG field unit representative collected a sample of cuttings for testing for contamination. The remaining soil cuttings were transported to Golder's geotechnical laboratory in Calgary and tested for contamination by CleanHarbors Environmental Services Inc. (CleanHarbors) for disposal purposes. The tests conducted by CleanHarbors indicated that the tested soil cuttings were non-hazardous and the soil was disposed as non-hazardous. The results of the tests conducted by MRG field unit were not provided to Golder.

3.2 Laboratory Testing

Laboratory testing consisted of water content and organic content determinations, grain size analyses, Atterberg Limit tests, large direct shear tests, Standard Proctor tests, California Bearing Ratio (CBR) tests (natural and soaked water content) and corrosion series tests consisting of sulphate, chloride, resistivity and pH tests. Table 3 provides a summary of the tests conducted. The laboratory test results are presented in Appendix B.

Table 3: Summary of Laboratory Tests

Test	Number of Tests	
	2015 Investigation	June 2016 Investigation
Water Content	57	204
Organic Content	--	11
Atterberg Limits	1	5
Particle Size Distribution	11	18
Sulphate, pH and Resistivity	--	5
Standard Proctor	--	4
CBR (soaked/natural water content)	--	6
Direct Shear Tests	--	1

4.0 GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Geology

Glacier National Park, Rogers Pass and the Illecillewaet Curve are located within the Selkirk Mountains, in the Cordilleran Physiographic Region of Canada. The Selkirk Mountain Range is part of the larger Columbia Mountains system. The Columbia Mountains, an uplifted and folded region, straddles the boundary between accreted terranes and Ancestral North America as part of the Omineca morphogeological belt (Gabrielse, 1991).

The project area is located within map sheet NTS 82N/5, in the Columbia Mountains Natural Region of southeastern BC, an area characterized by steep, angular mountains and deep, narrow valleys, numerous ice fields and glaciers. Bedrock is dominated by folded Paleozoic Hamill Group quartzite with minor slate phyllite and conglomerate and lesser Proterozoic Windermere Horsethief Creek Group slate and phyllite quartzite with slate and conglomerate (Wheeler, 1963). Bedrock in valley bottoms is blanketed by colluvium and till, including talus cones and rubble aprons of variable thickness and extent (Fulton et. al, 1989).

4.2 Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes and test pits and the results of in situ testing, and laboratory testing are presented on the Record of Borehole Sheets and Record of Test Pits provided in Appendix A.

The soil descriptions discussed in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice and in accordance to the Soil Classification System chart, provided in Appendix A. Classification and identification of soil involves judgment and Golder does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. The depths of stratigraphic changes are generally approximate and inferred since there is often a gradual transition between soil types. It should be noted that it is expected that variations in the subsurface conditions may occur between and beyond the boreholes. Detailed soil descriptions are provided on the Record of Borehole Sheets also available in Appendix A.

The following presents a generalized summary of the subsurface conditions encountered at the test locations during the investigation.

4.2.1 28.3 km to 26.1 km

Boreholes AH15-01 to 03, and BH16-11 to 14 were completed within this section of the highway.

Boreholes AH15-01 and AH15-02 encountered 0.15 mm of topsoil and fill.

The topsoil in AH15-01 was underlain by compact silty sand with inferred cobbles and boulders with depth to about 3.0 mbgs. The silty sand overlies compact silt with some sand and gravel to about 4.6 mbgs, which is underlain by stiff silty clay to clayey silt which extended to depth of termination of the borehole at 5.2 mbgs.

Boreholes AH15-02 and AH15-03, generally consisted of intermixed and layered silt, sand and gravel that extended to depths between 5.2 mbgs and 6.1 mbgs. The compactness of soils ranged from loose to compact and increased to dense to very dense with depth.

Borehole BH16-14 encountered 0.4 m of asphalt at surface followed by dense to compact gravelly silty sand fill with inferred cobbles and boulders, and woody debris to 11.6 mbgs. The fill was underlain by compact to very dense intermixed layers of sand and gravel to depth of termination of the borehole at 20.3 mbgs.

Borehole BH16-13 encountered 0.4 m of asphalt at surface followed by compact to very dense intermixed layers of gravelly silty sand and silty sand and gravel fill to 15.2 mbgs, underlain by loose gravelly silty sand and sandy gravel fill to 18.8 mbgs. Cobbles and boulders were inferred within the fill and woody debris were encountered. Hard gravelly silty clay was encountered within the fill from 6.6 mbgs to 7.6 mbgs. The fill was underlain by dense to very dense sandy gravel and gravelly sand to depth of termination of the borehole at 21.8 mbgs.

Boreholes BH16-11 and BH16-12 generally consisted of compact to very dense sand and gravel fill with variable amounts of silt, sand and gravel content to 9.1 mbgs and 8.4 mbgs respectively, followed by dense to very dense intermixed layers of sandy gravel, silty sand and gravelly silty sand to depth of termination of the boreholes BH16-11 and BH16-12.

4.2.2 26.1 km to 25.7 km

Borehole AH15-04 and BH16-08 to 10 were located along this section of highway.

Borehole AH15-04 encountered about 0.9 m of dense gravelly silty sand at ground surface and was underlain by loose silty sand layer about 0.6 m thick. The silty sand was underlain by a 1.2 m thick layer of loose silty peat overlying dense sandy gravelly silt to about 4.9 mbgs. The sandy gravel overlies dense sand to silty sand to depth of termination of the borehole at about 5.2 mbgs.

Borehole BH16-10 located at the traffic pull-over area near km 26.0 encountered fill to depth of termination of the borehole at 9.6 mbgs. The fill generally consisted of gravelly silty sand and dense gravel to 2.0 mbgs, underlain by loose to compact silt to 6.5 mbgs, underlain by dense gravelly silty sand. Cobbles and boulders were inferred in the fill. Rootlets and wire was encountered in the fill. A hydrocarbon odour was encountered below 8 mbgs and borehole was terminated at 9.6 mbgs due to suspected contamination.

Borehole BH16-09 encountered 0.5 m of asphalt at surface, followed by dense sand and gravel fill and very dense silty sand fill to depth of termination of the borehole at 6.1 mbgs.

Borehole BH16-08 encountered 0.5 m of asphalt at surface, underlain by dense to compact gravelly silty sand fill to 6.7 mbgs. The fill was underlain by organic clayey silt to 7.0 mbgs, followed by compact to very dense sand, gravelly silty sand and gravelly clayey sand to the depth of termination of the borehole at 11.0 mbgs.

4.2.3 25.7 km to 23.7 km

Boreholes AH15-05 to AH15-08, BH16-07, and test pits TP16-05 to 07 were located along this section of highway.

Borehole AH15-05 and AH15-08 encountered 0.6 m and 0.2 m of asphalt at surface, respectively. Borehole AH15-07 encountered about 0.2 m of topsoil/fill. Underlying the asphalt and topsoil, and extending from surface of AH15-06 was generally a mixture of interlayered silt, sand and gravel to depth of termination of the boreholes. The compactness ranged from loose to dense with depth. Inferred cobbles and boulders were noted below about 3.7 mbgs in AH15-05.

Borehole BH16-07 encountered 0.4 m of asphalt at surface followed by gravelly silty sand fill to 7.6 mbgs. The compactness of the fill changed from very dense to compact with depth. Woody debris was encountered in the fill and cobbles and boulders were inferred. The fill was underlain by dense to very dense silty sand and gravel to the depth of termination of the borehole at 9.7 mbgs.

Test pit TP16-07 encountered gravelly silty sand fill to 0.7 mbgs, followed by silt to 2 mbgs, and silty gravel and sand to termination of the test pit at 4 mbgs. Cobbles up to 0.3 m in diameter were encountered within the silt.

Test pit TP16-06 encountered sandy silty gravel to silty gravel and sand fill to 3 mbgs followed by silty gravel and sand to termination depth of the test pit at 3.4 mbgs. An abandoned Telus telephone line was encountered at 1.8 mbgs. Cobbles up to 0.3 m in diameter and boulders up to 0.5 m diameter were encountered in test pit TP16-06.

Test pit TP16-05 encountered sand and gravel fill, topsoil, and possible fill consisting of gravelly clayey sand and sandy silty gravel to termination of test pit at 4 mbgs. Cobbles up to 0.3 m diameter and boulders up to 1.5 m diameter were encountered.

4.2.4 23.7 km to 23.1 km

Borehole AH15-09 and BH16-04 to 06B, and test pits TP16-03 and TP16-02 were advanced along this section of highway.

Borehole AH15-09 encountered about 0.9 m of compact gravelly silty sand. This was followed by about 1.5 m of very loose silty peat to clayey organic silt and was underlain by about 0.6 m of very soft clayey organic silt. This was followed by about 1.5 m of very loose to loose peat and compact sand containing some gravel in which the borehole was terminated.

Boreholes BH16-06A and 06B were completed on the eastbound shoulder of the highway (about 2.0 m to 3.4 m from edge of asphalt) near km 23.7. Borehole BH16-06A encountered 0.5 m of asphalt at surface followed by compact gravelly silty sand fill to 2.7 mbgs. The odex casing and split spoon sampler sank under self-weight between 2.7 mbgs to 4.6 mbgs and there was no sample recovery from this depth range. Based on the above drilling observations, wet and very soft or very loose ground conditions are inferred between 2.7 mbgs to 4.6 mbgs. Wet organic clayey silt to clayey silt was encountered in the SPT sample at 4.6 mbgs. There was no sample recovery from 5.0 mbgs to 6.1 mbgs. Sand and gravel was encountered from 6.1 mbgs to the termination depth of the borehole at 8.1 mbgs. The compactness of sand and gravel increased from compact to dense with depth. A second borehole, BH16-06B was completed within about 10 m from BH16-06A to attempt better sample recovery. Borehole BH16-06B was advanced with odex drilling through gravelly silty sand to 2.7 mbgs, and advanced with hand augers from 2.7 mbgs to 6.1 mbgs. Wet gravelly silty sand was encountered from 2.7 mbgs to 6.1 mbgs. The limited effort required to hand auger to final depth suggested very loose and wet ground conditions from 2.7 mbgs to 6.1 mbgs.

Boreholes BH16-05 and BH16-04, were positioned near the edge of the westbound travel lane of the highway (about 5 m from edge of asphalt) near km 23.5 and km 23.3. Borehole BH16-05, encountered 0.5 m of asphalt underlain by compact to dense silty sand and gravel fill to 4.6 mbgs, underlain by firm sandy clayey silt fill to 6.1 mbgs, followed by very dense silty gravel and sand to termination depth of the borehole at 8.1 mbgs. Borehole BH16-04 encountered 0.5 m asphalt followed by very dense gravelly silty sand to 3.0 mbgs, underlain by firm sandy organic clayey silt to 4.3 mbgs, underlain by compact to very dense gravelly silty sand to termination of the borehole at 6.6 mbgs. Cobbles and boulders were inferred in both boreholes.

Test pits TP16-03 and TP16-02 were excavated along the westbound side of the highway about 3 m to 5 m from edge of asphalt. Test pit TP16-03 encountered loose sand fill to 0.3 mbgs underlain by sandy peat and silty peat to termination depth of the test pit at 4.0 mbgs. Firm clayey silt, sand, gravel, and silt deposits that are 0.3 m to 0.9 m thick were encountered interlayered with peat. Test Pit TP16-02, encountered organic clayey silt to silty peat to 1.5 mbgs, followed by gravelly silty sand to 4.0 mbgs

4.2.5 23.1 km to 22.2 km

Boreholes AH15-10 to AH15-12 were completed along this section of highway. All three boreholes were advanced through asphalt pavement with the thickness ranging from about 0.1 m to 0.2 m. Underlying the asphalt was generally a mixture of interlayered silt, sand and gravel with the relative density ranging from compact to very dense with depth.

A hydrocarbon odour was noted during drilling of the upper 2.1 mbgs of borehole AH15-10.

4.2.6 22.2 km to 21.1 km

Boreholes BH16-01 to 03 and Test Pit TP16-01 were completed along this section of highway. All three boreholes were advanced through asphalt pavement with the thickness ranging from about 0.2 m to 0.3 m. Underlying the asphalt was generally a mixture of interlayered silty sand and gravel, gravelly silty sand, sandy gravel or silty gravel and sand fill to 6.6 mbgs to 8.4 mbgs. Compact gravel and sand was encountered in borehole BH16-01 below the fill from 8.1 mbgs to 9.6 mbgs. Wood debris was encountered below the fill in borehole BH16-02 from 8.4 mbgs to 9.1 mbgs followed by compact to dense gravel. Borehole BH16-03 was terminated within the fill at 6.6 mbgs.

Test pit TP16-01 encountered silty sand fill followed by topsoil underlain by sand and gravel to termination depth of the test pit at 2.2 mbgs. The test pit was terminated due to practical refusal on a boulder.

4.2.7 Subsurface Conditions Encountered in Hand Auger Holes

Twenty-three (23) hand auger holes were completed on existing road embankment slopes, within expected peat areas, and possible “windrow” area identified by McElhanney. The subsurface conditions encountered in the hand auger holes are summarized in Table A-1 in Appendix A.

In general, the upper 1 m to 2 m of the existing road embankment slopes appear to be loose and generally consists of sand and gravel fill with varying amounts of silt.

Two hand auger holes HA16-05 and HA16-06 were advance along the westbound side of the highway at 13 m and 15 m away from the edge of pavement within the suspected peat area near km 23.3 and km 23.4. Hand auger hole HA16-05 encountered peat to 2.8 mbgs at which depth hand auger refusal was encountered due to large gravel or a cobble. Hand auger hole HA16-06 encountered peat to 2.5 mbgs at which depth hand auger refusal was encountered in a tree root or branch. Hand auger hole HA16-15 was advanced on the eastbound side of the highway about 7 m away from the edge of pavement near km 23.3. Peat was encountered to 2.7 mbgs at which depth hand auger refusal was encountered in tree roots.

Three hand auger holes located on the suspected “windrow” fill area, HA16-Berm 1 to 3 located from km 24.2 to 24.3 generally encountered loose to very loose gravelly silty sand to the termination depth of the auger holes at 0.8 mbgs to 3.6 mbgs. The hand auger holes were terminated due to hand auger refusal on large gravel or cobbles.

4.2.8 Groundwater

A summary of the groundwater levels observed within the boreholes and test pits during the sites investigations is provided in Table 4. The measured water levels recorded from the standpipes is provided in Table 5.

Table 4: Observed Groundwater Levels

Borehole Number	Station	Depth of Groundwater (mbgs)
AH15-01	27+840	3.0
AH15-03	27+010	2.5
AH15-05	25+658	0.6
AH15-09	23+370	0.6
BH16-01	21+100	6.8
BH16-04	23+260	3.0
BH16-05	23+520	4.6
BH16-06A	23+700	2.9
BH16-06B	22+710	2.7
BH16-07	25+200	5.5
BH16-08	25+800	6.7
BH16-11	27+150	16.8
BH16-14	28+120	13.7
TP16-02	23+250	1.5
TP16-03	23+400	0.8
TP16-06	24+640	3.0

Table 5: Water Level Readings from Standpipes

Borehole Number	Station	Water Level Readings (mbgs)	
		Installation	June 19, 2016
BH16-02	21+850	8.4	9.1
BH16-12	27+700	14.8	14.2
BH16-13	28+060	13.2	13.4

Water levels observed during drilling and measured in standpipes may not represent actual groundwater levels, or long-term stabilized groundwater conditions. Subsurface water levels are expected to fluctuate seasonally in response to changes in precipitation and snow melt, and may be expected to be higher during the spring and following periods of heavy precipitation, and vary within the project site.

5.0 GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

This section of the report provides geotechnical engineering comments and recommendations as input to the design of the proposed widening of the Trans-Canada Highway between km 20.6 and km 28.3 near the summit of Rogers Pass, Glacier National Park, BC. The recommendations are based on Golder's interpretation of the factual data obtained from the boreholes and test pits completed as part of the field investigations and our understanding of the design, based on the available information provided by McElhanney as referenced above, and discussed below. The interpretation and recommendations contained in this report are intended to provide the designers with information as input to the design and construction of the proposed widening. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the design drawings and tender and contract documents. Anyone requiring information on aspects of construction should make their own interpretation of the factual information provided, as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

5.1 Cut Slopes

Based on available design information and cross-sections provided, cut slopes are designed at the following locations as part of the TCH widening between km 20.65 and km 28.3:

Table 6: Cut Slope Widening

Lane	Approximate Stations	Closest Boreholes	Approx. Cut Height (m)	Approx. Cut Depth[(a)] (m)	Approx. Cut Slope Ratio (Horizontal:Vertical)	Approximate Widening (m)
WBL	20+650 to 21+000	BH16-01	1 to 2	0.5 to 1.0	4:1 to 5:1	n/a
WBL	21+160 to 21+210	BH16-01, TP16-01	1.5 to 2.0	0.5 to 1.0	2:1 to 5:1	n/a
WBL	21+300 to 21+440	TP16-01	2 to 8	0.5 to 2.0	2:1 to 4:1	n/a
WBL	23+040 to 23+700	AH15-09, BH16-04, BH16-05, BH16-06A, BH16-06B, TP16-02, TP16-03	1.0 to 4.5	1 to 3	2:1 to 5:1	0 to 5
WBL	23+700 to 23+790	AH15-08, BH16-06A, BH16-06B	4.0 to 7.5	2.0 to 3.5	2:1 to 4:1	n/a
EBL	23+700 to 23+790	AH15-08, AH15-09 BH16-06A, BH16-06B	2 to 4	2.0 to 3.5	2:1 to 3.1	0 to 5
WBL	23+790 to 24+140	AH15-08	1 to 4	0.5 to 1.5	2:1 to 4:1	n/a
WBL	24+300 to 24+640	AH15-08, AH15-07, TP16-05, TP16-06	0.5 to 8.0	1 to 3	2:1 to 4:1	n/a
WBL	24+820 to 25+040	AH15-06	2 to 5	1 to 4	2:1 to 2.5:1	n/a

Table 6: Cut Slope Widening

Lane	Approximate Stations	Closest Boreholes	Approx. Cut Height (m)	Approx. Cut Depth[(a)] (m)	Approx. Cut Slope Ratio (Horizontal:Vertical)	Approximate Widening (m)
EBL	25+300 to 25+670	AH15-05, BH16-07, TP16-07	2 to 5	2 to 8	2:1 to 4.5:1	5 to 12

Note:

[(a)] Cut depth is the vertical measurement at the deepest part of the cut along the slope.

Based on available information the design includes embankments cuts with about 2 m to 3 m in height on average and up to a maximum height of about 8 m. Design cut slopes of 4H:1V, 3H:1V, and 2H:1V are proposed for cuts with vertical slope heights of less than 3.0 m, 3.0 m to 4.0 m, and greater than 4.0 m, respectively. Based on the results of the investigation, the design cuts to accommodate widening will generally be carried out through sand, silty sand, gravelly sand, and sandy gravel soils.

5.1.1 Cut Slopes within Organic Soils

Peat and organic silt was encountered in boreholes AH15-09 and BH16-04, and test pits TP16-02 and TP16-03 advanced between km 23.15 and km 23.45. Based on the results of the investigation and site observation, the extent of the peat and organic soils within this area is expected be intermittent, and will comprise variable thickness and composition. Based on the site investigation the thickness of peat and organic soils was observed to vary up to more than 4 m thick. Further, based on observations of mature tree growth, hummocky ground and boggy areas along the road, the sections of organic soil and peat areas are generally considered to extend laterally along the highway over intermittent lengths along the westbound side of the highway. The full extent and delineation of the organic soils is not known. The groundwater level observed in boreholes and test pit in this area varied from 0.6 mbgs to 3.0 mbgs with surface water observed in the areas directly adjacent to the highway at AH15-09. The thickness of asphalt was about 0.5 m and road fill was about 2.5 m below the pavement. Based on the existing vegetation, and hummocky ground surface observed, similar ground conditions are expected along the eastbound side of the highway. Based on the design, it is understood that road widening and ditch construction is proposed on the westbound side of the highway within these organic soils and peat.

5.1.2 Cut Slopes within Wet Silty Sand

Two boreholes, BH16-06A and 06B advanced on the eastbound shoulder of the highway near km 23.7, encountered very loose, wet, gravelly silty sand below the road fill that extended to about 2.7 mbgs. Proposed cut slopes for ditch construction along the east side of the highway, extending from about km 23.68 to 23.78 are about 2 m deep in this area and may encounter wet silty sand. The road structure for the proposed widening within this same area may encounter silty sand subgrade (please refer to Section 5.9.4). Construction difficulties due to wet, silty ground conditions could be expected if this material is encountered. This material should be expected to be highly sensitive to disturbance and may have excessive seepage. The full extent of the wet silty sand parallel and perpendicular to the highway is unknown.

5.2 Fill Slopes

Based on available design information and cross-sections provided, fill slopes are designed at the following locations as part of the TCH widening between km 20.65 and km 28.3:

Table 7: Fill Slope Widening

Lane	Approximate Stations	Closest Boreholes	Approximate Fill Slope Height (m)	Approximate Fill Thickness (m)	Approximate Slope Ratio (H:V)	Approximate Widening (m)
WBL	20+760 to 21+000	BH16-01	0.5 to 2.0	0.5 to 1	3:1 to 4:1	2 to 5
WBL	21+000 to 21+300	BH16-01, TP16-01	0.5 to 4.5	1 to 2.5	2.5:1 to 5:1	0 to 7
WBL	21+460 to 22+100	AH15-13, BH16-02, BH16-03	3 to 8	1 to 4.5	2:1 to 4:1	3 to 7
WBL	22+100 to 22+280	AH15-13, BH16-03	1.0 to 3.5	0.5 to 1.5	3:1 to 4:1	2 to 5
EBL	22+340 to 22+460	AH15-12, AH15-13	0.5 to 3.5	0.5 to 1	3.5:1 to 4:1	0 to 2
EBL	23+560 to 23+680	AH15-09, BH16-05, BH16-06A, BH16-06B	2 to 3	0.5 to 1	3:1 to 4:1	1 to 3
EBL	23+790 to 23+950	AH15-08, BH16-06A BH16-06B	0.5 to 5.0	0.5 to 2.0	2.5:1 to 3.5:1	5 to 7
EBL	24+300 to 24+640	AH15-07, TP16-05, TP16-06	2 to 5	0.5 to 3.0	3.5:1 to 5:1	0 to 8
WBL	24+730 to 24+950	AH15-06	1 to 2	0.5 to 2.0	3:1 to 4.5:1	2 to 8
EBL	25+120 to 25+300	BH16-07	2 to 5	1 to 3	2.5:1 to 4.5:1	10 to 12
WBL	25+740 to 26+030	AH15-04, BH16-08, BH16-09, BH16-10	0.5 to 7.0	0.5 to 3.5	2:1 to 3.5:1	0 to 9
WBL	27+100 to 27+219	AH15-03, BH16-11,	up to 3	up to 3	Vertical	n/a
WBL	27+360 to 27+670	AH15-02, BH16-12	1 to 10	0.5 to 2.5	2:1 to 4:1	0 to 3
WBL	27+790 to 28+000	AH15-01, BH16-12	1 to 12	0.5 to 7.5	2:1 to 4:1	5 to 9
WBL	28+000 to 28+200	BH16-13, BH16-14	up to 5	up to 5	Vertical	1 to 9

Based on the available information the proposed widening of the existing highway embankments with fill slope construction will range up to 12 m along the project site. The resulting new fill embankments will range from less than 1 m to about 12 m in height, with a vertical thickness of fill up to about 7.5 m deep placed over the existing side slopes, which generally comprise sand, silty sand, gravelly sand, and sandy gravel soils. Based on available information the widened sections are designed to have fill slopes of 4H:1V and 3H:1V for fill heights of less than 2.0 m, and greater than 2.5 m, respectively, and 2H:1V (with barrier/guard rail) for mountainside/riverside fill embankments, which range up to about 12 m in height. It is understood that the engineered fill used to construct the embankments will comprise suitable, approved granular fill taken from the proposed cut sections along the alignment, which will generally comprise sand, silty sand, gravelly sand, and sandy gravel soils, and imported local manufactured granular fill (i.e. from local aggregate source)

5.3 Retaining Walls

It is understood that two MSE retaining walls are proposed along the westbound lanes. One retaining wall extends a total length of 100 m from km 27.08 to km 27.18 and the other retaining wall extends a total length of 182 m from km 28.00 to km 28.18. The preferred design for the retaining walls is understood to comprise a mechanically stabilized earth (MSE) wall.

Borehole BH16-11 was drilled on the westbound shoulder of the highway near km 27.15 along extent of retaining wall located from km 27.08 to km 27.18. A hand auger hole HA16-16 was also completed on the existing embankment slope at km 27.15, about 4 m below the crest of the slope. Based on the subsurface conditions encountered in borehole BH16-11, the base of the retaining wall will be founded on compact to dense silty sand to gravelly silty sand fill.

Boreholes BH16-13 and BH16-14 were drilled on the westbound shoulder of the highway at km 28.06 and km 28.12, respectively, along extents of the 180 m long retaining wall located from km 28.00 to km 28.18. A hand auger hole HA16-20 was completed near km 28.05 on the existing embankment slope about 4 m to 5 m below the crest of the slope. Based on subsurface conditions encountered in boreholes BH16-13 and BH16-14, the base of the retaining wall will be founded on dense to very dense gravelly silty sand fill.

Based on the generally compact to very dense granular soil conditions as encountered in the borehole drilled at the site, MSE walls are considered suitable. The compactness of the near surface fill on the existing embankment slopes are inferred to be loose in the upper 1 m to 2 m. The placement and compaction, and integration of new fill to the existing slope material, and erosion control requirements are discussed further below.

Based on information provided by McElhanney, it is understood that the retaining walls will be located as close as possible to the crest of the slope (i.e., edge of widening). The design geometries of the retaining walls, as provided by McElhanney are discussed further below.

5.4 Slope Stability Assessment

5.4.1 Cut and Fill Slopes in Granular Soils

For the purpose of the stability assessment subsurface stratigraphy comprised of sand, silty sand, gravelly sand, and sandy gravel soils and groundwater conditions inferred from observations at time of drilling, and measured from standpipe piezometers have been used. A friction angle ranging from about 36° to 40° is considered representative for existing granular road embankment fills and granular, native undisturbed soil with compact to very dense relative density. For fill embankments, it has been assumed that native granular sand and gravel materials excavated from cut slopes and imported granular fill, placed at a minimum 98% Standard Proctor Maximum Dry Density (SPMDD) will be used. For stability assessment purposes a friction angle of 38° have been used for existing granular fill, native granular soil and approved engineered granular backfill materials.

It has been assumed that minimum long and short-term factors of safety of 1.5 and 1.3 are required for design and construction considerations.

Based on review of select cut and fill sections provided and soils conditions encountered, the slopes designed at 3H:1V or shallower will result in adequate slope stability with local factor of safety of about 1.5 or greater. Flatter slopes will be required if less competent soil conditions and/or seepage is encountered, or if cuts extend below the groundwater level.

As noted in the design summary (Tables 6 and 7 above) cut slopes (4 m to 8 m high) and fill slopes (up to 12 m high) at 2H:1V are proposed. The assessment of cut slope stability indicates shallow failures (i.e., in the order of 3 m deep from surface) with factors of safety ranging from about 1.5 to 1.4 for cut slopes of 4 m to 8 m high, respectively. The assessment of proposed 2H:1V fill slopes (i.e., located from km 25.74 to km 27.9), which range up to maximum 12 m height indicates relatively shallow slope failures (i.e., factor of safety less than 1.5) within the fill for slopes higher than 10 m. Deeper seated failure surfaces extending into the slope have a factor of safety greater than 1.5. For design purposes, design slopes of at least 2.5H:1V or flatter should be used for cut and fill slopes greater than 5 m and 10 m in height, respectively.

There is a creek flowing at the toe of the existing slope from about km 25.7 to km 25.8. Areas with standing and/or flowing water was observed at the toe the existing slope between km 21.5 to km 22.5 was observed. Re-alignment of the existing creek, removal of soft or otherwise unsuitable materials from within the design footprint, and protecting the toe of the of the design slope should be implemented during design and construction.

It should be noted that very shallow, surficial slope failure surfaces with factors of safety less than 1.5 should be expected within granular slopes (i.e., erosional and ravelling type failures).

Based on the granular soil and groundwater conditions encountered and the design cross-sections, a minimum factor of safety of about 1.5 may generally be achieved for design slopes provided that the following assumptions are met:

1) Soils are not eroded at toe of cuts or fill embankments (i.e., the toe is protected and not eroded).

2) Cut and fill slopes comprising granular materials should be designed at 2.5H:1V or flatter, with maximum slope heights of 8.0 m and 12 m, respectively.

3) The engineered fill material shall comprise clean, well graded inorganic granular sand and gravel, with maximum particle size 75 mm with less than 10% fines (i.e., less than 10% passing the No. 200 sieve). The fill shall be placed in compacted lifts not exceeding 150 mm thick and compacted to not less than 98% of SPMDD at a moisture content of +/- 2% of optimum. The compacted strength characteristics of the fill shall be capable of achieving a friction angle of 38 degrees (i.e, tested in the laboratory using representative sample, per ASTM 3080-04).

4) Vegetation cover should be established on all disturbed slopes to protect against surficial erosion. An interceptor ditch should be included along the crest of the cut and fill slopes to minimize surface water flow over the crest and slope face, and minimize surface erosion potential.

5) Use of construction techniques to bench new embankment fill into the existing slopes (i.e., 0.5 m high by 0.5 m deep benches) to mitigate shallow failures between the interface of new fill and existing slopes due to existing loose road embankments fills on the upper 1 m to 2 m of the slope face.

6) Proper drainage and realignment of existing creeks or water flow at the toes of slopes should be provided and no seepage should be observed from existing slopes.

7) Soft, wet, deleterious and otherwise unsuitable materials shall be removed from subgrade within fill footprints, prior to placement of fill slope material (See Section 5.8 for embankment construction).

8) Excavations and cut slopes should be closely monitored by qualified geotechnical personnel at time of construction to confirm conditions are as assumed for final design.

The stability of the cut and fill slopes are sensitive to soil and groundwater conditions, height of fill, and overall slope geometry (existing and proposed), which should be further reviewed for final design and construction of Phase 2.

5.4.2 Retaining Walls

5.4.2.1 Retaining Wall from km 27.08 to km 27.18

For stability review purposes a maximum vertical wall height of 2.7 m with 100% embedment (i.e., reinforcement length of 2.7 m) has been assumed at the crest of a 18 m high slope (i.e., section at km 27.14) with native subsurface conditions comprising competent sand and gravel (minimum internal angle of friction of 38°), and assumed groundwater conditions (i.e. no slope seepage). Based on analysis, under these conditions a global factor of safety of about 1.4 is achieved. The local factor of safety immediately behind and below the wall is 1.5.

Review of the global stability of the existing slope at this section indicates a factor of safety (under inferred soil and groundwater conditions, without retaining wall construction and road widening) for a slip surface along a similar path (i.e., similar path and depth below ground for the global stability path identified with the retaining wall) is in the order of 1.4. Based on this relative assessment the addition of the retaining wall at the crest of the slope, maintains the existing global factor of safety of the slope. Shallow, surficial slope instability with factors of safety of less than 1 may be expected within granular fill slopes (i.e. erosional failures).

Based on this analysis, a minimum length of reinforcement is 100% of the wall height, or a minimum of 1.8 m (per AASHTO 2012) is recommended to result in the least impact to the existing slope stability. For FoS greater than 1.5 to be achieved, slope regrading (flattening), and/or other mitigation measures will be required, which have not been considered in this analysis or report.

A minimum MSE wall embedment depth 0.5 m, and minimum 1 m distance from the front toe of the MSE wall to the slope face is recommended. Further, compaction of the existing loose material on the face of the slope downslope of the retaining wall and erosion control measures at the toe of the MSE wall, shall be completed.

The internal stability and design of the retaining wall is to be completed by others.

5.4.2.2 Retaining Wall from km 28.00 to km 28.18

The height of the retaining wall varies from approximately 1.2 m to 5.2 from west to east. For stability review purposes a representative vertical wall height of 4.0 m with 150% embedment (i.e., reinforcement length of 6 m) has been assumed at the crest of a 12 m high slope (i.e., section at station 28+020) with subsurface conditions comprising gravelly silty sand (minimum internal angle of friction of 38°), and assumed groundwater conditions (i.e. no slope seepage). Based on analysis, under these conditions a global factor of safety of about 1.5 is achieved.

For shorter wall sections (less than 2.5 m high walls), a minimum length of reinforcement is 100% of the wall height, or a minimum of 1.8 m (per AASHTO 2012) is recommended to result in the least impact to the existing slope stability.

A minimum MSE wall embedment depth of 1.0 m or 20% of the wall height, and minimum 1 m distance from the front toe of the MSE wall to the slope face is recommended. Further, compaction of the existing loose material on the face of the slope downslope of the retaining wall and erosion control measures at the toe of the MSE wall shall be completed.

It should also be noted that the temporary cut slopes during construction of the wall may extend into the existing road and pavement structure, depending on final design reinforcement lengths. Disturbance to the existing pavement structure may be required to accommodate construction of retaining wall.

The internal stability and design of the retaining wall is to be completed by others.

5.5 Settlement Mitigation and Slope Stability in Peat and Organic Soil Areas

The proposed cut sections and widening along the westbound side of the highway from about km 23.08 to km 23.7 will likely encounter intermittent areas of compressible materials including peat and organic silts between km 23.15 and km 23.45. Based on the boreholes, test pits and hand auger holes advanced in the area, intermittent areas of peat and organic silt, that are variable in thickness and composition exists on both sides of the highway. Design and construction considerations for road widening and cut slopes (i.e., to construct shoulder widening, new ditch and mountainside cut) within these materials will be required.

Significant settlements of peat, comprising immediate and creep movement is expected within areas requiring loading of the peat soils, as part of construction for the proposed road widening. The immediate settlement due to loading may range in the order 30% to 50% of the peat thickness of the subsurface soils. To mitigate this immediate settlement and creep movement, pre-loading of this area, prior to construction is recommended. Recommendations for the preload is as follows:

- The preload should comprise a minimum design height of 1.2 m above the existing shoulder elevation immediately adjacent the existing pavement. The preload material should comprise relatively free draining sand and gravel fill to allow drainage.

- The preload should extend along the entire length of the expected peat area (i.e. km 23.15 to km 23.45) with a minimum top width of 7.5 m (crest to crest width). It is anticipated that the road side slope of the preload can be maintained at about 1.5H:1V (containment of the preload fill adjacent to the highway may be constructed using concrete barriers to develop the preload). It is anticipated that the constructed slope on the mountain side of the preload fill will be variable and may have irregular slopes which will develop due to immediate settlements that will be expected to vary in magnitude along this section, due to varying thickness and presence of compressible soils. Based on the general topography of the existing ditch area, the thickness of the design preload fill will likely be more than 1.5 m height at the mountain side of the preload.
- Due to the variable nature and intermittent presence of the peat encountered, immediate settlements will be variable. Some areas could experience up to 1.2 m of settlement while other areas may experience very little settlement, both longitudinally and laterally from the road within the footprint of the preload.
- Immediate settlements will likely occur within about 2 to 3 weeks after preloading (most of the immediate settlement of highly compressible material will occur during placement of preload fill). At the end of immediate settlement, the preload fill will require regrading to re-establish the crest of the preload. It is anticipated that the immediate settlements of the preload will vary significantly longitudinally along the preload, and laterally from the edge of the existing road to the mountainside toe of the preload, reflecting the variability of the thickness and presence of compressible material within preload footprint. A minimum preload height of about 500 mm above original grade over the design crest width should be developed after immediate settlement. Based on the proposed design cross-section of the preload, it is anticipated that excess material will result due to variable immediate settlements over the footprint of the preload. The final surface of the preload after 12 months is expected to be undulating and variable.
- Local failures on the mountain side of the preload fill that extend laterally from the preload area should be expected within compressible materials.
- Where the tree line (i.e. comprising large mature trees) along the highway extends within the footprint of the preload (e.g. km 23.3 to km 23.4), the preload fill footprint can be minimized to the extent of the tree line (i.e. removal of trees should not be required to accommodate the preload), as subsurface conditions are considered to likely comprise non-compressible soils capable of supporting large tree growth.
- The preload should remain in place for at least 12 months.
- The longitudinal and lateral extent of the compressible subsurface soils encountered should be further investigated to delineate the extent of compressible soils within the planned development area to establish a final preload area. This would typically be completed by hand auger investigation.

- For areas with the thickest compressible deposits (i.e. as encountered in AH15-09, BH16-05, TP16-03), estimated creep settlements in the order 60 mm to 90 mm are likely to occur within the first 3 months (i.e. the first log cycle of creep) of applying the preload. Thereafter, another 60 mm to 90 mm of creep settlement is expected to occur from 3 months to 3 years (second log cycle of creep). The majority of the creep settlements during the second log cycle is expected within the first two years of the cycle. The estimated settlement of the completed road (i.e. assuming construction after 12 month preload) over the thickest peat deposits may be in the order of 30 mm to 50 mm over the remaining portion of the second log cycle (i.e. year 1 to 2 after construction). The settlement is expected to vary differentially both longitudinally along the new pavement and laterally from the existing pavement within this area, reflecting the variations of subgrade materials and varying thicknesses and presence of compressible soils. More significant maintenance of the pavement structure should be expected in the first two years after paving. Creep settlements expected within the third log cycle (i.e. from 2 to 30 years after construction) is about 60 mm to 90 mm.
- Based on stability analysis completed for the proposed new ditch configuration along this area, design slopes should be 4H:1V or flatter on the roadside. The mountain side cut slopes within peat should also be 4H:1V or flatter. In areas where higher cuts are designed to extend into steeper mountain side slopes comprising granular soil (i.e. silty sand and gravel soils), these slopes should be designed at 2.5H:1V or flatter. Where slope conditions encounter seepage or different, weaker soils than anticipated, flatter slopes may be required.

5.6 MSE Wall Foundation Subgrade Preparation

Typically, an un-reinforced concrete footing/levelling pad (150 mm thick by 300 mm wide) is placed on a prepared leveling surface to receive the MSE wall panels. Based on available subsurface information, the bearing surface for the reinforced zone of the retaining walls has been inferred to comprise sand and gravel, which is considered suitable for retaining wall construction. Any soft, loose (i.e disturbed), frozen or otherwise unsuitable soil encountered should be over-excavated and backfilled with native sand and gravel or approved imported granular fill, compacted to 98% of the SPMDD. The bearing surface for the reinforced zone of the retaining walls should be confirmed by additional subsurface characterization.

The reinforced zone should not be placed on frozen subgrade or in freezing conditions. The exposed subgrade should be inspected by a qualified geotechnical engineer prior to construction to confirm that the subgrade is prepared in accordance with recommendations provided in this report. The zone of over-excavation (if required) below the reinforced zone should extend laterally beyond the wall footprint a distance equal to the depth of over-excavation below the bearing elevation.

5.7 Bearing Capacity for MSE Walls

The unfactored ultimate bearing capacity for the existing sand and gravel subgrade is 500 kPa. This is based on sand and gravel having a friction angle of 38˚ and a minimum 1.8 m wide reinforced zone (minimum foundation width).

In areas where weak or unsuitable subgrade material is identified, over-excavation to an acceptable bearing stratum and placement of native sand and gravel fill compacted to 98% of the SPMDD will be required, or modification to the unfactored ultimate bearing capacity value will be made.

The bearing capacity provided is subject to field confirmation and foundation preparation recommendations in Section 5.6. Appropriate factors of safety should be applied to the ultimate bearing capacity and ultimate sliding resistance to obtain factored bearing capacity and factored sliding resistance for design of the MSE wall.

5.8 Embankment Construction

Excavated material consisting of granular soils (sands and gravels) are considered to be suitable for reuse as fill provided they are free of topsoil, organics, frozen material, over-size material (i.e., cobble and boulder) and other deleterious material and are placed and compacted as outlined below. Silts, fine grained silty sand, and organic soil (peat, organic clayey silt) are not considered suitable for re-use as fill.

Material for use as engineered fill should comprise granular material compacted in layers not exceeding 200 mm loose lifts and to a minimum of 95% SPMDD as per ASTM D698 (road embankment only, fill slopes should be compacted to 98% SPMDD). Benching of the existing embankment side slopes should be carried out to “key in” the new fill materials for the widening. The granular fill should be placed at water contents between optimum and 2% wet of optimum. Full-time monitoring and compaction testing should be provided during any subgrade preparation, fill placement or proof-rolling to confirm that the specifications are being achieved. Qualified geotechnical personnel should perform review and testing for subgrade preparation on a full-time basis. The top surface of the engineered fill should be protected as necessary from construction traffic, excessive wetting or drying, and should be sloped to provide positive drainage for surface water during the construction period.

5.8.1 Subgrade Preparation

For the widening of the TCH, it is recommended that all topsoil/organic soils be stripped from within the footprint of the new widening areas to minimize settlement and improve the long-term performance of the new embankment fills. In these areas, the exposed subgrade soils should be proof-rolled prior to fill placement of engineered fill to confirm competent subgrade conditions, in accordance with conditions assumed for design.

It is understood that pavement widening near km 26.0 will extend to the existing traffic pull-over area. Based on boreholes AH15-04, BH16-09 and 10, the existing fill consists of loose silty peat, loose to compact silts and dense to very dense sand and gravels. Excavating the upper 3 m of the fill in this area and replacing and re-compacting after removing organic soils and unsuitable fill is recommended to achieve a suitable subgrade for the pavement.

5.9 Pavement Design

The results of Golder’s 2015 investigation and the June 2016 field investigation, laboratory testing and provided traffic data were used to develop a new construction pavement structure design for various widening locations throughout the project length. The specific data sources are noted below:

- Issued for 90% Review drawing package provided by McElhanney, dated February 26, 2016.
- McElhanney, Rogers Pass Traffic Database Volumes, provided to Golder via email on January 25, 2016.

The pavement structure was designed using the American Association of State Highway and Transportation Officials (AASHTO) 1993 method and previous experience on similar projects. The British Columbia Ministry of Transportation and Infrastructure 2015 Pavement Structure Design Guidelines (BC Guidelines), Technical Circular T-01/15 were followed in the development of the pavement structure design as well.

5.9.1 Traffic Analysis

Traffic data provided by McElhanney was used to estimate the cumulative Equivalent Single Axle Loads (ESALs) for a 20-year design period. Table 8 presents the parameters used to estimate the ESALs.

Table 8: Traffic Analysis

Parameter	Value
2014 AADT	5,316
2016 AADT	5,530
Growth Rate *	2.0
Design Period	20 Years
Percent Trucks **	9.4 %
Truck Factor	1.8
ESALs	4,200,000

Notes:

* Growth Rate of 2 % provided in BC Guidelines.

** Truck traffic was not provided by McElhanney. Values were taken from Golder's November 2010 Pavement Design Report for TCH Twinning km 76-82.

5.9.2 Pavement Structural Design

The parameters used in the pavement design are presented in Table 9.

Table 9: Pavement Structural Design Parameters

Parameters		Value
Design ESALs		4,200,000
Reliability		85%
Standard Deviation		0.45
Subgrade Resilient Modulus		30 MPa
Initial Serviceability		4.2
Terminal Serviceability		2.5
Structural Coefficient	New Asphalt Pavement (AP)	0.40
	New Crush Base Course (CBC) (25 mm and 50 mm)	0.14
	New Select Granular Sub-base (SGSB)	0.10
Drainage Coefficient	New AP	1.0
	New CBC (25 mm and 50 mm)	0.95
	New SGSB	0.95

Using the above noted input parameters, the required Structural Number (SN) for the new construction was calculated to be 129 mm.

The following pavement structure is recommended throughout the widening locations:

- 145 mm AP;
- 150 mm CBC (25 mm);
- 250 CBC (50 mm); and
- 300 mm SGSB.

5.9.3 Locations with Peat

As discussed in Section 5.5, subgrade conditions with peat and organic soils have been identified in the proposed widening alignment. Although preload mitigation measures are being proposed to minimize settlement of the new pavement structure (km 23.15 to km 23.45), it is anticipated that over time, additional creep settlement will occur. The condition of the pavement should be monitored regularly to ensure that any distresses are repaired effectively and efficiently. In addition, at the time of constructing the new pavement structure in these locations it is recommended that between the subgrade and the SGSB a layer of geotextile and geogrid shall be placed. A Terrafix 360 R geotextile or equivalent should be used. The type of geogrid should be determined using the gradation and CBR values of the proposed fill and SGSB materials.

5.9.4 Frost Susceptibility and Proposed Mitigations

In general, the soils within the proposed widening alignment were found to have low to moderate frost susceptibility. It is important to ensure that adequate surface and subsurface drainage is provided throughout the length of the project limits.

Soils within localized areas of the proposed widening alignment have been identified to be of moderate to high frost susceptibility (i.e. clayey silt and silty sand, encountered at BH16-06A and B). Further delineation and identification of frost susceptible soils should be done at the time of subgrade preparation and inspection during construction. If these materials are exposed within the subgrade during construction it is recommended that they be removed and replaced with non-frost susceptible material, such as SGSB. The material should be removed to a minimum depth of 70 percent of the anticipated frost penetration in the area, which is estimated to be 1.8 m for frost susceptible soils.

Based on the site investigation the subgrade soil conditions and groundwater level will vary along the alignment, and the expected frost penetration is anticipated to range from about 1.8 m to 3.0 m between silt/sandy silt, to sand and gravel type soils, respectively, and will also vary depending on the groundwater levels.

5.10 Culverts

Based on preliminary information, it is understood that up to 30 existing culverts ranging in diameter from 600 mm to 1,800 mm will likely require extension, relocation and/or replacement as part of this project. It is understood that a box culvert is proposed to be installed for the Connaught Creek at km 22.32. Details of the proposed box culvert are unknown at this time.

Culverts should be sized to limit backwater conditions and to convey flows downstream and designed with flared end treatments and riprap protection when required. Culverts should be place on undisturbed native soil or compacted general engineered fill material at the design subgrade elevation. If soft, lose or otherwise unsuitable soils are encountered at the bottom of the excavation they should be over-excavated to expose firm/compact subgrade soils and backfilled with approved compacted fill.

Culverts are to be backfilled in accordance with manufacturer's specifications, but in general they should be backfilled with inorganic soils after proper water conditioning. The backfill should not contain debris, organic material, frozen material, large stones or other objects that may be detrimental to the pipe or the embedment materials. Compaction shall be achieved with suitable equipment capable of achieving the compaction requirements. The equipment shall not damage the pipe, manhole, or related structure, or disturb the grade line of each. The contractor shall ensure there is sufficient cover over the pipe to facilitate construction operations such as compaction of the backfill over the culvert.

5.11 Temporary Excavations

Based on Golder's understanding of the general soil conditions (silty gravelly sand to sandy silty gravel), temporary shallow excavations up to 3.0 m depth should be sloped no steeper than 1H:1V with no vertical section at the toe of the excavation. Deeper excavations should be subject to detailed slope stability analysis, or stabilized using temporary shoring systems. Golder can provide further details on suitable shoring systems and associated design considerations, if required. All trenching and excavations should be carried out according to the latest version of British Columbia Occupational Health and Safety Regulations (OH&S). Specifically, Part 20 of the OH&S regulations deals with excavations.

Based on groundwater conditions observed during the drilling investigation, seepage within temporary excavations may be expected. Seepage should be handled by pumping from properly filtered sumps within the excavation. Groundwater levels should be further assessed before commencing excavations and monitored at the time of construction.

All excavations should be reviewed by a qualified geotechnical engineer in the field to confirm that soil and groundwater conditions are as anticipated. Specific ground conditions encountered may require adjustments to temporary slopes from the general recommendations provided above.

Stockpiling of materials should not take place within 3 m of the crest of excavations so as to not compromise stability of the excavation. Control of surface water should be maintained at all times and surface water should be directed away from all excavations and exposed subgrade soils.

5.12 Sign Foundation

It is understood that a major sign is proposed near km 22.46 along the east side of the highway. The subsurface conditions at the proposed sign foundation location are inferred to comprise compact to dense sandy silty gravel to sandy gravelly silt (borehole AH15-12 drilled to 5.6 mbgs located about 35 m away from the proposed sign location). Cobbles and boulders are anticipated to be present in the sand and gravel deposit. Groundwater was not encountered in borehole AH15-12 at the time of drilling.

Based on the inferred subsurface conditions, shallow or deep foundations may be considered. However, for the purpose of this report, it is understood that the preferred foundation type is deep foundations. Based on the inferred subsurface conditions, indicating presence of cobbles and boulders and high SPT blow counts (i.e. N=48 and 50 at 4 mbgs) encountered within the granular soils at relatively shallow depths, driven piles may be difficult to install to sufficient depths and have not been included in the recommendations for deep foundations. Recommendations for CIP concrete piles are provided.

Bored straight shaft CIP concrete piles (CIP piles) are considered feasible for foundation support for the proposed sign, provided appropriate geotechnical design and construction considerations are made.

For design purposes, the recommended unfactored ULS skin friction value for the design of CIP piles is given in Table 10. For pile design, end bearing is not considered. The design values have been estimated based on current conventional engineering practice, as described in CFEM. A geotechnical resistance factor (ϕ) of 0.4 should be applied for axial compression loading based on static parameters. For pile design under uplift condition, end bearing should not be considered when resisting uplift forces, and a resistance factor (ϕ) of 0.3 should be used.

Table 10: Recommended ULS Pile Design Parameters for CIP

Structure	Soil Stratum	Unfactored ULS Skin Friction q_s (kPa)
Sign Foundation	Compact to Dense Sandy Silty Gravel to Sandy Gravelly Silt	50

Note:

* Piles extending into gravelly and sandy soils below groundwater table should be designed as skin friction piles only.

5.12.1 Construction Considerations for CIP Concrete Piles

- Cobbles and boulders likely exist at the sign foundation location, which could result in problems during pile installation if encountered. The ground conditions, pile type, and installation methods should be evaluated by a qualified piling contractor with experience in similar soil conditions prior to beginning construction.
- Groundwater seepage and sloughing may be expected during installation of concrete CIP piles. Temporary casings will likely be required within the sand and gravel soils for the construction of these piles. The installation of casing should be completed in a manner that minimises disturbance of the soils around the casing pipe, particularly near ground surface. The piling contractor should be prepared to remove any loose or wet material prior to placing the concrete.
- Concrete should be placed during one continuous operation. Concrete should be placed using appropriate methods such that sloughing or collapse of the soil will not occur, which may contaminate/weaken the structural concrete of the completed pile. For wet holes at the time of concrete placement, tremmied concrete will likely be required.
- Full-time review by qualified geotechnical personnel during pile installation is recommended to maintain installation records. These records should include pile dimensions, bearing depth, encountered subsurface conditions, groundwater seepage, casing size and depth installed, and other relevant information.

5.12.2 General Pile Design Recommendations

For the design of single piles, SLS is not considered relevant as the anticipated settlement of individual piles is anticipated to be less than 15 mm. The design of pile groups may be governed by SLS conditions and further analysis will be required. A settlement analysis of pile groups can be completed by Golder upon request and upon submittal of detailed design information (number of piles, pile spacing, load conditions).

For the determination of axial pile capacity it is recommended that the skin friction be ignored in the upper 2.0 m below final grade due to the potential disturbance effects associated with frost, desiccation and construction.

5.12.2.1 Axial Capacity Reduction due to Group Effects

Piles spaced at greater than 2.5 pile diameters (center-to-center) can be assumed for preliminary design purposes to act as single piles, with no group interaction effects with regards to axial capacity. For piles spaced at less than 2.5 pile diameters, the ultimate axial pile capacity should be reduced using the following group reduction factors:

- 1.0 for piles at a spacing of 2.5 diameters or more;
- 0.7 for piles at a spacing of 1.5 diameters or more; and
- 0.55 for piles at a spacing of 1.25 diameters.

Group reduction factors for other pile spacing may be interpolated from the values above or Golder can provide reduction factors based on the proposed pile layout.

5.12.2.2 Downdrag Loads

Depending on the grading and loading conditions on site, downdrag loads should be assessed and may need to be considered in the pile design. Downdrag has no effect on the geotechnical axial capacity of deep foundations, however needs to be considered when evaluating the structural limit state of the foundation. Golder should be consulted to assist in evaluation of the downdrag loads.

5.12.2.3 Uplift Resistance of Pile Foundations

5.12.2.3.1 Single Piles

The design uplift resistance of a single straight shaft pile may be calculated using only the shaft resistance and the weight of the pile itself, and applying a resistance factor of 0.3 as per NBCC (2010).

5.12.2.3.2 Pile Groups

The ultimate uplift resistance of a pile group may be taken as the lesser of: (i) the sum of the individual pile uplift resistance or, (ii) the weight of the block of soil and concrete within the pile group, with no contribution from the soil shear strength along the assumed vertical uplift failure plane. A resistance factor of 0.3 should be applied to the ultimate group capacity to obtain the factored ultimate uplift resistance at ULS of the group.

5.12.2.4 Uplift Forces Due to Adfreeze Stress

An adfreeze stress of 65 kPa acting along the pile shaft down to the estimated frost depth of 3.0 m is recommended for concrete and steel piles, respectively. Where frost-jacking and transient uplift loads (such as wind loads) occur simultaneously, these two loads need not be considered together and the larger of the two should be used. Where piles are to be installed to shallower depths than required for frost resistance, rigid insulation may be used to reduce the frost penetration depth.

5.12.2.5 Lateral Resistance

The design of piles subjected to lateral loads should take into account factors such as the rigidity of the pile relative to surrounding soil, fixity condition at the pile head, structural capacity of the pile to withstand bending moments, mobilization of soil resistance, tolerable deflection at the pile head, and pile group effects.

Lateral resistance of ground is usually developed within the upper 4 to 6 m of the pile below ground surface. It is important that any gaps that may develop during pile installation between the ground and pile be filled to provide good contact between the ground and pile. If not, the lateral resistance of a vertical pile will be reduced significantly. Soil parameters for sandy silty gravel and sandy gravelly silt encountered within the upper 6 m (below ground surface) are provided in Table 11.

Table 11: Soil Parameters for Estimating Ultimate Lateral Pile Capacity

Soil Stratum	Bulk Unit Weight, γ (kN/m^3)	Coefficient of Horizontal Subgrade Reaction, k_s (MPa/m)[(a)]
Sandy Silty Gravel	20	6.6 z/d
Gravelly Sandy Silt	20	11 z/d

Note:

[(a)] d = pile diameter (m)

A resistance factor of 0.5 should be applied to the ultimate lateral pile capacity to calculate the factored capacity.

The coefficient of horizontal subgrade reaction when applied over a specific area provides a spring constant that is commonly used to model load deformation response of a pile subjected to lateral load. The lateral ground movement is given by the spring constant, which is bounded (limited) by a maximum lateral capacity (load) where there is no further increase in resistance with increasing lateral movement. This limiting value (ultimate lateral load capacity) corresponds to full mobilization of the passive resistance of the ground. Because of the lateral ground movement required to fully mobilize ULS lateral resistance, SLS criteria generally govern lateral resistance and should be considered as per the structural design specifications.

Group interaction effects should be considered when the piles in the direction of the applied loading are spaced at less than eight pile diameters. For pile spacing of three times the pile diameter or less a subgrade reduction factor of 0.25 should be applied to the coefficient of horizontal subgrade reaction value given in Table 11. For pile spacing of four and six times the pile diameter, the reduction factors become 0.4 and 0.7, respectively. For pile spacing of eight times the pile diameter and higher no reduction factor is required (i.e. the factor is 1.0). These reduction factors should be applied to all piles within the group, with the exception of the lead (first) piles, where no reduction factor is required. Golder should be given the opportunity to review and provide input to final design, should group interaction effects of laterally loaded piles be considered relevant.

6.0 CEMENT TYPE AND CORROSION POTENTIAL

Corrosion testing was conducted by ALS Laboratory Group in Calgary, Alberta, on soil samples from four boreholes (BH16-02, BH16-11, BH16-13 and BH16-14) for water soluble sulphate contents, resistivity, chlorides and pH. A summary of the corrosion test results are provided in Table 12 and shown in the Record of Borehole Sheets in Appendix A, and the Laboratory Testing Results (ALS Environmental Analytical Report) in Appendix B.

Table 12: Summary of Soil Corrosion Results

Borehole	Sample No.	Depth Below Ground Surface (m)	Resistivity (ohm-cm)	pH	Chloride (mg/L)	Sulphate Content (%)	Cement Type[a]
BH16-02	GB5	1.8 – 3.0	4400	7.91	251	0.01	GU[b]
BH16-11	GB5	2.3 – 3.0	6600	6.55	171	0.01	GU[b]
BH16-13	SS4&AS5	1.5 – 3.0	3480	7.12	583	0.001	GU[b]
BH16-13	GB7	3.5 – 4.6	14000	7.94	114	0.002	GU[b]
BH16-14	SS3&BS4	1.5 – 3.0	6470	7.72	168	0.005	GU[b]

Note:

[a] Cement type based on Table CSA A23.1 - Table 3 (Canadian Standards Association, Concrete Materials and Methods of Concrete Construction).

[b] Cement Type GU: General Use.

The soluble sulphate content test results ranged between 0.001% (16 mg/L) to 0.01% (119 mg/L) indicating negligible potential for sulphate attack. Based on the degree of exposure to sulphate attack following the Canadian Standards Association's Concrete Materials and Methods of Concrete Construction Recommendations, General Use (GU) Portland cement may be considered.

Imported soils should be tested for compatibility with recommended cement types. These recommendations are based on limited laboratory testing and limited review of available literature. A detailed analysis of concrete durability or performance properties or concrete material evaluation was beyond the scope of work of this project.

The test data provided in Table 12 should be reviewed by material manufacturers, supplier/installers and designers to provide suitable recommendations for corrosion protection of construction materials, if required. Imported fill that will be in contact with structures should also be tested.

7.0 FUTURE GEOTECHNICAL WORK

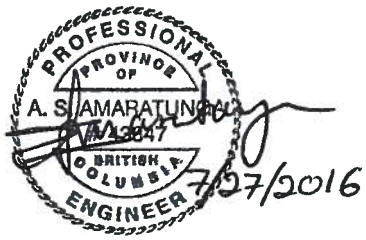
Where geotechnical recommendations are made, requiring design changes to either Phase 1 or Phase 2 of the work or where design is different than described herein, further geotechnical analysis may be required. As noted in Section 5.5, further investigation of the extent and existence of peat within the road widening should be completed to further delineate the required footprint of the recommended preload.

8.0 CLOSURE

We trust that the information presented in this report meets your present requirements. If you have any questions, please contact the undersigned at your convenience.

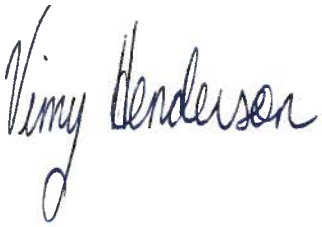
Yours truly,

GOLDER ASSOCIATES LTD.



Anupama Amaratunga, M.Sc., P.Eng.
Geotechnical Engineer

Cory Smith, P.Eng.
Principal, Senior Geotechnical Engineer



Vimy Henderson, Ph.D., P.Eng. (ON)
Pavement and Materials Engineer

VH/LU/AA/CS/sb

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

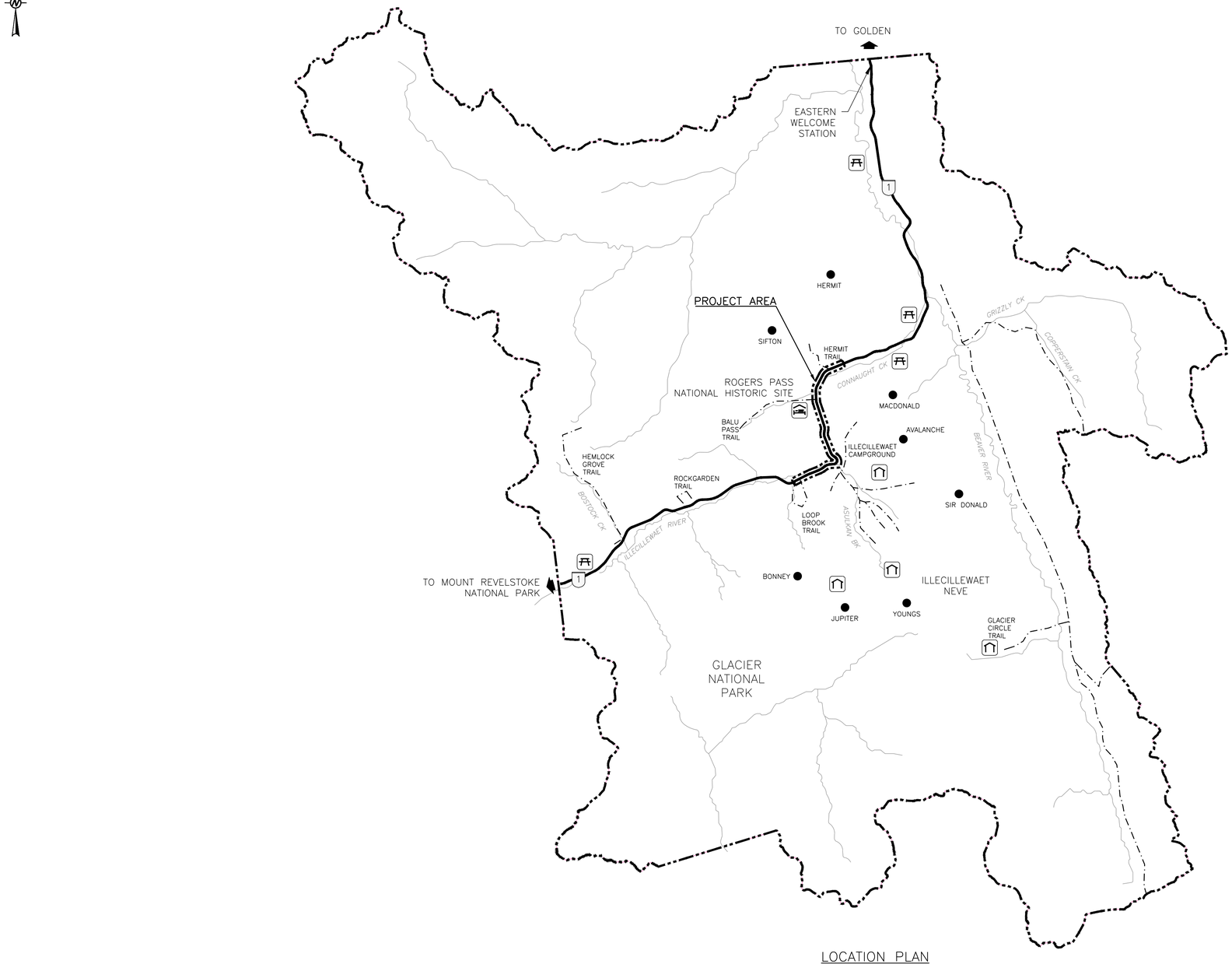
During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

FIGURES

Figure 1: Site Location Plan
Figures 2-1 to 2-6: Borehole Location Plan



LOCATION PLAN

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REFERENCE(S)
ORIGINAL DWG FILE No. 2511-00581-0-001
OBTINED AFROM CLIENT, DATED 2016.02.26

CLIENT
Parks Canada Agency
Western and Northern Region

L'Agence Parcs Canada
Ouest et Nord Région

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT
ROGERS PASS - ILLECILLEWAET CURVE

TITLE
LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0008	A	1

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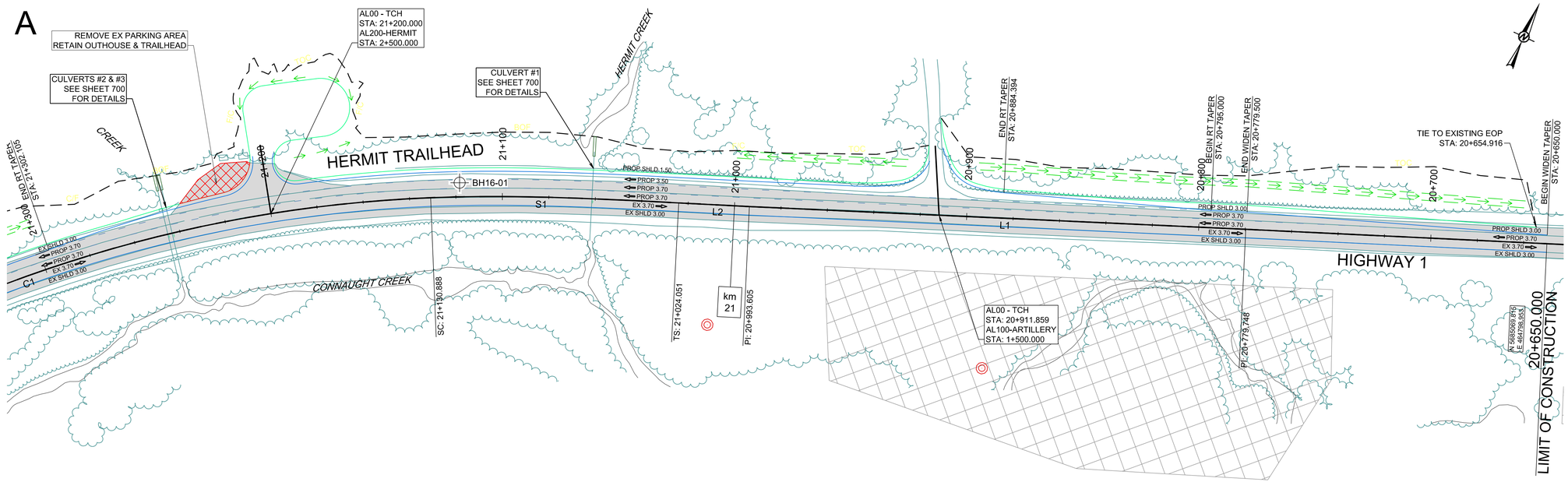

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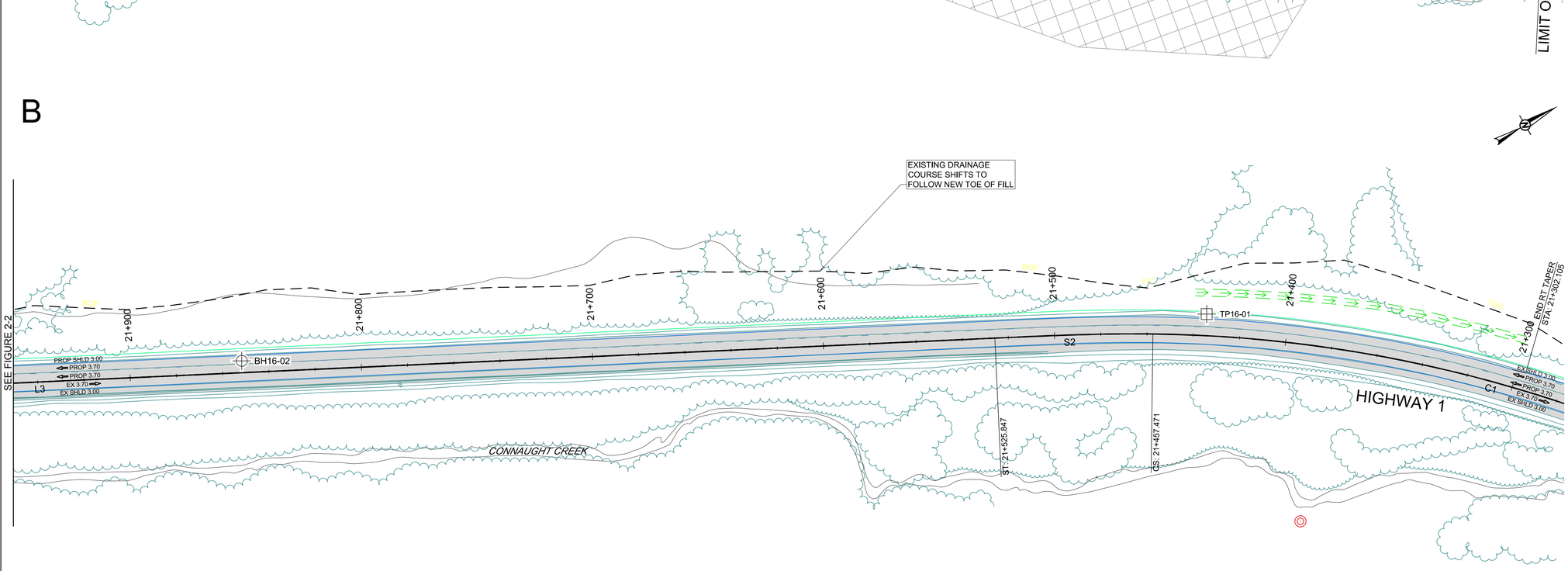

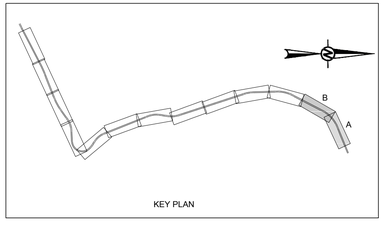

KEY PLAN

NOTE(S)

ALIGNMENT ABBREVIATIONS

BP - ALIGNMENT BEGINNING
EP - ALIGNMENT END
PC - POINT OF CURVATURE
PT - POINT OF TANGENCY
TC - TANGENT TO CURVE
CS - CURVE TO SPIRAL
SC - SPIRAL TO CURVE
CT - CURVE TO TANGENT
TS - TANGENT TO SPIRAL
ST - SPIRAL TO TANGENT
BVC - BEGINNING OF VERTICAL CURVE
EVC - END OF VERTICAL CURVE
PVI - POINT OF VERTICAL INTERSECTION
ELEV - ELEVATION
PI - POINT OF INTERSECTION
STA - STATION

MISCELLANEOUS ABBREVIATIONS

SHLD - SHOULDER
EOP - EDGE OF PAVEMENT
EX. - EXISTING
GP - GUN PLATFORM
CSP - CORRUGATED STEEL PIPE
R/W - RIGHT OF WAY

REFERENCE(S)

ORIGINAL DWG FILE No. 2511-00581-0-107
OBTAINED FROM CLIENT, DATED 2016.02.26

LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
	BOTTOM OF FILL	B.O.F.
	TOP OF CUT	T.O.C.
	DITCH	
	DRAINAGE FLOW DIRECTION	
	RETAINING WALL	RETAINING WALL
	LIGHT STANDARD	
	OVERHEAD POWER POLE	
	TREE LINE	
	CULVERT	
	CULVERT END	
	2015 BOREHOLE (PRELIMINARY INVESTIGATION)	
	2016 BOREHOLE (DETAILED INVESTIGATION)	
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	

1:1,000 0 25 50 METRES

CLIENT
Parks Canada Agency
Western and Northern Region
L'Agence Parcs Canada
Ouest et Nord Région

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT
ROGERS PASS - ILLECILLEWAET CURVE

TITLE
BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0001	A	2-1

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A

B

INSTALL NEW CULVERT P-1 SEE SHEET 700 FOR DETAILS
INSTALL GATE CONTROLLED ACCESS
TIE TO EXISTING STA: 22+514.970
CONNAUGHT CREEK
END RAMP TAPER STA: 22+346.335
CULVERT #5 SEE SHEET 700 FOR DETAILS
TIE TO EXISTING STA: 22+352.448
BEGIN RT TAPER STA: 22+272.739
BEGIN MED TAPER STA: 22+406.790
PROPOSED VEHICLE PONDING AREA
PROP 3.30 (TYP LANES)
PROP SHLD 1.50
PROP 3.50
PROP SHLD 3.00
PROP 3.70
EX 3.70
EX SHLD 3.00
22+200
22+300
22+400
22+500
22+600
22+100
22+000
CULVERT #4 SEE SHEET 700 FOR DETAILS
BEGIN RAMP TAPER STA: 22+116.877
AH15-13
BH16-03
END LT TAPER STA: 22+599.000
END RT TAPER STA: 22+560.300
BEGIN LT TAPER STA: 22+540.000
END MED TAPER STA: 22+522.045
EX SHLD VARIES
PROP 3.50
PROP 3.70
PROP SHLD 1.50
AH15-12
MAINTENANCE YARD SUBSTATION
ST: 22+472.920
BEGIN MED TAPER STA: 22+406.790
END MED & RT TAPER STA: 22+406.790
CS: 22+406.790
TIE TO EXISTING STA: 22+233.285
SUMMIT EAST GP
SC: 22+183.007
TS: 22+116.877
CONNAUGHT CREEK
HIGHWAY 1
km 22
PI: 21+983.842
SEE FIGURE 2-1
C2
S3
S4
L4
L3
L5

INSTALL GATE CLOSE ACCESS
CULVERT #6 SEE SHEET 700 FOR DETAILS
END MED TAPER STA: 23+113.708
BEGIN MED TAPER STA: 23+031.663
END RT TAPER STA: 23+088.532
TIE TO EXISTING STA: 22+927.364
BEGIN RT TAPER STA: 22+925.000
TS: 22+904.120
AL00 - TCH STA: 22+737.023
AL300-SUMMIT STA: 3+500.000
SUMMIT
AH15-11
AH15-10
TP16-02
BH16-04
SEE FIGURE 2-3
HIGHWAY 1
CS: 23+031.663
BEGIN RT TAPER STA: 23+015.000
SC: 22+986.166
km 23
BEGIN LT TAPER STA: 22+910.000
TIE TO EXISTING STA: 22+901.886
END RT TAPER STA: 22+870.870
END LT TAPER STA: 22+860.000
SUMMIT SOUTH GP
OVERHEAD POWER POLES TO BE REMOVED BY OTHERS
PARKS MAINTENANCE YARD
23+100
23+200
23+000
22+900
22+800
22+700
22+600
C3
S5
S6
L6
L5

KEY PLAN

NOTE(S)

ALIGNMENT ABBREVIATIONS
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- SC - SPIRAL TO CURVE
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- ST - SPIRAL TO TANGENT
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- PI - POINT OF INTERSECTION
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MISCELLANEOUS ABBREVIATIONS
- SHLD - SHOULDER
- EOP - EDGE OF PAVEMENT
- EX. - EXISTING
- GP - GUN PLATFORM
- CSP - CORRUGATED STEEL PIPE
- R/W - RIGHT OF WAY

REFERENCE(S)

ORIGINAL DWG FILE No. 2511-00581-0-107
OBTAINED FROM CLIENT, DATED 2016.02.26

LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
	BOTTOM OF FILL	B.O.F.
	TOP OF CUT	T.O.C.
	DITCH	
	DRAINAGE FLOW DIRECTION	
	RETAINING WALL	RETAINING WALL
	LIGHT STANDARD	
	OVERHEAD POWER POLE	
	TREE LINE	
	CULVERT	
	CULVERT END	
	2015 BOREHOLE (PRELIMINARY INVESTIGATION)	
	2016 BOREHOLE (DETAILED INVESTIGATION)	
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	

0 25 50
1:1,000 METRES

CLIENT
Parks Canada Agency
Western and Northern Region
L'Agence Parcs Canada
Ouest et Nord Région

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT
ROGERS PASS - ILLECILLEWAET CURVE

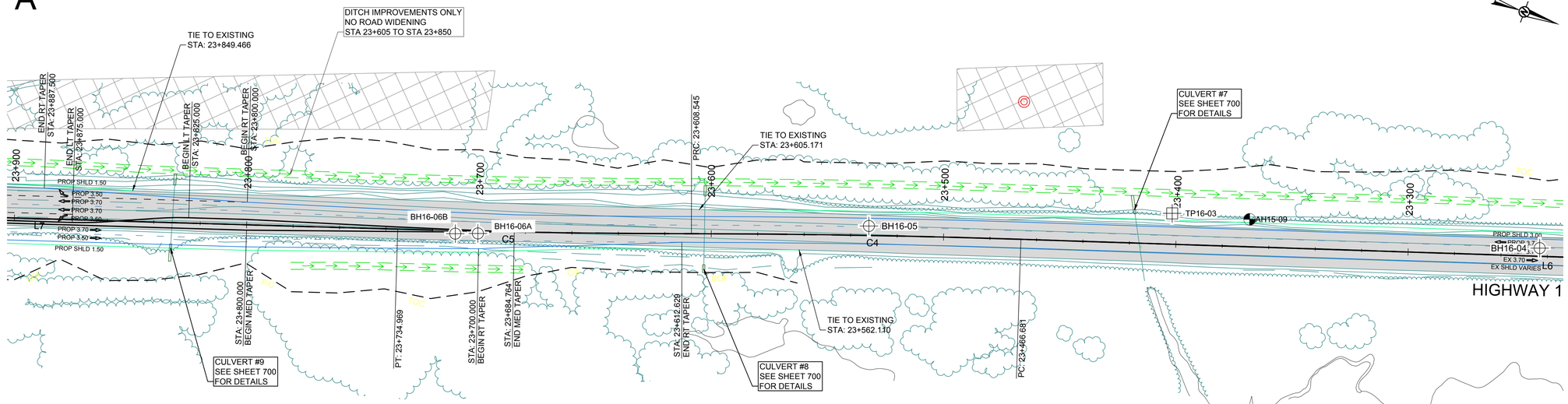
TITLE
BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0002	A	2-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 25 mm

Path: \\golder.gds\calgary\EDCAD\2016\1654325\PRODUCTION\FIGURES\ | File Name: 1538990-1000-BG-0002.dwg

A



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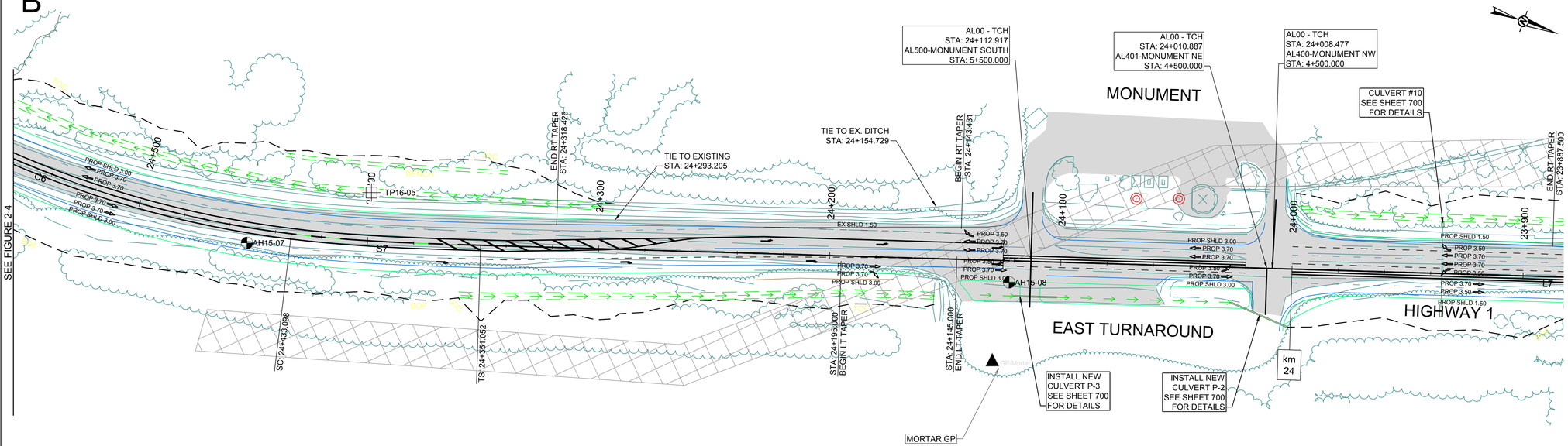
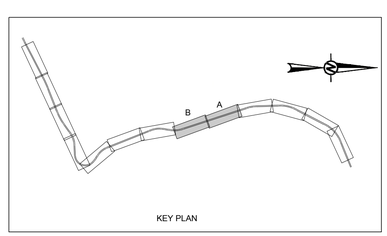


LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
	BOTTOM OF FILL	B.O.F.
	TOP OF CUT	T.O.C.
	DITCH	
	DRAINAGE FLOW DIRECTION	
	RETAINING WALL	RETAINING WALL
	LIGHT STANDARD	
	OVERHEAD POWER POLE	
	TREE LINE	
	CULVERT	
	CULVERT END	
	2015 BOREHOLE (PRELIMINARY INVESTIGATION)	
	2016 BOREHOLE (DETAILED INVESTIGATION)	
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	



NOTE(S)

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EOP - EDGE OF PAVEMENT
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GP - GUN PLATFORM
CSP - CORRUGATED STEEL PIPE
R/W - RIGHT OF WAY

REFERENCE(S)

ORIGINAL DWG FILE No. 2511-00581-0-107
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0 25 50
1:1,000 METRES

CLIENT

Parks Canada Agency
Western and Northern Region

L'Agence Parcs Canada
Ouest et Nord Région

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT

ROGERS PASS - ILLECILLEWAET CURVE

TITLE

BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0003	A	2-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

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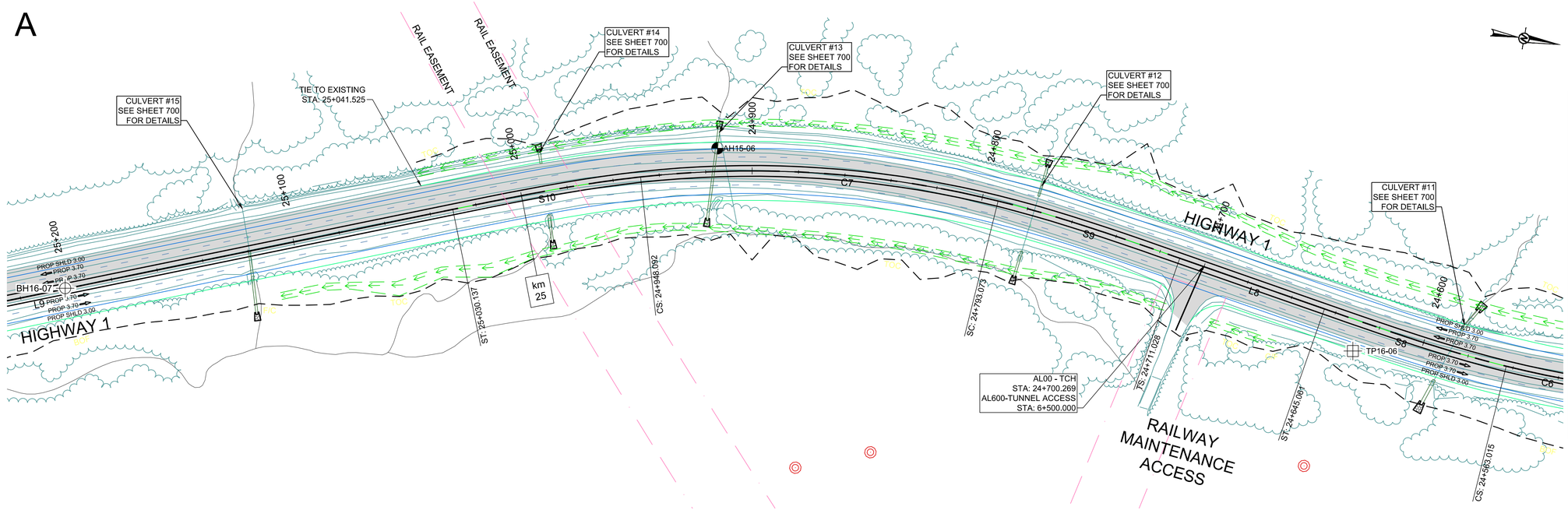

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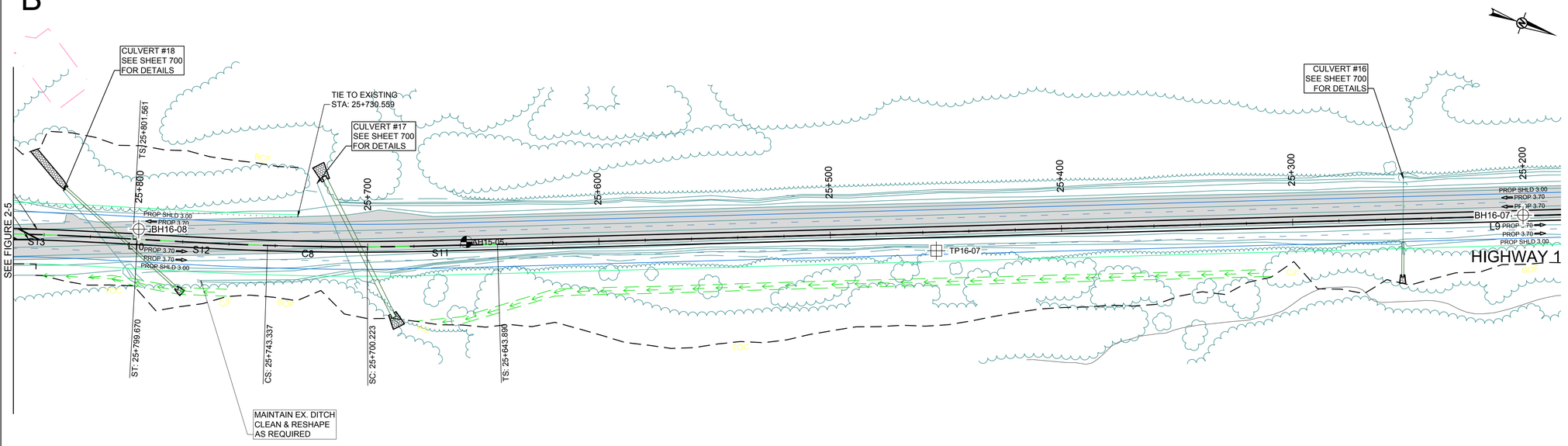

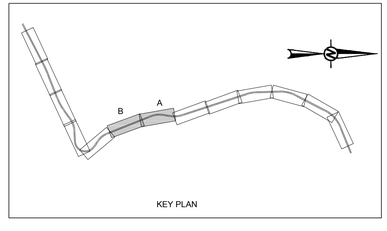

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- SC - SPIRAL TO CURVE
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- ST - SPIRAL TO TANGENT
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- EVC - END OF VERTICAL CURVE
- PVI - POINT OF VERTICAL INTERSECTION
- ELEV - ELEVATION
- PI - POINT OF INTERSECTION
- STA - STATION

MISCELLANEOUS ABBREVIATIONS

- SHLD - SHOULDER
- EOP - EDGE OF PAVEMENT
- EX. - EXISTING
- GP - GUN PLATFORM
- CSP - CORRUGATED STEEL PIPE
- R/W - RIGHT OF WAY

REFERENCE(S)

ORIGINAL DWG FILE No. 2511-00581-0-107
OBTAINED FROM CLIENT, DATED 2016.02.26

LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
	BOTTOM OF FILL	B.O.F.
	TOP OF CUT	T.O.C.
	DITCH	
	DRAINAGE FLOW DIRECTION	
	RETAINING WALL	RETAINING WALL
	LIGHT STANDARD	
	OVERHEAD POWER POLE	
	TREE LINE	
	CULVERT	
	CULVERT END	
	2015 BOREHOLE (PRELIMINARY INVESTIGATION)	
	2016 BOREHOLE (DETAILED INVESTIGATION)	
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	

SEE FIGURE 2-3

1:1,000 — 0 25 50 METRES

CLIENT

Parks Canada Agency
Western and Northern Region

L'Agence Parcs Canada
Ouest et Nord Région

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT

ROGERS PASS - ILLECILLEWAET CURVE

TITLE

BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0004	A	2-4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

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A

CLOSE MEDIAN ACCESS
REMOVE ASPHALT
& JOIN DITCH

AL00 - TCH
STA: 26+432.932
AL700-ILL CAMP
STA: 7+500.000

CULVERT #20
SEE SHEET 700
FOR DETAILS

CULVERT #19
SEE SHEET 700
FOR DETAILS

RETAIN EX
CONCRETE BARRIER

RELOCATE & RE-INSTALL
EX CONCRETE BARRIER

TIE TO EXISTING
STA: 26+171.359

℄ ALIGNMENT & PROFILE
ARE ILLUSTRATED FOR REFERENCE.
EACH CARRIAGEWAY IS CONTROLLED
INDEPENDENTLY.
SEE DRAWINGS 115 TO 119.

RAIL R/W

RAIL R/W

GODDARD GP
TO BE RELOCATED
(BY OTHERS)

TIE TO AL01 (WB)
STA: 25+843.093

TIE TO AL02 (EB)
STA: 25+846.560

BOF

TOC

BH16-10

AH15-04

BH16-09

C10

C9

S13

S14

S15

L11

26+200

26+300

26+400

26+500

26+600

25+900

PROP SHLD 3.00
PROP 3.70
PROP 3.70
EX 3.70
EX SHLD 3.00
EX SHLD VARIES
EX SHLD 1.50

ILLECILLEWAET
CAMPGROUND

HIGHWAY 1

SC: 26+359.172

TS: 26+163.078

ST: 26+119.923

CS: 26+126.973

MAINTAIN EX. DITCH
CLEAN & RESHAPE
AS REQUIRED

km
26

TIE TO EXISTING
STA: 25+922.404

SC: 25+881.783

SEE FIGURE 2-4

B

ILLECILLEWAET RIVER

START RETAINING WALL
STA: 27+100.000

CULVERT #24
SEE SHEET 700
FOR DETAILS

RETAINING
WALL

TIE TO EXISTING
STA: 27+009.259

SC: 27+005.681

CULVERT #23
SEE SHEET 700
FOR DETAILS

27+100

27+000

26+900

26+800

26+700

26+600

26+500

26+400

C11

C10

S17

S16

L12

TIE TO AL02 (EB)
STA: 27+100.000

AH15-03

km
27

TS: 26+925.489

CS: 26+762.454

CULVERT #22
SEE SHEET 700
FOR DETAILS

CULVERT #21
SEE SHEET 700
FOR DETAILS

END CONCRETE BARRIER
STA: 26+820.000

CLOSE MEDIAN ACCESS
REMOVE ASPHALT
& JOIN DITCH

RELOCATE & RE-INSTALL
EX CONCRETE BARRIER

RETAIN EX
CONCRETE BARRIER

ILLECILLEWAET RIVER

HIGHWAY 1

ASULKAN

AL00 - TCH
STA: 26+793.747
AL800-ASULKAN
STA: 8+500.000

ST: 26+765.563

RETAIN EX
CONCRETE BARRIER

SEE FIGURE 2-6

CULVERT #20
SEE SHEET 700
FOR DETAILS

AL00 - TCH
STA: 26+432.932
AL700-ILL CAMP
STA: 7+500.000

CLOSE MEDIAN ACCESS
REMOVE ASPHALT
& JOIN DITCH

LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
	BOTTOM OF FILL	B.O.F.
	TOP OF CUT	T.O.C.
	DITCH	
	DRAINAGE FLOW DIRECTION	
	RETAINING WALL	RETAINING WALL
	LIGHT STANDARD	
	OVERHEAD POWER POLE	
	TREE LINE	
	CULVERT	
	CULVERT END	
	2015 BOREHOLE (PRELIMINARY INVESTIGATION)	
	2016 BOREHOLE (DETAILED INVESTIGATION)	
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	

0 25 50
1:1,000 METRES

KEY PLAN

NOTE(S)

ALIGNMENT ABBREVIATIONS

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R/W - RIGHT OF WAY

REFERENCE(S)

ORIGINAL DWG FILE No. 2511-00581-0-107
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CLIENT

Parks Canada Agency
Western and Northern
Region

L'Agence Parcs
Canada
Ouest et Nord Région

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-07-26
DESIGNED	TF
PREPARED	AW
REVIEWED	AA
APPROVED	CS

PROJECT
ROGERS PASS - ILLECILLEWAET CURVE

TITLE
BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0005	A	2-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

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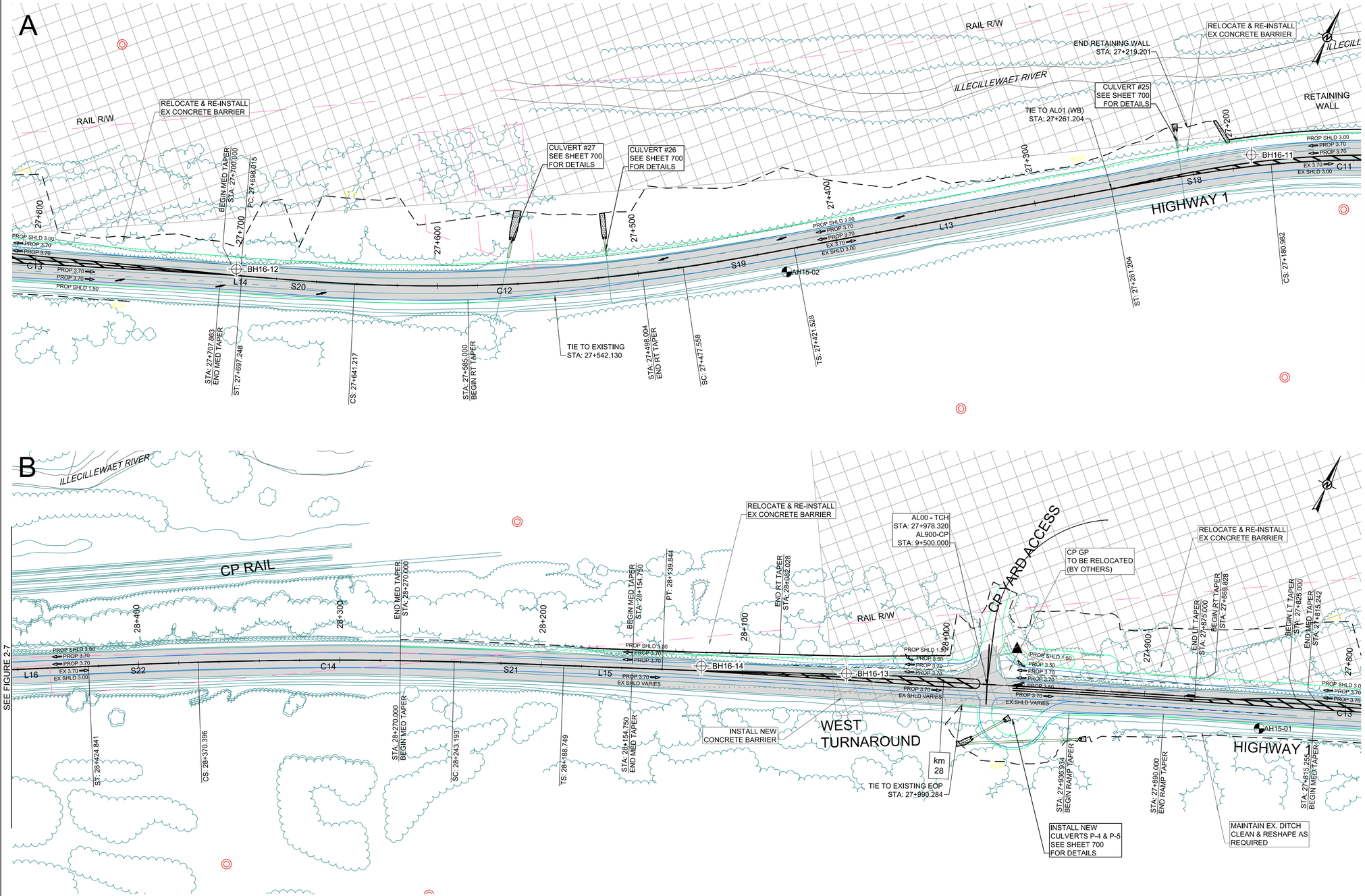

LEGEND

ROAD CONSTRUCTION

EXISTING	DESCRIPTION	PROPOSED
	KM MARKER	km 21
	CONTROL LINE AND STATIONING	21+500
	ALIGNMENT TIE POINTS & STATIONING	ST 21+525.847
	EXISTING PAVED ROAD	
	EDGE OF GRAVEL SHOULDER	
	EDGE OF ROAD	
	ARCHAEOLOGICAL SITE (GENERAL AREA)	
	CLEARING	
	REMOVALS	
	ARCHAEOLOGICAL SITE	
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	DITCH	
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	CULVERT	
	CULVERT END	
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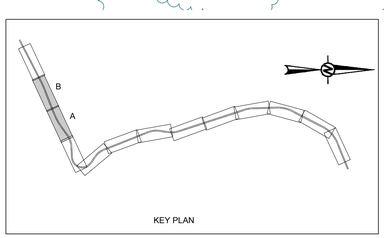
	2016 TEST PIT	
	LANE INFORMATION	PROP 3.70
	ALIGNMENT SEGMENT LABEL	C2
	CURVE INFO (NON ALIGNMENT)	C203
	GUN PLATFORM	
	CONCRETE BARRIER	
	CLEARING LIMIT DAYLIGHT	
1210	CONTOUR	
	SIGN	



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PROJECT
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TITLE
BOREHOLE AND TEST PIT LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1654325	1000-BG -0006	A	2-6

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0 25 mm

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APPENDIX A

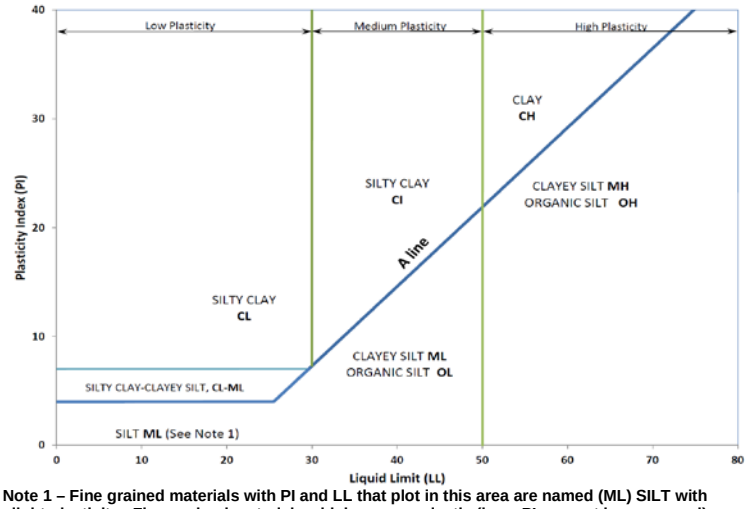
Method of Soil Classification
Abbreviations and Terms used on Records of Boreholes and Test Pits
List of Symbols
Record of Borehole Sheets AH15-01 to AH15-12
Record of Borehole Sheets BH16-01 to BH16-14
Record of Test Pit Sheets TH16-01 to TH16-07
Table A1 – Subsurface Conditions Encountered in Hand Auger Holes

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil		Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
					Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)		Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
					Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
					Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
				Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
					None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)		Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
				Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
				Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures								30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat								75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5679425.35 E: 463718.20 Zone: 11U

RECORD OF BOREHOLE: AH15-01

DRILLING DATE: Sept 29, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl; NP - Non-Plastic)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -; Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002 GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0			Ground Surface		1158.81															
			TOPSOIL		1158.66															
		Solid Stem Auger	(SM) gravelly SILTY SAND; brown; non-cohesive, compact.		0.15	1	SS	54	10			0	84	16						
					1158.05	2	AS													
1	B-80 Truck Mounted Drill		(SM) gravelly SILTY SAND; light brown; inferred cobbles and boulders; non-cohesive, moist, compact.		0.76															
2																				
3		Odex Downhole Hammer			1155.76															Inferred Water Table 3m Sept 29, 2015
			(ML) SILT, some sand, some gravel; dark brown; non-cohesive, loose to compact.		3.05	3	SS	42	7											
4						4	BS										NP			
					1154.24															
			(CL/ML) SILTY CLAY to CLAYEY SILT, some sand, some gravel; dark brown; cohesive, stiff.		4.57	5	SS	13	10											
5					1153.63															
			End of Borehole.		5.18															
6			Notes: Borehole backfilled with cuttings and bentonite seal at ground surface.																	
7																				
8																				
9																				
10																				

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5679605.26 E: 464093.21 Zone: 11U

RECORD OF BOREHOLE: AH15-02

DRILLING DATE: Sept 29, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -, Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1175.12													
0	B-80 Truck Mounted Drill / Odex Downhole Hammer	FILL		1174.97													
		(SM) gravelly SILTY SAND; brown; non-cohesive, loose to compact.		0.15	1	SS	50	7		18	61	21					
				1174.21													
1		(SM) SILTY SAND some gravel; light brown; non-cohesive, moist, inferred compact.		0.91	2	BS											
2		--- Inferred cobbles and boulders from 1.8 m															
3				1172.07													
		(SM) SILTY SAND & GRAVEL; brown; Inferred cobbles and boulders; non-cohesive, dense to very dense.		3.05	3	SS	46	>50									
4					4	BS											
					5	SS	29	>50									
5				1169.94													
		End of Borehole.		5.18													
		Notes: Borehole backfilled with cuttings and bentonite seal at ground surface.															
6																	
7																	
8																	
9																	
10																	

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5679794.23 E: 464450.48 Zone: 11U

RECORD OF BOREHOLE: AH15-03

DRILLING DATE: Oct 1, 2015

SHEET 1 OF 1

DATUM: NAD 83

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl; NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -; Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
			Ground Surface		1190.88													
0	B-80 Truck Mounted Drill	Odex Downhole Hammer	(SM) gravelly SILTY SAND; brown; non-cohesive, compact.		0.00	1	SS	75	15		23	59	18					
					1189.97													
1			(GM) Sandy SILTY GRAVEL; brown; non-cohesive, compact.		0.91													
2						2	SS	75	23									
					1188.44													
			(SM) SILTY SAND, some gravel; light brown; non-cohesive, moist to wet, inferred compact.		2.44													
					1188.14													
3			(ML) SILT, some sand, some gravel; light brown; non-cohesive, dense to very dense.		2.74	3	SS	54	>50									
					1187.50													
			(SP) gravelly SAND; brown; inferred cobbles and boulders; non-cohesive, wet, dense to very dense.		3.38													
4																		
5																		
6					1184.79													
			End of Borehole.		6.10													
7			Notes: Borehole backfilled with cuttings and bentonite seal at ground surface.															
8																		
9																		
10																		

Inferred Water Table 2.45m Sept 29, 2015

DEPTH SCALE
1 : 50

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

Golder Associates

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5680414.72 E: 464530.65 Zone: 11U

RECORD OF BOREHOLE: AH15-04

DRILLING DATE: Oct 1, 2015

SHEET 1 OF 1

DATUM: NAD 83

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic; SHEAR STRENGTH Cu, kPa; nat V. +, rem V. ⊕, Pocket Pen -; Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002 GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
			Ground Surface		1241.93														
0	B-80 Truck Mounted Drill	Odex Downhole Hammer	(SM) gravelly SILTY SAND; grey to brown; inferred cobbles; non-cohesive, dense.		0.00	1	SS	92	50		32	48	20						
					1241.02														
1			(SM) SILTY SAND; light brown; non-cohesive, moist, inferred loose.		0.91														
					1240.41														
			(PT) SILTY PEAT; dark brown; non-cohesive, inferred loose.		1.52	2	SS	0	5										
2																			
					1239.19														
			(ML) Sandy Gravelly SILT; brown; non-cohesive, moist to wet, dense.		2.74														
3						3	SS	4	33										
4																			
					1237.06	4	SS	92	35										
5			(SP-SM) SAND to SILTY SAND, some fines; brown; non-cohesive, moist, dense.		4.88														
					1236.75														
			End of Borehole.		5.18														
6			Notes: Borehole backfilled with cuttings and bentonite seal at ground surface.																
7																			
8																			
9																			
10																			

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5680676.79 E: 464450.94 Zone: 11U

RECORD OF BOREHOLE: AH15-05

DRILLING DATE: Sept 30, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SAMPLES: BLOWS/0.3m	WATER CONTENT PERCENT / SHEAR STRENGTH Cu, kPa	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1258.26														
0	B-80 Truck Mounted Drill / Odex Downhole Hammer	Asphalt		0.00														
				1257.65														
		(SP) gravelly SAND, some fines; grey to brown; non-cohesive, compact to dense.		0.61	1	SS	50	25		29	63	8						Inferred Water Table 0.61m Sept 30, 2015
1																		
2					2	SS	12	>50										
3				1255.21														
		(SM/GM) SILTY SAND and GRAVEL; brown; non-cohesive, inferred dense.		3.05	3	BS												
				1254.60														
4		(ML/GC) CLAYEY SILT and CLAYEY GRAVEL; grey and brown, inferred cobbles and boulders, oxidized, laminated; non-cohesive, dense.		3.66	4	SS	92	52										
				1253.99														
		(SM) gravelly SILTY SAND; brown; Inferred cobbles and boulders; non-cohesive, compact to dense.		4.27	5	BS												
5				1253.08														
		End of Borehole.		5.18														
		Note: Borehole backfilled with cuttings and cold mix asphalt patch at ground surface.																
6																		
7																		
8																		
9																		
10																		

WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80

DEPTH SCALE

1 : 50

SOIL CLASSIFICATION SYSTEM: GACS

LOGGED: CH

CHECKED: BS

Golder Associates

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5681368.04 E: 464175.77 Zone: 11U

RECORD OF BOREHOLE: AH15-06

DRILLING DATE: Oct 1, 2015

SHEET 1 OF 1

DATUM: NAD 83

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -, Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
			Ground Surface		1304.27													
0	B-80 Truck Mounted Drill	Solid Stem Auger	(SP) gravelly SAND, trace fines; grey; non-cohesive, moist, dense to very dense.		0.00	1	AS				28	68	4					
					1303.41													
1			(GM) sandy SILTY GRAVEL; light brown; non-cohesive, compact to dense.		0.86	2	AS											
2						3	SS	79	25									
3		Odex Downhole Hammer				4	SS	50	30									
4																		
5					1299.09	5	SS	100	43									
			End of Borehole.		5.18													
6			Note: Borehole backfilled with cuttings and bentonite seal at ground surface.															
7																		
8																		
9																		
10																		

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5681830.99 E: 464209.27 Zone: 11U

RECORD OF BOREHOLE: AH15-07

DRILLING DATE: Sept 29, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0			Ground Surface		1326.12													
			TOPSOIL/ FILL		1325.97													
	B-80 Truck Mounted Drill	Odex Downhole Hammer	(SM) gravelly SILTY SAND; brown; non-cohesive, compact.		0.15	1	SS	67	11									
1						2	BS			16	60	24						
2						3	SS	75	26									
			(SM) SILTY SAND, trace gravel; brown; non-cohesive, compact to loose.		1323.99 2.13	4	BS											
3						5	SS	29	4									
			(SP) gravelly SAND; brown; non-cohesive, loose to compact.		1322.46 3.66	6	BS											
4					1321.85													
			(ML) gravelly SILT; brown; non-cohesive, loose to compact.		4.27													
5						7	SS	46	4									
					1320.94													
			End of Borehole.		5.18													
6			Note: Borehole backfilled with cuttings and bentonite seal at ground surface.															
7																		
8																		
9																		
10																		

WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80

GRADATION % CLAY PARTICLE SIZE <= 0.002

DEPTH SCALE
1 : 50

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

Golder Associates

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5682146.55 E: 464112.56 Zone: 11U

RECORD OF BOREHOLE: AH15-08

DRILLING DATE: Sept 29, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -, Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1325.64													
0	B-80 Truck Mounted Drill / Odex Downhole Hammer	Asphalt		0.00 / 1325.42													
		(SM) gravelly SILTY SAND; brown to grey; non-cohesive, dense.		0.23 / 1324.88	1	SS	88	>50		21	53	26					
1		(SM) SILTY SAND, trace to some gravel; brown; non-cohesive, compact.		0.76 / 1324.12	2	BS											
2		(SW) SAND, trace to some fine gravel, trace to some organics (roots and tree limbs); grey; non-cohesive, compact.		1.52 / 1322.44	3	SS	83	10									
					4	BS											
3		(SP) SAND some gravel; brown; non-cohesive, compact.		3.20 / 1321.53	5	SS	17	17									
4					6	BS											
		(SM) SILTY SAND; brown, compact.		4.11 / 1320.54													
5		End of Borehole.		5.11													
6		Note: Borehole backfilled with cuttings and cold mix asphalt patch at ground surface.															
7																	
8																	
9																	
10																	

DEPTH SCALE

1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS

LOGGED: CH

CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5682854.26 E: 463852.63 Zone: 11U

RECORD OF BOREHOLE: AH15-09

DRILLING DATE: Sept 30, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic; SHEAR STRENGTH Cu, kPa; nat V. +, rem V. ⊕, Pocket Pen -; Q -, U -)	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1315.97														
0	B-80 Truck Mounted Drill / Odex Downhole Hammer	(SM) gravely SILTY SAND, trace organics; brown; non-cohesive, moist, compact.		0.00	1	SS	50	10		23	58	19						Inferred Water Table 0.6m Sept 30, 2015
				1315.05														
1		(PT/OH) SILTY PEAT to Clayey ORGANIC SILT; grey to brown, strong organic odour; non-cohesive, very loose.		0.91														
2					2	SS	54	2	59									
				1313.53														
		(OH) Clayey ORGANIC SILT; dark brown; cohesive, very soft.		2.44														
3				1312.92														
		(PT) Amorphous PEAT, some fines; brown, organics inlcude whole branches and roots; non-cohesive, very loose to loose.		3.05	3	SS	42	7	371									
4																		
				1311.40														
		(SP) SAND, some gravel; grey; non-cohesive, compact.		4.57	4	SS	79	24										
5				1310.79														
		End of Borehole.		5.18														
		Note: Borehole backfilled with cuttings and bentonite seal at ground surface.																
6																		
7																		
8																		
9																		
10																		

DEPTH SCALE
1 : 50

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

Golder Associates

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5683238.05 E: 463768.89 Zone: 11U

RECORD OF BOREHOLE: AH15-10

DRILLING DATE: Sept 30, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -, Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0			Ground Surface		1313.69													
	B-80 Truck Mounted Drill	Solid Stem Auger	Asphalt		0.08													
			(SM/GM) SILTY SAND and GRAVEL; brown, strong hydrocarbon odour; inferred cobbles and boulders; non-cohesive, compact.			1	AS											
1																		
						2	SS	42	28									
2					1311.55	3	BS											
			(SP) gravelly SAND, trace to some non-plastic fines; brown; inferred cobbles; non-cohesive, compact to very dense.		2.13													
		Odex Downhole Hammer																
3						4	SS	100	98									
4																		
						5	SS	100	63									
					1308.74													
5			End of Borehole.		4.95													
			Note: Borehole backfilled with cuttings and cold mix asphalt patch at ground surface.															
6																		
7																		
8																		
9																		
10																		

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5683688.21 E: 463743.09 Zone: 11U

RECORD OF BOREHOLE: AH15-11

DRILLING DATE: Sept 29, 2015

INCLINATION: -90°

SHEET 1 OF 1

DATUM: NAD 83

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic; 10 20 30 40) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen - ■; Q - ●, U - ◐; 20 40 60 80)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0			Ground Surface		1311.74													
	B-80 Truck Mounted Drill	Odex Downhole Hammer	Asphalt		0.00 1311.51													
			(GM) SILTY GRAVEL; brown to grey; non-cohesive, very dense.		0.23	1	SS	75	>50		27	51	22					
1						2	BS											
					1310.21													
			(SM/GM) SILTY SAND and GRAVEL; brown to grey; inferred boulders and cobbles; non-cohesive, compact to dense.		1.52													
2						3	BS											
3																		
						4	SS	8	>50									
4						5	BS											
5						6	SS	92	>50									
					1306.25													
			End of Borehole.		5.49													
6			Note: Borehole backfilled with cuttings and cold mix asphalt patch at ground surface.															
7																		
8																		
9																		
10																		

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

PROJECT No.: 1538990 / 1000 / 1003

CLIENT: Parks Canada
PROJECT: ParksCanada/Transcanada Hwy- ILLECILLE
LOCATION: Rogers Pass, BC
N: 5684042.41 E: 463790.22 Zone: 11U

RECORD OF BOREHOLE: AH15-12

DRILLING DATE: Sept 30, 2015

SHEET 1 OF 1
DATUM: NAD 83

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SAMPLES: BLOWS/0.3m	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -, Q -, U -)	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	PLASTICITY INDEX %	ORGANIC CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1306.48													
0	Solid Stem Auger	Asphalt		1306.38													
		(GM) Sandy SILTY GRAVEL; brown to grey; inferred cobbles; non-cohesive, compact.		0.10	1	AS			○	38	42	20					
1																	
	B-80 Truck Mounted Drill / Odex Downhole Hammer				2	SS	58	24	○								
2																	
3				1303.13													
		(GW) Sandy GRAVEL; brown to grey; inferred cobbles; non-cohesive, dense.		3.35	3	SS	67	>50	○								
4																	
				1301.91													
		(ML) sandy, gravelly, SILTY; brown; inferred cobbles; non-cohesive, dense.		4.57													
5					4	SS	29	48	○								
				1300.89													
		End of Borehole.		5.59													
6		Note: Borehole backfilled with cuttings and cold mix asphalt patch at ground surface.															
7																	
8																	
9																	
10																	

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: CH
CHECKED: BS

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-01

SHEET 1 OF 2

LOCATION: km 21+100

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684896 E: 464364

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (10 20 30 40); nat V. + Q - ●; rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1286.48							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	ASPHALT		0.00 / 1286.15							
		(SM) SILTY SAND and GRAVEL to gravelly SILTY SAND; brown, (FILL); non-cohesive, very dense becoming compact		0.33	1	AS			○		
1		--- decreased gravel content below 0.75 m			2	SS	56		○		
		--- trace woody debris			3	SS	REF 27/ 50/ 6"		○		
2					4	AS			○		
3		--- trace rootlets			5	SS	92		○		
4											
		--- hydrocarbon odour, trace rootlets, trace coal, black			6	AS					
		--- inferred cobbles and boulders			7	SS	27		○		
5		--- (GM) Sandy SILTY GRAVEL 4.9 m to 6.1 m			8	AS					
6	B80 Truck Mounted Rig, Ø150 mm Odex, Earth Drilling			1280.38							
		(GP) GRAVEL, some sand, some cohesive fines; brown, (FILL); non-cohesive, moist becoming wet, compact		6.10	9	SS	20		○		
		--- inferred cobbles and boulders									13/06/2016 ▽ Inferred water table
7		--- seepage encountered at 6.8 m during drilling			10	AS					
				1278.86							
		(SC) CLAYEY SAND, some gravel; brown, (FILL); non-cohesive, wet, loose		7.62	11	SS	10		○		
8				1278.40							
		(GW) GRAVEL, some sand to sandy, some cohesive fines; brown; non-cohesive, wet, compact		8.08	12	AS					
		--- inferred cobbles and boulders									
9				1277.33							
		(SW) SAND and GRAVEL; brown; non-cohesive, wet, compact		9.14	13	SS	29		○		
				1276.88							
		End of BOREHOLE.		9.60							
10											
		CONTINUED NEXT PAGE									

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-01

SHEET 2 OF 2

LOCATION: km 21+100

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684896 E: 464364

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		NOTES: Inferred water table at 6.8 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-02

SHEET 1 OF 2

LOCATION: km 21+850

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684317 E: 463934

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1298.46							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	ASPHALT		0.00 / 1298.17							Well Cover
		(SM) Gravelly SILTY SAND, fine to coarse gravel, fine to coarse sand; grey, minor oxidation, (FILL); non-cohesive, dense becoming compact		0.28	1	AS			○		Sand
1		--- SPT hammer bouncing			2	SS	REF 28/ 34/ 4"		○		Bentonite
					3	AS			○		
					4	SS	REF 27/ 32/ 5"		○		
2		--- SPT hammer bouncing									
					5	GRAB				CL=251mg/L Resistivity=4400 ohm cm SO_4=119mg/L pH=7.91	
3		--- compact below 3.05 m			6	SS	20		○	Gravel=31% Sand=51% Silt/Clay=18%	
					7	GRAB					
4				1293.88							Cuttings
		(GW) Sandy GRAVEL, fine to coarse gravel; grey brown, (FILL); non-cohesive, compact		4.57	8	SS	21		○		
5		--- inferred large cobble or boulder at 4.6 m			9	GRAB					
6	B80 Truck Mounted Rig, Ø150 mm Odex, Earth Drilling			1292.36							
		(GM) SILTY GRAVEL and SAND, fine to coarse subangular to angular gravel; brown, (FILL); non-cohesive, loose		6.10	10	SS	6		○		
7					11	GRAB					
		--- Attempted SPT at 7.6 m, no penetration, no recovery. Inferred cobble or boulder.			12	GRAB					
8				1290.07							14/06/2016 ▽
		WOOD DEBRIS; brown; non-cohesive, dry, loose		8.38	13	GRAB					Bentonite
9				1289.31							19/06/2016 ▽ Sand
		(GW) GRAVEL, some sand to sandy, fine to coarse gravel; brown; non-cohesive, wet, compact becoming dense		9.14	14	SS	12		○		
		--- seepage observed at 9.1 m during drilling			15	GRAB					Granular Slough
10		*CONTINUED NEXT PAGE*									

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-02

SHEET 2 OF 2

LOCATION: km 21+850

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684317 E: 463934

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	Earth Drilling	(GW) GRAVEL, some sand to sandy, fine to coarse gravel; brown; non-cohesive, wet, compact becoming dense *(continued)*			15	GRAB					Granular Slough
11		--- becoming dense below 9.1 m		1287.33	16	SS	62				Slough
		End of BOREHOLE.		11.13							
12		NOTES: Borehole sloughed to 10.7 mbgs when odex casing was removed. Standpipe installed to 10.7 mbgs. Backfilled with sand, cuttings, bentonite and flush mount well cover. Standpipe water level upon completion: 8.4 mbgs Standpipe water level June 19, 2016: 9.14 mbgs									
13											
14											
15											
16											
17											
18											
19											
20											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-03

SHEET 1 OF 1

LOCATION: km 22+100

BORING DATE: 17 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684102 E: 463822

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1304.46							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	ASPHALT		0.00 / 1304.23							
		(SM) Gravelly SILTY SAND to SILTY SAND and GRAVEL; brown, (FILL); non-cohesive, dense becoming loose		0.23	1	AS			○		
1					2	SS	36		○		
					3	SS	REF 24/16		○		
2		--- SPT hammer bouncing			4	AS			○		
		--- boulder encountered at 2.7 m									
3		--- SPT hammer bouncing, inferred cobbles and boulders			5	SS	REF 20		○		
		--- decreased non-plastic fines content below 3.6 m			6	AS			○		
4		--- loose			7a	SS	8		○		
		--- (PT) SILTY PEAT, black, firm at 4.8 m		1299.56 / 4.90	7b	SS			○	69	
5		(GM/SM) SILTY GRAVEL and SAND; brown, (FILL); non-cohesive, dense									
6					8	SS	37		○		Gravel=44% Sand=37% Silt/Clay=19%
		End of BOREHOLE.		1297.91 / 6.55							
7		NOTES: Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-04

SHEET 1 OF 1

LOCATION: km 23+260

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682976 E: 463822

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1316.27							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	ASPHALT		0.00							
				1315.81							
		(SM) Gravelly SILTY SAND; brown, (FILL); non-cohesive, very dense		0.46	1	AS			○		
1					2	SS	72		○		
					3	AS			○		
					4	SS	60		○		
2		--- (GM) Sandy SILTY GRAVEL, angular gravel from 2 m to 3 m, inferred cobbles and boulders			5	AS			○		
				1313.22							16/06/2016 ▽
3	B80 Truck Mounted Rig, Ø150 mm Odex, Earth Drilling	(OH) Sandy ORGANIC CLAYEY SILT, trace fibers; black, cohesive, w>PL, firm --- no sample recovery 3.0 to 3.5 m		3.05	6	NR	7				Inferred water table
					7	GRAB		+			
4				1312.00							
		(SM) Gravelly SILTY SAND; grey-brown; non-cohesive, compact becoming dense --- inferred cobbles and boulders		4.27	8	SS	26		○		
5					9	GRAB			○	Gravel=14.8% Sand=48.2% Silt=34.5% Clay=2.5%	
6		--- mottled orange-brown, dense			10	SS	46		○		
				1309.72							
		End of BOREHOLE.		6.55							
7		NOTES: Inferred water table at 3.05 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
8											
9											
10											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-05

SHEET 1 OF 1

LOCATION: km 23+520

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682701 E: 463911

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	Ground Surface		1318.39							
		ASPHALT		0.00							
				1317.94							
		(SM) SILTY SAND AND GRAVEL; brown, (FILL); non-cohesive, compact to dense		0.46	1	AS					
1		--- No SPT recovery from 0.8 to 1.2 m, inferred cobbles and boulders				NR	REF 19/ 21/ 30/ 3"				
2		--- Attempted SPT, hammer bouncing, no penetration, no recovery, inferred cobbles and boulders			2	BS					
3					3	SS	32				
4	B80 Truck Mounted Rig, Ø150 mm Odex, Earth Drilling	--- Inferred cobbles and boulders			4	GRAB					16/06/2016 ▽
				1313.82							
		(ML) Sandy CLAYEY SILTY, some gravel, some fibers and wood chips; grey-black; cohesive, firm		4.57	5	SS	9			Organic Matter<1.0%	Inferred water table
5					6	GRAB					
6				1312.30							
		(GM) SILTY GRAVEL and SAND; brown, non-cohesive, wet, very dense --- Attempted SPT, hammer bouncing, no recovery, inferred cobbles and boulders		6.10	7	GRAB					
7											
		--- (SW) SAND, fine to coarse grained from 7.62 m to 7.77 m			8	SS	81				
8				1310.32							
		End of BOREHOLE.		8.08							
		NOTES: Water level measured in borehole at 2.19 mbgs upon completion of drilling. Inferred water table at 4.6 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
9											
10											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-06A

SHEET 1 OF 1

LOCATION: km 23+700

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682535 E: 463975

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1320.34							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers, Earth Drilling	ASPHALT		0.00 1319.88							
		(SM) Gravelly SILTY SAND, trace construction debris; brown, (FILL); non-cohesive, compact to very dense		0.46	1	AS					
1		--- No recovery in split spoon, SPT hammer bouncing				SS	REF/ 16/ 34				
					2	SS	25				
2		--- becomes light grey --- (GM) Sandy SILTY GRAVEL from 1.9 to 3 m			3	GRAB					
				1317.60							
3		--- No recovery from 2.74 m to 4.57 m		2.74							16/06/2016 ▽
	B80 Truck Mounted Rig, Ø150 mm Odex, Earth Drilling	--- 0 kPa measured with shear vane, odex casing and split spoon sampler sank to depth under its own weight									Inferred water table
4				1315.77							
		(OH) ORGANIC CLAYEY SILT to CLAYEY SILT, some sand, trace gravel; black, organic odour		4.57	4a	SS	6			Organic Matter=3.6%	
5				1315.31	4b	SS			85		
		--- No recovery from 5.03 m to 6.1 m		5.03							
6				1314.24							
		(SW) SAND AND GRAVEL, some non-plastic fines; brown; non-cohesive, wet, compact becoming dense		6.10	5	SS	15				
7					6	GRAB					
					7	SS	32				
8				1312.26							
		End of BOREHOLE. NOTES: Inferred water table at 2.9 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.		8.08							
9											
10											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-06B

SHEET 1 OF 1

LOCATION: km 23+710

BORING DATE: 17 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682544 E: 463972

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1320.54							
0	B80 Truck Mounted Rig, Ø150 mm Odex Earth Drilling	ASPHALT		0.00							
				1320.08							
		(SM) Gravelly SILTY SAND; brown, (FILL); non-cohesive, moist		0.46							
1											
2											
				1317.80							17/06/2016 ▽
3		(SM) Gravelly SILTY SAND; brown; non-cohesive, wet, very loose --- seepage observed at 2.7 mbgs		2.74	1	AS			○		Inferred water table
		--- no sample recovery									
4	Ø50mm Hand Auger				2	AS			○	Gravel=16.7% Sand=37.3% Silt=43.0% Clay=3.0%	
5		--- no sample recovery			3	AS			○		
6				1314.44							
		End of BOREHOLE.		6.10							
7		NOTES: Hand auger refusal at 6.1 m, possibly due to roots/wood or sand and gravel. Inferred water table at 2.7 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-07

SHEET 1 OF 2

LOCATION: km 25+200

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5681102 E: 464284

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (10 20 30 40); nat V. + Q - ●; rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1286.55							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers; Earth Drilling	ASPHALT		0.00							
				1286.15							
		(SM) Gravelly SILTY SAND; brown, (FILL); non-cohesive, moist becoming wet, very dense becoming compact		0.41	1	AS			○		
1					2	SS	55		○		
		--- cobble or boulder encountered			3	AS			○		
					4	SS	36		○		
2											
					5	AS			○	Gravel=21.2% Sand=30.1% Silt=47.1% Clay=1.6%	
3		--- becomes compact below 3.1 m			6	SS	22		○		
4					7	AS			○		
					8	SS	16		○		
5											13/06/2016 ▽
		--- some plastic fines, trace woody debris, inferred cobble, seepage observed			9	AS				Organic Matter=4.0%	Inferred water table
6		--- inferred cobbles and boulders			10	SS	REF 50/ 1"		○		
		--- increased non-plastic fines content with depth									
7		--- inferred cobbles and boulders based on auger grinding			11	AS			○		
				1278.93							
		(SM) SILTY SAND and GRAVEL, fine grained sand; brown; non-cohesive, wet, dense becoming very dense		7.62	12	SS	47		○		
8											
9					13	AS			○		
					14	SS	66		○		
				1276.80							
		End of BOREHOLE.		9.75							
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-07

SHEET 2 OF 2

LOCATION: km 25+200

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5681102 E: 464284

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		NOTES: Inferred water table at 5.5 mbgs. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-08

SHEET 1 OF 2

LOCATION: km 25+800

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680542 E: 464494

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1249.67							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers; Earth Drilling	ASPHALT		0.00							
				1249.16							
		(SM) Gravelly SILTY SAND; brown, (FILL); non-cohesive, dense		0.51	1	AS			○		
1		--- inferred cobbles or boulders			2	SS	49		○		
				1248.15							
		(SM/SC) Gravely SILTY SAND; brown with black staining, (FILL); non-cohesive, dense becoming compact		1.52	3	SS	29		○		
2		--- inferred cobbles and boulders			4	AS			○		
3					5	SS	32		○		
4					6	AS			○		
5					7	SS	27		○	Gravel=23% Sand=37% Silt/Clay=40%	
6		--- woody debris			8	AS			○		
					9	SS	14		○		14/06/2016 ▽
				1242.97							
		(OH) ORGANIC CLAYEY SILT, dark brown to black, cohesive, soft		6.71	10	AS			○	Organic Matter=7.2%	Inferred water table
7				1242.66							
		(SP) SAND, fine grained; brown; non-cohesive, compact		7.01							
					11	SS	24		○		
8											
				1241.14							
		(SM) Gravelly SILTY SAND, brown; non-cohesive, very dense		8.53	12	AS			○		
9		--- inferred cobbles and boulders			13	SS	81		○	Gravel=30% Sand=46% Silt/Clay=24%	
		--- some plastic fines			14	AS			○		
10											
		CONTINUED NEXT PAGE									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-08

SHEET 2 OF 2

LOCATION: km 25+800

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680542 E: 464494

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		(SM) Gravelly SILTY SAND, brown; non-cohesive, very dense *(continued)* --- inferred cobbles and boulders		1239.01							
11	Earth Drilling	(SC) Gravelly CLAYEY SAND; brown; non-cohesive, very dense --- no auger sample recovery 10.7 to 11.6 m		10.67	15	SS	REF 22/ 50/ 6"		○		
				1238.07	16	SS	REF 50/ 1"		○		
12		End of BOREHOLE.		11.61							
		NOTES: Backfilled with cuttings, bentonite and cold patch asphalt to surface. Inferred water table at 6.7 mbgs.									
13											
14											
15											
16											
17											
18											
19											
20											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-09

SHEET 1 OF 1

LOCATION: km 25+900

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680447 E: 464530

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1243.82							
0	B80 Truck Mounted Rig, Ø150 mm Solid Stem Augers Earth Drilling	ASPHALT		0.00 / 1243.36							
		(SW) SAND AND GRAVEL, fine to coarse sand, fine to coarse gravel; brown, (FILL); non-cohesive, dense		0.46 / 1242.60	1	AS			○		
1					2	SS	37		○		
		(SM) SILTY SAND, fine sand, some fine to coarse sub-angular to angular gravel; brown, (FILL); non-cohesive, very dense		1.22	3	AS			○		
2					4	SS	58		○		
					5	AS			○		
3					6	SS	REF 18/ 50/ 4"		○		
		--- increased gravel content below 3.5 m, coarse grained, potential broken cobbles			7	AS			○		
4					8	SS	64		○		
5					9	AS			○		
6		--- attempted SPT at 6.1 m, hammer bouncing, no penetration, no recovery		1237.72							
		End of BOREHOLE.		6.10							
7		NOTES: Borehole sloughed to 5.2 mbgs upon completion. No water level reading due to slough. Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
8											
9											
10											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-10

SHEET 1 OF 2

LOCATION: km 25+980

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680360 E: 464560

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1238.67							
0	Solid Stem Augers / Earth Drilling	(SM) Gravelly SILTY SAND, fine gravel; brown, (FILL); non-cohesive, moist		0.00	1	AS					
				1238.06							
1	B80 Truck Mounted Rig, Ø150 mm	(GP) GRAVEL, some sand; brown, (FILL); non-cohesive, dry to moist, dense		0.61	2	GRAB					
		--- inferred cobbles and/or boulders			3	SS	46				
2				1236.68							
		(ML) SILT, some sand and gravel; brown, (FILL); non-cohesive, moist, loose		1.98	4	GRAB					
3		--- SPT attempted at 3 m. SPT spoon damaged. No recovery.									
4					5	GRAB					
					6	SS	9				
5	B80 Truck Mounted Rig, Ø150 mm Odex Casing / Earth Drilling	--- inferred cobbles and/or boulders			7	GRAB					
6					8	SS	REF 34/ 50/ 5"				
				1232.11							
		(SM) Gravelly SILTY SAND; brown, (FILL); non-cohesive, moist, dense		6.55	9	GRAB					
7											
					10	SS	38				
8		---strong hydrocarbon odour (possible hydrocarbon contamination). --- rootlets and small gauge wire observed			11	GRAB					
9					12	SS	REF 22/ 50				
				1229.06							
		End of BOREHOLE.		9.60							
10		NOTES:									
		CONTINUED NEXT PAGE									

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-10

SHEET 2 OF 2

LOCATION: km 25+980

BORING DATE: 14 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680360 E: 464560

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		Borehole terminated due to suspected hydrocarbon contamination. Cuttings and samples disposed off-site. Borehole backfilled with sand and bentonite.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-11

SHEET 1 OF 3

LOCATION: km 27+150

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679755 E: 464278

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1185.19							
0	B80 Truck Mounted Rig, Ø150mm Solid Stem Auger, Earth Drilling	ASPHALT		0.00 / 1184.80							
		(SM) SILTY SAND, some gravel to gravelly, fine to coarse subrounded gravel; brown, (FILL); non-cohesive, compact to dense		0.40	1	AS			○		
1					2	SS	37		○		
					3	AS			○		
		--- SPT hammer bouncing, inferred cobble or boulder			4	SS	REF 23/ 2"		○		
2		--- some organics, dark brown, gravelly									
					5	GRAB				CL=171mg/L Resistivity=6600 ohm cm SO_4=89.2mg/L pH=6.55	
3		--- compact below 3.1 m			6	SS	17		○		
4					7	GRAB					
	B80 Truck Mounted Rig, Ø150 mm Odex Casing, Earth Drilling	(SW/GW) SAND and GRAVEL, coarse sub-angular to angular gravel, coarse sand, some fines; brown, (FILL); non-cohesive, very dense becoming compact		1180.62 / 4.57	8	SS	53		○	Gravel=42% Sand=46% Silt/Clay=12%	
5					9	GRAB					
6					10	SS	42		○	Gravel=42% Sand=49% Silt/Clay=9%	
7					11	GRAB					
		--- becomes moist			12	SS	29		○		
8				1176.81							
		(GW) Sandy GRAVEL, coarse sub-angular to angular gravel, coarse sand; grey, (possible native soil); non-cohesive, dense to very dense		8.38	13	GRAB					
9					14	SS	39		○		
					15	GRAB					
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-11

SHEET 2 OF 3

LOCATION: km 27+150

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679755 E: 464278

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	B80 Truck Mounted Rig, Ø150 mm Odex Casing; Earth Drilling	(GW) Sandy GRAVEL, coarse sub-angular to angular gravel, coarse sand; grey, (possible native soil); non-cohesive, dense to very dense *(continued)*			15	GRAB					
					16	SS	REF 18/ 25/ 15/ 1"		○		
11		--- SPT hammer bouncing, inferred cobble or boulder									
					17	GRAB					
12					18	SS	51		○		
13					19	GRAB					
				1171.48							
		(SM) SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse gravel; brown, non-cohesive, dense		13.72	20	SS	43		○		
14											
					21	GRAB					
15		--- SPT hammer bouncing			22	SS	REF 24/ 30/ 3"		○		
				1169.65							
		(SW) SAND and GRAVEL, fine to coarse sand, fine to coarse gravel; brown; non-cohesive, dense		15.54							
16					23	GRAB					
											16/06/2016 ▽
		--- (GM) Sandy SILTY GRAVEL, coarse sub-angular to angular gravel; brown; non-cohesive, wet from 16.8 m to 17.2 m			24	SS	REF 21/ 50/ 6"		○		Inferred water table
17				1167.97							
		--- seepage observed at 16.8 m during drilling		17.22							
		(GW) Sandy GRAVEL, fine to coarse gravel, fine to coarse sand; brown; non-cohesive, wet, very dense			25	GRAB					
18					26	SS	REF 20/ 2"		○		
19					27	GRAB					
		--- attempted SPT at 19.8 m, no penetration, no recovery		1165.38							
				19.81	28	GRAB					
20		*CONTINUED NEXT PAGE*									

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-11

SHEET 3 OF 3

LOCATION: km 27+150

BORING DATE: 16 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679755 E: 464278

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	B80 Truck Mounted Rig, Ø150 mm Odex Casing, Earth Drilling	(GM) Sandy SILTY GRAVEL, fine to coarse gravel; brown; non-cohesive, dense *(continued)*			28	GRAB					
21				1163.86							
		(SM) Gravelly SILTY SAND, trace coarse sand, coarse angular gravel; brown; non-cohesive, very dense		21.34	29	SS	REF 21/ 40/ 2.5"			Gravel=23.3% Sand=36.0% Silt=37.4% Clay=3.3%	
22					30	GRAB					
23					31	SS	REF 29/ 50/ 6"				
				1161.88							
		(GW) Sandy GRAVEL; brown, non-cohesive, wet, very dense		23.32	32	GRAB					
24				1160.76	33	SS	REF 20/ 2"				
		(SM) SILTY SAND, some gravel; brown; non-cohesive, wet, very dense		24.44							
25					34	GRAB					
				1159.23	35	SS	REF 20/ 2"				
26		End of BOREHOLE.		25.96							
		NOTES: Borehole water level upon completion: 24 mbgs. Inferred water table: 16.8 m Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
27											
28											
29											
30											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-12

SHEET 1 OF 2

LOCATION: km 27+700

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679491 E: 463845

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		1164.85							
	B80 Truck Mounted Rig, Ø150mm Solid Stem Auger, Earth Drilling	ASPHALT		0.00							Well Cover
				1164.52							Sand
		(SM) Gravelly SILTY SAND becoming SILTY SAND and GRAVEL, fine to coarse gravel, find to coarse sand, trace organics; brown, (FILL); non-cohesive, compact		0.33		AS					Bentonite
1		--- SPT hammer bouncing			2	SS	REF 16/ 30/ 3"				
					3	AS					
					4	SS	21				
2		--- increased gravel content below 2 m			5	AS					
					6	SS	28				
					7	AS					
4					8	GRAB					
					9	SS	12				
5				1159.82							
	B80 Truck Mounted Rig, Ø150 mm Odex Casing, Earth Drilling	(GM) SILTY GRAVEL AND SAND, fine to coarse sand, fine to coarse sub-angular gravel, decreasing sand content with depth, trace organics; brown, (FILL); non-cohesive, compact to dense		5.03	10	GRAB					Cuttings
6					11	SS	33				
		--- decreased sand content below 6.6 m									
7					12	GRAB					
		--- SPT hammer bouncing, inferred cobble or boulder.			13	SS	REF 50/ 6"				
8					14	GRAB					
9				1155.71							
		(GW) Sandy GRAVEL, fine to coarse sand, fine to coarse sub-angular to angular gravel, increased sand content with depth; grey-brown; non-cohesive, dense to very dense		9.14	15	GRAB					
10		*CONTINUED NEXT PAGE*									

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-12

SHEET 2 OF 2

LOCATION: km 27+700

BORING DATE: 13 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679491 E: 463845

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp ○ W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	B80 Truck Mounted Rig, Ø150 mm Odex Casing Earth Drilling	(GW) Sandy GRAVEL, fine to coarse sand, fine to coarse sub-angular to angular gravel, increased sand content with depth; grey-brown; non-cohesive, dense to very dense *(continued)*			15	GRAB					Cuttings
11		--- Attempted SPT at 9.1 m. Hammer bouncing, no penetration.			16	GRAB					
12		--- SPT hammer bouncing, inferred cobble or boulder			17	SS	REF 27/ 27/ 3"		○		Bentonite
13					18	GRAB					
14		--- increased sand content below 13.8 m			19	SS	66		○		Sand 19/06/2016 ▽
15		--- inferred boulder		1149.61	20	GRAB					13/06/2016 ▽
		End of BOREHOLE.		15.24							
16		NOTES: Standpipe installed to 15.2 mbgs. Backfilled with sand, cuttings, bentonite and flush mount well cover. Standpipe water level upon completion: 14.82 mbgs Standpipe water level June 19, 2016: 14.17 mbgs									
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-13

SHEET 1 OF 3

LOCATION: km 28+060

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679363 E: 463521

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1153.83							
0	B80 Truck Mounted Rig, Ø150mm Solid Stem Auger, Earth Drilling	ASPHALT		0.00 / 1153.47							Well Cover; Sand
		(SM) Gravelly SILTY SAND, fine to coarse sub-angular to angular gravel; brown, (FILL); non-cohesive, dense		0.36	1	AS			○		Bentonite
1					2	SS	39		○		
		--- trace organics			3	AS			○		
					4	SS	33		○	CL=583mg/L Resistivity=3480 ohm cm SO_4=15.8mg/L pH=7.12	
2					5	AS			○		
3					6	SS	44		○		
	B80 Truck Mounted Rig, Ø150 mm Odex Casing, Earth Drilling				7	GRAB				CL=114mg/L Resistivity=14000 ohm cm SO_4=24.6mg/L pH=7.94	
4		--- attempted SPT at 4.6 m, hammer bouncing, no penetration, no recovery									
5					8	GRAB					Cuttings
6					9	SS	47		○	Gravel=35% Sand=38% Silt/Clay=27%	
		(CL) Gravelly SILTY CLAY, fine to coarse sub-angular to angular gravel; brown, (FILL), cohesive, w<PL, hard		1147.28 / 6.55							
7					10	GRAB					
		(GM) SILTY GRAVEL and SAND, fine to coarse sub-angular to angular gravel, fine sand; brown mottled blue and white, (FILL); non-cohesive, very dense		1146.21 / 7.62	11	SS	80		○		
8		(SM) Gravelly SILTY SAND, fine to coarse sub-angular to angular gravel; brown (FILL); non-cohesive, moist, very dense		1145.75 / 8.08							
					12	GRAB					
9		(GM) Sandy SILTY GRAVEL, sub-angular to angular gravel; brown, (FILL); non-cohesive, very dense --- SPT hammer bouncing		1144.69 / 9.14	13	SS	REF 34/ 25/ 2"		○		
					14	GRAB					
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-13

SHEET 2 OF 3

LOCATION: km 28+060

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679363 E: 463521

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (10 20 30 40) Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	B80 Truck Mounted Rig, Ø150 mm Odex Casing; Earth Drilling	(GM) Sandy SILTY GRAVEL, sub-angular to angular gravel; brown, (FILL); non-cohesive, very dense *(continued)*			14	GRAB					
		--- inferred boulder									
		--- Attempted SPT at 10.7 m, hammer bouncing, no penetration, no recovery									
11					15	GRAB					Cuttings
		--- trace woody debris between 10.6-12.1 mbgs									
12					16	SS	71			Gravel=45% Sand=29% Silt/Clay=26%	
				1141.18							
		(SM) SILTY SAND, some gravel, fine sub-angular gravel; brown, (FILL); non-cohesive, very dense		12.65							
13					17	GRAB					15/06/2016
											19/06/2016
				1140.11	18	SS	REF 12/ 1"				Screen
		(SP) SAND AND GRAVEL, fine to coarse gravel; brown, (FILL); non-cohesive, wet, dense		13.72							
14		---SPT hammer bouncing, seepage observed at 13.7 m during drilling			19	GRAB					
15				1138.59							
		(SM) Gravelly SILTY SAND, fine sand, fine gravel, trace organics (woody debris); grey, (FILL); non-cohesive, wet, loose		15.24	20	SS	8				
16					21	GRAB					
17					22	SS	5			50.9	
		--- wood chips 17.2 to 17.5 m			23	GRAB					
				1136.30							
		(GP) Sandy GRAVEL, fine to coarse grained, trace woody debris; grey, (FILL); non-cohesive, wet, loose		17.53							Slough
18					24	GRAB					
				1135.54							
		(SP) SAND, coarse grained, some gravel, trace organics; grey, (FILL); non-cohesive, loose		18.29	25	SS	4				
				1135.08							
19		(GP) Sandy GRAVEL; brown; non-cohesive, dense		18.75							
					26	GRAB					
				1134.02							
				19.81	27	SS	REF 50/				
20		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-13

SHEET 3 OF 3

LOCATION: km 28+060

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679363 E: 463521

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20											
		(SP) Gravelly SAND to SAND and GRAVEL, coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey-brown; non-cohesive, very dense becoming dense *(continued)*					2.5"				
		---SPT hammer bouncing			28	GRAB					
21											Slough
					29	SS	45		○		
				1132.04							
		End of BOREHOLE.		21.79							
22		NOTES: Borehole sloughed to 15.2 when odex casing was removed. Standpipe installed to 15.2 mbgs. Backfilled with sand, cuttings, bentonite and flush mount well cover. Standpipe water level upon completion: 13.2 mbgs Standpipe water level June 19, 2016: 13.36 mbgs									
23											
24											
25											
26											
27											
28											
29											
30											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-14

SHEET 1 OF 3

LOCATION: km 28+120

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679336 E: 463454

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1152.44							
0	B80 Truck Mounted Rig, Ø150mm Solid Stem Auger Earth Drilling	ASPHALT		0.00 / 1152.08							
		(SM) Gravelly SILTY SAND; brown and grey, (FILL); non-cohesive, very dense to compact		0.36	1	AS					
1					2	SS	REF 25/ 50/ 4"				
					3	SS	69			CL=168mg/L Resistivity=6470 ohm cm SO_4=46.8mg/L pH=7.72	
2											
					4	GRAB					
3		--- SPT hammer bouncing			5	SS	REF 22/ 36				
4					6	GRAB					
	B80 Truck Mounted Rig, Ø150 mm Odex Casing Earth Drilling				7	SS	68				
5		--- woody debris at 5.5 m			8	GRAB					
6		--- brown and grey below 6.2 m			9	SS	47				
		--- trace woody debris and rootlets at 6.25 m ---grey			10	GRAB					
7											
		--- trace rootlets at 7.6 m			11	SS	65				
8											
					12	GRAB					
9					13	SS	29				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-14

SHEET 2 OF 3

LOCATION: km 28+120

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679336 E: 463454

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	B80 Truck Mounted Rig, Ø150 mm Odex Casing; Earth Drilling	(SM) Gravelly SILTY SAND; brown and grey, (FILL); non-cohesive, very dense to compact *(continued)*			14	GRAB					
		--- trace rootlets and woody debris to 11.6 m									
11		--- inferred cobble			15	SS	29		○		
					16	GRAB					
				1140.86							
		(SM) Gravelly SILTY SAND, fine angular gravel, trace coal; brown; non-cohesive, compact		11.58							
12					17	SS	24		○		
13					18	GRAB					
		---inferred cobble, wet below 13.8 m			19	SS	REF 50/ 2"		●		15/06/2016 ▽ Inferred water table
14				1138.42							
		(GP) GRAVEL, angular, some silty sand; brown; non-cohesive, very dense		14.02							
					20	GRAB					
15					21	SS	REF 39/ 50		○		
16		--- trace to some silty sand			22	GRAB					
				1135.98							
		(GM) SILTY GRAVEL and SAND, fine to medium sand, some non plastic fines; brown; non-cohesive, very dense		16.46							
17					23	SS	84		○		
					24	GRAB					
18		--- (SP) SAND, some fine gravel and non plastic fines; brown; non-cohesive, wet from 18.3 to 18.75 m			25	SS	REF 50/ 2"		●		
				1133.69							
		(GP) Sandy GRAVEL, some non plastic fines; brown; non-cohesive, very dense		18.75							
19					26	GRAB					
				1132.63							
				19.81	27	SS	70		○		
20		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF BOREHOLE: BH16-14

SHEET 3 OF 3

LOCATION: km 28+120

BORING DATE: 15 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5679336 E: 463454

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20		(SP) SAND, fine grained, some gravel to gravelly; brown; non-cohesive, very dense *(continued)*		1132.17 / 20.27	27	SS	70				
		End of BOREHOLE.									
		NOTES: Borehole water level upon completion: 13.71 mbgs Backfilled with cuttings, bentonite and cold patch asphalt to surface.									
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL BOREHOLE RECORDS_20160722.GPJ CALGARY.GDT 26/7/16

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MG

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-01

SHEET 1 OF 1

LOCATION: km 21+400

BORING DATE: 8 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5684688 E: 464125

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp ○ W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1289.99							
0	305.5E Tracked Excavator On the Mark	(SM) SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-angular to angular gravel, trace organics; brown, (FILL); non-cohesive		0.00	1	GRAB			○		
				1289.39							
		(SM) Gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-angular to sub-rounded gravel, trace rootlets; dark brown, (TOPSOIL)		0.60	2	GRAB			○		
				1289.19							
1		(SW/GW) SAND and GRAVEL, fine to coarse sub-angular to angular gravel, some fines; light brown; non-cohesive, with cobbles up to 30 cm diameter up to 5% by volume		0.80	3	GRAB			○		
		--- encountered small boulders up to 0.6 m diameter at 1.4 m --- cobbles up to 10% by volume, up to 300 mm diameter, boulders up to 20% by volume up to 1 m diameter below 1.5 m --- "slate" boulder, 1 m long, 0.1 m thick encountered at 1.5 m			4	GRAB			○		
2					5	BS			○	Gravel=44% Sand=46% Silt/Clay=10% SPMDD=2178 kg/m^3 Optimum WC=7.8%	
				1287.79							
		End of TEST PIT.		2.20							
		NOTES: Practical refusal on boulders. Backfilled and bucket packed with spoil, organics placed last. Hand seeded with approved MRG seed mix.									
3											
4											
5											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-02

SHEET 1 OF 1

LOCATION: km 23+250

BORING DATE: 8 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682988 E: 463806

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		1315.52							
	305.5E Tracked Excavator On the Mark	(OH) ORGANIC CLAYEY SILT, trace gravel; brown; non-cohesive		0.00 / 1315.32	1	GRAB				66.9 Organic Matter=5.3%	
		(PT) ORGANIC CLAYEY SILT to SILTY PEAT, some roots; brown; cohesive, soft		0.20 / 1314.02	2	GRAB				181.9 Organic Matter=32.7%	08/06/2016 ▽ Inferrred water table
1											
2		(SM) Gravelly SILTY SAND, fine to coarse angular gravel, fine to coarse sand; brown; non-cohesive, wet, with cobbles up to 75 mm diameter up to 5% by volume --- seepage encountered at 1.5 m		1.50	3	GRAB				Gravel=25.5% Sand=44.3% Silt=27.2% Clay=3.0%	
					4	GRAB					
		--- some non plastic fines, minor oxidation 2.7 to 3.25 m --- gravel becomes coarse below 2.7 m			5	BS				Gravel=28% Sand=47% Silt/Clay=25% SPMDD=2104 kg/m^3 Optimum WC=8.8%	
3					6	GRAB					
4		End of TEST PIT.		4.00 / 1311.52							
		NOTES: Seepage observed at 1.5 mbgs during excavation. Backfilled and bucket packed with spoil, organics placed last. Hand seeded with approved MRG seed mix.									
5											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-03

SHEET 1 OF 1

LOCATION: km 23+400

BORING DATE: 8 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5682822 E: 463862

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		1316.23							
	305.5E Tracked Excavator On the Mark	(SM) SAND, some gravel; brown, (FILL); non-cohesive, loose		0.00	1	GRAB					
				1315.93							
		(PT) SANDY PEAT, tree branches and rootlets; black		0.30	2	GRAB				133.5	Organic Matter=24.6%
					3	GRAB				470.5	Organic Matter=87.2%
		--- seepage observed at 0.8 m		1315.33							
1		(ML) CLAYEY SILT, some sand, trace fine to coarse gravel, rootlets, brown; cohesive, firm		0.90	4	GRAB				52.6	
		---increased fine sand content below 1.2 m			5	GRAB					
				1314.43							
		(PT) SILTY PEAT, tree branches; black		1.80	6	GRAB				295.7	Organic Matter=36.6%
2					7	GRAB				318.8	Organic Matter=65.9%
				1313.33							
3		(SW) Gravelly SAND, coarse sand, fine to coarse gravel; grey; non-cohesive		2.90	8	GRAB					
				1313.13							
		(ML)SILT and SAND, minor oxidation; brown; non-cohesive		3.10	9	GRAB				89	
				1312.83							
		(PT) SILTY PEAT, tree branches and rootlets; black		3.40	10	GRAB				374.6	Organic Matter=61.7%
				1312.23							
4		End of TEST PIT.		4.00							
		NOTES: Seepage observed at 0.8 mbgs during excavation. Backfilled and bucket packed with spoil, organics placed last. Hand seeded with approved MRG seed mix.									
5											

PIEZOMETER OR STANDPIPE INSTALLATION: 08/06/2016 ▽ Inferrred water table

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-05

SHEET 1 OF 1

LOCATION: km 24+400

BORING DATE: 8 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5681874 E: 464170

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1325.79							
0	305.5E Tracked Excavator On the Mark	(SW) SAND AND GRAVEL, fine to coarse sand, fine to coarse sub-angular to angular gravel; brown, (FILL); non-cohesive, moist		0.00							
				1325.49							
		(TOPSOIL) brown, rootlets, organic odour, cohesive, w<PL		0.40							
		(SC) Gravelly CLAYEY SAND, fine to coarse sand, fine to coarse gravel, trace organics; brown, (possible FILL); non-cohesive			1	GRAB					
1		--- cobbles up to 300 mm diameter, up to 15% by volume below 1 m			2	GRAB					
		--- increased gravel content below 1.6 m			3	GRAB					
2		--- boulders up to 1.2 m diameter, up to 10% by volume below 2 m			4	BS					
				1323.19							
		(GM) Sandy SILTY GRAVEL, fine to coarse angular gravel, trace rootlets; brown, (possible FILL); non-cohesive		2.60	5	GRAB				Gravel=39.8% Sand=30.2% Silt=28.1% Clay=1.9%	
3		---boulders up to 1.5 m diameter up to 10% by volume below 3 m			6	GRAB					
				1322.39							
		(SC) Gravelly CLAYEY SAND, fine to coarse angular gravel, trace rootlets; brown, (possible FILL); non-cohesive		3.40	7	GRAB					
				1321.79							
4		End of TEST PIT.		4.00							
		NOTES: Backfilled and bucket packed with spoil, organics placed last.									
5											

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-06

SHEET 1 OF 1

LOCATION: km 24+640

BORING DATE: 9 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5681653 E: 464214

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (10 20 30 40) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (10 20 30 40) Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1320.00							
0	305.5E Tracked Excavator On the Mark	(GM) Sandy SILTY GRAVEL to SILTY GRAVEL AND SAND, fine to coarse sub-angular gravel, trace organics and rootlets; brown, (FILL); non-cohesive		0.00	1	GRAB			○		
					2	GRAB			○		
1		--- with cobbles up to 300 mm diameter up to 5% by volume and boulders up to 0.5 m diameter up to 5% by volume			3	GRAB			○		
		--- abandoned telephone line encountered			4	GRAB			○		
2		--- increased sand content below 2.2 m			5	GRAB			○		
					6	GRAB			○		
				1317.00							09/06/2016 ▽
3		(GW/SW) SILTY GRAVEL and SAND, fine to coarse gravel; brown, (possible native soil); non-cohesive, wet, with cobbles up to 150 mm dimeter up to 10% by volume --- seepage encountered at 3 m		3.00	7	BS			○	Gravel=40% Sand=40% Silt/Clay=20% SPMDD=2083 kg/m^3 Optimum WC=8.5%	Inferrred water table
				1316.55	8	GRAB			○		
		End of TEST PIT.		3.45							
4		NOTES: Seepage observed at 3 mbgs during excavation. Backfilled and bucket packed with spoil, organics placed last.									
5											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

DATA ENTRY: AW

PROJECT No.: 1654325

RECORD OF TEST PIT: TP16-07

SHEET 1 OF 1

LOCATION: km 25+450

BORING DATE: 9 June 2016

DATUM: UTM Zone 11 (Nad 83)

N: 5680869 E: 464385

Parks Canada - Illecillewaet Curve

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (10 20 30 40)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		1270.24							
0	305.5E Tracked Excavator On the Mark	(SM) Gravelly SILTY SAND, fine to coarse sand, fine gravel, some organics and roots; brown, (FILL); non-cohesive		0.00	1	GRAB					
					2	GRAB					
				1269.54							
		(ML) SILT, some sand, some gravel, light brown; non-cohesive		0.70	3	GRAB					
1		--- cobbles up to 300 mm diameter up to 5% by volume below 1 m									
					4	GRAB					
				1268.24							
2		(SM) Gravelly SILTY SAND, fine to coarse sand, coarse grained angular gravel (possible broken cobbles); brown; non-cohesive		2.00	5	GRAB					
					6	BS				Gravel=29% Sand=34% Silt/Clay=37% SPMDD=1994 kg/m^3 Optimum WC=10.5%	
3					7	GRAB					
					8	GRAB					
					9	GRAB					
				1266.24							
4		End of TEST PIT.		4.00							
		NOTES: Backfilled and bucket packed with spoil, organics placed last.									
5											

BOREHOLE - EXPANDED ADD. LAB TESTING FINAL TEST PIT RECORDS_20160722.GPJ CALGARY.GDT 22/7/16

DEPTH SCALE

1 : 25

Golder Associates

LOGGED: AW

CHECKED: AA

Table A1: Subsurface Conditions at Hand Auger Hole Locations

Hand Auger Hole Number	Approximate Station and Location			Encountered Subsurface Conditions	Reason for Termination
	Station	Side of Highway	Distance from Shoulder		
HA16-01	21+600	Westbound, on roadway embankment slope	5 m	■ 0 - 1.25 m (SC) CLAYEY SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 1.25 m on a rock
HA16-02	21+800	Westbound, on roadway embankment slope	5.0 m	■ 0 - 0.75 m (SC) CLAYEY SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 0.75 m on a rock
HA16-03	22+000	Westbound	5.4 m	■ 0 - 0.65 m (SC) CLAYEY SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 0.65 m on a rock
HA16-04	23+200	Westbound	18 m west of creek	■ 0 - 0.4 m (PT) SILTY PEAT, soft seepage at 0.4 m ■ 0.4 - 0.7 m (GP) GRAVEL and SAND; non-cohesive, wet, loose ■ 0.7 - 0.9 m (SM) SILTY SAND; non-cohesive, moist becoming wet, loose ■ 0.9 – 1 m (ML) Sandy CLAYEY SILT, cohesive, w~PL, soft	Refusal at 1.18 m on gravel
HA16-05	23+300	Westbound	15.5 m	■ 0 - 2.8 m (PT) Fibrous to Amorphous PEAT, soft. Standing water at ground surface ■ 2.8 - 2.9 m (ML) CLAYEY SILTY and GRAVEL, some coarse sand; grey; non-cohesive, wet, compact	Refusal at 2.9 m on gravel
HA16-06	23+400	Westbound	13.0 m	■ 0 - 0.2 m TOPSOIL ■ 0.2 - 1.1 m (SM) SILTY SAND (FILL); non-cohesive, moist, loose ■ 1.1 - 1.3 m (PT) Fibrous to Amorphous PEAT; soft ■ 1.3 - 1.5 m (SM) SILTY SAND and GRAVEL (FILL); non-cohesive, wet, compact. Seepage encountered at 1.5 m ■ 1.5 - 2.5 m (OH/PT) ORGANIC CLAYEY SILT TO Fibrous PEAT; soft	Refusal at 2.5 m on wood
HA16-07	23+840	Westbound	25.0 m	■ 0 - 0.1 m TOPSOIL ■ 0.1 - 2.9 m (CL/ML) SILTY CLAY to CLAYEY SILT, cohesive, w~PL, firm. Seepage encountered at 2.5 m ■ 0 - 1.2 m (SM) Gravelly SILTY SAND to SILTY SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 2.9 m on a rock
HA16-08	25+800	Westbound, on roadway embankment slope	5.7 m	■ 0 - 1.2 m (SM) Gravelly SILTY SAND to SILTY SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 1.2 m on a rock
HA16-09	27+800	Westbound, on roadway embankment slope	3.0 m	■ 0 – 1 m (SW) SAND and GRAVEL (FILL); non-cohesive, moist, loose	Refusal at 1.0 m on a rock
HA16-10	25+250	Eastbound, on bench	12.5 m	■ 0 - 0.5 m (SW) SAND and GRAVEL, (FILL); non-cohesive, wet, loose ■ 0.5 - 0.7 m (PT) Fibrous PEAT; cohesive, wet	Refusal at 0.7 m on a rock
HA16-11	24+400	Eastbound, on roadway embankment slope	8.8 m	■ 0 - 0.7 m (SW) SAND and GRAVEL (FILL); non-cohesive, wet, loose	Refusal at 0.7 m on a rock
HA16-12	23+670	Eastbound	18.0 m	■ 0 - 0.1 m TOPSOIL ■ 0.1 - 0.4 m (GW) GRAVEL and SAND; non-cohesive, moist, loose	Refusal at 0.4 m on gravel
HA16-13	23+500	Eastbound	12.0 m	■ 0 - 0.05 m TOPSOIL ■ 0.05 - 0.15 m (GW) GRAVEL and SAND; non-cohesive, moist, loose ■ 0.15 - 0.4 m (SW) SAND and GRAVEL; moist, loose	Refusal at 0.4 m on gravel
HA16-14	23+400	Eastbound	13.0 m	■ 0 - 0.3 m TOPSOIL ■ 0.3 - 1.4 m (ML) Sandy CLAYEY SILT; cohesive, w~PL, soft ■ Increased water content at 1 m ■ Grinding at 1.2 m	Refusal at 1.4 m on gravel
HA16-15	23+300	Eastbound	7.0 m	■ 0 - 0.7 m (SW) SAND and GRAVEL (FILL); non-cohesive, moist, loose ■ 0.7 - 2.7 m (PT) Fibrous PEAT, cohesive, wood pieces, w>PL, soft ■ Seepage at 1 m	Refusal at 2.7 m on roots
HA16-16	27+150	Westbound, on roadway embankment slope	9.0 m (about 4.0 m below the crest of the slope)	■ 0 - 1.3 m (SM) SILTY SAND and GRAVEL to Gravelly SILTY SAND (FILL); non-cohesive, moist, loose ■ 2 - 2.25 m (CL) Sandy SILTY CLAY (FILL); cohesive, w~PL, soft	Refusal at 1.3 m on rocks

Hand Auger Hole Number	Approximate Station and Location			Encountered Subsurface Conditions	Reason for Termination
	Station	Side of Highway	Distance from Shoulder		
HA16-17	27+200	Westbound, on roadway embankment slope	22.0 m (on the bench)	■ 0 - 0.2 m TOPSOIL ■ 0.2 – 2 m (ML) Sandy SILT (FILL); non-cohesive, moist, loose	Refusal at 2.25 m on rocks
HA16-18	27+500	Westbound, on roadway embankment	8.0 m	■ 0 - 0.8 m (SW) SAND AND GRAVEL (FILL); non-cohesive, moist, loose ■ Grinding at 0.65m	Refusal at 0.8 m on rocks
HA16-19	27+750	Westbound, at toe of slope	~50 m	■ 0 - 0.3 m (ML) Sandy SILT (FILL); cohesive, w<PL, soft	Refusal at 0.3 m on rocks
HA16-20	28+050	Westbound, on roadway embankment slope	5.0 m	■ 0 - 0.6 m (SW) SAND AND GRAVEL (FILL); non-cohesive, moist, loose ■ 0.6 - 0.7 m (ML) Sandy SILT (FILL); non-cohesive, moist, loose ■ 0.7 - 0.8 m (SW) SAND (FILL); non-cohesive, wet, loose	Refusal at 0.8 m on rocks
HA16-Berm 1	24+200	Eastbound	East end of windrow, top of berm	■ 0 - 0.1 m TOPSOIL ■ 0.1 - 2.8 m (SM) Gravelly SILTY SAND (FILL); non-cohesive, moist, very loose ■ Rocks at 2.5 m	Refusal at 2.8 m on rocks
HA16-Berm 2	24+250	Eastbound	~Middle of windrow, top of berm	■ 0 - 0.07 m TOPSOIL ■ 0.07 - 3 m (SM) Gravelly SILTY SAND (FILL); non-cohesive, moist, very loose ■ Layers of silt, moisture content increasing at 2.5 m ■ 3 - 3.55 m (ML) Sandy SILT (FILL); non-cohesive, moist, very loose	Refusal at 3.55 m on a rock
HA16-Berm 3	24+300	Eastbound	West end of windrow, top of berm	■ 0 - 0.07 m TOPSOIL ■ 0.07 - 0.8 m (SM) Gravelly SILTY SAND (FILL); non-cohesive, moist, loose	Refusal at 0.8 m on a rock

APPENDIX B

Laboratory Test Results

WATER CONTENT DETERMINATION

ASTM D 2216

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Project No.: 1538990 **Phase:** 1000 **Task:** 1003
Lab Schedule No.:

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
AH15-01	**1**		0.00	0.61	**18.3**
AH15-01	**2**		0.61	0.91	**9.4**
AH15-01	**3**		3.05	3.66	**17.2**
AH15-01	**4**		3.66	4.57	**17.0**
AH15-01	**5**		4.57	5.18	**14.3**
AH15-02	**1**		0.00	0.61	**10.8**
AH15-02	**2**		0.61	1.52	**5.2**
AH15-02	**3**		3.05	3.66	**9.8**
AH15-02	**4**		3.66	4.57	**5.4**
AH15-02	**5**		4.57	5.18	**6.8**
AH15-03	**1**		0.00	0.61	**10.5**
AH15-03	**2**		1.52	2.13	**13.4**
AH15-03	**3**		3.05	3.35	**9.1**
AH15-04	**1**		0.00	0.61	**5.4**
AH15-04	**3**		1.52	2.13	**17.9**
AH15-04	**4**		3.05	3.66	**10.3**
AH15-05	**1**		0.61	1.22	**9.1**
AH15-05	**2**		2.13	2.74	**18.6**
AH15-05	**3**		2.74	3.66	**15.1**
AH15-05	**4**		3.66	4.27	**13.0**
AH15-05	**5**		4.27	5.18	**10.3**
AH15-06	**1**		0.00	0.86	**3.5**
AH15-06	**2**		0.86	1.07	**5.1**
AH15-06	**3**		1.52	2.13	**1.8**
AH15-06	**4**		3.05	3.66	**23.3**
AH15-06	**5**		4.57	5.18	**13.4**
AH15-07	**1**		0.00	0.61	**10.0**
AH15-07	**2**		0.61	1.52	**7.3**
AH15-07	**3**		1.52	2.13	**17.0**
AH15-07	**4**		2.13	3.05	**16.3**
AH15-07	**6**		3.66	4.57	**9.4**
AH15-07	**7**		4.57	5.18	**24.7**
AH15-08	**1**		0.23	0.84	**6.1**
AH15-08	**2**		0.23	1.75	**10.8**

BS 10/30/2015
Checked Date

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WATER CONTENT DETERMINATION

ASTM D 2216

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Project No.: 1538990 **Phase:** 1000 **Task:** 1003
Lab Schedule No.:

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
AH15-08	**3**		1.75	2.36	**33.4**
AH15-08	**4**		2.36	3.05	**16.7**
AH15-08	**5**		3.28	3.89	**16.2**
AH15-08	**6**		3.89	4.80	**17.9**
AH15-09	**1**		0.00	0.61	**17.4**
AH15-09	**2**		1.52	2.13	**58.9**
AH15-09	**3**		3.05	3.66	**370.7**
AH15-09	**4**		4.57	5.18	**17.6**
AH15-10	**1**		0.00	1.30	**7.8**
AH15-10	**2**		1.30	1.91	**10.8**
AH15-10	**3**		1.30	2.82	**5.8**
AH15-10	**4**		2.82	3.43	**8.0**
AH15-10	**5**		4.34	4.95	**9.0**
AH15-11	**1**		0.30	0.91	**8.0**
AH15-11	**2**		0.30	1.83	**7.7**
AH15-11	**3**		1.83	3.35	**1.7**
AH15-11	**4**		3.35	3.96	**1.1**
AH15-11	**5**		3.35	4.88	**4.0**
AH15-11	**6**		4.88	5.49	**6.1**
AH15-12	**1**		0.15	0.91	**6.6**
AH15-12	**2**		1.30	1.91	**6.0**
AH15-12	**3**		3.43	4.04	**6.7**
AH15-12	**4**		4.95	5.33	**3.9**

BS 10/30/2015
Checked Date

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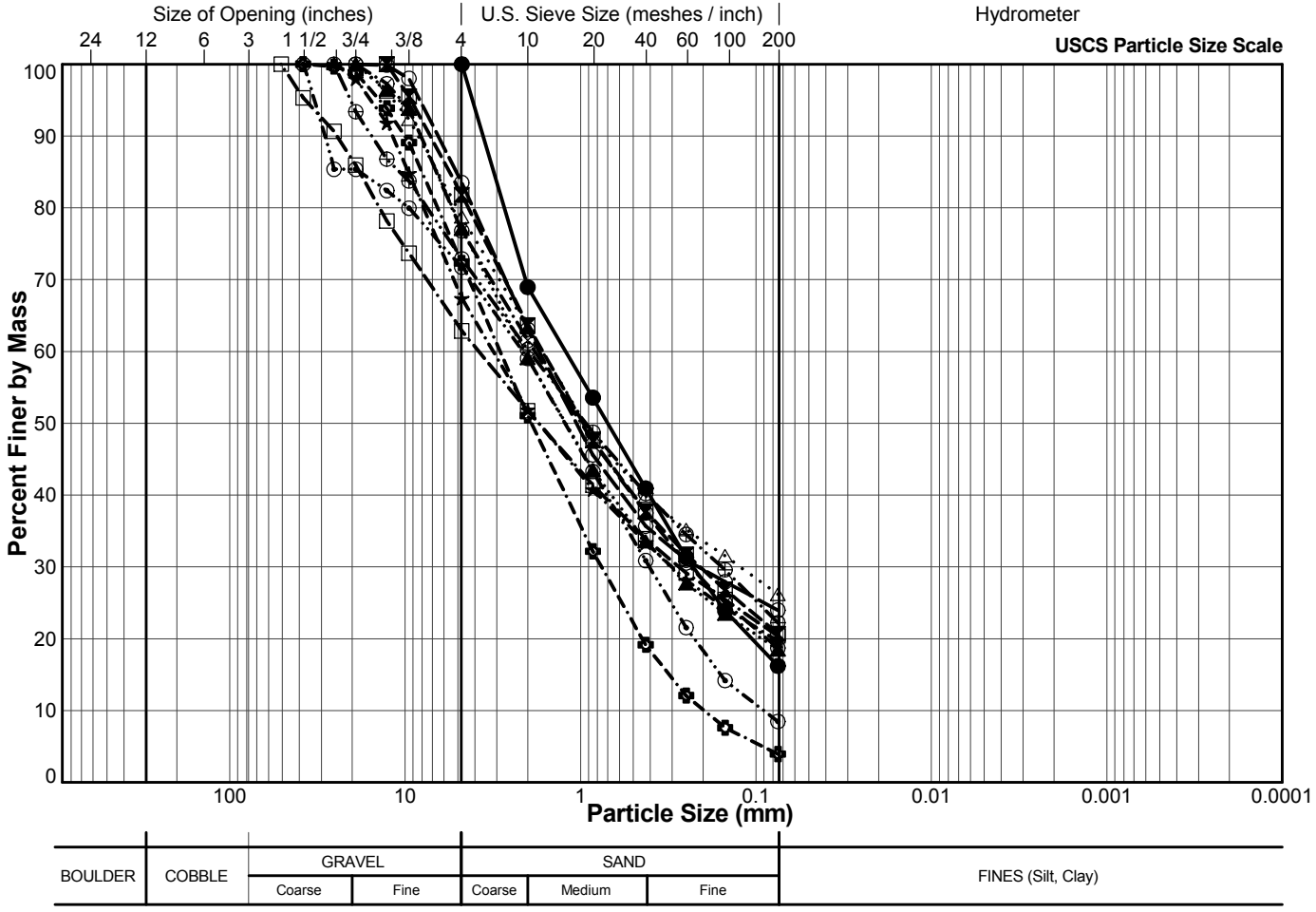
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003



Legend

Sym.	Test Hole	Sample Number	From (m)	To (m)
●	AH15-01	1	0.00	0.61
⊠	AH15-02	1	0.00	0.61
▲	AH15-03	1	0.00	0.61
★	AH15-04	1	0.00	0.61
⊙	AH15-05	1	0.61	1.22
✿	AH15-06	1	0.00	0.86
○	AH15-07	2	0.00	1.52
△	AH15-08	1	0.23	0.84
⊗	AH15-09	1	0.00	0.61
⊕	AH15-11	1	0.30	0.91
□	AH15-12	1	0.15	0.91

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

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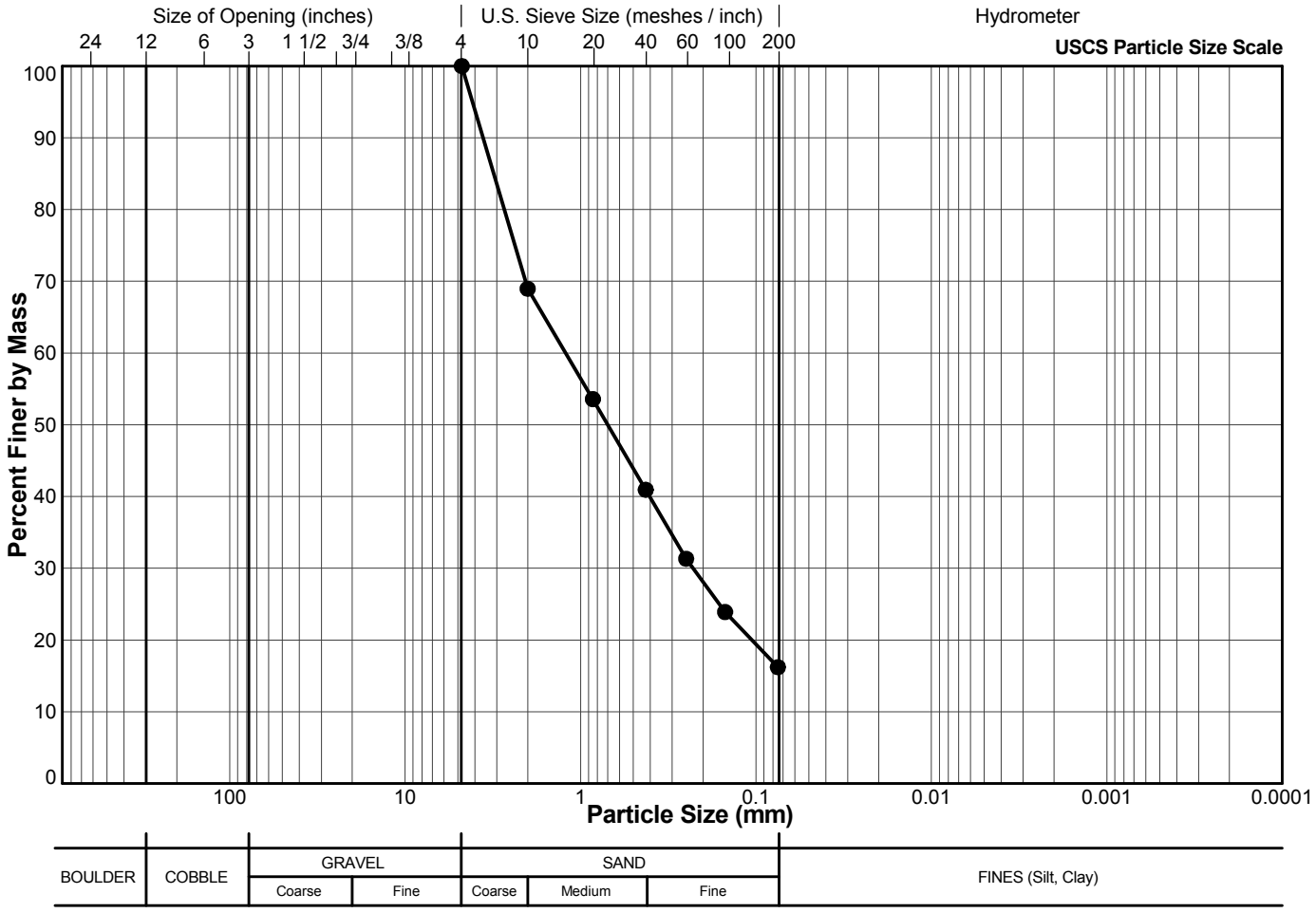
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-01
Sample No.: 1
Depth Interval (m): 0.00 to 0.61
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
#4 US MESH	4.75		100.0
#10 US MESH	2		69.0
#20 US MESH	0.85		53.6
#40 US MESH	0.425		40.9
#60 US MESH	0.25		31.3
#100 US MESH	0.15		23.9
#200 US MESH	0.075		16.2

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

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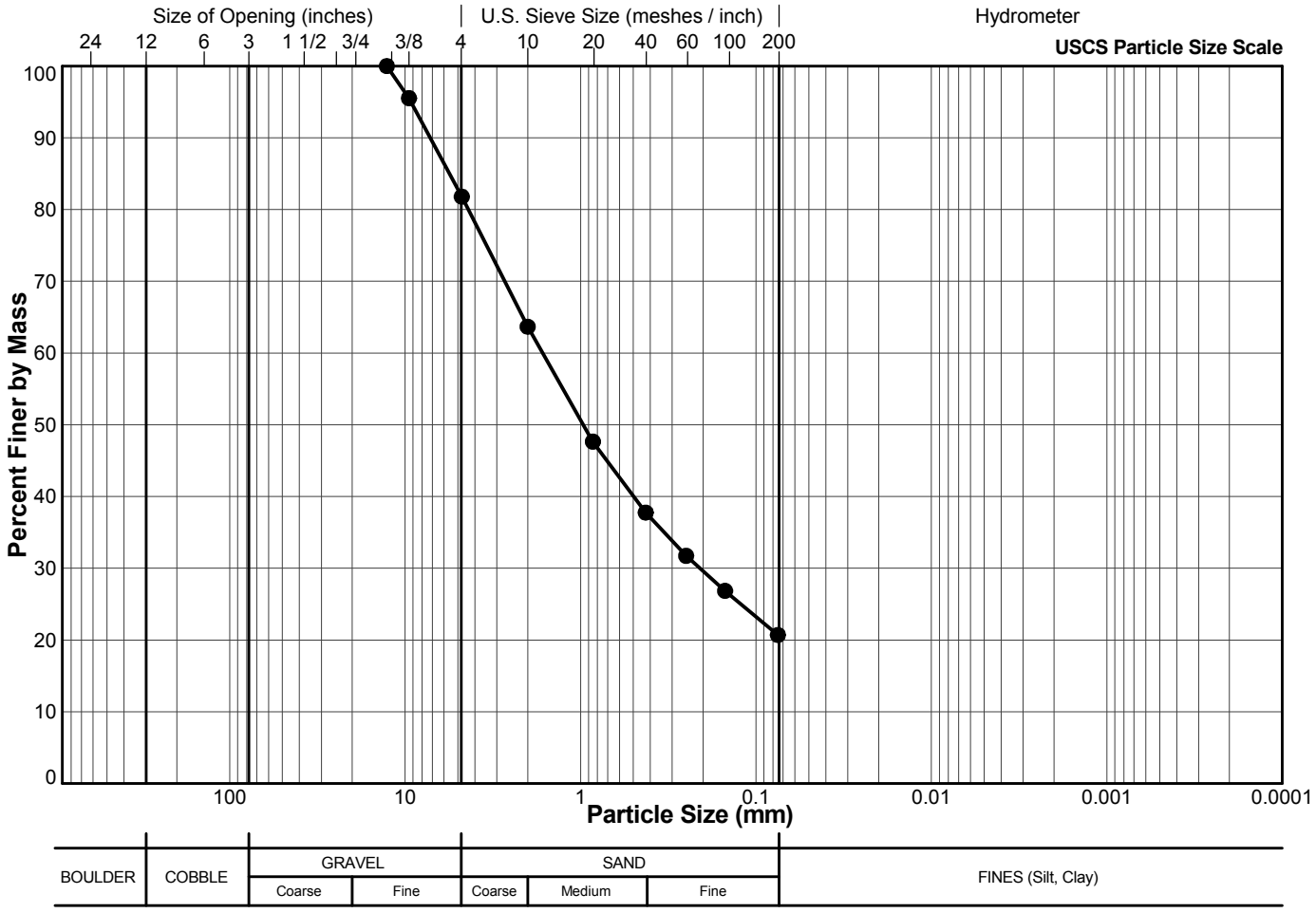
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-02
Sample No.: 1
Depth Interval (m): 0.00 to 0.61
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1/2"	12.7		100.0
3/8"	9.5		95.5
#4 US MESH	4.75		81.8
#10 US MESH	2		63.7
#20 US MESH	0.85		47.6
#40 US MESH	0.425		37.8
#60 US MESH	0.25		31.7
#100 US MESH	0.15		26.9
#200 US MESH	0.075		20.7

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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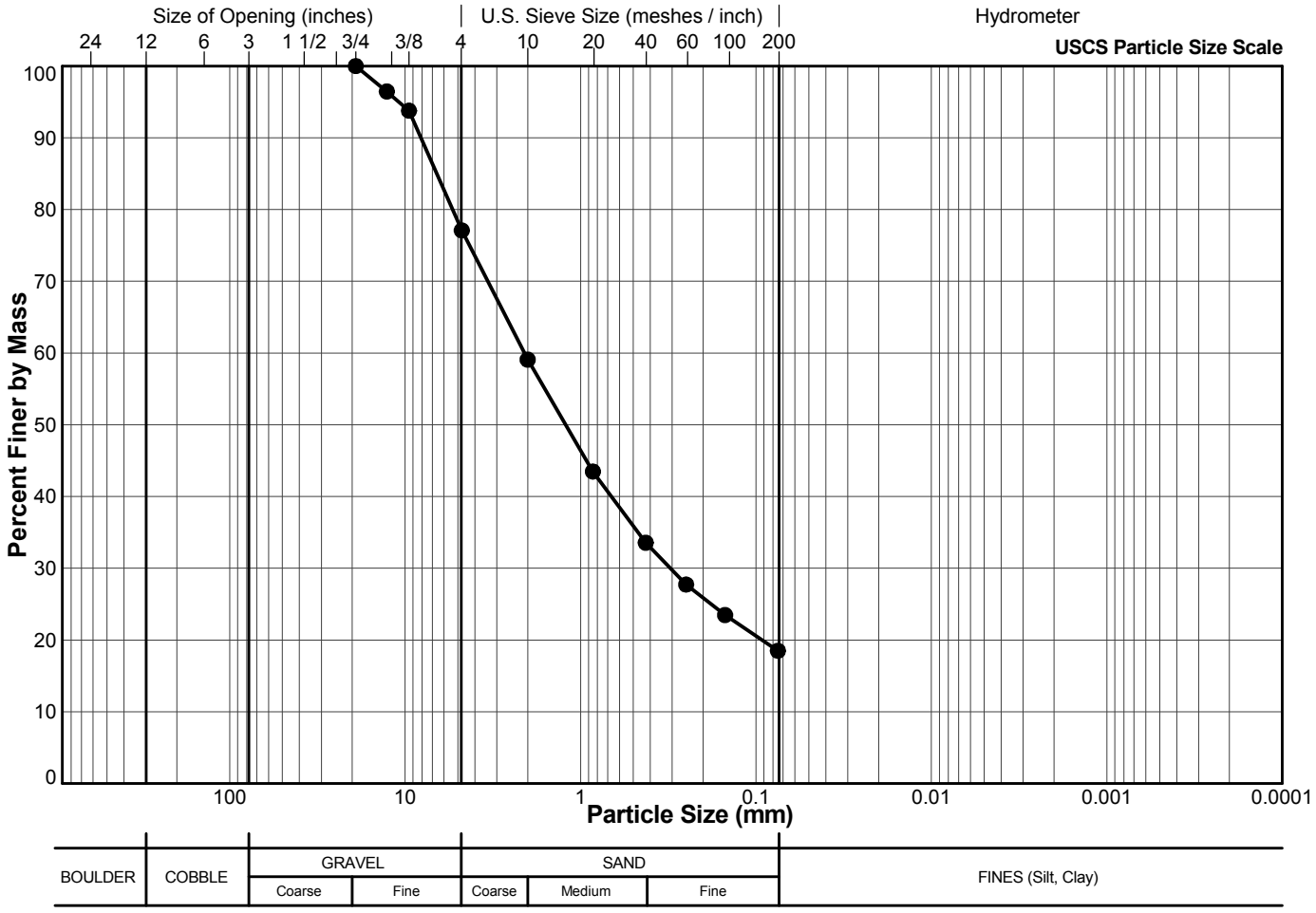
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-03
Sample No.: 1
Depth Interval (m): 0.00 to 0.61
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3/4"	19.1		100.0
1/2"	12.7		96.5
3/8"	9.5		93.8
#4 US MESH	4.75		77.1
#10 US MESH	2		59.1
#20 US MESH	0.85		43.5
#40 US MESH	0.425		33.6
#60 US MESH	0.25		27.7
#100 US MESH	0.15		23.5
#200 US MESH	0.075		18.5

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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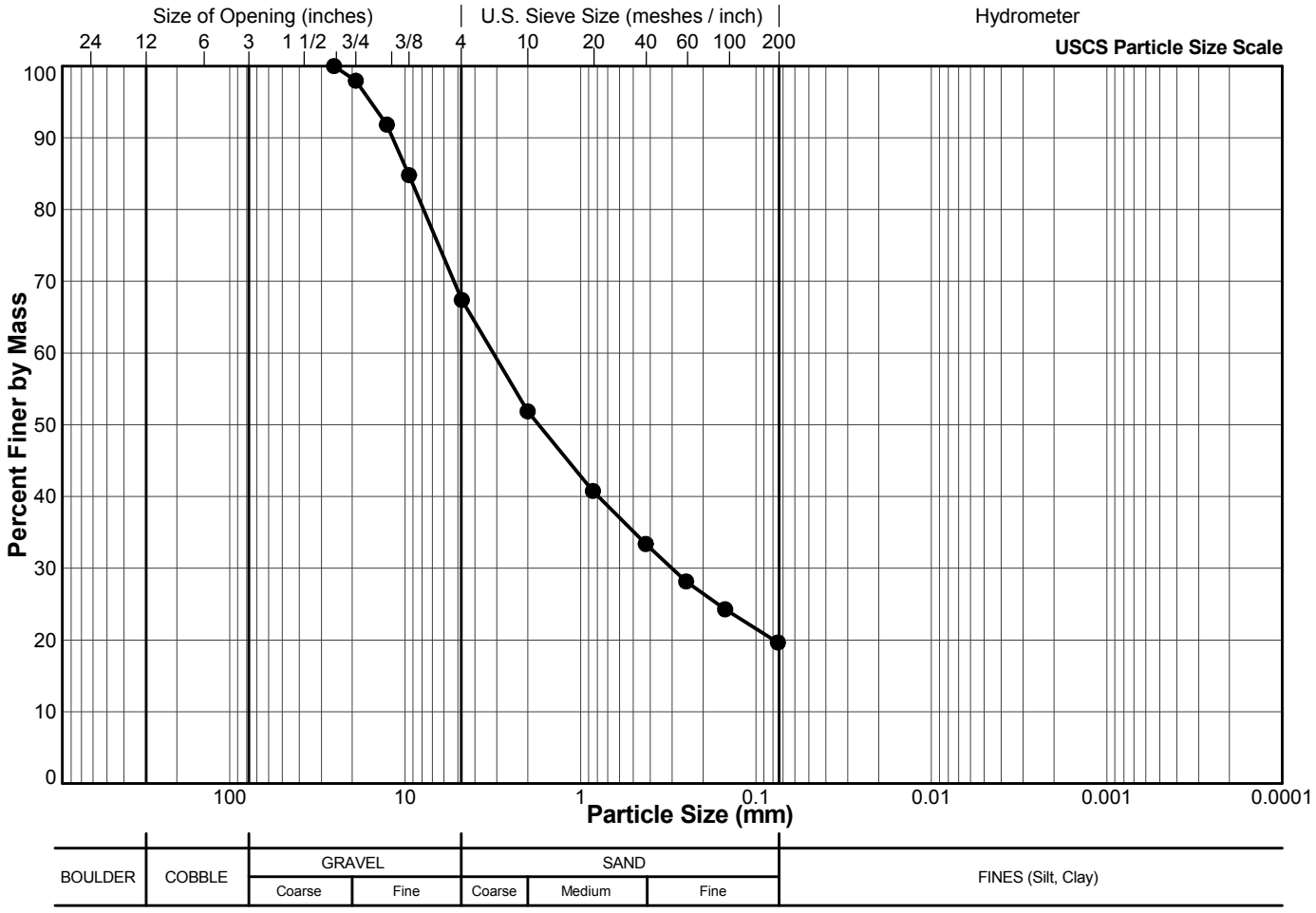
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-04
Sample No.: 1
Depth Interval (m): 0.00 to 0.61
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1"	25.4		100.0
3/4"	19.1		98.0
1/2"	12.7		91.8
3/8"	9.5		84.8
#4 US MESH	4.75		67.4
#10 US MESH	2		51.9
#20 US MESH	0.85		40.8
#40 US MESH	0.425		33.4
#60 US MESH	0.25		28.2
#100 US MESH	0.15		24.3
#200 US MESH	0.075		19.6

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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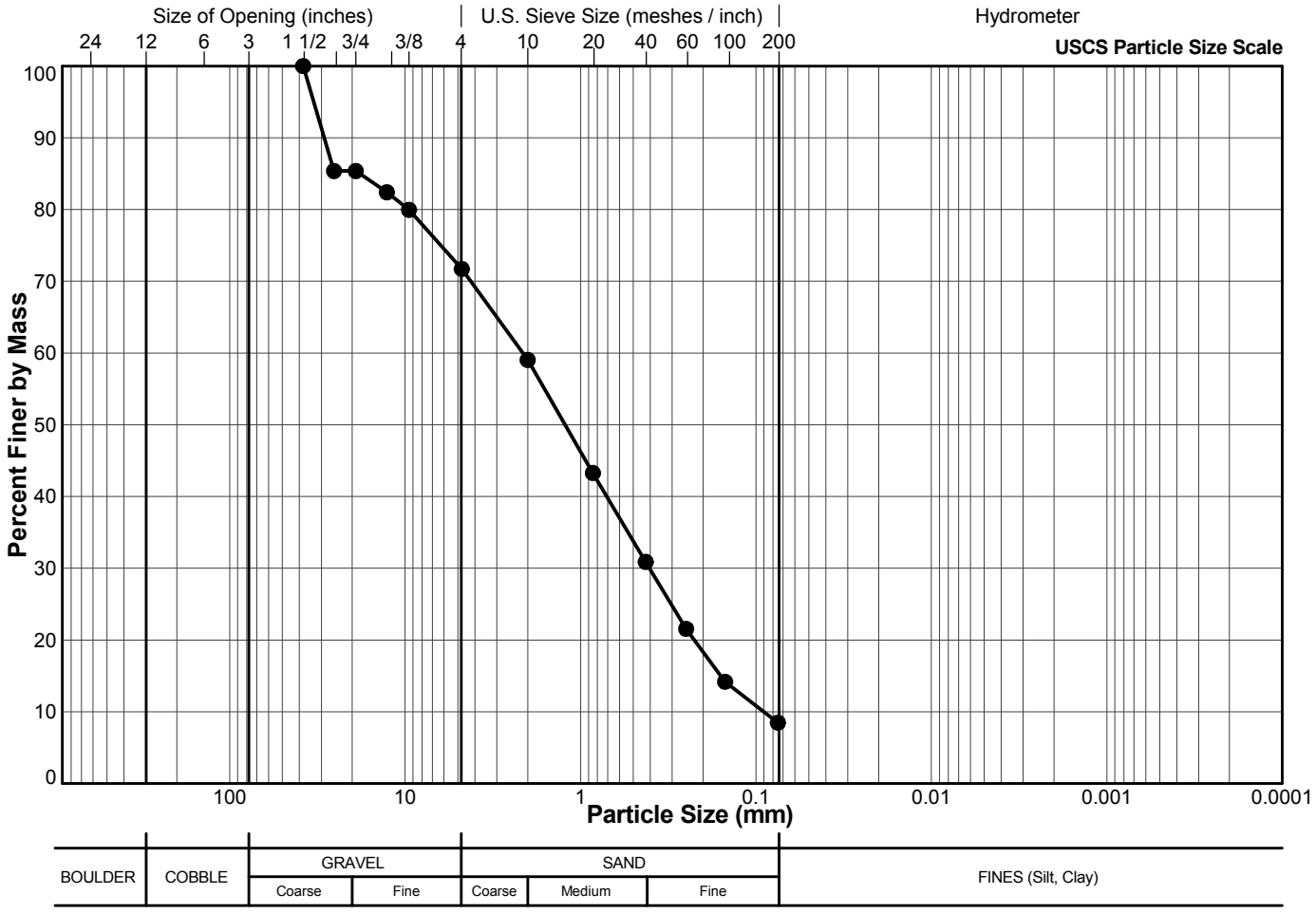
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-05
Sample No.: 1
Depth Interval (m): 0.61 to 1.22
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1 1/2"	38.1		100.0
1"	25.4		85.4
3/4"	19.1		85.4
1/2"	12.7		82.4
3/8"	9.5		80.0
#4 US MESH	4.75		71.7
#10 US MESH	2		59.0
#20 US MESH	0.85		43.3
#40 US MESH	0.425		30.9
#60 US MESH	0.25		21.5
#100 US MESH	0.15		14.2
#200 US MESH	0.075		8.5

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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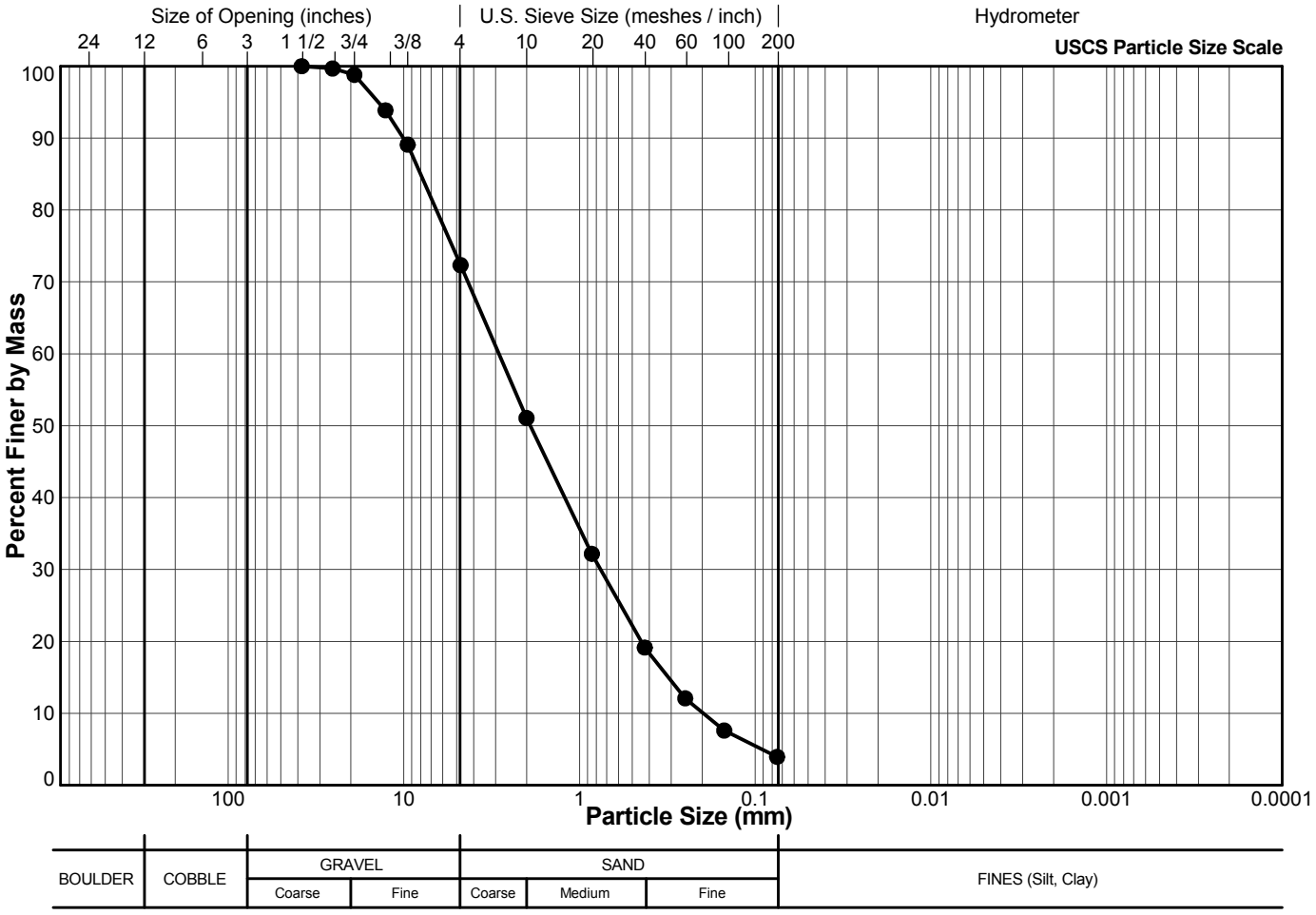
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-06
Sample No.: 1
Depth Interval (m): 0.00 to 0.86
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1 1/2"	38.1		100.0
1"	25.4		99.7
3/4"	19.1		98.8
1/2"	12.7		93.9
3/8"	9.5		89.1
#4 US MESH	4.75		72.3
#10 US MESH	2		51.1
#20 US MESH	0.85		32.2
#40 US MESH	0.425		19.1
#60 US MESH	0.25		12.1
#100 US MESH	0.15		7.6
#200 US MESH	0.075		3.9

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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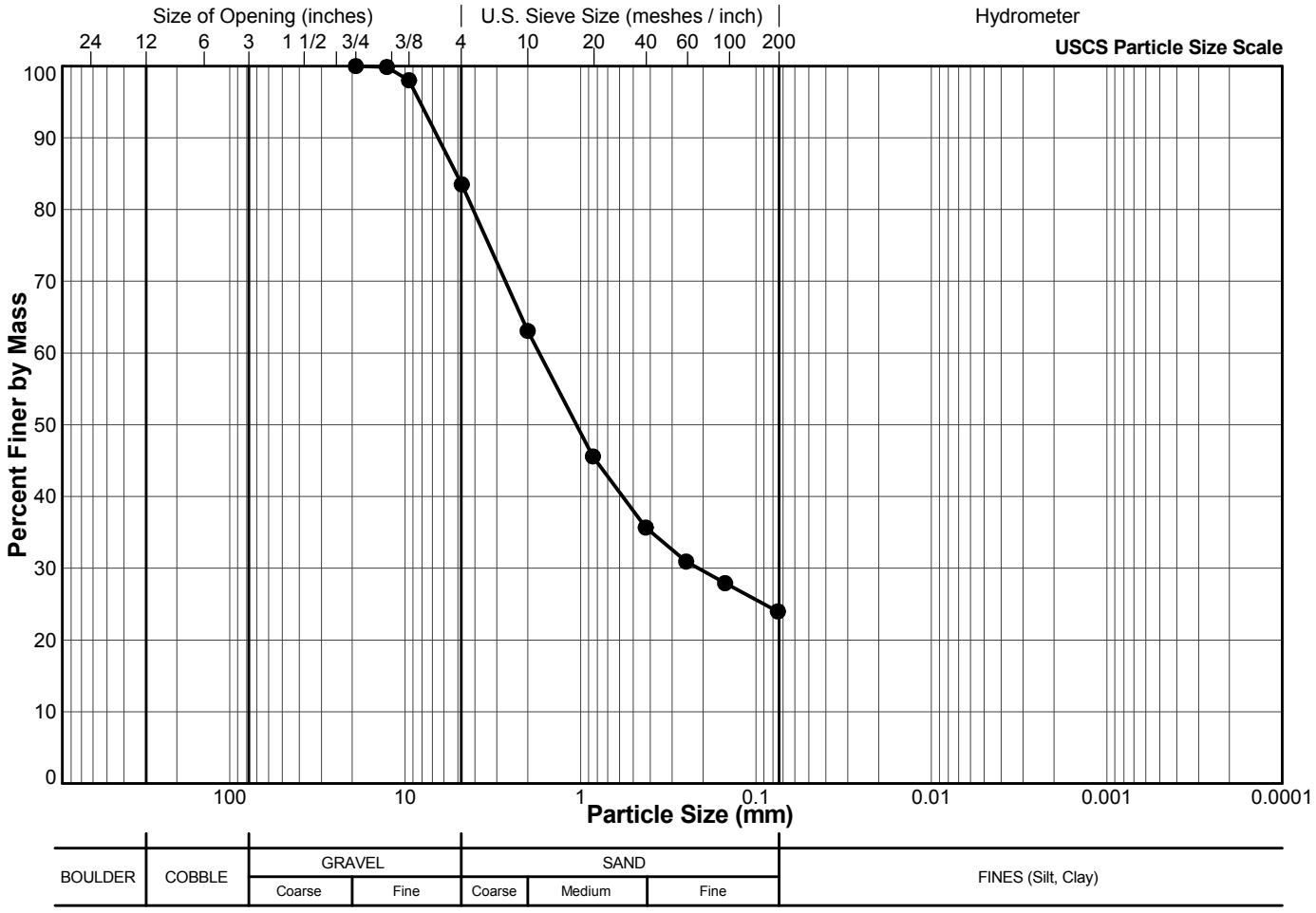
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-07
Sample No.: 2
Depth Interval (m): 0.00 to 1.52
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3/4"	19.1		100.0
1/2"	12.7		99.9
3/8"	9.5		98.0
#4 US MESH	4.75		83.5
#10 US MESH	2		63.1
#20 US MESH	0.85		45.6
#40 US MESH	0.425		35.7
#60 US MESH	0.25		30.9
#100 US MESH	0.15		27.9
#200 US MESH	0.075		24.0

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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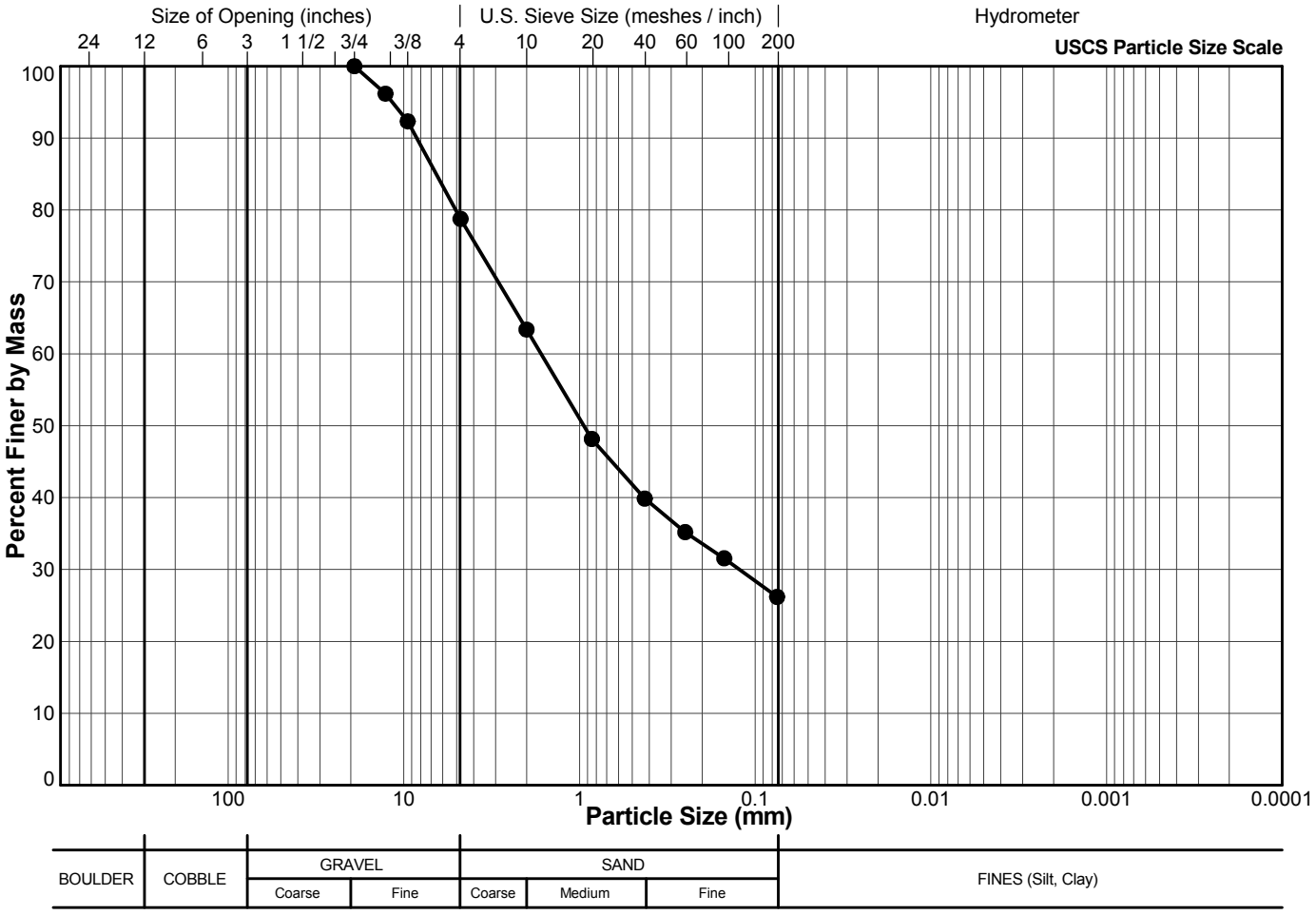
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-08
Sample No.: 1
Depth Interval (m): 0.23 to 0.84
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3/4"	19.1		100.0
1/2"	12.7		96.2
3/8"	9.5		92.3
#4 US MESH	4.75		78.8
#10 US MESH	2		63.4
#20 US MESH	0.85		48.2
#40 US MESH	0.425		39.9
#60 US MESH	0.25		35.2
#100 US MESH	0.15		31.6
#200 US MESH	0.075		26.2

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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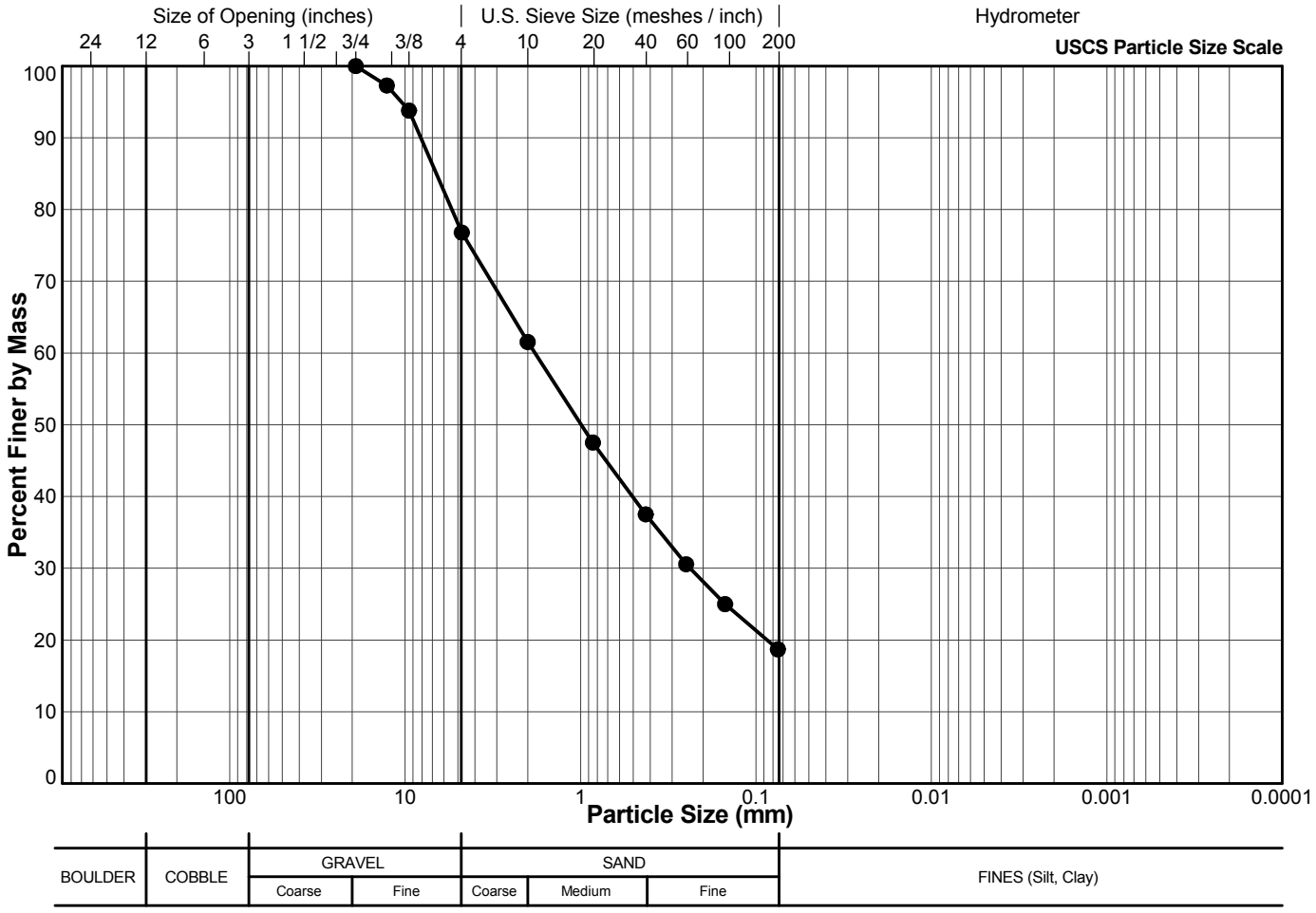
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-09
Sample No.: 1
Depth Interval (m): 0.00 to 0.61
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3/4"	19.1		100.0
1/2"	12.7		97.3
3/8"	9.5		93.8
#4 US MESH	4.75		76.8
#10 US MESH	2		61.5
#20 US MESH	0.85		47.5
#40 US MESH	0.425		37.5
#60 US MESH	0.25		30.6
#100 US MESH	0.15		25.0
#200 US MESH	0.075		18.7

JK/ST	10/26/2015	BS	10/27/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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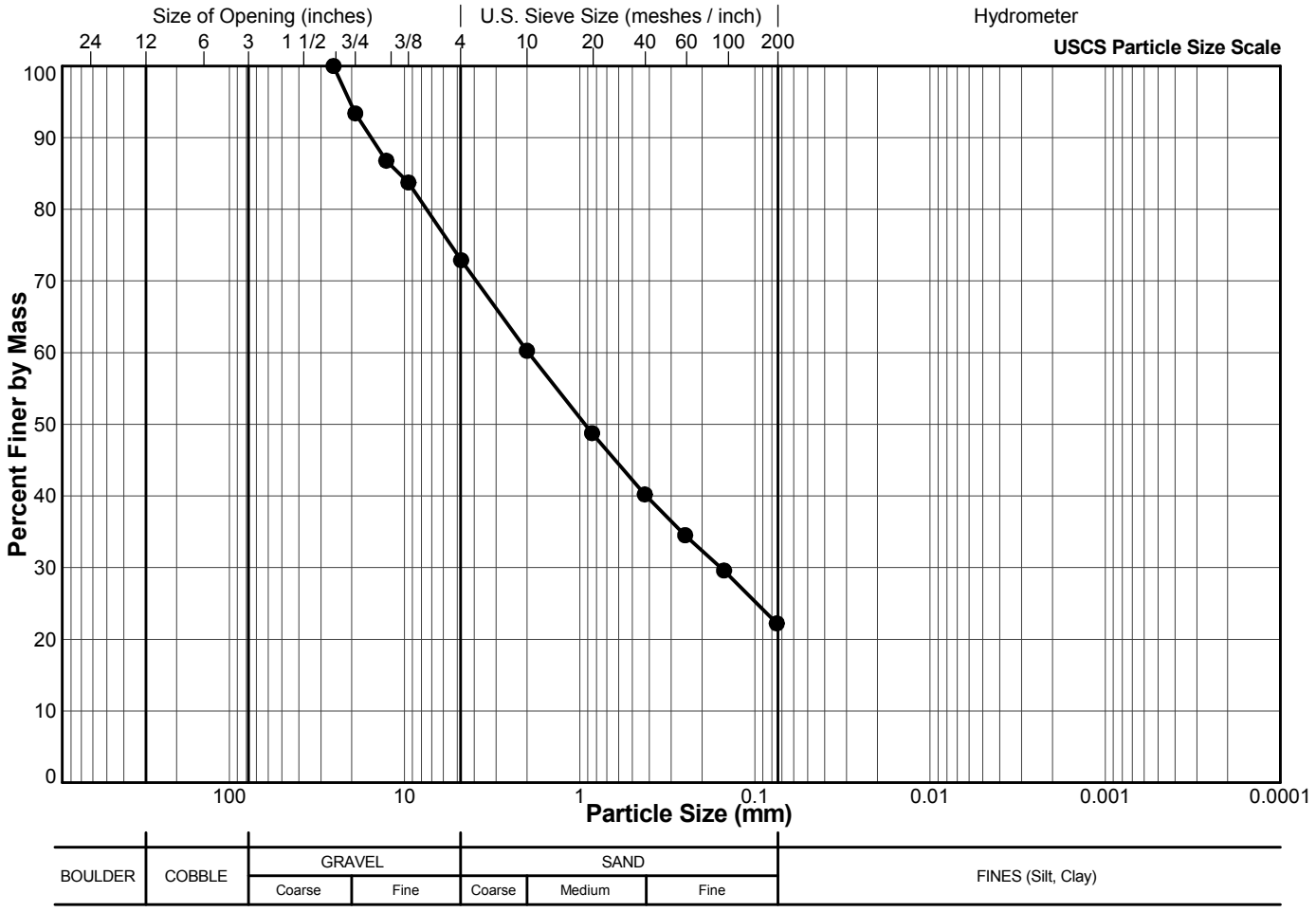
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-11
Sample No.: 1
Depth Interval (m): 0.30 to 0.91
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1"	25.4		100.0
3/4"	19.1		93.4
1/2"	12.7		86.8
3/8"	9.5		83.7
#4 US MESH	4.75		72.9
#10 US MESH	2		60.3
#20 US MESH	0.85		48.8
#40 US MESH	0.425		40.2
#60 US MESH	0.25		34.5
#100 US MESH	0.15		29.6
#200 US MESH	0.075		22.2

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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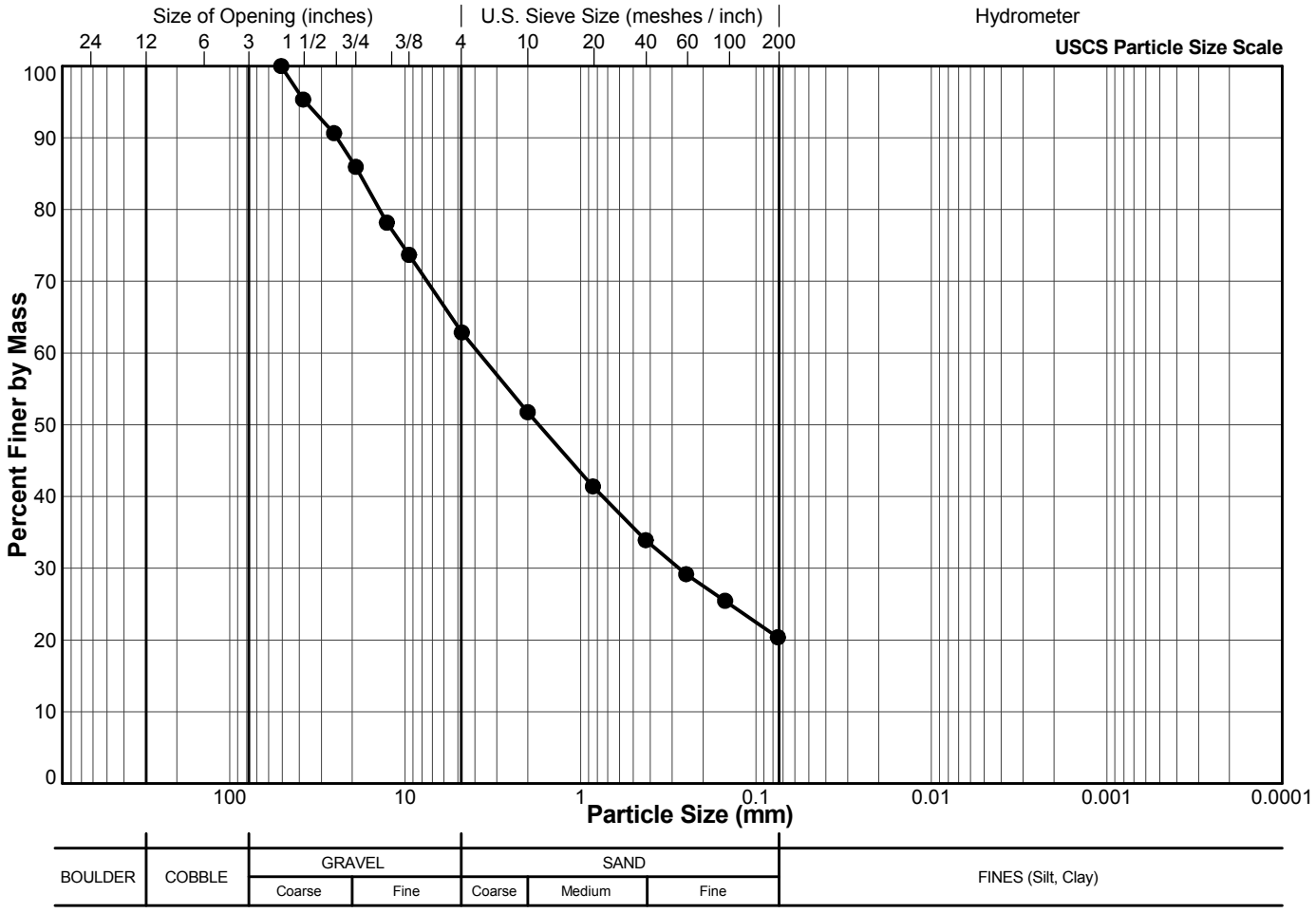
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM C136

Client: Parks Canada
Project: ParksCanada/Transcanada Hwy- ILLECILLE
Location: Rogers Pass, BC
Project No.: 1538990 **Phase:** 1000 **Task:** 1003

Sample Location: AH15-12
Sample No.: 1
Depth Interval (m): 0.15 to 0.91
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
2"	50.8		100.0
1 1/2"	38.1		95.3
1"	25.4		90.6
3/4"	19.1		85.9
1/2"	12.7		78.2
3/8"	9.5		73.7
#4 US MESH	4.75		62.9
#10 US MESH	2		51.8
#20 US MESH	0.85		41.4
#40 US MESH	0.425		33.9
#60 US MESH	0.25		29.2
#100 US MESH	0.15		25.5
#200 US MESH	0.075		20.4

JK/ST	10/26/2015	BS	10/29/2015
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:1073 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2015 STurner 10/30/15

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

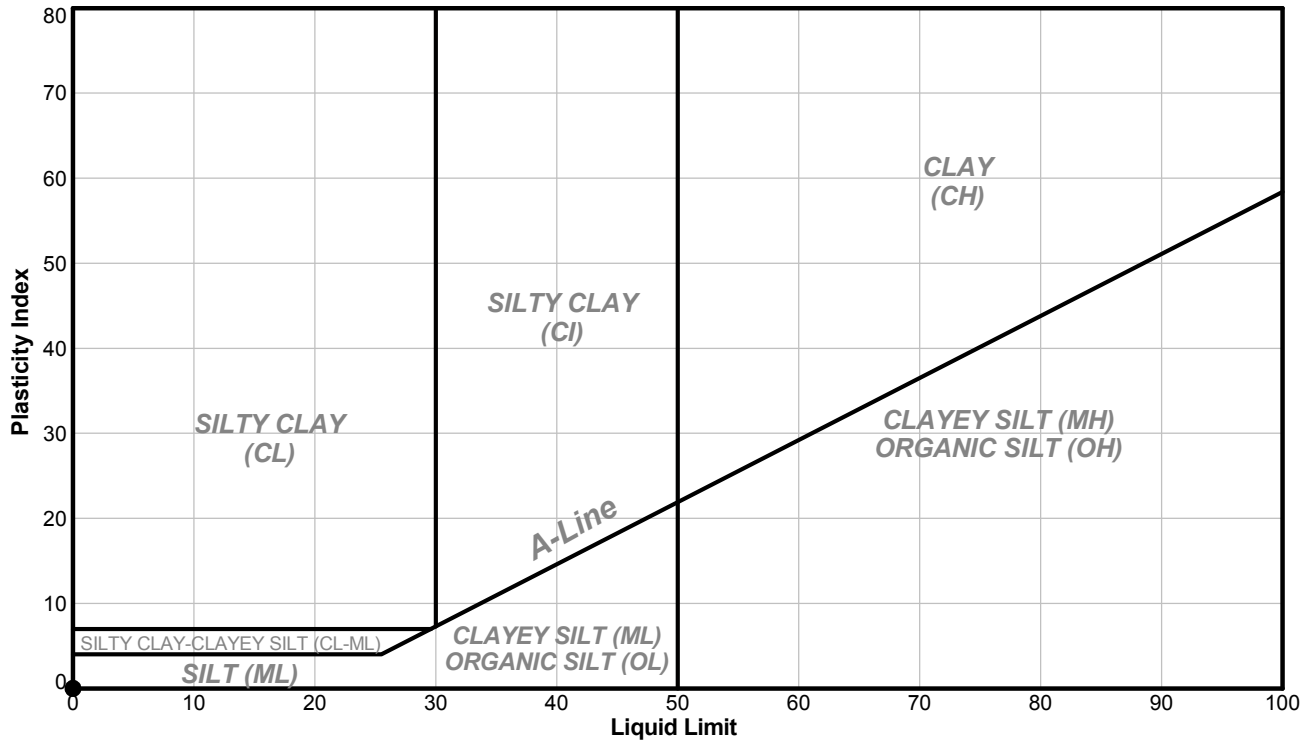
ASTM D 4318-10

Client:	Parks Canada	**Borehole ID:**	**AH15-01**
Project:	ParksCanada/Transcanada Hwy- ILLECILLE	**Sample No.:**	**4**
Location:	Rogers Pass, BC	**Depth Interval (m):**	3.66 to 4.57
Project No.:	1538990 **Phase:** 1000 **Task:** 1003	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method:	**Preparation Method: Sample air-dried before preparation**

PLASTICITY CHART



Sym.	Sample Location	Sample / Specimen Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	AH15-01	4	3.66	4.57	ND	NP	NP	NP	17.0	NP

NP - NON-PLASTIC RESULT ND - NOT DETERMINED

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

ST	**10/27/2015**	**BS**	**10/29/2015**
Tech	Date	Checked	Date

Golder Associates Ltd.
220 - 1755 Springfield Road Kelowna, British Columbia V1Y 5V5
Tel: (250) 860 8424 Ext. 218 Fax: (250) 860 9874 www.golder.com

Golder Associates

General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-01	AS1	0.33	0.76	B855-01	4.9					
	SS2	0.76	1.22	B855-02	7.4					
	SS3	1.52	1.83	B855-03	6.0					
	AS4	2.13	2.74	B855-04	8.2					
	SS5	3.05	3.51	B855-05	8.7					
	BS6	4.27	4.57	B855-06						
	SS7	4.57	5.03	B855-07	4.7					
	BS8	5.03	6.10	B855-08						
	SS9	6.10	6.55	B855-09	9.9					
	BS10	6.55	7.62	B855-10						
	SS11	7.62	8.08	B855-11	30.6					
	BS12	8.08	9.15	B855-12						
	SS13	9.15	9.60	B855-13	12.3					
BH16-02	AS1	0.28	0.76	B855-14	3.7					
	SS2	0.76	1.02	B855-15	10.1					
	AS3	1.22	1.52	B855-16	5.2					
	SS4	1.52	1.80	B855-17	6.3					
	GB5	1.83	3.05	B855-18						
	SS6	3.05	3.51	B855-19	8.1					
	GB7	3.51	4.57	B855-20						
	SS8	4.57	5.03	B855-21	4.6					
	GB9	5.03	6.10	B855-22						
	SS10	6.10	6.55	B855-23	11.6					
	GB11	6.55	7.62	B855-24						
	GB12	7.62	8.38	B855-25						
	GB13	8.38	9.15	B855-26						
	SS14	9.15	9.60	B855-27	16.9					
	GB15	9.60	10.67	B855-28						
	SS16	10.67	11.13	B855-29	11.5					

Reviewed By: 

Golder Associates

General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-03	AS1	0.23	0.76	B855-30	5.6					
	SS2	0.76	1.22	B855-31	6.6					
	SS3	1.52	1.98	B855-32	6.3					
	AS4	1.98	3.05	B855-33	7.4					
	SS5	3.05	3.51	B855-34	6.2					
	AS6	3.51	4.57	B855-35	9.1					
	SS7a	4.57	5.01	B855-36	10.2					
	SS7b	5.01	5.03	B855-37	69.0					
	SS8	6.10	6.71	B855-38	5.3					
BH16-04	AS1	0.46	0.76	B855-39	4.3					
	SS2	0.76	1.22	B855-40	5.5					
	AS3	1.22	1.52	B855-41	4.6					
	SS4	1.52	1.98	B855-42	4.6					
	AS5	1.98	3.05	B855-43	5.6					
	SS6	3.05	3.51	B855-44	missing					
	BS7	3.51	4.27	B855-45						
	SS8	4.57	5.03	B855-46	9.6					
	BS9	5.18	5.79	B855-47	14.5	NP	NP	NP		
	SS10	6.10	6.55	B855-48	11.5					
BH16-05	AS1	0.46	0.76	B855-49	6.6					
	BS2	1.98	3.05	B855-50						
	SS3	3.05	3.51	B855-51	8.4					
	BS4	3.51	4.57	B855-52						
	SS5	4.57	5.03	B855-53	20.4					
	BS6	5.03	6.10	B855-54	21.2					
	BS7	6.10	7.62	B855-55						
	SS8	7.62	8.08	B855-56	12.9					

Reviewed By: 

Golder Associates

General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-06 A	AS1	0.46	0.76	B855-57	10.7					
	SS2	1.52	1.98	B855-58	9.4					
	BS3	1.98	3.05	B855-59						
	SS4a	4.57	4.98	B855-60	42.8					
	SS4b	4.98	5.03	B855-61	85.0					
	SS5	6.10	6.55	B855-62	14.8					
	BS6	6.55	7.62	B855-63						
	SS7	7.62	8.08	B855-64	14.0					
BH16-06 B	HA1	3.05	3.35	B855-65	27.2					
	HA2	4.27	4.57	B855-66	31.1	NP	NP	NP		
	HA3	5.18	6.10	B855-67	24.6					
BH16-07	AS1	0.41	0.76	B855-68	5.8					
	SS2	0.76	1.22	B855-69	6.0					
	AS3	1.22	1.52	B855-70	5.3					
	SS4	1.52	1.98	B855-71	6.1					
	AS5	2.44	3.05	B855-72	11.8	NP	NP	NP		
	SS6	3.05	3.51	B855-73	13.0					
	AS7	3.96	4.27	B855-74	11.7					
	SS8	4.57	5.03	B855-75	11.0					
	AS9	5.49	5.79	B855-76	38.5					
	SS10	6.10	6.55	B855-77	22.8					
	AS11	6.71	7.62	B855-78	21.6					
	SS12	7.62	8.08	B855-79	20.0					
	AS13	8.84	9.15	B855-80	14.1					
	SS14	9.15	9.76	B855-81	12.8					

Reviewed By: 

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General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-08	AS1	0.61	0.76	B855-82	3.2					
	SS2	0.76	1.22	B855-83	8.7					
	SS3	1.52	1.98	B855-84	10.1					
	AS4	1.98	3.05	B855-85	10.2					
	SS5	3.05	3.51	B855-86	9.4					
	AS6	3.96	4.57	B855-87	10.8					
	SS7	4.57	5.03	B855-88	10.9					
	AS8	5.79	6.10	B855-89	11.3					
	SS9	6.10	6.55	B855-90	15.5					
	AS10	6.71	7.01	B855-91	42.4					
	SS11	7.62	8.08	B855-92	27.1					
	AS12	8.54	9.15	B855-93	11.7					
	SS13	9.15	9.60	B855-94	11.6					
	AS14	9.76	10.06	B855-95	14.6					
	SS15	10.67	11.13	B855-96	13.6					
	SS16	11.59	11.61	B855-97	12.4					
BH16-09	AS1	0.46	0.76	B855-98	1.8					
	SS2	0.76	1.22	B855-99	3.7					
	AS3	1.22	1.52	B855-100	9.7					
	SS4	1.52	1.98	B855-101	8.0					
	AS5	2.29	3.05	B855-102	19.6					
	SS6	3.05	3.30	B855-103	14.8					
	AS7	3.30	4.57	B855-104	8.3					
	SS8	4.57	5.03	B855-105	9.4					
	AS9	5.03	6.10	B855-106	7.0					

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General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
	AS1	0.41	0.76	B855-107	4.1					
	SS2	0.76	1.22	B855-108	8.1					
	AS3	1.22	1.52	B855-109	7.7					
	SS4	1.52	1.58	B855-110	7.5					
	GB5	2.29	3.05	B855-111						
	SS6	3.05	3.51	B855-112	9.9					
	GB7	3.51	4.57	B855-113						
	SS8	4.57	5.03	B855-114	3.7					
	GB9	5.03	6.10	B855-115						
	SS10	6.10	6.55	B855-116	3.8					
	GB11	6.55	7.62	B855-117						
	SS12	7.62	8.08	B855-118	4.3					
	GB13	8.08	9.15	B855-119						
	SS14	9.15	9.60	B855-120	3.6					
	GB15	9.60	10.67	B855-121						
	SS16	10.67	11.00	B855-122	3.9					
	GB17	11.00	12.20	B855-123						
BH16-11	SS18	12.20	12.65	B855-124	2.2					
	GB19	12.65	13.72	B855-125						
	SS20	13.72	14.18	B855-126	9.6					
	GB21	14.18	15.24	B855-127						
	SS22	15.24	15.55	B855-128	11.0					
	GB23	15.55	16.77	B855-129						
	SS24	16.77	17.07	B855-130	10.3					
	GB25	17.07	18.29	B855-131						
	SS26	18.29	18.34	B855-132	8.2					
	GB27	18.34	19.82	B855-133						
	GB28	19.82	21.34	B855-134						
	SS29	21.34	21.71	B855-135	8.6	NP	NP	NP		
	GB30	21.71	22.87	B855-136						
	SS31	22.87	23.17	B855-137	9.8	NP	NP	NP		
	GB32	23.17	24.39	B855-138						
	SS33	24.39	24.44	B855-139	15.1					
	GB34	24.44	25.91	B855-140						
	SS35	25.91	25.97	B855-141	16.2					

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General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-12	AS1	25.97	0.36	B855-142	5.4					
	SS2	0.76	0.99	B855-143	6.9					
	AS3	1.52	1.98	B855-144	8.8					
	SS4	1.52	1.98	B855-145	11.3					
	AS5	1.98	3.05	B855-146	10.4					
	SS6	3.05	3.51	B855-147	12.5					
	AS7	3.51	3.96	B855-148	11.5					
	GB8	3.96	4.57	B855-149						
	SS9	4.57	5.03	B855-150	11.0					
	GB10	5.03	6.10	B855-151						
	SS11	6.10	6.55	B855-152	7.6					
	GB12	6.55	7.62	B855-153						
	SS13	7.62	7.77	B855-154	7.6					
	GB14	7.77	9.15	B855-155						
	GB15	9.15	10.67	B855-156						
	GB16	10.67	12.20	B855-157						
	SS17	12.20	12.42	B855-158	3.3					
	GB18	12.50	13.72	B855-159						
	SS19	13.72	14.18	B855-160	7.5					
	GB20	14.18	15.24	B855-161						

Reviewed By:

Golder Associates

General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
BH16-13	AS1	0.36	0.76	B855-162	4.3					
	SS2	0.76	1.22	B855-163	6.6					
	AS3	1.22	1.52	B855-164	7.6					
	SS4	1.52	1.98	B855-165	7.5					
	AS5	1.98	3.05	B855-166	7.8					
	SS6	3.05	3.51	B855-167	6.2					
	GB7	3.51	4.57	B855-168						
	GB8	4.57	6.10	B855-169						
	SS9	6.10	6.55	B855-170	9.6					
	GB10	6.55	7.62	B855-171						
	SS11	7.62	8.08	B855-172	6.4					
	GB12	8.08	9.15	B855-173						
	SS13	9.15	9.35	B855-174	4.2					
	GB14	9.38	10.67	B855-175						
	GB15	10.67	12.20	B855-176						
	SS16	12.20	12.65	B855-177	6.9					
	GB17	12.65	13.72	B855-178						
	SS18	13.72	13.74	B855-179	14.5					
	GB19	13.74	15.24	B855-180						
	SS20	15.24	15.70	B855-181	20.3					
	GB21	15.70	16.77	B855-182						
	SS22	16.77	17.23	B855-183	50.9					
	GB23	17.23	17.53	B855-184						
	GB24	17.53	18.29	B855-185						
	SS25	18.29	18.75	B855-186	21.9					
	GB26	18.75	19.82	B855-187						
	SS27	19.82	19.87	B855-188	17.3					
	GB28	20.27	21.34	B855-189						
	SS29	21.34	21.80	B855-190	13.6					

Reviewed By:

Golder Associates

General Lab Testing Summary

Project No.: 1654325
Short Title: PCA/GlacierNP-CU11/I-Curve
Tested By: DS

Phase: 3000
Sched: B855
Date: 24-Jun-16

Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
	AS1	0.36	0.76	B855-191	9.0					
	SS2	0.76	1.22	B855-192	1.6					
	SS3	1.52	1.98	B855-193	5.4					
	BS4	2.74	3.05	B855-194						
	SS5	3.05	3.51	B855-195	4.6					
	BS6	3.51	4.57	B855-196						
	SS7	4.57	5.03	B855-197	6.2					
	BS8	5.49	6.10	B855-198						
	SS9	6.10	6.55	B855-199	7.6					
	BS10	6.71	7.32	B855-200						
	SS11	7.62	8.08	B855-201	8.9					
	BS12	8.23	9.15	B855-202						
	SS13	9.15	9.60	B855-203	9.2					
BH16-14	BS14	10.06	10.37	B855-204						
	SS15	10.67	11.13	B855-205	11.7					
	BS16	11.13	11.59	B855-206						
	SS17	12.20	126.52	B855-207	9.9					
	BS18	12.80	13.41	B855-208						
	SS19	13.72	14.18	B855-209	17.0					
	BS20	14.18	15.24	B855-210						
	SS21	15.24	15.70	B855-211	12.2					
	BS22	16.16	16.46	B855-212						
	SS23	16.77	17.07	B855-213	13.1					
	BS24	17.23	18.29	B855-214						
	SS25	18.29	18.75	B855-215	17.9					
	BS26	18.75	19.82	B855-216						
	SS27	19.82	20.27	B855-217	20.3					

Reviewed By:

Golder Associates

General Lab Testing Summary

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Sched:	B856
Tested By:	DS	Date:	24-Jun-16

Sample Identification					Laboratory Test Results		
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	SPMDD (kg/m^3)	Optimum w (%)
TP16-01	GB1	0.00	0.50	B856-01	7.4		
	GB2	0.60	0.80	B856-02	7.7		
	GB3	0.80	1.00	B856-03	8.1		
	GB4	1.00	2.00	B856-04	8.1		
	BS5a	2.00	2.20	B856-05	8.6		
	BS5b	2.00	2.20	B856-06	8.8	2178	7.8
	BS5c	2.00	2.20	B856-07	8.4		
TP16-02	GB1	0.00	0.20	B856-08	66.9		
	GB2	0.20	1.30	B856-09	181.9		
	GB3	1.50	2.10	B856-10	24.8		
	GB4	2.10	2.70	B856-11	18.1		
	BS5a	2.70	3.25	B856-12	18.2		
	BS5b	2.70	3.25	B856-13	17.2	2104	8.8
	BS5c	2.70	3.25	B856-14	18.4		
	GB6	3.25	3.90	B856-15	9.6		
TP16-03	GB1	0.00	0.30	B856-16	20.9		
	GB2	0.30	0.70	B856-17	133.5		
	GB3	0.70	0.80	B856-18	470.5		
	GB4	0.90	1.20	B856-19	52.6		
	GB5	1.20	1.50	B856-20	44.5		
	GB6	1.80	2.00	B856-21	295.7		
	GB7	2.00	2.60	B856-22	318.8		
	GB8	2.90	3.10	B856-23	17.0		
	GB9	3.10	3.40	B856-24	89.0		
	GB10	3.40	3.60	B856-25	374.6		

Reviewed By:

Golder Associates

General Lab Testing Summary

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Sched:	B856
Tested By:	DS	Date:	24-Jun-16

Sample Identification					Laboratory Test Results		
Borehole No.	Sample No.	Depth (m) from	Depth (m) to	Lab No.	Water Content (%)	SPMDD (kg/m^3)	Optimum w (%)
TP16-05	GB1	0.50	1.20	B856-26	16.2		
	GB2	1.30	1.60	B856-27	11.3		
	GB3	1.60	2.00	B856-28	11.4		
	BS4	2.00	2.60	B856-29	16.7		
	GB5	2.60	3.00	B856-30	17.5		
	GB6	3.00	3.40	B856-31	21.3		
	GB7	3.40	4.00	B856-32	21.6		
TP16-06	GB1	0.00	0.50	B856-33	9.6		
	GB2	0.50	1.00	B856-34	8.2		
	GB3	1.20	1.40	B856-35	7.9		
	GB4	1.50	2.00	B856-36	8.8		
	GB5	2.20	2.30	B856-37	8.6		
	GB6	2.50	3.00	B856-38	8.3		
	BS7a	3.00	3.40	B856-39	17.0	2083	8.5
	BS7b	3.00	3.40	B856-40	17.0		
	BS7c	3.00	3.40	B856-41	14.6		
	BS7d	3.00	3.40	B856-42	15.1		
	GB8	3.40	3.45	B856-43	11.0		
TP16-07	GB1	0.00	0.50	B856-44	20.2		
	GB2	0.50	0.70	B856-45	12.4		
	GB3	0.70	1.00	B856-46	11.9		
	GB4	1.30	1.50	B856-47	17.2		
	GB5	2.00	2.20	B856-48	13.2		
	BS6a	2.50	2.80	B856-49	9.4	1994	10.5
	BS6b	2.50	2.80	B856-50	11.9		
	BS6c	2.50	2.80	B856-51	12.8		
	GB7	2.80	3.20	B856-52	10.5		
	GB8	3.20	3.60	B856-53	10.2		
	GB9	3.60	4.00	B856-54	11.9		

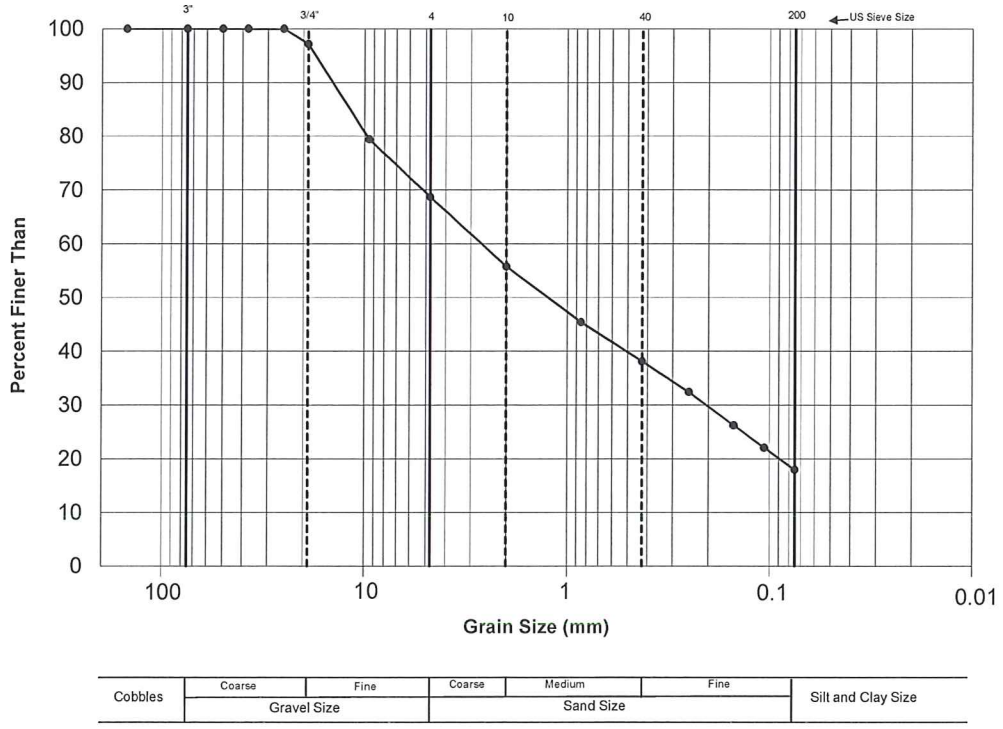
Reviewed By: _____

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-02
Lab No.:	B855-19		Northing:	-	m	Sample No.:	SS6
Sampled By:	AW/MG		Easting:	-	m	Depth From:	3.05 m
Sample Date:	14-Jun-16		Elevation:	-	m	Depth To:	3.51 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	100
19.0	97
9.5	79
4.75	69
2.00	56
0.85	45
0.425	38
0.250	32
0.150	26
0.106	22
0.075	18

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
8.1	0	31	51	18	2.9	0.2	N/A	N/A	N/A

Sample Description: (SM) gravelly fine to coarse SILTY SAND, fine sub-angular gravel; brown; non-cohesive, moist

USCS Classification: SM

Remarks:

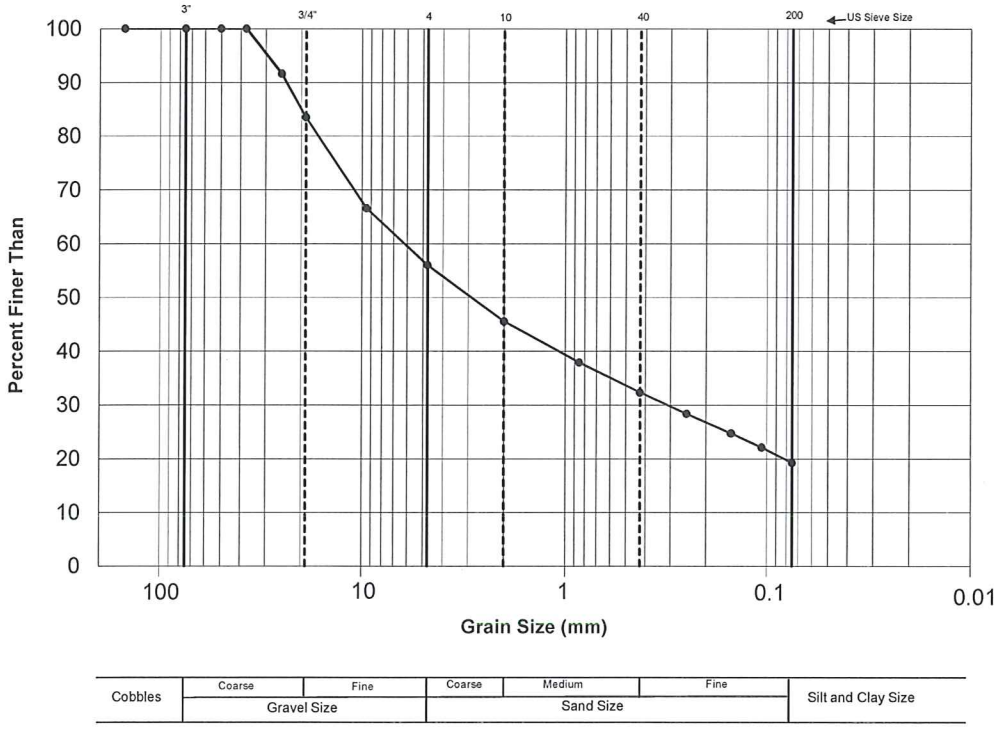
Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-03
Lab No.:	B855-38		Northing:	-	m	Sample No.:	SS8
Sampled By:	AW/MG		Easting:	-	m	Depth From:	6.10 m
Sample Date:	17-Jun-16		Elevation:	-	m	Depth To:	6.71 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	92
19.0	84
9.5	67
4.75	56
2.00	46
0.85	38
0.425	32
0.250	28
0.150	25
0.106	22
0.075	19

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
5.3	0	44	37	19	6.5	0.3	N/A	N/A	N/A

Sample Description: (GM) fine to coarse sub-angular SILTY GRAVEL and fine to coarse SAND; light brown; non-cohesive, moist

USCS Classification: GM

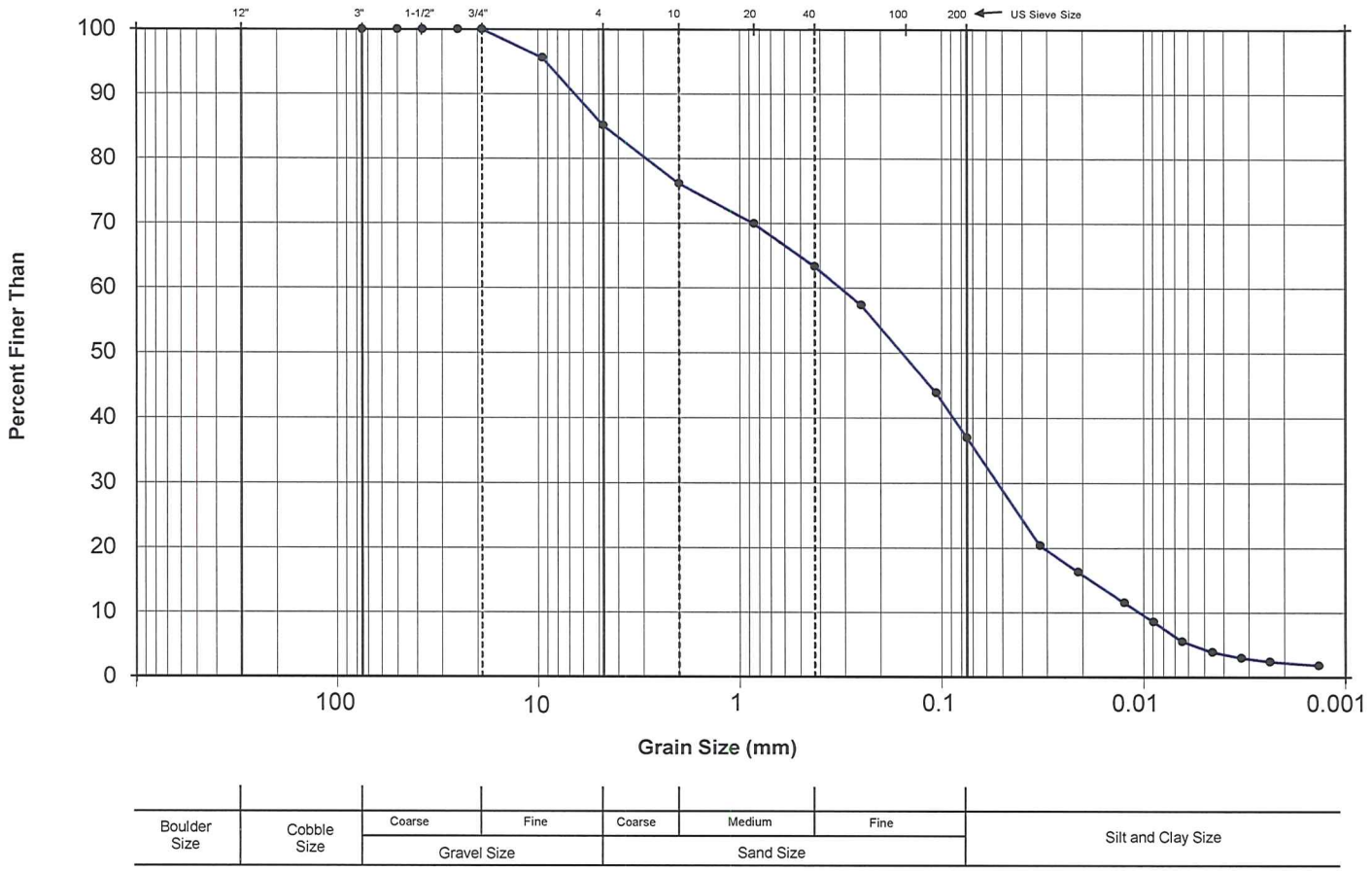
Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by:

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	1654325.3000	Lab No.:	B855-47
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	BH16-04	Sample No.:	BS9
Depth:	5.18-5.79 m		
Date Tested:	24-Jun-16	By:	DS



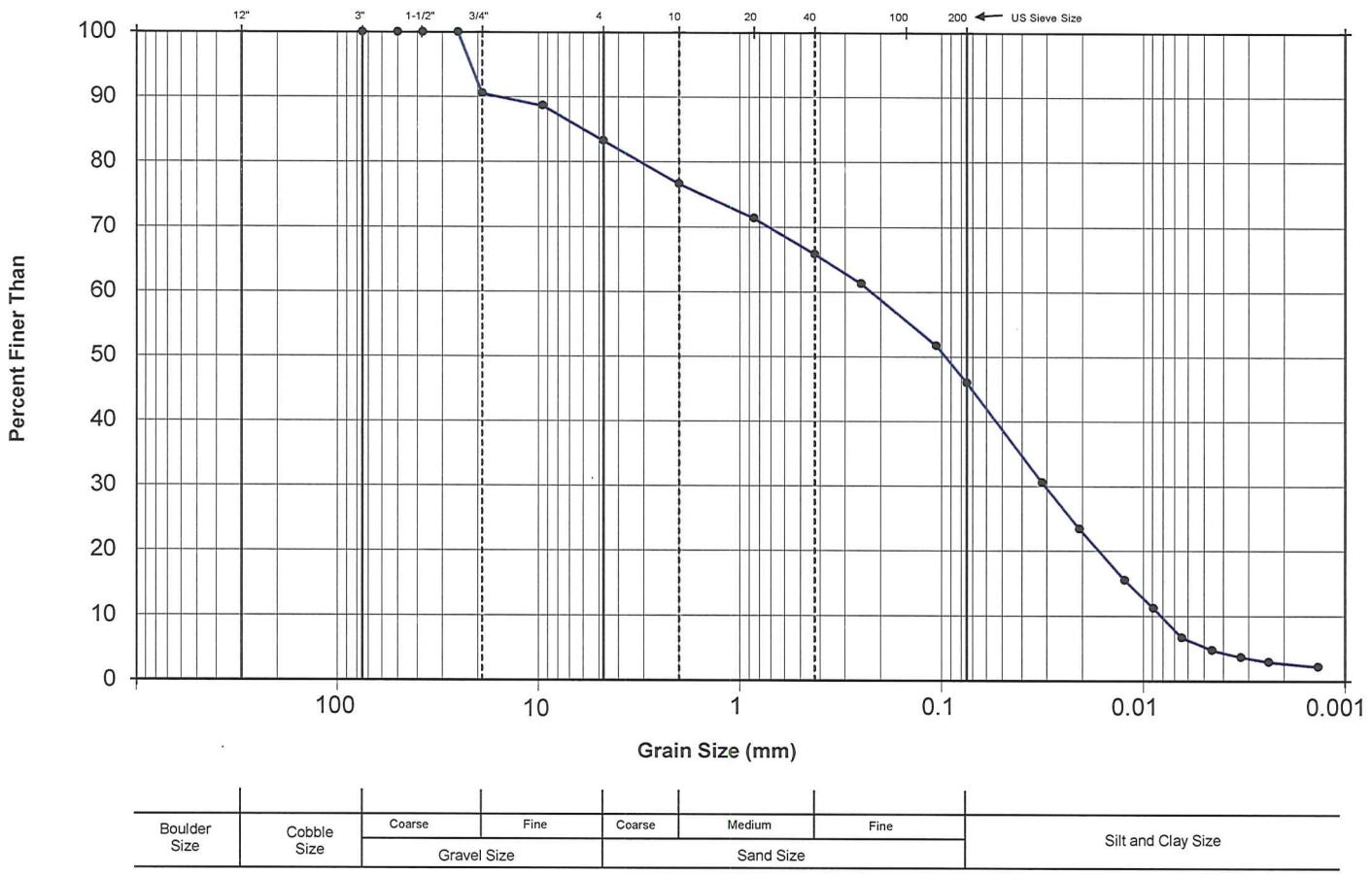
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	95.6
4.75	85.2
2.0	76.2
0.850	70.0
0.425	63.4
0.250	57.4
0.106	43.9
0.075	37.0
0.033	20.4
0.021	16.3
0.012	11.6
0.009	8.6
0.006	5.5
0.005	3.9
0.003	3.0
0.002	2.5
0.001	1.9

Comments:

Reviewed:

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	1654325.3000	Lab No.:	B855-66
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	BH16-06B	Sample No.:	HA2
Depth:	4.27-4.57 m		
Date Tested:	24-Jun-16	By:	DS



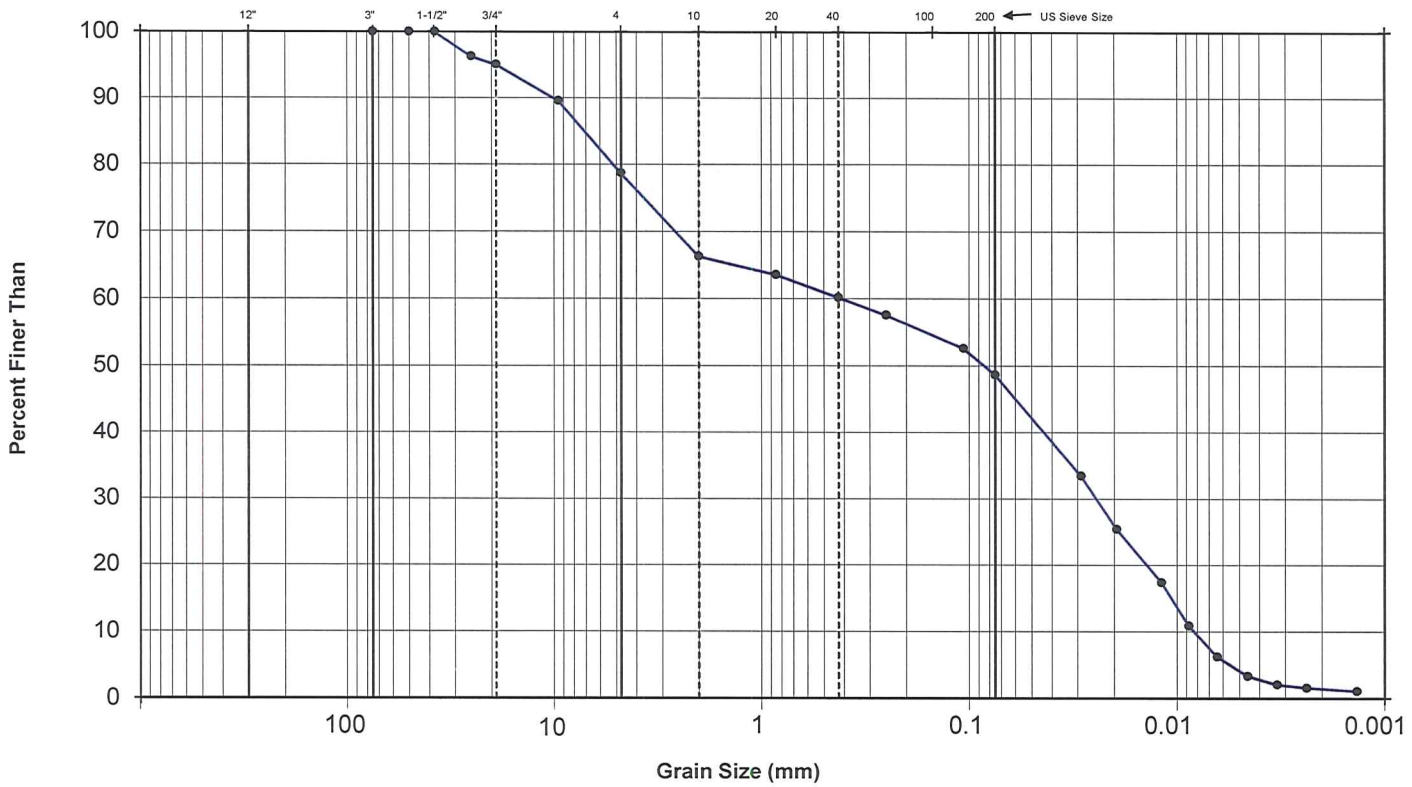
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	90.6
9.5	88.7
4.75	83.3
2.0	76.7
0.850	71.4
0.425	65.9
0.250	61.3
0.106	51.7
0.075	46.0
0.032	30.5
0.021	23.4
0.012	15.5
0.009	11.2
0.006	6.7
0.005	4.8
0.003	3.7
0.002	3.0
0.001	2.3

Comments:

Reviewed:

Project No.:	1654325.3000	Lab No.:	B855-72
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	BH16-07	Sample No.:	AS5
Depth:	2.44-3.05 m		
Date Tested:	24-Jun-16	By:	DS

Particle Size Analysis of Soil
(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	96.3
19.0	95.1
9.5	89.6
4.75	78.8
2.0	66.3
0.850	63.6
0.425	60.2
0.250	57.6
0.106	52.6
0.075	48.7
0.029	33.4
0.019	25.4
0.012	17.4
0.009	10.9
0.006	6.2
0.005	3.3
0.003	2.1
0.002	1.6
0.001	1.1

Comments:

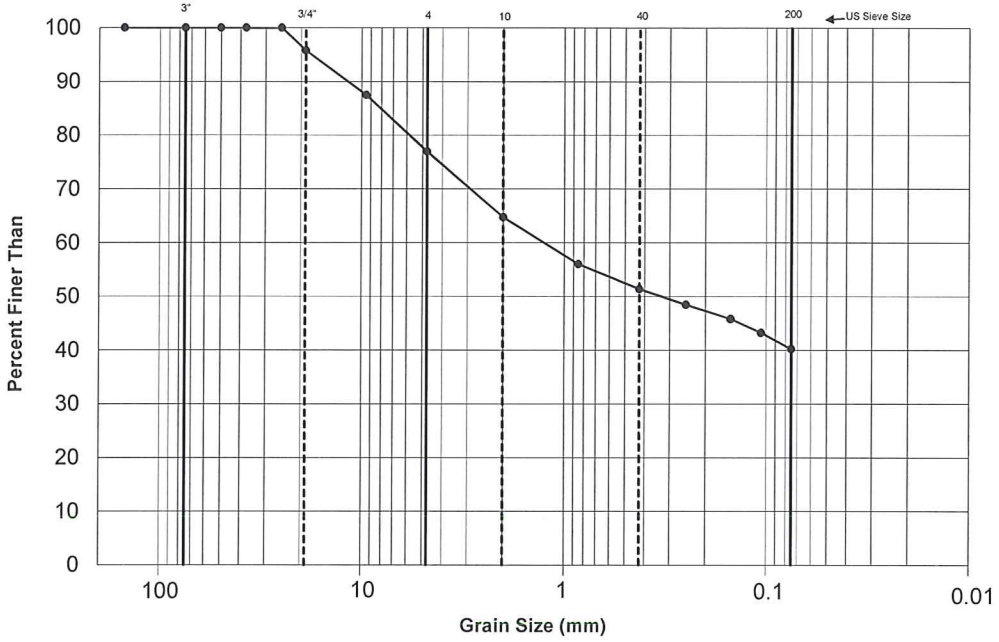
Reviewed:

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-08
Lab No.:	B855-88		Northing:	-	m	Sample No.:	SS7
Sampled By:	AW/MG		Easting:	-	m	Depth From:	4.57 m
Sample Date:	14-Jun-16		Elevation:	-	m	Depth To:	5.03 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	100
19.0	96
9.5	87
4.75	77
2.00	65
0.85	56
0.425	51
0.250	48
0.150	46
0.106	43
0.075	40

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
10.9	0	23	37	40	1.4	N/A	N/A	N/A	N/A

Sample Description: (SM) gravelly fine to coarse SILTY SAND, fine sub-angular gravel; light brown; non-cohesive, moist

USCS Classification: SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

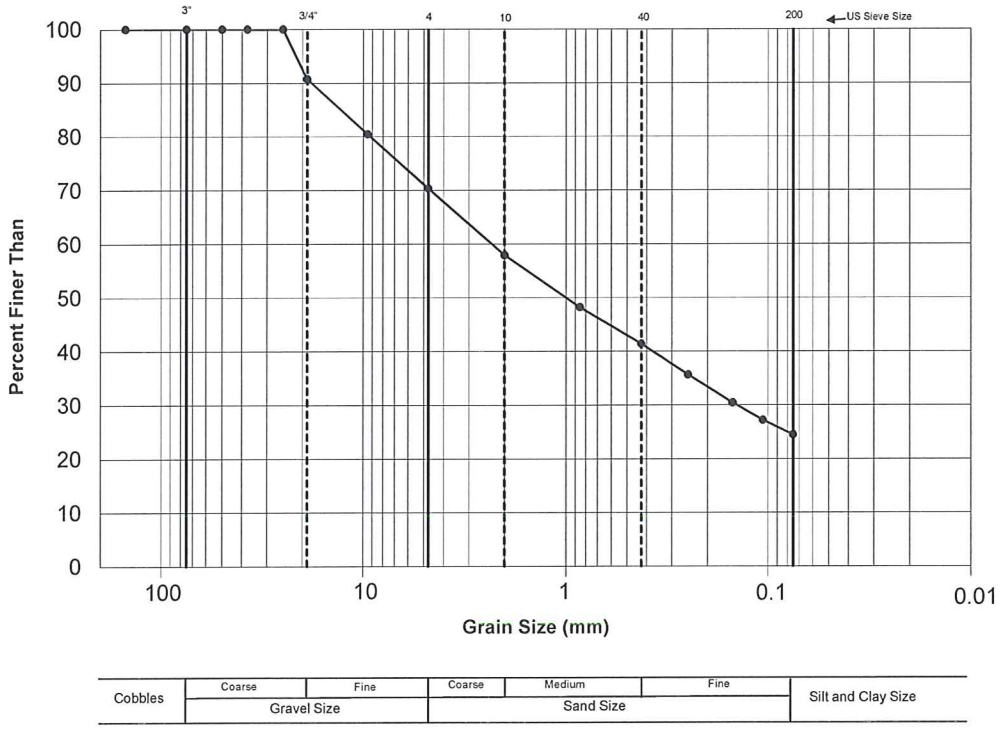
Reviewed by: _____

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-08
Lab No.:	B855-94		Northing:	-	m	Sample No.:	SS13
Sampled By:	AW/MG		Easting:	-	m	Depth From:	9.15 m
Sample Date:	14-Jun-16		Elevation:	-	m	Depth To:	9.60 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	100
19.0	91
9.5	80
4.75	70
2.00	58
0.85	48
0.425	41
0.250	36
0.150	30
0.106	27
0.075	24

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
11.6	0	30	46	24	2.5	0.1	N/A	N/A	N/A

Sample Description: (SM) gravelly SILTY SAND, fine to coarse sand, fine sub-angular gravel, some coarse gravel; light brown; non-cohesive, moist

USCS Classification: SM

Remarks:

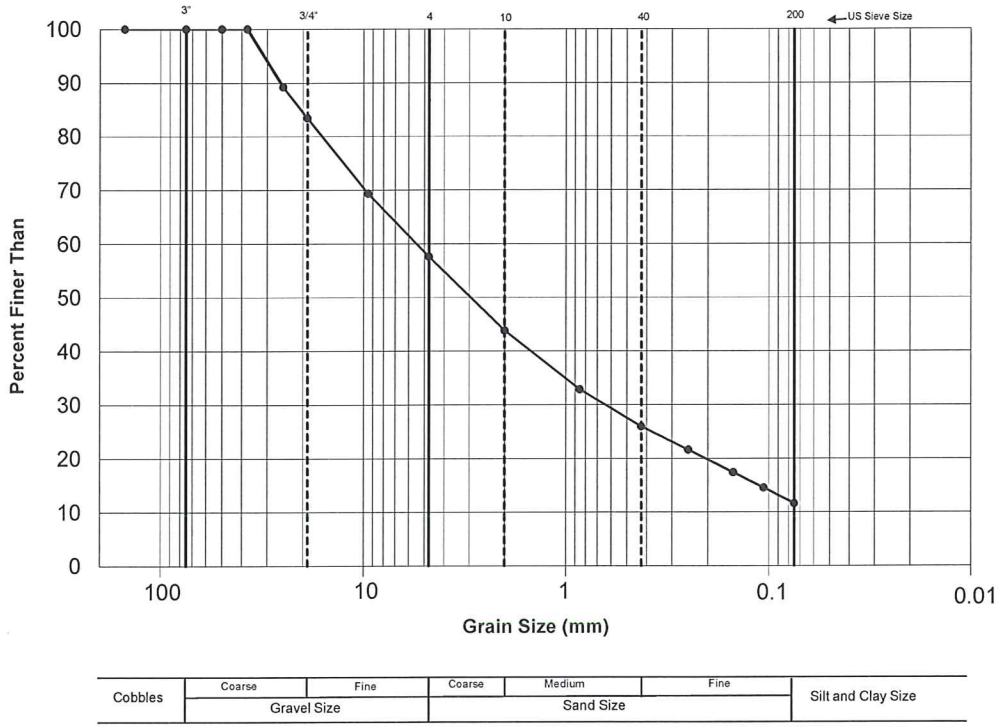
Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-11
Lab No.:	B855-114		Northing:	-	m	Sample No.:	SS8
Sampled By:	AW/MG		Easting:	-	m	Depth From:	4.57 m
Sample Date:	16-Jun-16		Elevation:	-	m	Depth To:	5.03 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	89
19.0	83
9.5	69
4.75	58
2.00	44
0.85	33
0.425	26
0.250	22
0.150	17
0.106	14
0.075	12

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
3.7	0	42	46	12	5.7	0.7	N/A	N/A	N/A

Sample Description: (SP-SM) fine to coarse SAND and fine to coarse sub-angular GRAVEL; light brown; non-cohesive, moist

USCS Classification: SP-SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

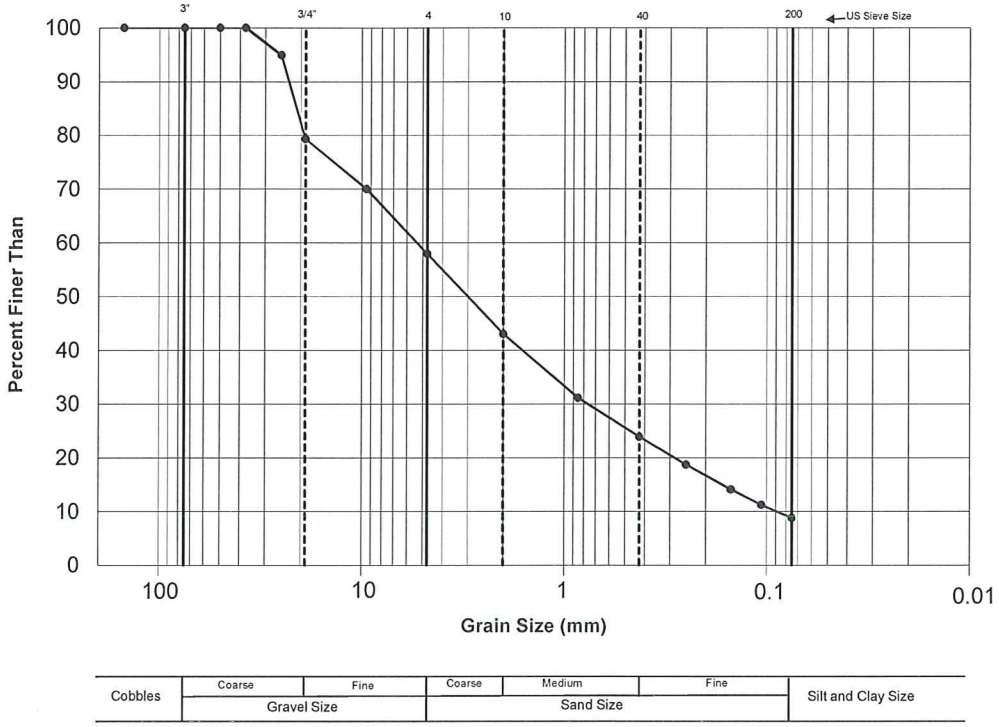
Reviewed by: _____

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-11
Lab No.:	B855-116		Northing:	-	m	Sample No.:	SS10
Sampled By:	AW/MG		Easting:	-	m	Depth From:	6.10 m
Sample Date:	16-Jun-16		Elevation:	-	m	Depth To:	6.55 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	95
19.0	79
9.5	70
4.75	58
2.00	43
0.85	31
0.425	24
0.250	19
0.150	14
0.106	11
0.075	9

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
3.8	0	42	49	9	5.6	0.8	0.1	61.6	1.2

Sample Description: (SW-SM) fine to coarse SAND and fine to coarse sub-angular GRAVEL, some non-plastic fines; light brown; non-cohesive, moist

USCS Classification: SW-SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

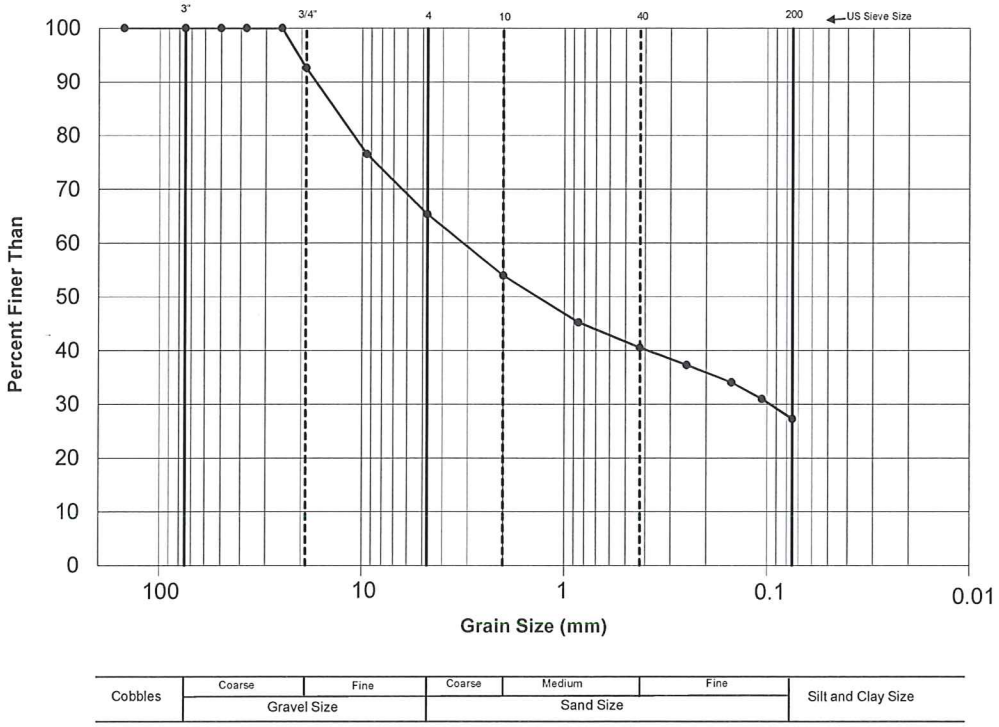
Reviewed by: _____

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-13
Lab No.:	B855-170		Northing:	-	m	Sample No.:	SS9
Sampled By:	AW/MG		Easting:	-	m	Depth From:	6.10 m
Sample Date:	15-Jun-16		Elevation:	-	m	Depth To:	6.55 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	100
19.0	93
9.5	77
4.75	65
2.00	54
0.85	45
0.425	41
0.250	37
0.150	34
0.106	31
0.075	27

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
9.6	0	35	38	27	3.5	0.1	N/A	N/A	N/A

Sample Description: (SM) gravelly fine to coarse SILTY SAND, fine sub-angular gravel, some coarse gravel; light brown; non-cohesive, moist

USCS Classification: SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

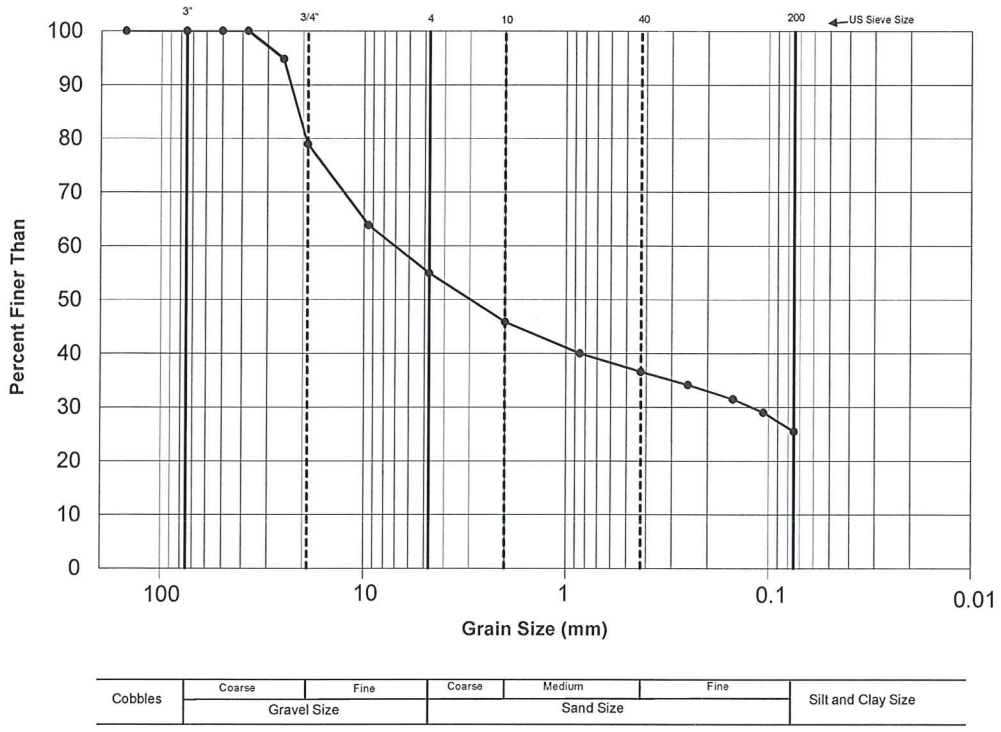
Reviewed by: _____

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	BH16-13
Lab No.:	B855-177		Northing:	-	m	Sample No.:	SS16
Sampled By:	AW/MG		Easting:	-	m	Depth From:	12.20 m
Sample Date:	15-Jun-16		Elevation:	-	m	Depth To:	12.65 m
Test Method:		A	Drying Method:	Oven			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25.0	95
19.0	79
9.5	64
4.75	55
2.00	46
0.85	40
0.425	37
0.250	34
0.150	32
0.106	29
0.075	26

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
6.9	0	45	29	26	7.4	0.1	N/A	N/A	N/A

Sample Description: (GM) sandy fine to coarse sub-angular SILTY GRAVEL, fine to coarse sand; light brown; non-cohesive, moist

USCS Classification: GM

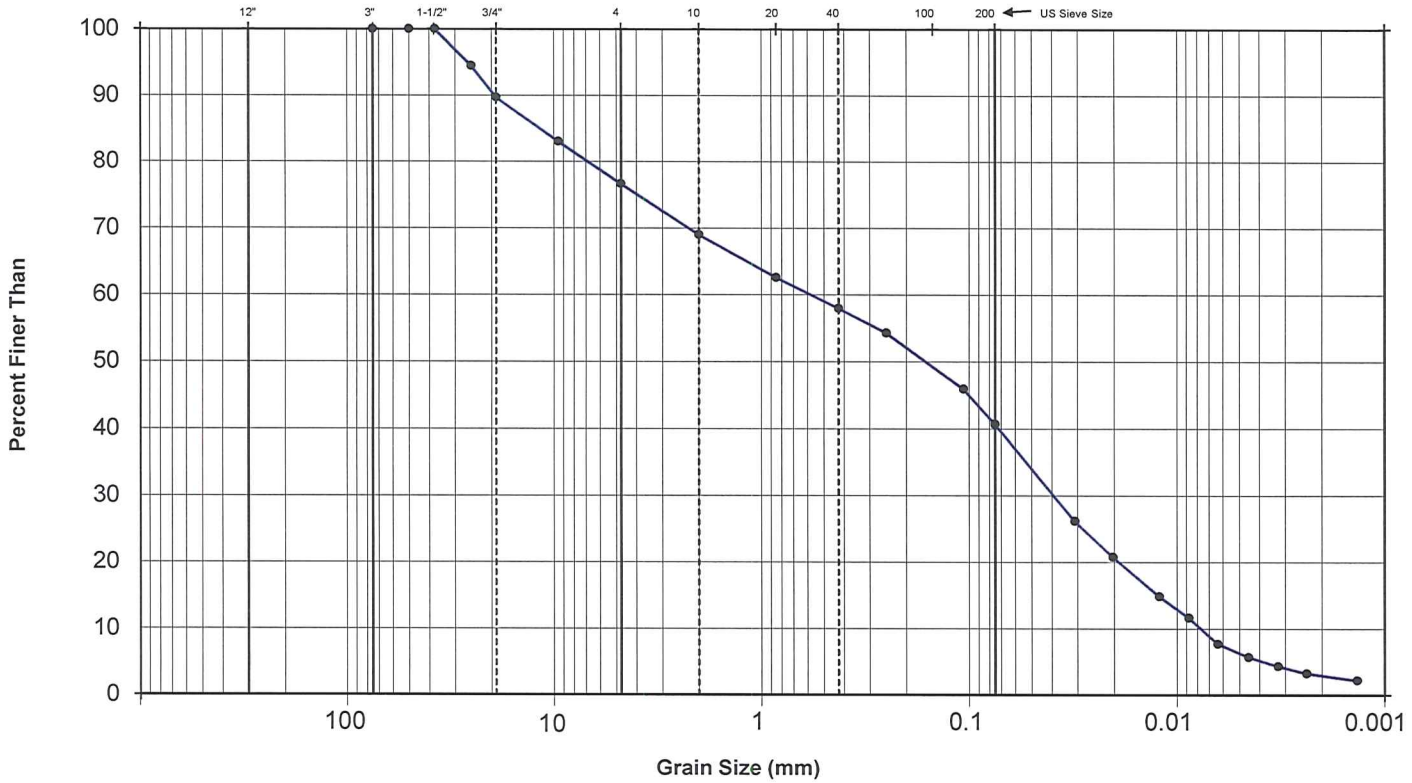
Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	1654325.3000	Lab No.:	B855-135&137
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	BH16-11	Sample No.:	SS29 & SS31
Depth:	21.34-21.71 & 22.87-23.17 m		
Date Tested:	24-Jun-16	By:	DS



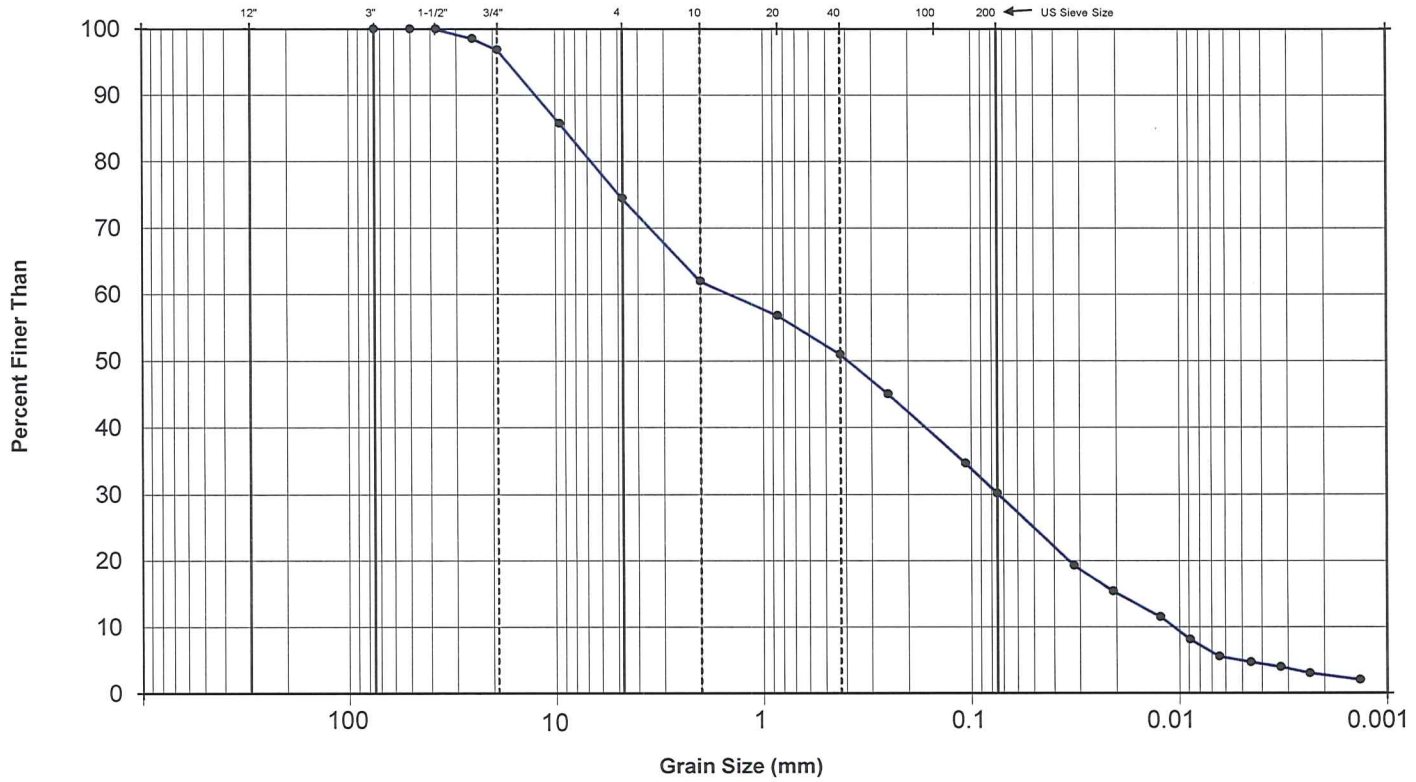
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	94.5
19.0	89.7
9.5	83.1
4.75	76.7
2.0	69.0
0.850	62.6
0.425	58.0
0.250	54.3
0.106	45.9
0.075	40.7
0.031	26.1
0.020	20.8
0.012	14.9
0.009	11.6
0.006	7.7
0.005	5.7
0.003	4.4
0.002	3.3
0.001	2.2

Comments:

Reviewed:

Project No.:	1654325.3000	Lab No.:	B856-10
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	TP16-02	Sample No.:	GB3
Depth:	1.50-2.10 m		
Date Tested:	24-Jun-16	By:	DS

Particle Size Analysis of Soil
(ASTM D422)



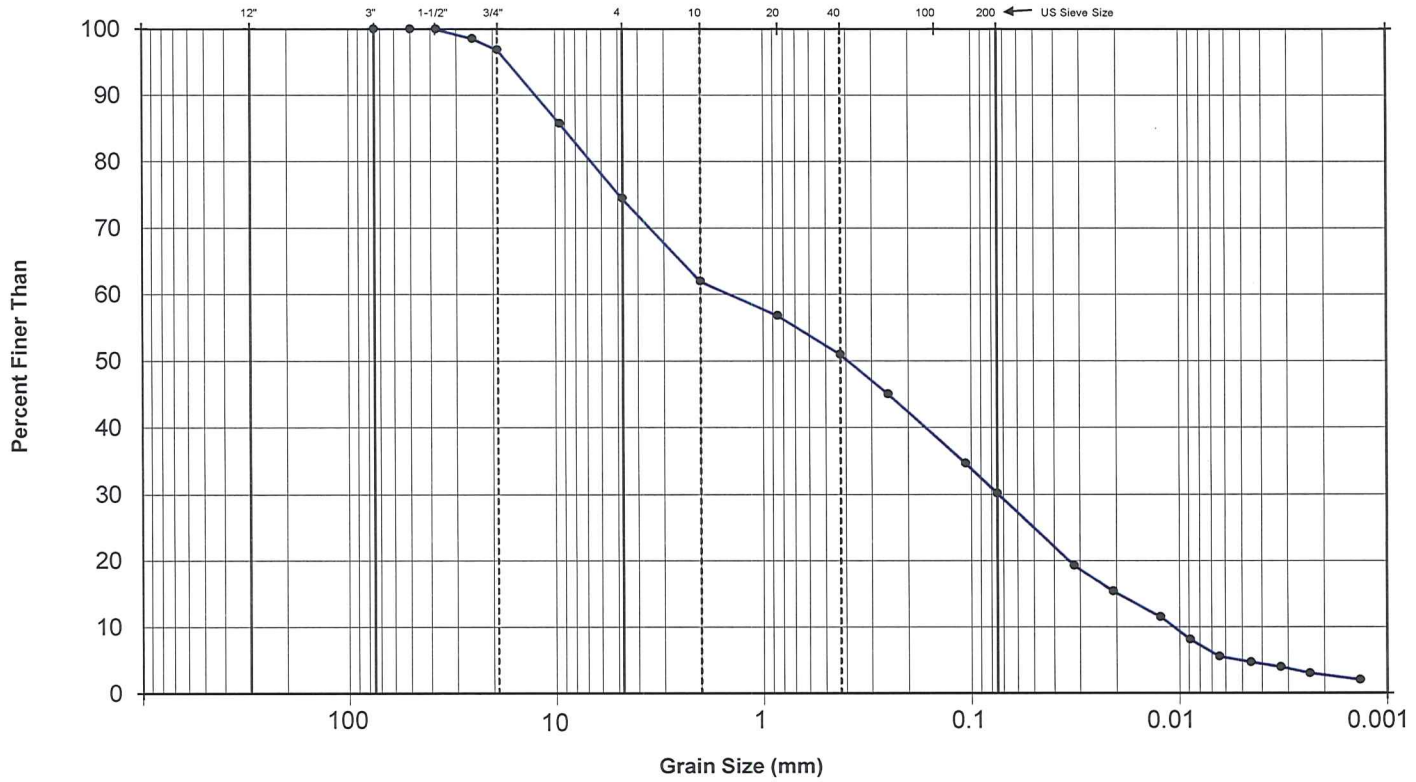
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	98.5
19.0	96.8
9.5	85.8
4.75	74.5
2.0	62.0
0.850	56.8
0.425	51.0
0.250	45.0
0.106	34.7
0.075	30.2
0.032	19.3
0.021	15.4
0.012	11.5
0.009	8.1
0.006	5.6
0.005	4.7
0.003	4.0
0.002	3.0
0.001	2.0

Comments:

Reviewed:

Project No.:	1654325.3000	Lab No.:	B856-10
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	TP16-02	Sample No.:	GB3
Depth:	1.50-2.10 m		
Date Tested:	24-Jun-16	By:	DS

Particle Size Analysis of Soil
(ASTM D422)



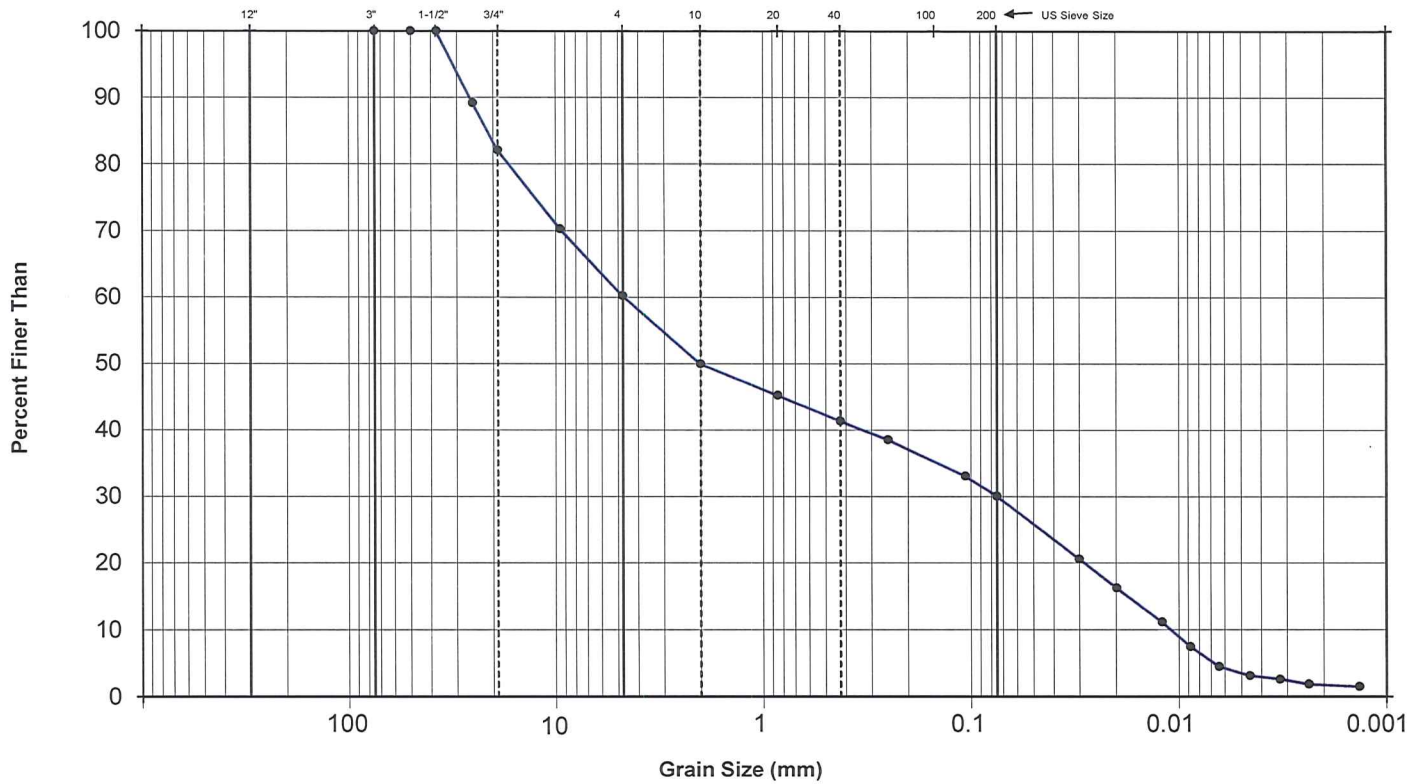
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	98.5
19.0	96.8
9.5	85.8
4.75	74.5
2.0	62.0
0.850	56.8
0.425	51.0
0.250	45.0
0.106	34.7
0.075	30.2
0.032	19.3
0.021	15.4
0.012	11.5
0.009	8.1
0.006	5.6
0.005	4.7
0.003	4.0
0.002	3.0
0.001	2.0

Comments:

Reviewed:

Project No.:	1654325.3000	Lab No.:	B856-30
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	TP16-05	Sample No.:	GB5
Depth:	2.60-3.00 m		
Date Tested:	24-Jun-16	By:	DS

Particle Size Analysis of Soil
(ASTM D422)



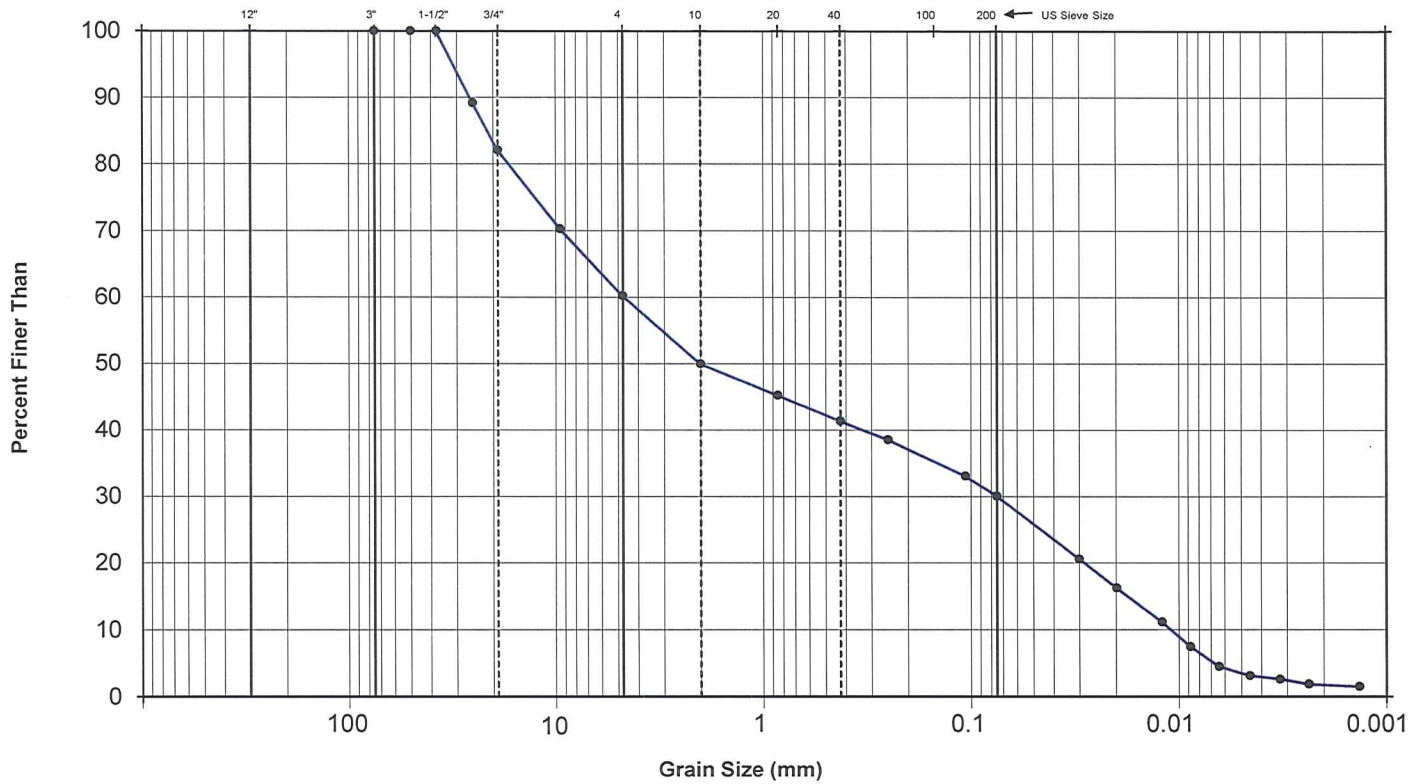
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	89.2
19.0	82.1
9.5	70.3
4.75	60.2
2.0	49.9
0.850	45.2
0.425	41.4
0.250	38.5
0.106	33.0
0.075	30.0
0.030	20.6
0.020	16.2
0.012	11.1
0.009	7.5
0.006	4.5
0.005	3.2
0.003	2.6
0.002	1.9
0.001	1.5

Comments:

Reviewed:

Project No.:	1654325.3000	Lab No.:	B856-30
Project Title:	PCA/GlacierNP-CU11/I-Curve		
Borehole:	TP16-05	Sample No.:	GB5
Depth:	2.60-3.00 m		
Date Tested:	24-Jun-16	By:	DS

Particle Size Analysis of Soil
(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	89.2
19.0	82.1
9.5	70.3
4.75	60.2
2.0	49.9
0.850	45.2
0.425	41.4
0.250	38.5
0.106	33.0
0.075	30.0
0.030	20.6
0.020	16.2
0.012	11.1
0.009	7.5
0.006	4.5
0.005	3.2
0.003	2.6
0.002	1.9
0.001	1.5

Comments:

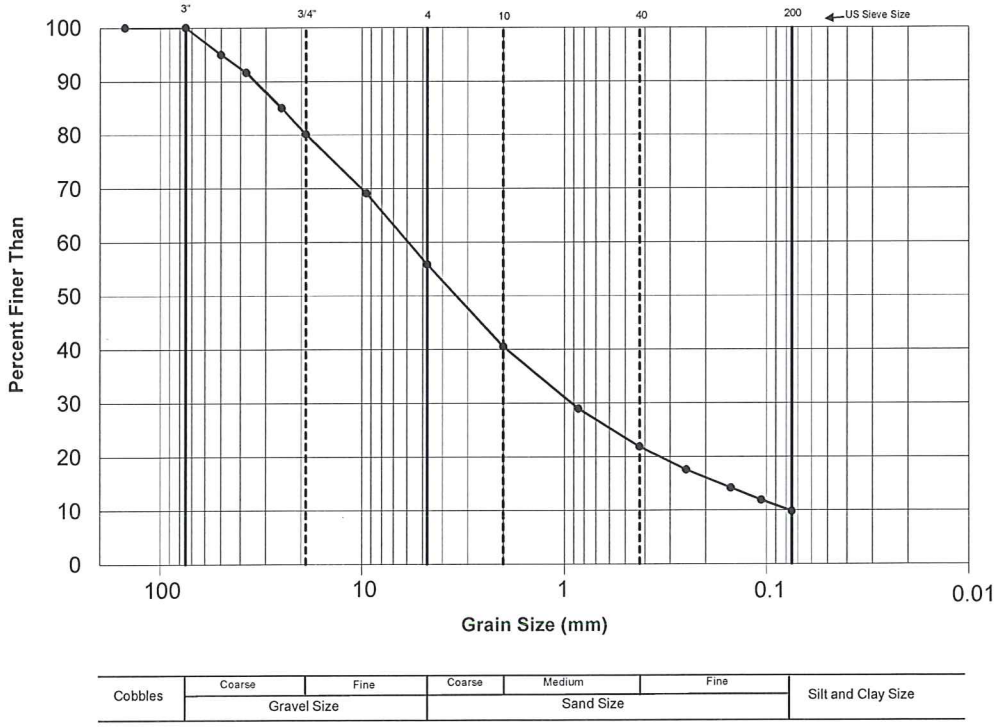
Reviewed:

Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325		Phase:	3000		Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS		Washed By:	DS		Sieved By:	DS
Field Tag No.:	-		Source:		-	BH No.:	TP16-01
Lab No.:	B856-05 to 07		Northing:	-	m	Sample No.:	BS5a to BS5c Combined
Sampled By:	AW/MG		Easting:	-	m	Depth From:	2.00 m
Sample Date:	8-Jun-16		Elevation:	-	m	Depth To:	2.20 m
Test Method:		A	Drying Method:	Air Dry			
Composite Sieve:		Yes	if Yes, Split on:	4.75	mm		
Material Excluded from Sieve:		No	Describe:				
Prior Testing on Sample:		No	Describe:				



Sieve Size (mm)	Passing %
150	100
75	100
50	95
37.5	92
25.0	85
19.0	80
9.5	69
4.75	56
2.00	41
0.85	29
0.425	22
0.250	18
0.150	14
0.106	12
0.075	10

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
4.3	0	44	46	10	6.2	1.0	0.1	79.9	1.9

Sample Description: (SW-SM) fine to coarse SAND and fine to coarse sub-rounded GRAVEL, some non-plastic fines; brown; non-cohesive, moist

USCS Classification: SW-SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

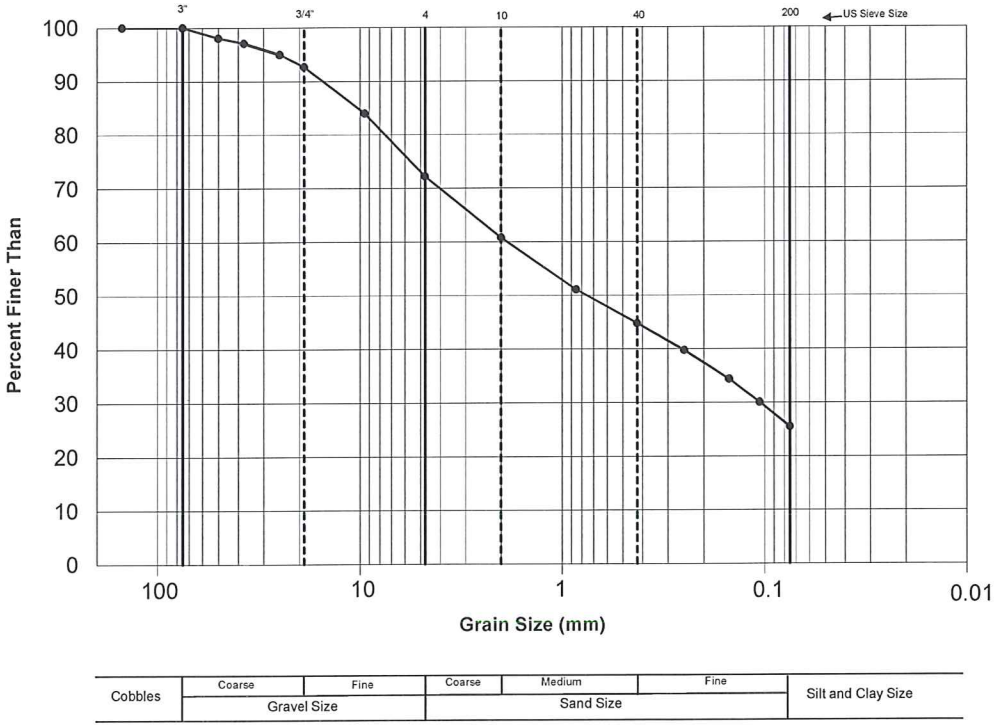
Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1654325	Phase:	3000			Date:	24-Jun-16
Short Title:	PCA/GlacierNP-CU11/I-Curve						
Sub Sampled By:	DS	Washed By:	DS			Sieved By:	DS
Field Tag No.:	-	Source:		-		BH No.:	TP16-02
Lab No.:	B856-12 to 14	Northing:	-	m		Sample No.:	BS5a to BS5c Combined
Sampled By:	AW/MG	Easting:	-	m		Depth From:	2.70 m
Sample Date:	8-Jun-16	Elevation:	-	m		Depth To:	3.25 m

Test Method:	A	Drying Method:	Air Dry	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Excluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	98
37.5	97
25.0	95
19.0	93
9.5	84
4.75	72
2.00	61
0.85	51
0.425	45
0.250	40
0.150	34
0.106	30
0.075	25

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
4.8	0	28	47	25	1.9	0.1	N/A	N/A	N/A

Sample Description: (SM) gravelly fine to coarse SILTY SAND, fine to coarse sub-angular gravel; brown; non-cohesive, wet

USCS Classification: SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Golder Associates Ltd.
ATTN: DEREK HUDSON
8, 820-28th Street NE
Calgary AB T2A 6K1

Date Received: 28-JUN-16
Report Date: 05-JUL-16 12:06 (MT)
Version: FINAL

Client Phone: 403-248-6386

Certificate of Analysis

Lab Work Order #: L1790240

Project P.O. #:	NOT SUBMITTED
Job Reference:	1654325.3000
C of C Numbers:	10-254890
Legal Site Desc:	PCA/GLACIER NP-CUI1/I-CURVE

Jessica Spira, Env. Tech. DIPL
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1790240-1 TP16-02 GB1 (0-0.20M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	4.4		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	5.3		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-2 TP16-02 GB2 (0.20-1.30M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	25.8		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	32.7		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-3 TP16-03 GB2 (0.30-0.70M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	19.5		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	24.6		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-4 TP16-03 GB3 (0.70-0.80M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	68.3		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	87.2		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-5 TP16-03 GB6 (1.80-2.00M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	28.8		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	36.6		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-6 TP16-03 GB7 (2.00-2.60M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	51.7		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	65.9		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790240-7 TP16-03 GB10 (3.40-3.60M)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	48.4		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	61.7		1.0	%	04-JUL-16	04-JUL-16	R3496167

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

10-254890

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Golder Associates Ltd.
8, 820-28th Street NE
Calgary AB T2A 6K1
Contact: DEREK HUDSON

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
OM-LOI-SK	**Soil**							
Batch R3496167								
WG2340119-3 IRM		**SAL2001**						
Organic Matter			102.1		%		80-120	04-JUL-16
Loss on Ignition @ 375 C			101.9		%		80-120	04-JUL-16
WG2340119-2 MB								
Organic Matter			<1.0		%		1	04-JUL-16
Loss on Ignition @ 375 C			<1.0		%		1	04-JUL-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

Chain of Custody / Analytical Requ
Canada Toll Free: 1 800 668 9
www.alsglobal.com

L1790240-COFC

0-254890

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	Golder Associates Ltd.	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Derek Hudson	Select: PDF ✓	Excel Digital Fax	Priority (2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	8-820, 28th ST. NE Calgary, AB	Email 1:	dhudson@golder.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
		Email 2:	imelda_cuva@golder.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	Fax:			

Invoice To	Same as Report ? (circle) (Yes) or No (if No, provide details)	Client / Project Information	
	Copy of Invoice with Report? (circle) Yes or (No)	Job #:	1654325.3000
Company:		PO / AFE:	
Contact:		LSD:	PCA/GlacierNP-CH11/T-Curve
Address:			
Phone:	Fax:	Quote #:	

Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Organic Content	Number of Containers
✓	TP16-02 GB1 (0-0.20 m)				X	
✓	TP16-02 GB2 (0.20-1.30m)				X	
✓	TP16-03 GB2 (0.30-0.70m)				X	
✓	TP16-03 GB3 (0.70-0.80 m)				X	
✓	TP16-03 GB6 (1.80-2.00 m)				X	
✓	TP16-03 GB7 (2.00-2.60 m)				X	
✓	TP16-03 GB10 (3.40-3.60 m				X	

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
D. Sobredo	24 June 16	17:06		June 28	1:06	24 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

Golder Associates Ltd.
ATTN: DEREK HUDSON
8, 820-28th Street NE
Calgary AB T2A 6K1

Date Received: 28-JUN-16
Report Date: 06-JUL-16 15:49 (MT)
Version: FINAL

Client Phone: 403-248-6386

Certificate of Analysis

Lab Work Order #: L1790253

Project P.O. #:	NOT SUBMITTED
Job Reference:	1654325.3000
C of C Numbers:	10-254888
Legal Site Desc:	PCA/GLACIERNP-CUI1/I-CURVE

Jessica Spira, Env. Tech. DIPL
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1790253-1 BH16-05 SS5&B56 COMBINED (15.0-20FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	<1.0		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	<1.0		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790253-2 BH16-06A SS4A&SS4B COMBINED (15.0-16.5FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	3.1		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	3.6		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790253-3 BH16-07 A59 (18.0-19.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	3.4		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	4.0		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790253-4 BH16-02 GB5 (6.0-10.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	28.5		1.0	%		06-JUL-16	R3497043
Chloride (Cl)	251		20	mg/L		06-JUL-16	R3497196
Resistivity	4400		1.0	ohm cm		06-JUL-16	R3496967
Sulfur (as SO4)	119		6.0	mg/L		06-JUL-16	R3497203
pH in Saturated Paste	7.91		0.10	pH		06-JUL-16	R3497043
L1790253-5 BH16-11 GB5 (7.5-10.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	34.0		1.0	%		06-JUL-16	R3497043
Chloride (Cl)	171		20	mg/L		06-JUL-16	R3497196
Resistivity	6600		1.0	ohm cm		06-JUL-16	R3496967
Sulfur (as SO4)	89.2		6.0	mg/L		06-JUL-16	R3497203
pH in Saturated Paste	6.55		0.10	pH		06-JUL-16	R3497043
L1790253-6 BH16-13 SS4&AS5 COMBINED (5.0-10.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	26.9		1.0	%		06-JUL-16	R3497043
Chloride (Cl)	583		20	mg/L		06-JUL-16	R3497196
Resistivity	3480		1.0	ohm cm		06-JUL-16	R3496967
Sulfur (as SO4)	15.8		6.0	mg/L		06-JUL-16	R3497203
pH in Saturated Paste	7.12		0.10	pH		06-JUL-16	R3497043
L1790253-7 BH16-13 GB7 (11.5-15.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1790253-7 BH16-13 GB7 (11.5-15.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
% Saturation	23.8		1.0	%		06-JUL-16	R3497043
Chloride (Cl)	114		20	mg/L		06-JUL-16	R3497196
Resistivity	14000		1.0	ohm cm		06-JUL-16	R3496967
Sulfur (as SO4)	24.6		6.0	mg/L		06-JUL-16	R3497203
pH in Saturated Paste	7.94		0.10	pH		06-JUL-16	R3497043
L1790253-8 BH16-08 A510 (22.0-23.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Organic Matter by LOI at 375 deg C.							
Organic Matter	5.9		1.0	%	04-JUL-16	04-JUL-16	R3496167
Loss on Ignition @ 375 C	7.2		1.0	%	04-JUL-16	04-JUL-16	R3496167
L1790253-9 BH16-14 SS3&BS4 COMBINED (5.0-10.0FT)							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	29.9		1.0	%		06-JUL-16	R3497043
Chloride (Cl)	168		20	mg/L		06-JUL-16	R3497196
Resistivity	6470		1.0	ohm cm		06-JUL-16	R3496967
Sulfur (as SO4)	46.8		6.0	mg/L		06-JUL-16	R3497203
pH in Saturated Paste	7.72		0.10	pH		06-JUL-16	R3497043

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-PASTE-COL-CL	Soil	Chloride in Soil (Paste) by Colorimetry	CSSS, APHA 4500-Cl E
A soil extract produced by the saturated paste extraction procedure is analyzed for Chloride by Colourimetry.			
OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160
The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.			
Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23			
PH-PASTE-CL	Soil	pH in Saturated Paste	CSSS 16.2
A soil extract produced by the saturated paste extraction procedure is analyzed by pH meter.			
RESISTIVITY-PASTE-CL	Soil	PASTE RESISTIVITY	ASTM G57-95A
This analysis is carried out using procedures adapted from ASTM G57-95a (2001) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method". In summary, 200 to 500 grams of sample is mixed with deionized water as required to create a saturated paste. The sample is then placed directly into a four electrode resistivity soil box and measured for resistivity using a resistivity meter.			
SAT-PCNT-CL	Soil	% Saturation	CSSS 18.2-Calculation
SO4-PASTE-ICP-CL	Soil	Sulphate (SO4)	CSSS CH15/EPA 6010B
A soil extract produced by the saturated extraction procedure is analyzed for sulfate by ICPOES.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

10-254888

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Golder Associates Ltd.
8, 820-28th Street NE
Calgary AB T2A 6K1
Contact: DEREK HUDSON

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-PASTE-COL-CL	**Soil**							
Batch R3497196								
WG2341675-7 IRM		**SAL-STD8**						
Chloride (Cl)			92.5		%		70-130	06-JUL-16
WG2341675-5 MB								
Chloride (Cl)			<20		mg/L		20	06-JUL-16
OM-LOI-SK	**Soil**							
Batch R3496167								
WG2340119-1 DUP		**L1790253-1**						
Organic Matter		<1.0	<1.0	RPD-NA	%	N/A	20	04-JUL-16
Loss on Ignition @ 375 C		<1.0	<1.0	RPD-NA	%	N/A	25	04-JUL-16
WG2340119-3 IRM		**SAL2001**						
Organic Matter			102.1		%		80-120	04-JUL-16
Loss on Ignition @ 375 C			101.9		%		80-120	04-JUL-16
WG2340119-2 MB								
Organic Matter			<1.0		%		1	04-JUL-16
Loss on Ignition @ 375 C			<1.0		%		1	04-JUL-16
PH-PASTE-CL	**Soil**							
Batch R3497043								
WG2341675-7 IRM		**SAL-STD8**						
pH in Saturated Paste			7.22		pH		6.9-7.5	06-JUL-16
RESISTIVITY-PASTE-CL	**Soil**							
Batch R3496967								
WG2341744-1 IRM		**SAL-STD8**						
Resistivity			101.9		%		80-120	06-JUL-16
SAT-PCNT-CL	**Soil**							
Batch R3497043								
WG2341675-7 IRM		**SAL-STD8**						
% Saturation			99.4		%		80-120	06-JUL-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

Chain of Custody / Analytical
Canada Toll Free: 1 800
www.alsglobal.co

L1790253-COFC

10-254888

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)	
Company:	Golder Associates Ltd.	Standard: ✓	Other (specify):	✓	Regular (Standard Turnaround Times - Business Days)
Contact:	Derek Hudson	Select: PDF ✓	Excel Digital Fax		Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	8-820, 28th St. NE Calgary, AB	Email 1:	dhudson@golder.com		Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
		Email 2:	melda_sutka@golder.com		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	Fax:				

Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)	Client / Project Information	
	Copy of Invoice with Report? (circle) Yes or No	Job #:	1654325.3000
Company:		PO / AFE:	
Contact:		LSD:	PCA/GlacierNP-CU11/I-Curve
Address:			
Phone:	Fax:	Quote #:	

Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Sulphates	Resistivity	pH	Chlorides	Organic Carbon	Number of Containers
	BH16-05 SS5 & BS6 Combined (15.0-20ft.)				[redacted]				X	1
	BH16-06A SS4a & SS4b Combined (15.0-16.5ft.)								X	1
	BH16-07 AS9 (18.0-19.0 ft.)								X	1
	BH16-02 GB5 (6.0-10.0 ft.)				X	X	X	X		1
	BH16-11 GB5 (7.5-10.0 ft.)				X	X	X	X		1
	BH16-13 SS4 & AS5 Combined (5.0-10.0ft.)				X	X	X	X		1
	BH16-13 GB7 (11.5-15.0ft.)				X	X	X	X		1
	BH16-08 AS10 (22.0-23.0 ft.)								X	1
	BH16-14 SS3 & BS4 Combined (5.0-10.0 ft.)				X	X	X	X		1

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
D. Sobreda	27 June 16	16:50		June 28	1:06	2 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

Laboratory Compaction Characteristics of Soil using Standard Effort

(ASTM D698)

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Lab No.:	B856-05 to 07
Tested By:	DS	Test Date:	29-Jun-16

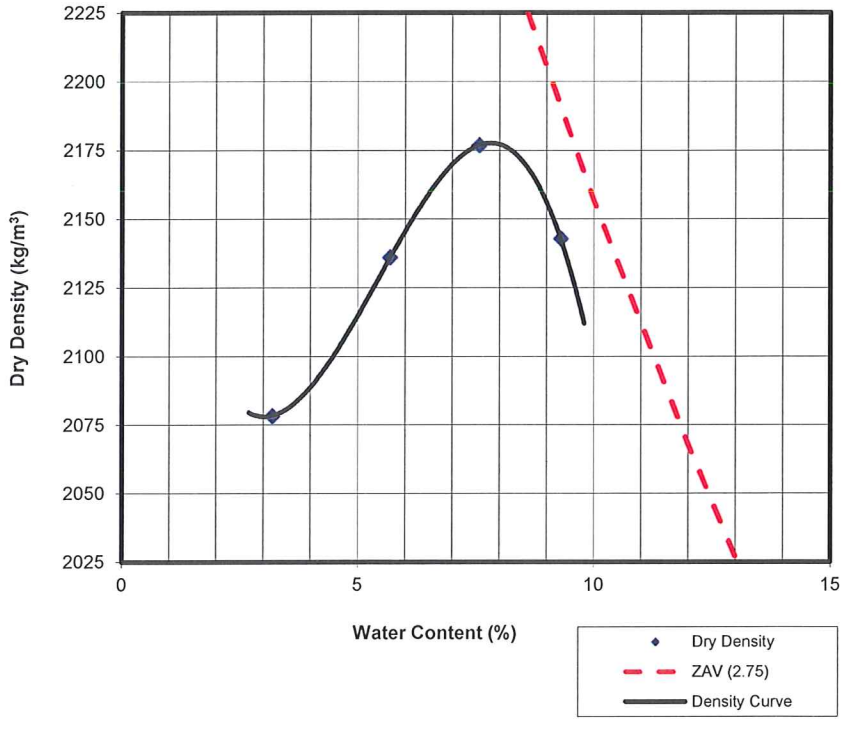
Borehole:	TP16-01	Date Sampled:	9-Jun-16
Sample No.:	BS5a to BS5c (Combined)	Sample Source:	Native Material
Sampled By:	AW/MG	Sample Description:	Please see remarks

MOISTURE DENSITY RELATIONSHIP

Trial No.	1	2	3	4	5	6
Mold No.						
Wt of sample wet + mold (g)	10228.80	10466.10	10643.70	10644.60		
Wt. Of mold (g)	5707.40	5707.40	5707.40	5707.40		
Wt. Of sample wet (g)	4521.40	4758.70	4936.30	4937.20		
Volume of Mold (cm^3)	2107.97	2107.97	2107.97	2107.97		
Wet Density (kg/m^3)	2144.91	2257.48	2341.73	2342.16		
Dry Density (kg/m^3)	2078	2136	2177	2143		

WATER CONTENT

Tare No.						
Wt of sample wet + tare (g)	1892.90	1782.20	1538.60	2002.80		
Wt of sample dry + tare (g)	1837.40	1691.20	1437.30	1841.00		
Wt. Water	55.50	91.00	101.30	161.80		
Tare mass (g)	102.00	90.30	99.70	100.90		
Wt. Dry soil (g)	1735.40	1600.90	1337.60	1740.10		
Water content (%)	3.20	5.68	7.57	9.30		



Maximum Dry Density

Max. Dry Density **2178** kg/m^3

Optimum w **7.8** %

Method **C**

Rock Correction (if required)

% Oversize 20 %

Max. Dry Density 2273 kg/m^3 @ 6.6%

Assumed Specific Gravity = 2.75

Remarks:

(SW-SM) fine to coarse SAND and fine to coarse sub-rounded GRAVEL, some non-plastic fines; brown; non-cohesive, moist

As Received Water Content: 8.6%

Reviewed:

Golder Associates Ltd.
8 - 820 28th Street N.E
Calgary, AB
T2A 6K1

Laboratory Compaction Characteristics of Soil using Standard Effort

(ASTM D698)

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Lab No.:	B856-12 to 14
Tested By:	DS	Test Date:	29-Jun-16

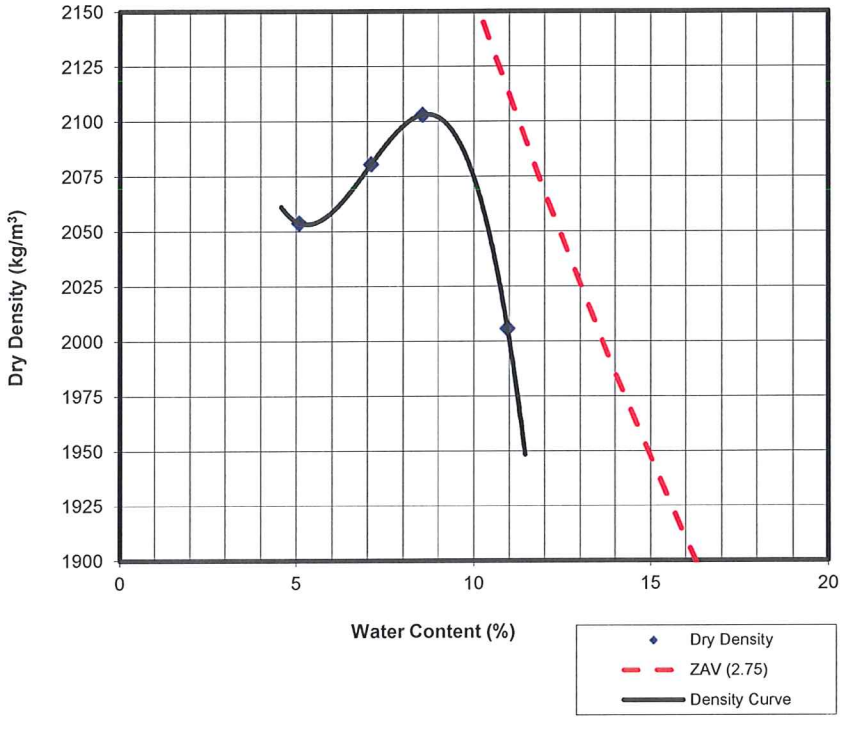
Borehole:	TP16-02	Date Sampled:	8-Jun-16
Sample No.:	BS5a to BS5c (Combined)	Sample Source:	Native Material
Sampled By:	AW/MG	Sample Description:	Please see remarks

MOISTURE DENSITY RELATIONSHIP

Trial No.	1	2	3	4	5	6
Mold No.						
Wt of sample wet + mold (g)	10257.00	10404.80	10519.80	10398.90		
Wt. Of mold (g)	5707.40	5707.40	5707.40	5707.40		
Wt. Of sample wet (g)	4549.60	4697.40	4812.40	4691.50		
Volume of Mold (cm^3)	2107.97	2107.97	2107.97	2107.97		
Wet Density (kg/m^3)	2158.28	2228.40	2282.95	2225.60		
Dry Density (kg/m^3)	2054	2081	2103	2006		

WATER CONTENT

Tare No.						
Wt of sample wet + tare (g)	1675.50	1748.20	2114.70	1847.20		
Wt of sample dry + tare (g)	1599.10	1638.90	1955.80	1674.10		
Wt. Water	76.40	109.30	158.90	173.10		
Tare mass (g)	95.20	100.30	98.70	93.50		
Wt. Dry soil (g)	1503.90	1538.60	1857.10	1580.60		
Water content (%)	5.08	7.10	8.56	10.95		



Maximum Dry Density

Max. Dry Density **2104** kg/m^3

Optimum w **8.8** %

Method **C**

Rock Correction (if required)

% Oversize 15 %

Max. Dry Density 2181 kg/m^3 @ 7.8%

Assumed Specific Gravity = 2.75

Remarks:

(SM) gravelly fine to coarse SILTY SAND, fine to coarse sub-angular gravel; brown; non-cohesive, wet

As Received Water Content: 17.9%

Reviewed:

Golder Associates Ltd.
8 - 820 28th Street N.E
Calgary, AB
T2A 6K1

Laboratory Compaction Characteristics of Soil using Standard Effort

(ASTM D698)

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Lab No.:	B856-39 to 42
Tested By:	DS	Test Date:	30-Jun-16

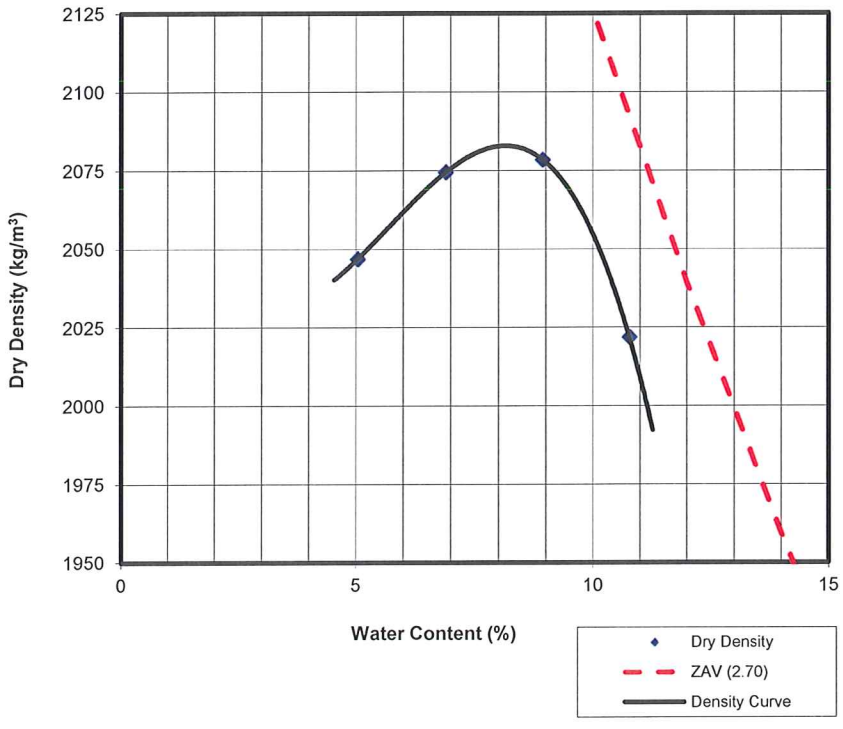
Borehole:	TP16-06	Date Sampled:	8-Jun-16
Sample No.:	BS7a to BS7d (Combined)	Sample Source:	Native Material
Sampled By:	AW/MG	Sample Description:	Please see remarks

MOISTURE DENSITY RELATIONSHIP

Trial No.	1	2	3	4	5	6
Mold No.						
Wt of sample wet + mold (g)	10240.00	10382.00	10480.00	10428.90		
Wt. Of mold (g)	5707.40	5707.40	5707.40	5707.40		
Wt. Of sample wet (g)	4532.60	4674.60	4772.60	4721.50		
Volume of Mold (cm^3)	2107.97	2107.97	2107.97	2107.97		
Wet Density (kg/m^3)	2150.22	2217.58	2264.07	2239.83		
Dry Density (kg/m^3)	2047	2074	2078	2022		

WATER CONTENT

Tare No.						
Wt of sample wet + tare (g)	1737.00	1942.00	1908.20	1958.00		
Wt of sample dry + tare (g)	1659.20	1823.10	1760.00	1777.20		
Wt. Water	77.80	118.90	148.20	180.80		
Tare mass (g)	116.80	99.30	100.70	99.10		
Wt. Dry soil (g)	1542.40	1723.80	1659.30	1678.10		
Water content (%)	5.04	6.90	8.93	10.77		



Maximum Dry Density

Max. Dry Density **2083** kg/m^3

Optimum w **8.2** %

Method **C**

Rock Correction (if required)

% Oversize 15 %

Max. Dry Density 2157 kg/m^3 @ 7.3%

Assumed Specific Gravity = 2.70

Remarks:

(SM) gravelly fine to coarse SILTY SAND, fine to coarse sub-angular gravel; brown; non-cohesive, wet

As Received Water Content: 16.0%

Reviewed:

Golder Associates Ltd.
8 - 820 28th Street N.E
Calgary, AB
T2A 6K1

04/07/2016

Laboratory Compaction Characteristics of Soil using Standard Effort

(ASTM D698)

Project No.:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve	Lab No.:	B856-49 to 51
Tested By:	DS	Test Date:	29-Jun-16

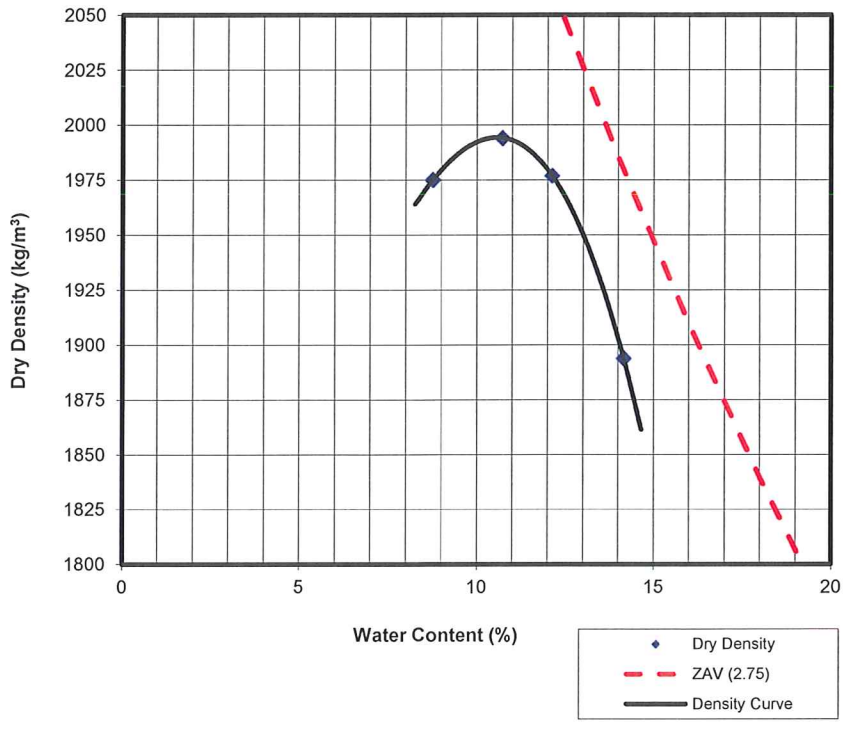
Borehole:	TP16-07	Date Sampled:	9-Jun-16
Sample No.:	BS6a to BS6c (Combined)	Sample Source:	Native Material
Sampled By:	AW/MG	Sample Description:	Please see remarks

MOISTURE DENSITY RELATIONSHIP

Trial No.	1	2	3	4	5	6
Mold No.						
Wt of sample wet + mold (g)	6395.70	6451.60	6459.90	6408.80		
Wt. Of mold (g)	4380.90	4380.90	4380.90	4380.90		
Wt. Of sample wet (g)	2014.80	2070.70	2079.00	2027.90		
Volume of Mold (cm^3)	937.86	937.86	937.86	937.86		
Wet Density (kg/m^3)	2148.30	2207.91	2216.76	2162.27		
Dry Density (kg/m^3)	1975	1994	1977	1894		

WATER CONTENT

Tare No.						
Wt of sample wet + tare (g)	1215.90	1141.10	1162.50	1087.30		
Wt of sample dry + tare (g)	1125.70	1040.30	1047.60	964.90		
Wt. Water	90.20	100.80	114.90	122.40		
Tare mass (g)	96.60	100.10	100.40	100.60		
Wt. Dry soil (g)	1029.10	940.20	947.20	864.30		
Water content (%)	8.76	10.72	12.13	14.16		



Maximum Dry Density

Max. Dry Density **1994** kg/m^3

Optimum w **10.5** %

Method **B**

Rock Correction (if required)

% Oversize 15 %

Max. Dry Density 2080 kg/m^3 @ 9.2%

Assumed Specific Gravity = 2.75

Remarks:

(SM) gravelly fine to coarse SILTY SAND, fine sub-angular and angular gravel; brown; non-cohesive, moist

As Received Water Content: 11.4%

Reviewed:

Golder Associates Ltd.
8 - 820 28th Street N.E
Calgary, AB
T2A 6K1

GOLDER ASSOCIATES - Calgary Lab

Bay 7, 820 28th St. NE

Calgary, AB, T2A 6K1

ASTM D 3080-04

Direct Shear Tests of Soils - Drained
(ASTM D3080)

Sample Identification

Project No.:	1654325.3000	Test Condition:	Moist
Client:	Parks Canada Agency	Sample:	BS7
Project :	PCA/GlacierNP-CU11/I-Curve	Lab No.:	B856-39 to 42
Borehole:	TP16-06	Client Reference:	-

INITIAL - Sample Dimensions

Test No.	1	2	3
Shear Box Geometry	Rectangular	Rectangular	Rectangular
Length, mm	302	302	302
Width, mm	302	302	302
Height, mm	240	240	240
Area, cm^2	912	912	912
Volume, cm^3	21889	21889	21889

Weight Volume Relationships

Test No.	1	2	3
Sample Type	Reconstituted	Reconstituted	Reconstituted
Initial Wet Wt, kg	47.86	47.86	47.86
Initial Dry Wt, kg	44.33	44.33	44.33
Initial w, %	7.96	7.96	7.96
Final w, %	8.14	7.76	7.48
Initial γ_{dry}, kg/m^3	2025	2025	2025
Specific Gravity (assumed)	2.65	2.65	2.65
Initial Void Ratio, e	0.31	0.31	0.31

Equipment Description - LDS_30S

Axial LDT	Serial #	512414
Normal Load Cell	Serial #	978593
Shear Load Cell	Serial #	1084597
Vertical LDT	Serial #	BBD110465

Remarks

- Area correction applied to normal and shear stress calculations
- Minus 40mm material used
- Each test specimen was placed in 3 layers

Sample Description: (GM) fine to coarse sub-angular SILTY GRAVEL and fine to coarse SAND; brown; non-cohesive, moist

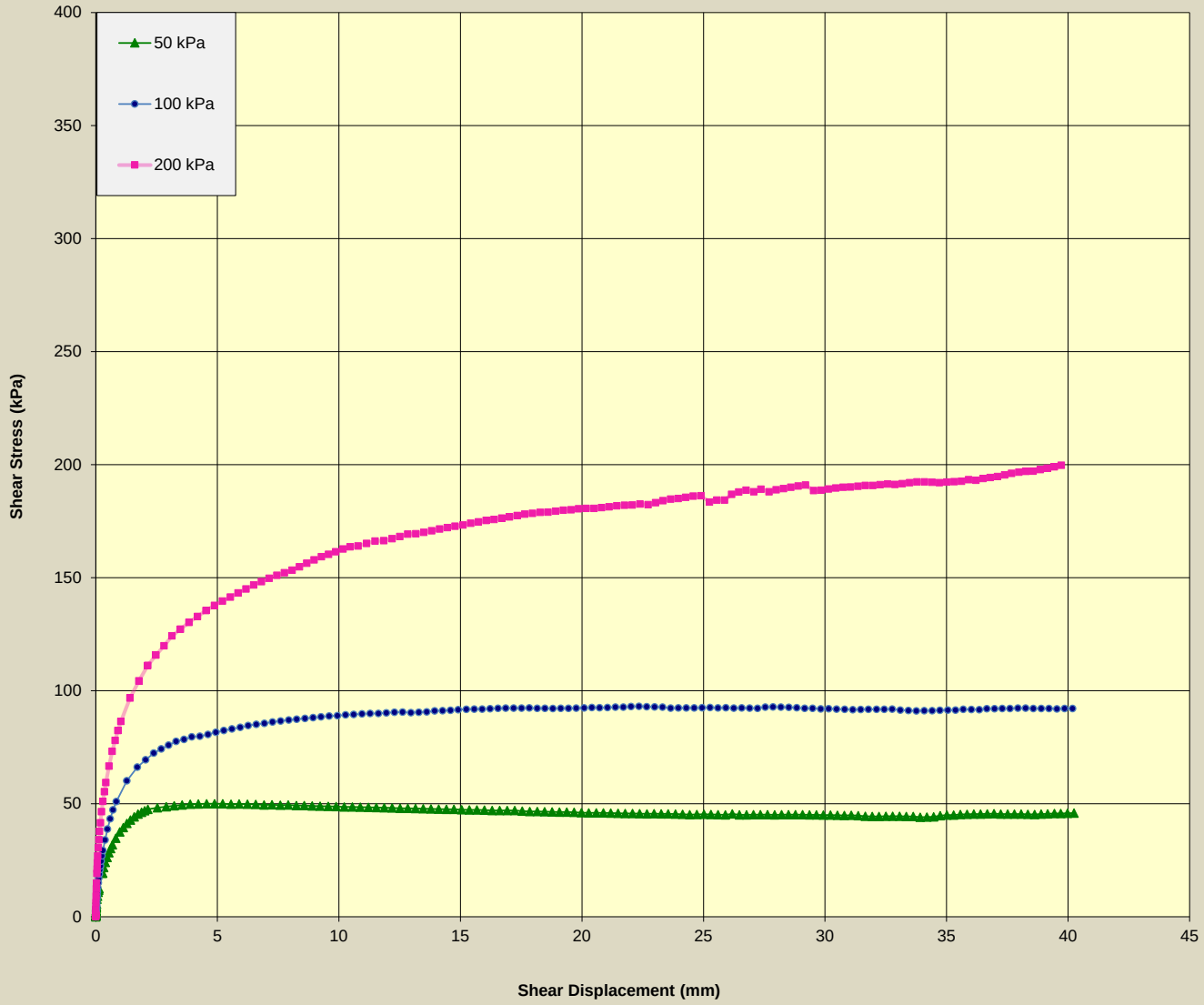
Tested By: FC Date Completed: 07-Jul-16

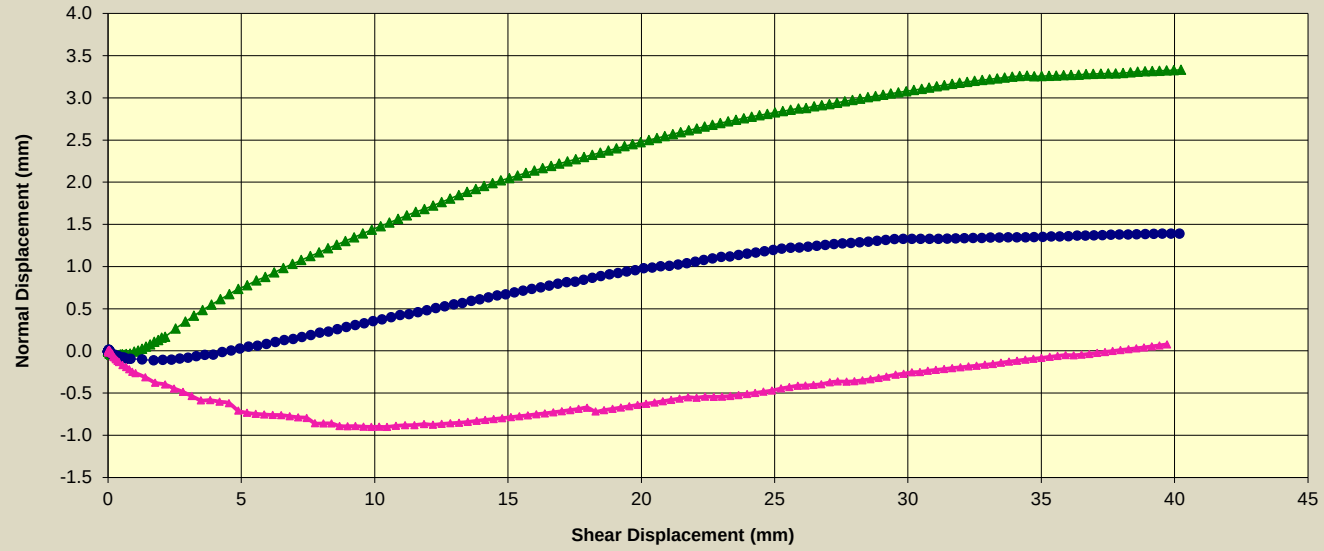
Approved By: MB Signature:

Golder Associates

Direct Shear Tests of Soils - Drained
(ASTM D3080)

Project Number:	1654325.3000
Project Title:	PCA/GlacierNP-CU11/I-Curve
Source:	TP16-06
Sample:	BS7
Depth:	3.0 - 3.45m



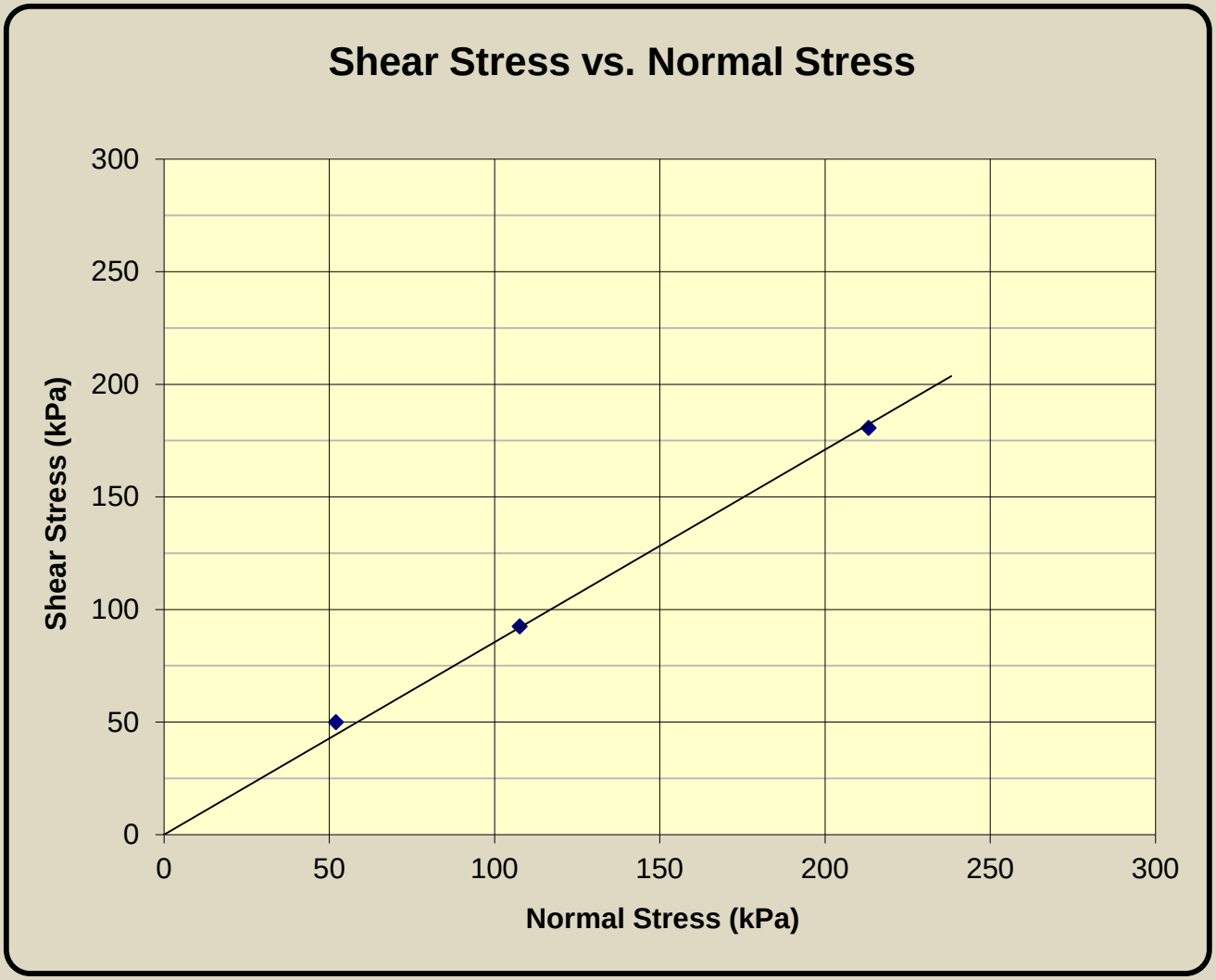


Direct Shear Tests of Soils - Drained
(ASTM D3080)

Project Number:	1654325.3000
Project Title:	PCA/GlacierNP-CU11/I-Curve
Source:	TP16-06
Sample:	BS7
Depth:	3.0 - 3.45m

Normal Stress (kPa)	Shear Stress (kPa)
52	50
108	93
213	181

Friction Angle:	**40** degrees
Apparent Cohesion:	**0** kPa



Large Direct Shear Testing - Test Photos

Project No.:	1654325.3	Phase:	3000
Short Title:	Parks Canada Agency		
Tested by:	FC	Date:	07-Jul-16

Lab No.:	B856-39 to 42	Source:	TP16-06	Sample:	BS7

Sample Description (GM) fine to coarse sub-angular SILTY GRAVEL and fine to coarse SAND; brown; non-cohesive, moist

Test Photos - 200 kPa

Bay 7, 820 - 28 St. NE
Calgary, AB T2A 6K1

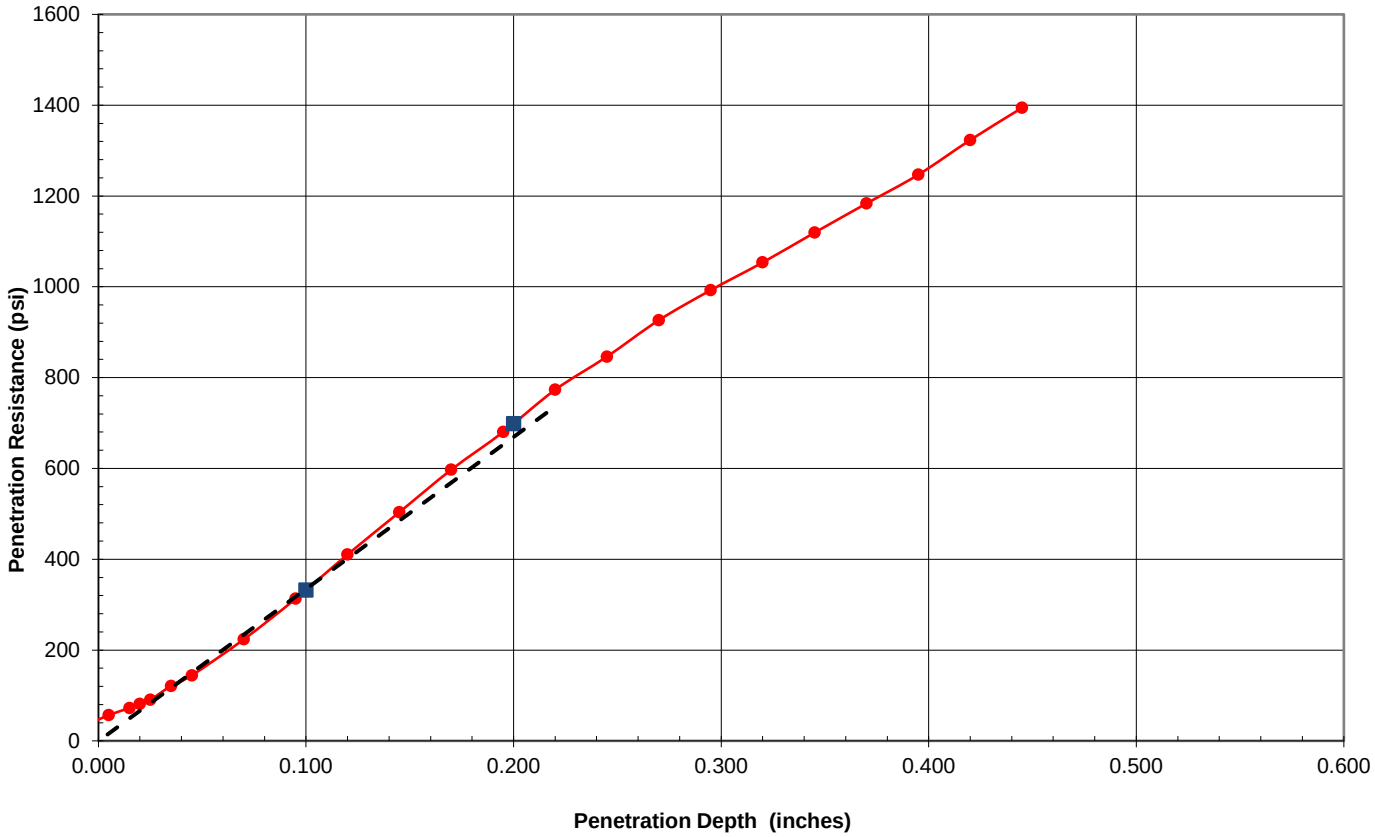
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	4-Jul-16

Lab No.:	B856-05	Test Condition:	Soaked
BH/Location:	TP16-01	Compaction Method:	ASTM D698
Sample No.:	BS 5a, 5b, 5c	% Retained 19 mm:	20%
Depth:	2.0 - 2.2 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2091	8.1	96	10	96.2	-2.49%	8.7	**33.2**	**46.6**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
fine to coarse SAND and fine to coarse sub-rounded GRAVEL, some non-plastic fines; brown; non-cohesive.	(SW-SM)	2178	7.8	N/A	N/A



Comment

Both end were subjected to shearing, both resulted with higher CBR on 0.2 in.

Charted data corrected for surface irregularities and and upward curve.

Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

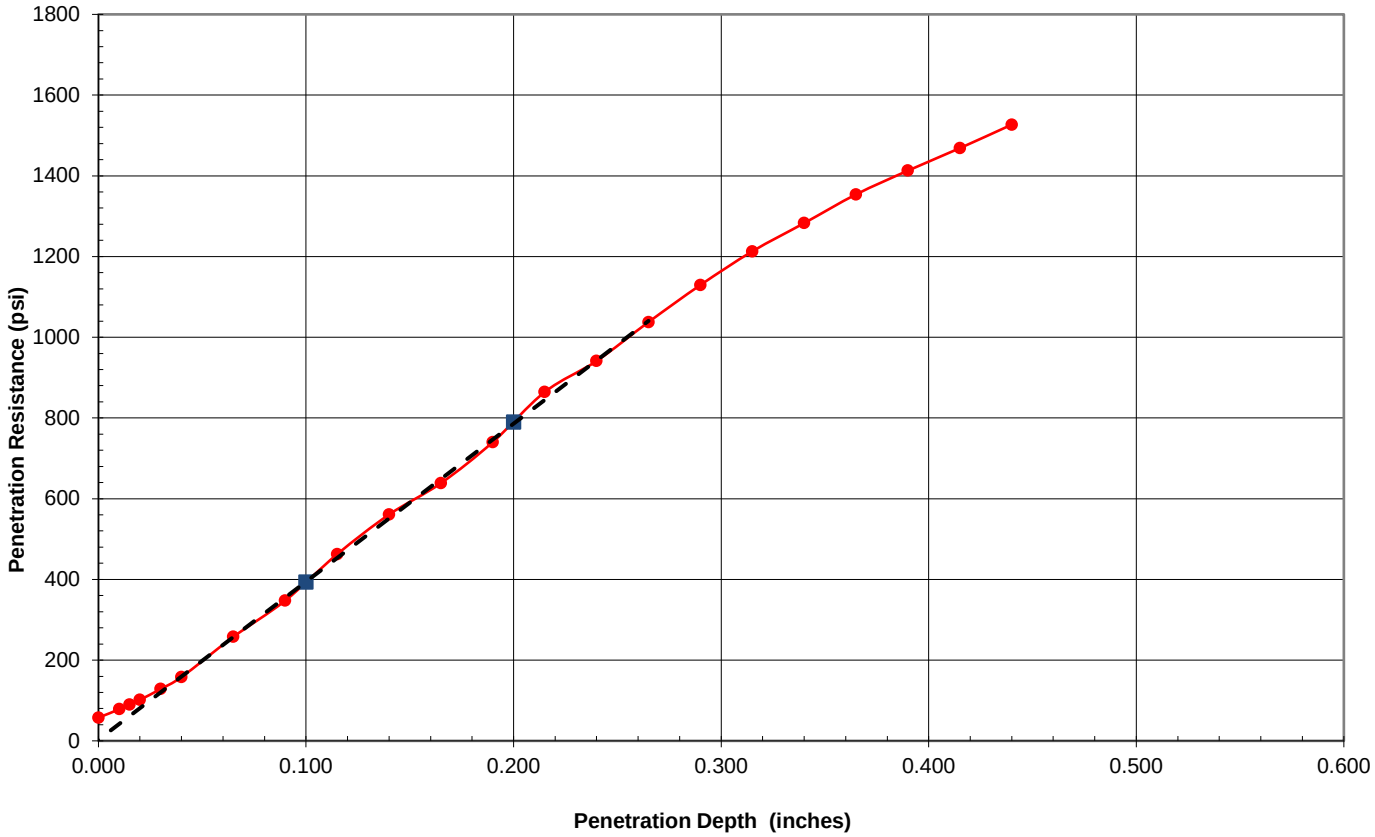
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	6-Jul-16

Lab No.:	B856-05	Test Condition:	Unsoaked
BH/Location:	TP16-01	Compaction Method:	ASTM D698
Sample No.:	BS 5a, 5b, 5c	% Retained 19 mm:	20%
Depth:	2.0 - 2.2 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2114	8.1	97	10	N/A	N/A	8.1	**39.4**	**52.7**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
fine to coarse SAND and fine to coarse sub-rounded GRAVEL, some non-plastic fines; brown; non-cohesive.	(SW-SM)	2178	7.8	N/A	N/A



Comment

Both end were subjected to shearing, both resulted with higher CBR on 0.2 in.

Charted data corrected for an upward shape of curve.

Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

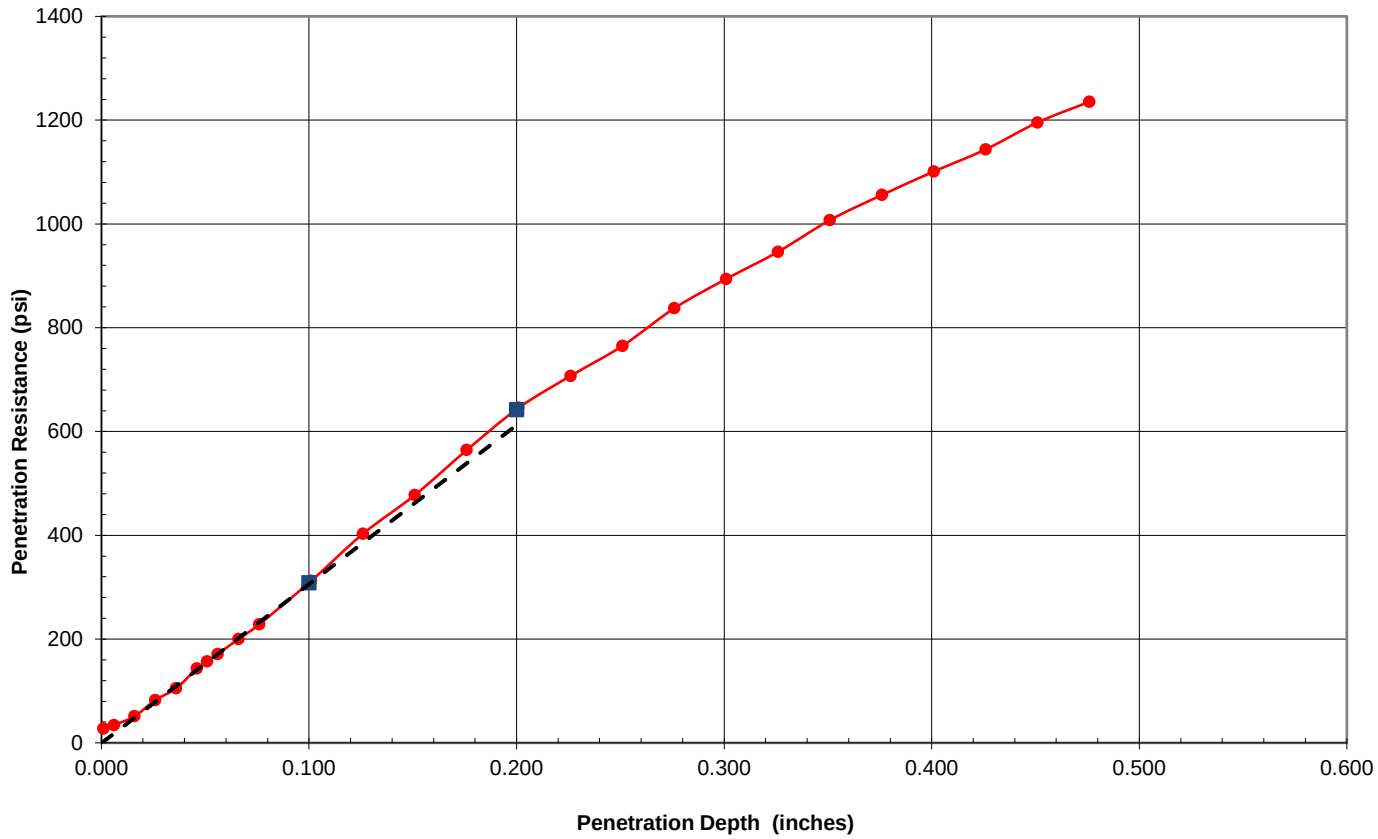
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	4-Jul-16

Lab No.:	B856-12	Test Condition:	Soaked
BH/Location:	TP16-02	Compaction Method:	ASTM D698
Sample No.:	BS5a, 5b, 5c	% Retained 19 mm:	15%
Depth:	2.7 - 3.25 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2054	8.7	98	10	96.1	-0.15%	10.0	**30.9**	**42.8**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
gravelly fine to coarse SILTY SAND, fine to coarse sub angular gravel; brown; non cohesive, wet.	SM	2104	8.8	N/A	N/A



Comment

Both end were subjected to shearing, both resulted with higher CBR on 0.2 in.

Charted data corrected for an upward shape of curve

Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

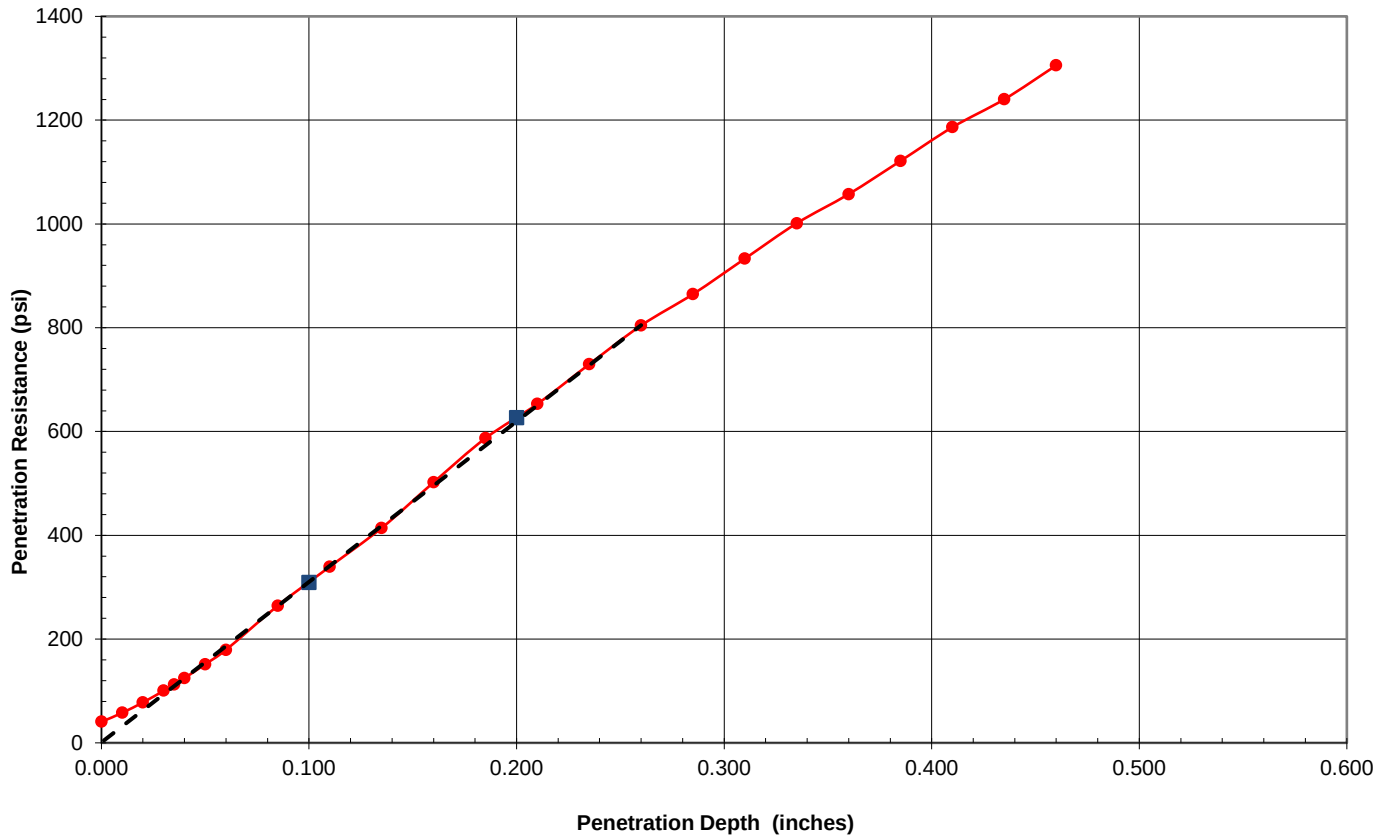
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	6-Jul-16

Lab No.:	B856-12	Test Condition:	Unsoaked
BH/Location:	TP16-02	Compaction Method:	ASTM D698
Sample No.:	BS5a, 5b, 5c	% Retained 19 mm:	15%
Depth:	2.7 - 3.25 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2067	8.7	98	10	N/A	N/A	8.9	**30.9**	**41.8**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
gravelly fine to coarse SILTY SAND, fine to coarse sub angular gravel; brown; non cohesive, wet.	SM	2104	8.8	N/A	N/A



Comment

Both end were subjected to shearing, both resulted with higher CBR on 0.2 in.

Charted data corrected for an upward shape of curve

Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

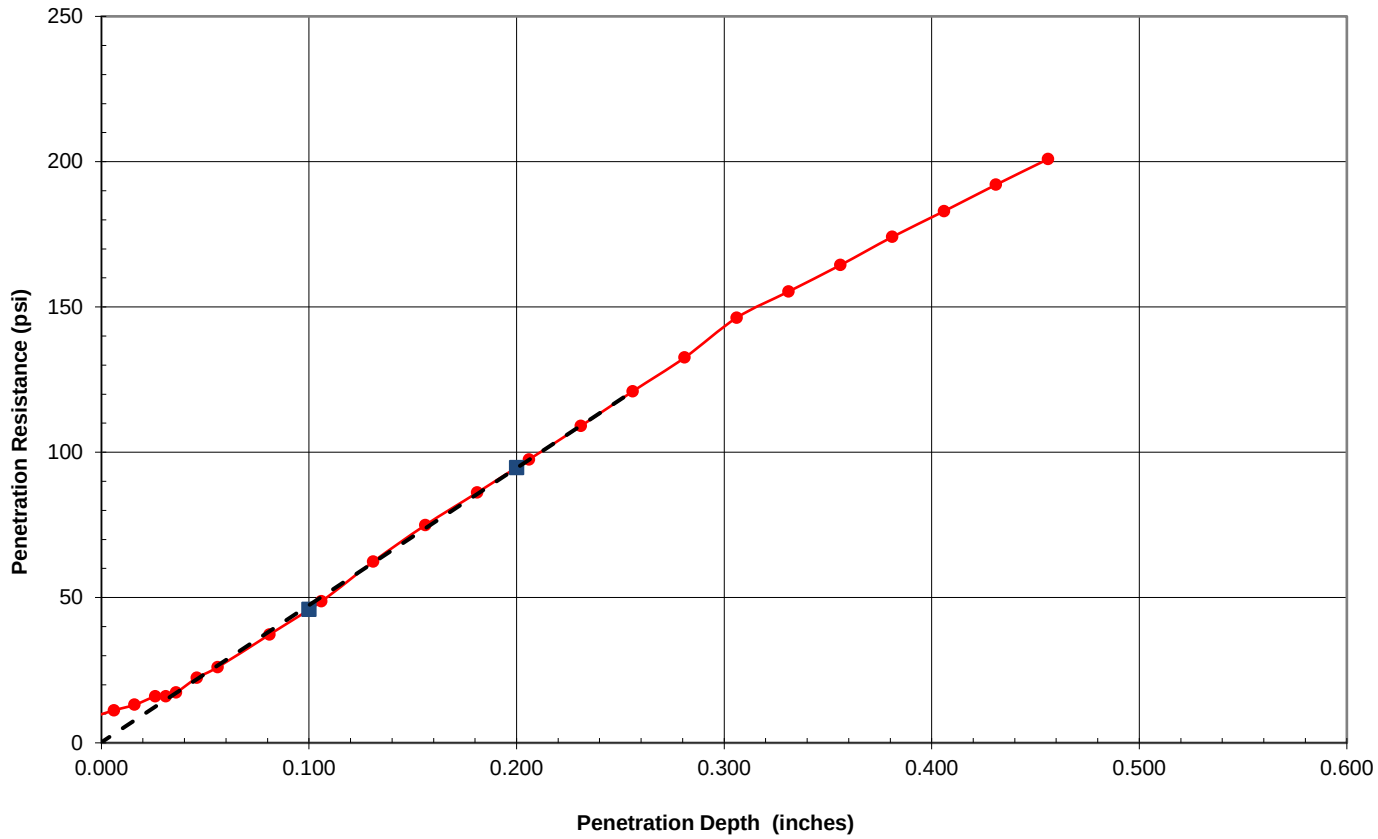
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	4-Jul-16

Lab No.:	B856-49	Test Condition:	Soaked
BH/Location:	TP16-07	Compaction Method:	ASTM D698
Sample No.:	BS5a, 5b, 5c	% Retained 19 mm:	4%
Depth:	2.5 - 2.8 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2046	10.0	103	10	95.5	2.44%	13.2	**4.6**	**6.3**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
gravelly fine to coarse SILTY SAND, fine sub-angular and angular gravel; brown; non-cohesive, moist	(SM)	1994	10.5	N/A	N/A



Comment

Both end were subjected to shearing, both resulted with higher CBR on 0.2 in.

Proctor completed was method B, so oversize material of +9.5 to -19mm added back to sample.

Charted data corrected for an upward shape of curve

Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

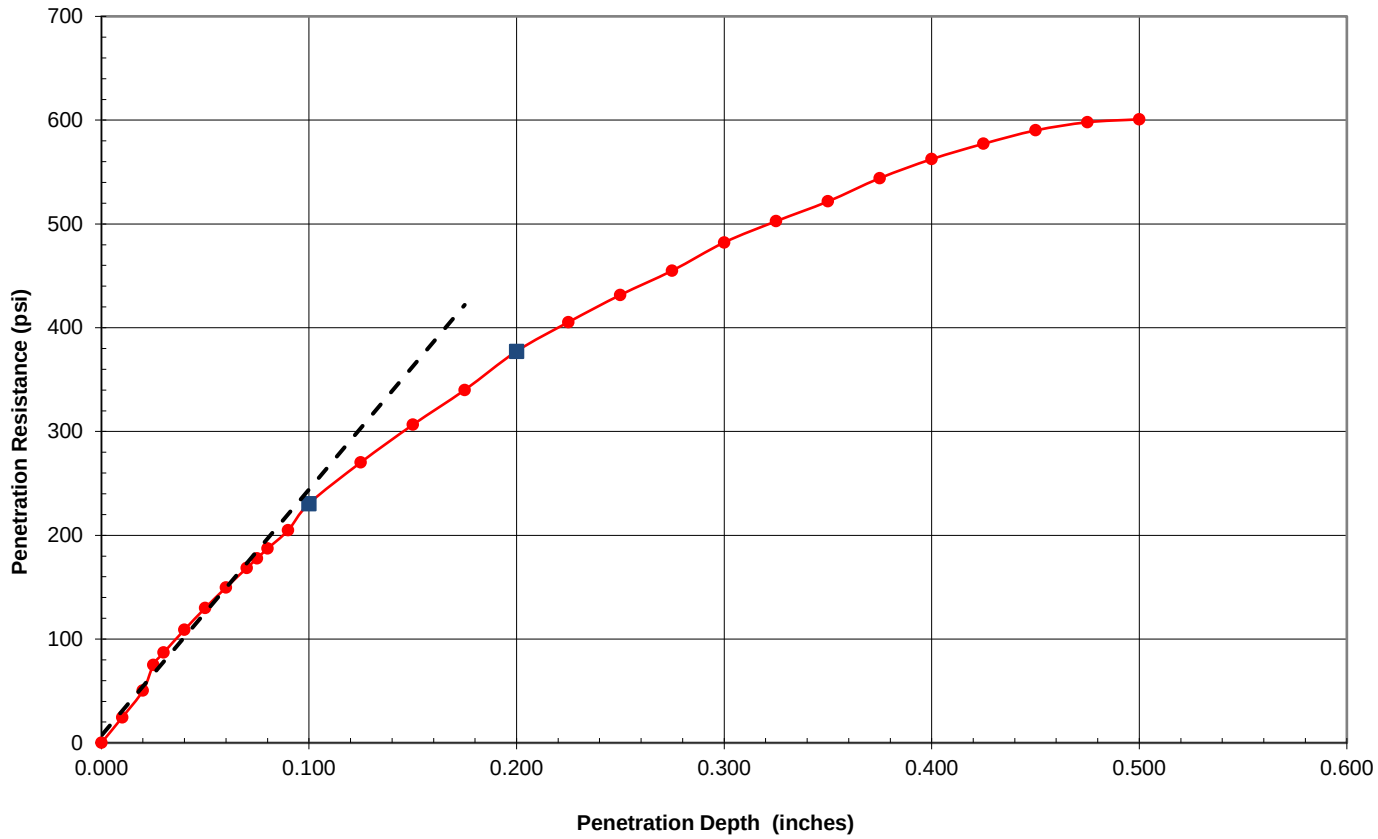
California Bearing Ratio (ASTM D1883)

Project #:	1654325	Phase:	3000
Short Title:	PCA/GlacierNP-CU11/I-Curve		
Tested by:	FC/	Date:	6-Jul-16

Lab No.:	B856-49	Test Condition:	unsoaked
BH/Location:	TP16-07	Compaction Method:	ASTM D698
Sample No.:	BS5a, 5b, 5c	% Retained 19 mm:	4%
Depth:	2.5 - 2.8 m	Blows/layer:	56/3

Dry Density (kg/m^3)	Moisture (%)	Percent of SPMDD(%)	Surcharge (lbs)	Hours Soaked	Max. Swell (%)	Moisture Top 1"(%)	CBR (%)	
							0.10 in	**0.20 in**
2026	10.0	102	10	N/A	N/A	10.1	**23.1**	**25.2**

Material Description	USCS	Max Dens. (kg/m^3)	Opt. Moist. (%)	Liquid Limit	Plasticity Index
gravelly fine to coarse SILTY SAND, fine sub-angular and angular gravel; brown; non-cohesive, moist	(SM)	1994	10.5	N/A	N/A



Comment

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Bay 7, 820 - 28th St. NE, Calgary, AB, T2A 6K1

Reviewed by:_____

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For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
102, 2535 - 3rd Avenue S.E.
Calgary, Alberta, T2A 7W5
Canada
T: +1 (403) 299 5600

Golder Associates