File: 292-30/OGC2021-011

December 24, 2021

VIA ELECTRONIC MAIL:

Dear

Re: Request for Information – Release
***Freedom of Information and Protection of Privacy Act* (FOIPPA)**

I am writing further to your request received by the BC Oil and Gas Commission (Commission) for: *"TC Energy's geotechnical plans for the drilling under the Morice River."*

Please find enclosed a copy of the records located in response to your request. These records will be published on the Commission's website 72 hours after release. To find out more about the proactive disclosure of requests, please access the Commission's website at: https://www.bcogc.ca/about/freedom-of-information/

Your file is now closed.

Pursuant to section 52 of the FOIPPA, you may ask the Office of the Information and Privacy Commissioner (OIPC) to review any decision, act, or failure to act with regard to your request under FOIPPA.

Please note that you have 30 business days to file your review with the OIPC. In order to request a review please write to:

Information and Privacy Commissioner
PO Box 9038 Stn Prov Govt
4th Floor, 947 Fort Street
Victoria BC V8W 9A4
Phone: 250.387.5629 Fax: 250.387.1696
Email: info@oipc.bc.ca

If you request a review, please provide the OIPC with a copy of your original request, a copy of the Commission's response, and the reasons or grounds upon which you are requesting the review. Further information on the complaint and review process can be found on the OIPC website: https://www.oipc.bc.ca

Please write FOIIntake@bcogc.ca, if you have any questions regarding your request.

Sincerely,

Julie Davidson

Julie Davidson
FOIPP Specialist
BC Oil and Gas Commission

Coastal GasLink – Morice River Crossing

Geophysical and Geotechnical Investigation

CGL4703-GALV-GT-RP-0035

May 28, 2021

Revision 1

Issued for Use

Confidential

GOLDER
MEMBER OF WSP

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Revision Log

Rev	Section	Revision Description
0	All	Issued for Use
1	Section 5.6.7	Addition of ARD/ML Geochemical section, Issued for Use
1	Attachment	Updated Legal Limitations
1	Figure 5	Modelled Resistivity – BH20-MOR- updated bedrock elevation adjusted upwards by 1 m

REPORT

Coastal GasLink - Morice River Crossing

Geophysical and Geotechnical Investigation

Submitted to:

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CGL4703-GALV-GT-RP-0035 Rev 1

28 May 2021

Distribution List

1 e-copy - Coastal GasLink Ltd.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Coastal GasLink (CGL) to conduct a geophysical survey and a geotechnical investigation to provide input to design for the proposed Morice River Crossing (The Site) along the proposed CGL right-of-way (ROW). Golder was authorized to carry out this work under Project Engineering Service Agreement No. 4600007484 and PO No. 4500278361 dated 5 November 2019.

Golder's scope of work is based on the river crossing designer, CCI Solutions (CCI), Scope of Work (SOW) package CGL4703-CCI-GT-SOW-0001 provided by CGL and based on email correspondence with CGL on 06 September 2019. The SOW herein is described in Golder's proposal submitted to CGL via email on 22 May 2019 (P19122805-001-P-Rev0).

Golder submitted a cost estimate for carrying out the Morice River investigation based on the CCI SOW to CGL on 22 January 2020. The updated cost estimate was approved by the CGL project team on 26 May 2020. Due to adjustments in scope at the Morice River Crossing, Golder provided an updated cost estimate to CGL via email on 15 October 2020.

The purpose of the investigation is to collect information on the subsoil and groundwater conditions as preliminary input to the design and construction of a subsurface pipeline crossing.

Based on developed SOW package, the agreed scope is summarized as follows:

- Conduct a pre-disturbance site inspection with a CGL Representative and the Prime Contractor, Pacific Atlantic Pipeline Construction (PAPC), supervisors to assess the suitability of the proposed sites.
  - This included the inspection of drill sites, general forest cover, clearing progress, river conditions, and proposed geophysics lines prior to drill or geophysics crew mobilizations. This was completed on 16 September 2020.
  - An additional pre-start site safety review was completed on 31 October 2020 where a borehole specific emergency response plan was reviewed with PAPC and CGL safety teams.
- Conduct a drilling investigation using a tracked sonic drill rig at two borehole locations terminated in bedrock or 30 metres below ground surface (BH20-MOR-01 and BH20-MOR-06) and one location to a depth of 60 meters below ground surface (BH20-MOR-05) regardless of bedrock depth. A coring head to be installed once bedrock has been encountered with drilling proceeding using HQ3 coring techniques to target depth of the borehole.
- Conduct a drilling investigation using a helicopter-portable sonic drill rig at one borehole location to 85 meters below ground surface (BH20-MOR-02) and two (2) borehole locations to 90 meters below ground surface (BH20-MOR-03 and BH20-MOR-04). A coring head to be installed once bedrock has been encountered with drilling proceeding using HQ3 coring techniques to target depth of the borehole.
- Collect geophysics data using Electrical Resistivity Tomography (ERT) and Seismic Refraction Tomography (SRT) methods:
  - Collect data transects oriented along the proposed crossing path to investigate stratigraphy, including depth to bedrock, of proposed trenchless crossings at the Sites.
  - Survey parameters to be designed to investigate to the final depth of the proposed boreholes.

- ERT survey lines to be extended approximately 100 m past the proposed borehole locations and will include a geophysical transect across the river if safe crossing can be achieved.
- SRT survey lines to be extended approximately 100 m past the proposed borehole locations and will terminate on the eastern and western banks of the Morice River.
- Lateral positions of the survey to be recorded with a differential Global Positioning System (dGPS) device. Elevations to be extracted from existing LiDAR data during the data processing stage.
- River bottom bathymetry to be completed along the proposed Morice river crossing through shallow water Real-time Kinematic (RTK) surveying and zodiac mounted bathymetry equipment.

- Produce a factual geotechnical report including details of the subsurface investigation, material laboratory testing, processed and interpreted geophysical and bathymetric results in section and/or map format, summarizing the anticipated geotechnical conditions.

This factual report summarizes the methods used and the soil stratigraphic conditions encountered at the Sites as input for design and construction of the proposed river crossing. Use of this report is subject to conditions outlined in the *"Important Information and Limitations of this Report"* section which follows the main text and forms an integral part of this document.

Where comments are made on the general site conditions and impacts on future construction, they are provided to highlight aspects that could affect the design of the project. Those requiring information on geotechnical aspects of the site beyond the scope of this report must make their own interpretation of the subsurface information, particularly as it affects their proposed construction methods, costs, equipment selection, scheduling and the like.

2.0 SITE AND PROJECT DESCRIPTION

The Coastal GasLink project involves construction and operation of a natural gas pipeline from the area near the community of Groundbirch to the LNG Canada Development Inc. liquefied natural gas export facility near Kitimat, BC. The project includes the construction and operation of:

- Approximately 670 km of 1220 mm diameter pipeline
- Metering facilities at the receipt and delivery points at up to 3 locations
- Compressor stations at up to 8 locations.

The pipeline alignment extends over a variety of terrain, from mountainous, densely vegetated forest conditions with rivers and streams to moderately vegetated forest conditions, wetlands and rolling hills. There are several communities along the alignment, including many First Nations traditional territories.

As part of the pipeline construction, there will be several river and stream crossings. The proposed Morice River crossing is approximately located 52 km southwest of Houston, BC between CGL Kilometre Post (KP) 557+785 to 559+200.

3.0 GEOTECHNICAL AND GEOPHYSICAL INVESTIGATIONS

Golder completed a site reconnaissance with a CGL representative and PAPC supervisors on 16 September 2020 to assess the planned borehole locations, including inspection of drill sites, general forest cover, access conditions, and proposed geophysics lines prior to drill or geophysics crew mobilizations.

An additional pre-start safety review was completed on 31 October where a borehole-specific emergency response plan was reviewed by CGL and PAPC safety teams.

Golder completed a BC One Call prior to mobilization with no utilities identified onsite. A third party locate sweep was completed by PAPC sub-contractor Apex Geomatics on 15 October 2020, and no evidence of existing utilities was detected. Golder acquired a borehole specific PAPC Ground Disturbance permit prior to conducting any drilling operations at each Site.

Golder geophysics and geotechnical crews took part in PAPC Site Orientations and pre-access certifications prior to working at Site. Golder contacted the Yinka Dene Economic Development Limited Partnership (YDEDLP), the corporate business arm of the Wet'suwet'en Frist Nation, prior to the geophysics team mobilization to engage a geophysics helper for the upcoming investigation. The YDEDLP were unable to accommodate the request and Golder fulfilled the helper positions with Golder personnel. Site preparation and first aid was coordinated with PAPC and CGL.

3.1 Geophysical Field Program and Data Acquisition

The geophysical program was completed over two mobilizations to Site, the first being 1 to 9 November, 2020 and the second being 12 to 14 December, 2020. The combination ERT-SRT geophysics survey was designed to provide continuous coverage laterally and vertically between borehole locations. During all in-river operations the geophysics crew was accompanied by Raven Rescue personnel, a swift water rescue and safety planning subcontractor. Prior to the undertaking of all river work, a swift water rescue and risk mitigation plan was prepared by Raven Rescue staff. The in-river work consisted of bathymetric surveying and deploying the bottom-laid resistivity cable across the river. This work was completed using a 14-foot zodiac and 25-horsepower jet engine slung by helicopter to the riverbank. The rest of the geophysical alignment was accessed on-foot along the cleared ROW from parking locations at the far west and east ends of the survey area.

All geophysical data were collected along the proposed pipe centreline and survey lines were laid out along the cleared ROW. ERT data were collected using an ERT system manufactured by IRIS instruments. Resistivity surveys were completed using 10 m electrode spacing for a total ERT transect length of 1,700 m. Both dipole-dipole and Wenner-Schlumberger array types were collected. The maximum depth of investigation for the ERT survey is 90 metres below ground surface (mbgs). Seismic data were collected for the on-land portions of the transect on either side of the river. The SRT method measures variations of compressional or primary (p-wave) seismic wave velocity along a 2-D profile. SRT data were collected using a 24 channel Geometrics Geode seismic system, with 4.5 Hz geophones placed at 10 m spacing for a total of 1,600 m of SRT data. Bathymetric survey data were collected using a Sonarmite single-beam depth sounder and integrated real-time kinematic (RTK) positioning.

During the first mobilization (1 to 9 November 2020) all on-land SRT and ERT data up to the east and west banks of the Morice River were collected. An attempt was made to collect a continuous profile of ERT data spanning the river; however, the field work occurred during a period of high runoff and peak water volume in the Morice River making conditions unsuitable for safely deploying the resistivity cable across the river. High water levels also limited the bathymetric coverage to areas of the river that were safely accessible with the zodiac and 25-horsepower jet engine.

A second mobilization (12 to 14 December 2020) was required to collect ERT data beneath the river. Water levels were significantly lower during this period, allowing the field crew to wade from the west side of the river to approximately the centre of the river, laying the ERT cable along the river bottom for this portion. The eastern

portion of the river consists of class 2 rapids and shallow rocks which present a challenge to the standard boat-deployed bottom-laid cable approach. The field crew employed an alternative approach of setting up an anchor point at the mid-point of the river and tensioning the cable slightly submerged in the river from the mid-point anchor to an anchor on the east bank. Spotters were positioned upriver and downriver to direct any boat traffic to the west section of the river where the cable was bottom-laid. Once the in-river cable was positioned, resistivity cables and electrodes were installed on land on either side of the river for a total line length of 950 m, to achieve overlapping coverage with ERT data collected during the first mobilization.

The proposed crossing alignment was surveyed and cleared prior to the arrival of the geophysics crew. The location of electrodes and geophones were recorded using a differential Global Positioning System (dGPS) Trimble GeoXT GPS device generally capable of sub-metre horizontal precision. Elevations along the geophysical survey lines were extracted from a Light Detection and Ranging (LiDAR) data set provided to Golder by CGL. Positional information was integrated into the data for the velocity and resistivity modelling processes.

A site plan displaying the locations of the ERT/SRT transects, bathymetric coverage, and borehole locations is provided as Figure 2 in this report. The geophysical methods used are discussed in greater detail in APPENDIX E.

3.2 Borehole Investigation

To obtain site-specific subsurface geotechnical information, Golder conducted a drilling investigation between 02 November 2020 and 15 December 2020. A helicopter portable Boart Longyear 33K sonic drill rig owned and operated by Blue Max Drilling (Blue Max) out of Surrey, BC was used to complete boreholes BH20-MOR-02 and BH20-MOR-04, and a helicopter portable Hydracore HC5000S sonic drill rig owned and operated by Mud Bay Drilling (Mud Bay) out of Calgary, AB was used to complete borehole BH20-MOR-03. Track accessible boreholes (BH20-MOR-01, BH20-MOR-05, and BH20-MOR-06) were completed using a tracked Boart Longyear LS250 sonic drill rig owned and operated by Blue Max, out of Terrace BC. Helicopter portable drill rigs were staged from the CGL Laydown 29 for the duration of the drilling investigation. Mobilization of helicopter portable drilling equipment was completed using a Eurocopter A-Star B3 helicopter owned and operated by Canadian Helicopters, out of Smithers BC and under contract to CGL. As directed by CGL and PAPC, the CGL Laydown 29 was utilized for all helicopter portable drill rig refueling operations. All drilling equipment underwent an environmental inspection by CGL Section 7 Environmental Inspectors at the PAPC Huckleberry Camp prior to mobilizing to site.

All drilling, setup and slinging operations were monitored and observed by members of Golder's geotechnical staff, who logged the subsurface soil, rock and groundwater conditions at each borehole location and collected samples for visual classification and laboratory testing. Selected representative soil and rock samples were submitted for laboratory testing. Detailed descriptions of the subsurface soil and rock conditions encountered at each borehole location, together with laboratory index test results are presented in the Record of Sonic Hole and Drillhole Sheets in APPENDIX A.

Field identification and classification of soils was conducted in accordance with Golder's soil classification system (June 2018, Revision 5) which is generally consistent with the concepts presented in ASTM International (ASTM) D2487 and D2488 and the Canadian Foundation Engineering Manual (CFEM, 2017), with some differences intended to improve the compatibility of the soil descriptions with the material geotechnical engineering behaviour. This system is generally consistent with the Unified Soil Classification System (USCS). Coarse-grained soils are classified based on USCS and are described in terms of relative proportions of the mineral constituents; whereas, fine-grained soils are classified with reference to Golder's soil classification system, and are based on plasticity

(Atterberg limits testing) with reference to the ASTM D2487 plasticity chart. A summary of the key aspects of Golder's soil classification system is presented on the "Geotechnical Soil Description Terminology" fly sheets, which immediately precede the Record of Sonic Hole and Drillhole sheets in APPENDIX A.

The geotechnical drilling investigation program consisted of six boreholes advanced from 8.23 to 90.18 m depth on the east and west sides of the Morice River. Boreholes were advanced utilizing sonic drill rigs capable of 127 and 171 mm casing sonic drilling and HQ coring methods. The borehole locations were adjusted from the original proposed locations described in the CCI SOW (Document Number: CGL4703-CCI-GT-SOW-0001) to comply with onsite environmental and access restrictions. Golder coordinated with CGL and CCI to adjust the location of the following boreholes BH20-MOR-02, BH20-MOR-03, and BH20-MOR-05 prior to conducting drilling operations:

- **MOR-BH20-02** – Borehole shifted approximately 18 m east to minimize disturbance to established protestor structure, mitigate impact to nearby non-classified drainage (NCD), and to allow for more favourable ground conditions for drilling and pad construction.
- **MOR-BH20-03** – Borehole shifted approximately 27 m north-west to maximize buffer between the drill site and the Morice River and to allow for more favourable ground conditions for drilling and pad construction.
- **MOR-BH20-05** – Borehole shifted approximately 8 m east to allow for more favourable ground conditions for drilling.

Boreholes were marked and surveyed in the field with a handheld GPS typically capable of +/- 5 m precision upon completion of grouting activities. A CGL-coordinated McElhanney survey crew completed a survey of the completed boreholes on 30 November, 04 and 09 December, 2020 and 09 April, 2021. The surveyed test hole coordinates and ground elevations are presented on the Record of Sonic Hole and Drillhole Sheets in APPENDIX A and Table 1. All depths referenced herein are to ground surface at the time of drilling.

Standard Penetration Test (SPT) split-spoon sampling was conducted at regular depth intervals (1.5 m) in the upper 15 m, where conditions allowed (i.e., not in rock), and every 3 m at greater depths, until termination of the borehole. It is noted that SPTs within sonic boreholes are not conducted strictly in accordance with ASTM standards, which calls for a mud-supported borehole. The drilling technique may affect the SPT test results, such that they cannot strictly be correlated to N-Values; however, Golder's experience is that the SPT in sonic boreholes provides useful data on relative density and consistency of the soils encountered, as well as disturbed samples. The sonic drilling method provides continuous core samples, which is very helpful in providing a near-continuous characterization of the subsurface conditions with few data gaps. Due to the vibratory nature of the sonic method, soil and weak rock structure as usually not preserved in the highly disturbed core. Detailed descriptions of the subsurface soil and rock conditions encountered at each borehole location, together with laboratory index test results, are presented in the Record of Borehole Sheets in APPENDIX A.

The collected rock core was photographed during Golder's detailed core logging phase at the Golder Terrace BC Office. No 'stitching' or any other digital processing of the photographs was conducted other than cropping and straightening. The core photographs presented in APPENDIX D are of the wet and dry core, which generally provided a good representation of the colour of the rock.

Table 1: Summary of Borehole Details

Borehole No.	Description	Northing (m)	Easting (m)	Elevation (m geodetic)	Termination Depth (mbgs)	Depth to Bedrock (mbgs)	Drilling Method
BH20-MOR-01	Entry Point (east side)	6004737.320	606921.850	768.15	65.58	-	Sonic
BH20-MOR-02	East Bank	6004862.530	606670.860	744.75	85.92	49.99	Sonic and HQ3
BH20-MOR-03	West Bank	6005000.640	606354.010	727.80	45.69	26.06	Sonic and HQ3
BH20-MOR-04	West Bank	6005093.480	606172.250	743.13	90.18	14.33	Sonic and HQ3
BH20-MOR-05	West Bank	6005195.950	605938.830	769.52	60.0	19.20	Sonic and HQ3
BH20-MOR-06	Exit Point (west side)	6005321.12	605671.63	777.66	8.23	1.68	Sonic

3.2.1 Borehole Closure and Drill Water Management

Upon completion, the boreholes were backfilled with cementitious grout via a 1" PVC tremie line and topped up with bentonite chips in conformance with BC Groundwater Protection Act (BC GWPA) regulations. As agreed with CGL, collected rock core was boxed and returned to the Golder Terrace office and soil drill cuttings were spread out onsite near the borehole locations.

Prior to conducting drilling activities at site, PAPC installed drill water containment sumps adjacent or directly under the proposed borehole locations for tracked and helicopter portable drilling operations, respectively. In general, the drill water return during sonic drilling was minimal and contained within the excavated sump. A notable increase in water returns while HQ3 rock coring was observed and periodic dewatering of the sump was required. Dewatering of the sump comprised of a 2" water line and pump system to remove collected drill water from the sump to a CGL approved discharge location. A CGL approved nominal diameter geotextile silt bag was affixed to the outlet of the 2" discharge line to mitigate the number of fines discharged to the ground surface. Discharged drill water was allowed to percolate back into the ground surface and was periodically monitored to mitigate inadvertent flow to nearby watercourses. No flow of discharged drill water to nearby watercourses was observed during Golder's field investigation.

Approved discharge locations were selected by CGL General Inspectors in the field and were generally located in areas where discharged water would not affect identified NCDs or other sensitive areas. Jacobs Engineering Group (JEG) provided water quality monitoring services to CGL of the nearby Morice River and Morice River side-channel during drilling operations at BH20-MOR-03 and BH20-MOR-04.

Additional water quality sampling of discharged drill water was completed at BH20-MOR-01 to BH20-MOR-04. Water quality sampling was completed by collecting water from the 2" discharge lines during sump dewatering

activities. All excess drill water during sampling was captured and discharged at the CGL approved discharge locations. Water quality sampling activities were monitored by CGL General Inspectors and the First Nations representative, Northwest Research and Monitoring (NWRM), out of Smithers BC.

3.3 Laboratory Testing

The soil samples collected in the field were shipped to Golder's Burnaby laboratory and testing was conducted on selected representative samples. The soil testing program consisted of sixty-four natural moisture contents, eight organic content determinations, nine Atterberg Limits, twenty-two particle size distribution tests, twelve hydrometer tests, and three standard specific gravity determinations.

Soil index testing was conducted at Golder's Burnaby laboratory and in accordance with ASTM standards as follows:

- ASTM D2216 Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D6913 Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D2974 Standard Test Methods for Determining the Water Content, Ash Content, and Organic Material of Peat and Other Organic Soils
- ASTM D854 Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

Rock testing consisted of five Unconfined Compressive Strength (UCS) tests, one hundred fifty-six Point Load Tests (PLT), two rock core petrography tests, two gravel petrography tests, three Acid Rock Drainage / Metal Leaching (ARD/ML) geochemical analyses, three dry density determinations, and six Cerchar rock abrasivity tests.

Rock testing was conducted at Golder's Burnaby and Terrace laboratories and in general accordance with ASTM standards as follows:

- ASTM D7012 Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
- ASTM D5731 Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications
- ASTM C295/C295-19 Standard Guide for Petrographic Examination of Aggregates for Concrete
- ASTM C1721-15 Standard Guide for Petrographic Examination of Dimension Stone
- ASTM D7625 Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the CERCHAR Method
- ISRM Suggested Methods for Determining Water Content, Porosity, Density, Absorption and Related Properties

The laboratory test results are presented in detail in APPENDIX B and APPENDIX C.

3.3.1 Petrographic Examination of Gravel Portions – CSA A23.2-15A/ASTM C295/C295-19

Petrographic examinations of granular materials were conducted on two selected overburden samples from boreholes BH20-MOR-01 and BH20-MOR-03. It should be noted that sand sized portions (0.075 to 4.75 mm) were not included in the petrographic examination. The gravel portion of the soil samples was evaluated and categorized by percent mass for each type of rock noting the shape, range of colours, textures, and lithologies. The detailed results from the petrographic examination are presented in APPENDIX C.

3.3.2 Petrographic Examination of Collected Rock Core – ASTM C1721-15

Petrographic examinations of collected HQ core were conducted on two selected samples from boreholes BH20-MOR-03 and BH20-MOR-04. Samples were selected to further understanding of the in-situ bedrock's physical and chemical characteristics for a potential trenchless crossing.

Rock samples were cut and polished by Precision Petrographics in Vancouver, BC in preparation for examination of samples in Golder's Burnaby Laboratory. The detailed results from the petrographic examination are presented in APPENDIX C.

3.3.3 Unconfined Compressive Strength Testing – ASTM D7012-07

Unconfined Compressive Strength (UCS) tests were conducted on four selected samples of bedrock. A fifth sample, sample no. 27 from BH20-MOR-05, broke during preparation and was found not to be suitable for testing. After sample preparation of sample no. 24 from BH20-MOR-04 it was determined that the sample length (1.94:1) did not conform to ASTM requirements on minimum sample size (2.0 to 2.5:1). However, it is noted that the sample is only slightly smaller (3.52 mm in height) than the ASTM requirements on minimum sample size, therefore, it will likely not result in any significant reduction of recorded UCS test results. Based on Golder's understanding of the UCS test, we infer that the non-standard test result would likely be a lower-bound value for the actual strength. The other tested samples conformed with the ASTM sample size requirement.

3.3.4 Point Load Strength Index Test – ASTM D5731

The Point Load index tests were conducted on one hundred fifty-six sample and are preformed by subjecting a rock specimen to an increasingly concentrated load until failure occurs by splitting the specimen. Loads are applied parallel (axial test) or perpendicular (diametral test) to the core axis. Point Load Strength Index values (Is_{50}) were calculated using the following equation, in accordance with ASTM specification D5731.

$$Is_{50} = (\frac{{D_e}^{0.5}}{50})^{0.45} x \frac{P}{{D_e}^2}$$

Where D_e is the equivalent diameter and equal to the specimen diameter (D) for the diametral tests or $(4AD/\pi)^{0.5}$ for axial tests, A is the length of the sample between the PLT contact points or "platens", and P is the maximum applied load. Detailed laboratory tests results are presented in APPENDIX C.

3.3.5 Cerchar Abrasivity Tests – ASTM D7625-10

Cerchar Abrasivity testing was conducted to determine the Cerchar Abrasivity Index (CAI) of selected rock samples from the geotechnical investigation. CAI data is collected by measuring the wear of a steel stylus tip after it has been used to abrade a specimen under a specific normal force over a set distance of 10 mm. A microscope

is used to measure the wear surface area of the stylus and then multiplied by 10 to produce the dimensionless unit CAI. Cerchar Abrasivity test results were averaged based on the rock unit and cross-referenced against the Cerchar Abrasiveness Index described in Table 2.

Table 2: Criteria for the Cerchar Abrasiveness Index

Classification	Average CAI (Cerchar, 1986)	Average CAI (Michalakopoulos et al, 2006)
Very Low Abrasiveness	0.3 – 0.50	0.32 – 0.66
Low Abrasiveness	0.50 – 1.00	0.66 – 1.51
Medium Abrasiveness	1.00 – 2.00	1.51 – 3.22
High Abrasiveness	2.00 – 4.00	3.22 – 6.62
Extreme Abrasiveness	4.00 – 6.00	6.62 – 10.03
Quartzitic	6.00 – 7.00	N/A

3.3.6 Acid Rock Drainage and Metal Leaching Geochemical Testing

Geochemical analysis was carried out on four samples obtained from the geotechnical rock core. The purpose of the analysis was to assess the acid rock drainage and metal leaching (ARD/ML) potential of bedrock encountered at the proposed compressor station site, which may be excavated and potentially re-used for construction purposes. The samples were submitted to SGS Canada Inc. (SGS) in Burnaby, British Columbia for specialized geochemical analysis to assess ARD/ML potential. SGS carried out the requested analyses according to the following methods:

Acid Base Accounting (rock) (ABA) – ABA testing provides quantitative information on the sulphide-sulphur concentration, and other sulphur species in a rock sample. The oxidation of sulphide-sulphur is the primary chemical process responsible for the acid rock drainage potential of a rock sample (MEND 2009)[1].

Total metals (rock) (ICP) by ICP-MS (Multi-Element Analysis) - Analysis of the rock samples was carried out to measure the solid-phase concentrations of various metals that could affect site drainage quality.

Shake Flask Extraction (leachate test) (SFE) - SFE testing provides preliminary information on the leaching potential of various geochemical parameters in leachates generated from contact between crushed rock and de-ionized water. Geochemical analyses of the SFE leachates included dissolved phase major and trace cations, dissolved anions, acidity/alkalinity, pH, hardness and conductivity.

Laboratory data from ABA, ICP and SFE testing was used to assess ARD potential and initial indications of ML potential of the rock samples tested. Definitions of the ABA test parameters used to characterize the ARD potential of a rock sample are as follows:

[1] MEND. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. CANMET – Mining and Minerals Sciences Laboratories, Natural Resources Canada. MEND Report 1.20.1.

Acid generation potential (AP) is calculated from the sulphide sulphur concentration of a rock. The acid generation potential of most typical rock is associated with the process of oxidation of sulphide minerals such as pyrite (MEND 2009).

Bulk acid neutralization potential (also referred to as "Sobek NP" or "NP") of a sample is considered to reflect the NP contributions from carbonate minerals such as calcite as well as other reactive silicates that may be available to contribute to acid neutralization (MEND 2009).

Carbonate acid neutralization potential (carbonate NP, or caNP) assumes the NP is in the form of reactive carbonates, specifically calcite (MEND 2009). The Sobek NP of a given rock sample is typically higher than the carbonate NP for rocks containing both carbonate and aluminosilicate minerals, as a result of the relatively aggressive nature of the geochemical test method.

Neutralization potential ratio (NPR) is defined as the ratio of the acid neutralization potential to the acid generation potential (i.e., NPR = NP/AP) and can be used to classify sulphide-bearing rocks according to their ARD potential (MEND 2009). Table 3 provides a summary of the screening criteria for the classification of ARD potential based on the scheme proposed in the ARCRP (2018), which is a variant of the ARD classification presented in MEND (2009). For the purposes of this screening level assessment, an NPR based on the ratio of the carbonate NP (caNP) to the AP of less than 1.0 is considered to indicate that a rock sample is *potentially acidic drainage generating* (PAG). An NPR of between 1.0 and 2.0 is considered to indicate that a material is *capable of generating* ARD. An NPR greater than 2.0 is considered to indicate the rock sample is *not acidic drainage generating* (Non-PAG).

Acid Rock Drainage Potential Assessment

The MEND (2009) ARD classification criteria have been adopted with minor modification for the CGL project according to Section 4.1 of the *Acid Rock Construction Response Plan* (ARCRP, Coastal GasLink 2018)[2]. The classification system being used for CGL is presented in Table 3. Under the ARCRP, the carbonate NP is to be used in classification of ARD potential. NPRs calculated using the bulk NP will also be considered for comparison purposes.

Table 3: Screening Criteria for ARD Potential (ARCRP 2018, Section 4.1)

Screening Criteria	ARD Potential
NPR < 1 and sulphide sulphur ≥ 0.1%	Potentially Acidic Drainage Generating (PAG)
1 ≤ NPR ≤ 2 and sulphide sulphur ≥ 0.1%	Uncertain of Generating Acidic Drainage
NPR > 2 or sulphide sulphur < 0.1%	Not Potentially Acidic Drainage Generating (non-PAG)

NPR = Neutralization Potential Ratio based on ratio of carbonate neutralization potential to acid potential

[2] Coastal GasLink (ARCRP). 6 November 2018. Acid Rock Construction Response Plan. Revision 3. Prepared for the British Columbia Oil and Gas Commission. Coastal GasLink Pipeline Project: CGL document no. CGL4703-CGP-ENV-PLN-014.

Metal Leaching Potential Assessment

Total Metals (ICP) Assessment

The total metals results for selected parameters were compared to "normal trace element concentrations in selected rock types" according to Price (1997)[3]. The rock types associated with the normal trace element concentrations presented in Price were selected based on similarities with the sample lithologies indicated in Section 5.6.2. Metal concentrations measured in the samples collected from the various sites in Section 8 were compared to one, five and ten times (i.e. 1x, 5x and 10x) the values presented in Price (1997). This comparison is made to identify geochemical parameters present in the rock at concentrations that may have the potential to affect water quality as a result of contact between surface water and excavated rock material or rock cuts, i.e. "contact water" quality. Exceedances identified by the comparison are not indicative of an ML concern, however, when viewed together with shake flask extraction testing results, they can be useful in the interpretation of ML potential and whether additional testing may be required to assess metal leachability.

Shake Flask Extraction (SFE) Assessment

The SFE results were compared to current approved and working British Columbia Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life. This comparison is conducted to identify potential geochemical parameters of concern present in the rock that may have the potential to affect contact water quality. The results of the SFE testing are not intended to be a simulation of expected or actual site drainage quality but are useful in developing a preliminary understanding of the potential leachability of geochemical parameters of concern, particularly selected trace metals.

4.0 SURFICIAL AND BEDROCK GEOLOGY

Regional geological mapping (Cui *et al.*, 2017) indicates that the general bedrock geology at the proposed Morice River Crossing site comprises Paleogene (23 to 65 million years old) sandstone, siltstone, conglomerate, shale, coaly shale, coal, interbedded tuff, tuffaceous siltstone, and fanglomerates of the Sifton Formation. Based on published geological mapping the bedrock is assumed to be of fluvial origin. A visual representation of mapped bedrock areas along the proposed Morice River Crossing is presented in Figure 3.

Geological Survey of Canada's geology of Smithers Area map (Tipper and Richards, 1976) and the preliminary interpretation of glacial features of the Smithers Area map (Tipper, 1994) indicates that the Morice River Crossing is located in an extensive area of Quaternary glacial outwash deposits. Surficial geology is expected to generally comprise of recent alluvium, till, and outwash sediments such as sand and gravel mixtures with some inclusions of cobbles, boulders, and discrete deposits of fine-grained silts and clays. Preglacial river channels have not been identified on maps reviewed by Golder, although the presence of such channels could impact the proposed directional drilling pathway. If existing, preglacial river channels are expected to have incised into the existing bedrock and may not coincide with the current river channel location. Preglacial river channels are expected to comprise of sand to boulder sized alluvial deposits.

Terrain mapping conducted by Worley Parsons (2019) for CGL (CGL Document No. CGL4703-WPC-G-MP-065_0) indicates that the Morice River Crossing topography generally comprises of flat to gently sloping upland landforms with valley slopes comprising of terraces interconnected by steep potentially unstable slopes (27% -

[3] Price, W.A. 1997. DRAFT Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. British Columbia Ministry of Employment and Investment, Energy and Minerals Division, Smithers, BC, (April), 143 p.

70%). Mapped terrain stability classes and slope classes for the proposed CGL Morice River Crossing area range from I – V and 1 – 5, respectively. An additional site investigation pertinent to landslides has been competed by Worley in this area (CGL4703-WPC-GT-RP-049_0, Appendix F). Surficial geology of the upland area (proposed crossing entry and exit points and BH20-MOR-05) generally comprises a gravelly silty sand veneer of fluvial origins underlain by glaciolacustrine clayey silty sands. The surficial geology along the valley slopes identifies clayey silty sand, gravelly sand, and gravelly silty sand of glaciolacustrine origin. The drainage is classified as moderate to well. The base of the Morice River valley comprises level to gently sloped (0-26%) sandy gravel and gravelly sand terraces of glaciofluvial origin and fluvial gravelly silty sand plains. Drainage is classified as well to imperfect drainage.

5.0 INFERRED SUBSURFACE CONDITIONS

Detailed descriptions of the soil, bedrock and groundwater conditions encountered at the test hole locations are presented on the Record of Sonic Hole and Record of Drillhole sheets in APPENDIX A. Results of the geotechnical laboratory tests are presented in APPENDIX B.

The following sections summarize the soil and groundwater conditions encountered at the test hole locations. The interpretation presented herein is based on the stratigraphy encountered at the specific borehole locations only, augmented by interpretation of the geophysics surveying. The actual soil and groundwater conditions may vary between boreholes and is expected to vary with increasing distance away (north – south) from the investigated alignment.

In general, the inferred subsurface conditions at the site are as follows:

- Compact to very dense inferred glacial outwash deposits comprising high-energy depositional environments, sands and gravels, to low-energy depositional environments, non-plastic silt to low plasticity silty clays.
- Glaciolacustrine deposits of very stiff to hard silt to silty clay, brown to maroon in colour, varved with grey silty clay encountered at BH20-MOR-01 to BH20-MOR-03.
- Interpreted glacial till deposits comprising of hard silty clays with varying proportions of sands and gravels, with presence of cobbles and boulders to termination depth.
- Strong, massive conglomerate bedrock with discrete sandstone and mudstone facies observed at BH20-MOR-02 to BH20-MOR-06.

A visual representation of the identified subsurface soil strata and modelled resistivity and seismic sections across the proposed Morice River Crossing is presented in Figure 4 and Figure 5, respectively.

5.1 Geophysical Results

Figure 5 presents the combined results of the ERT and SRT surveys along with an interpreted bedrock interface. Electrical resistivity and seismic p-wave (primary or compressional wave) velocity variations are illustrated using colour contour maps in units of ohm-metres and metres per second, where increasing resistivity and velocity are indicated by a gradation from cool colours (blues and greens) to warm colours (yellows and reds). The sections are displayed in terms of elevations above mean sea level and horizontal distance in UTM coordinates (NAD83, Zone 10N). An inset map displays the location of the geophysical lines, the CGL centreline Rev G, and geotechnical boreholes BH20-MOR-01 to BH20-MOR-06. Simplified results of the geotechnical boreholes logs have been overlaid on the cross sections to facilitate a correlation of resistivity and seismic data to lithology.

In general, coarse-grained soil (gravel and sand) exhibits higher resistivity compared to fine-grained soil (e.g., silt and clay). Similarly, coarse-grained rock (conglomerate) exhibits higher resistivity compared to fine-grained rock (mudstone and siltstone).

The seismic velocity of a material is predominately dependent upon the density, which means loose or less consolidated materials like till and overburden have a strong velocity contrast to dense material like competent bedrock. Material interfaces are generally interpreted to occur at steep gradients of velocity increases with depth.

There is not always a detectable density contrast between materials of different compositions. Similarly, resistivity is not uniquely indicative of grain size and soil type and there are overlaps in the expected ranges of many soil and rock types. Contrasts and structures that may be apparent in seismic velocity data may not be apparent in resistivity, and vice versa. For this reason, collection and analysis of coincident ERT and SRT data provides a more complete geophysical understanding of subsurface structure than one method alone would.

On Figure 5, the resistivity profile directly beneath the Morice river and at either bank consists of very high resistivity material (150 to 1000 Ohm-m) in the upper 15 to 30 metres of the subsurface which generally thins further away from the river. This area of elevated resistivity is attributed to coarse-grained river deposited soil consisting of sand, gravel, boulders, and cobbles. Very fresh water without the presence of dissolved ions may also contribute to higher resistivity values in the river vicinity. The upper higher resistivity layer is underlain by relatively lower resistivity values which are attributed to an increased proportion of fine-grained sediments (silt, clay and some sand) at greater depths. The borehole closest to the river, BH20-MOR-03, shows a lithological correlation between the higher resistivity upper layer of sand and gravels and the lower resistivity silty clay layer beneath. The higher resistivity layer becomes thinner away from the river to the west near BH20-MOR-04 and up onto the western terrace near BH20-MOR-05 and BH20-MOR-06. To the east of the river, the higher resistivity layer varies between 10 to 20 m in thickness (e.g. near BH20-MOR-02) and is overlain by a lower resistivity layer 5 to 10 m thick on the eastern terrace near BH20-MOR-01 which is attributed to fine-grained soil.

The west side of the resistivity profile generally shows a weak correlation between resistivity values and the top of bedrock. Seismic and borehole data are used for primary guidance for the interpreted top of bedrock west of the river. Beneath the river and east of the river, there is a transition from lower to higher resistivity at depth coincident with the interpreted bedrock surface. This resistivity transition correlates with top of bedrock in BH20-MOR-02.

The velocity profile on the west side of the river contains a sharp increase in velocity with depth (2100 to 4500 m/s) that is attributed to the transition from soil to bedrock. The bedrock interpretation approximately follows the 3000m/s seismic velocity contour. This sharp increase becomes more gradational toward the Morice River as a denser, and therefore faster, intermediate overburden layer is present in the 2100 to 2800 m/s range. Seismic data on the west side of the river strongly correlate with borehole data and provide primary guidance for the top of bedrock interpretation.

The velocity profile on the east side of the river shows top of bedrock at the deepest limits of the seismic refraction survey. Higher velocity values indicative of bedrock were only detected on the farthest seismic source offsets and therefore only captured on the bottom edge of the velocity model. Overburden velocities in the range of 2100 to 2900 m/s are present between the river and east of BH20-MOR-02, which suggests very dense and compact soil. Further upslope near BH20-MOR-01 overburden velocities are generally lower suggesting less dense and less consolidated soil in this area. Borehole data east of the river indicates a mix of sand, silt, and gravels. It is likely that the variability of overburden velocity east of the river are related to consolidation of these materials and not the material type.

It is important to note that due to overlapping resistivity and seismic velocity ranges for different soil and rock types, it is not always possible to uniquely identify soil or rock type based solely on resistivity and seismic velocity information. On the west of the river seismic velocity proved to be the distinguishing material property while on the east side of the river resistivity values most strongly correlated with the bedrock interface (due in part to the depth of bedrock being near to or beyond the depth of investigation of the seismic survey). The interpreted sections should therefore be treated as an approximation subject to the limitations of geophysical methods as stated in APPENDIX E. Confidence in the interpreted bedrock surface is greatest at the borehole locations and decreases with distance from the boreholes; beyond the boreholes, a variation in the interpreted geophysical bedrock surface shown on Figure 4 and 5 of ±2 m should be assumed. Should additional verification data be made available through future work, Golder should be requested to re-evaluate the interpretations, conclusions, and recommendations of this report, and to provide amendments, as required.

5.2 Inferred Glacial Outwash Deposits - Sands and Gravels

Inferred glacial outwash deposits, generally consisting of sands and gravel with varying fines content from silty to trace non-plastic fines were encountered at boreholes BH20-MOR-01 to BH20-MOR-05 from surface (727.85 to 769.52 m geodetic) to 52.12 m depth (763.4 to 701.2 m geodetic).

Recorded uncorrected SPT blow counts ranged from 20 to above 50 blows per 300 mm. This corresponds to a compact to very dense condition, although the presence of gravel can affect the recorded blow count, rendering it unrepresentative of the matrix relative density. Twenty-nine natural water content determinations were conducted on selected samples of the inferred glacial outwash deposits and were found to range from approximately 2 and 18%, with an average natural water content of approximately 8%; however, moisture content determinations in granular soils may not be representative of insitu conditions because of drainage during sampling and transportation.

Ten particle size analyses were conducted on selected samples of the inferred glacial outwash deposits and the results are summarized in Table 4 and are presented graphically in APPENDIX B. Note that the maximum particle size determined from the laboratory tests is limited by the dimensions of the sampling equipment (127 mm in the case of sonic samples and 51 mm for SPT samples). Cobbles up to 120 mm in diameter were observed in collected drill core at boreholes BH20-MOR-01 to BH20-MOR-05. Based on drilling action, an inferred cobble and boulder zone was encountered at BH20-MOR-02 from 36.9 to 39.9 m.

Three organic content determinations were conducted on selected samples of the inferred glacial outwash deposits and were found to range from approximately 0.5 to 1.3%, with an average organic content of 0.8% of the sample’s oven dried mass. One specific gravity determination was conducted on a sample of the inferred glacial outwash deposits from BH20-MOR-02. A specific gravity of 2.73 was determined.

Table 4: Geotechnical Testing Summary – Inferred Glacial Outwash Sand and Gravel Deposits

Borehole ID	Sample No.	Depth		Natural Moisture Content (%)	Gravel %	Sand %	Fines %	Silt %	Clay %
		Top (m)	Bottom (m)						
BH20-MOR-01	16	14.33	14.48	2.6	54	31	15		
BH20-MOR-01	26	25.91	26.06	8.8	35	49	16		
BH20-MOR-01	39	53.34	53.49		31	48	21		
BH20-MOR-01	40	56.08	56.24		57	38	5		
BH20-MOR-02	8	5.64	5.79	6.7	44	54	2		
BH20-MOR-02	38	36.58	36.73	18.2	0	48	52	50	2
BH20-MOR-03	5	4.72	4.88	2.9	71	28	1		
BH20-MOR-03	19	13.87	14.02	5.7	60	36	4		
BH20-MOR-04	6	4.88	5.03	5.7	53	47	0		
BH20-MOR-05	3	2.44	2.59	10.7	27	50	23		

Two petrographic examinations of the gravel fraction from the inferred glacial outwash deposits at BH20-MOR-01 and BH20-MOR-02 were conducted in Golder's Burnaby Laboratory. A summary of the petrographic descriptions is provided in Table 5 and shown in detail in APPENDIX C.

Table 5: Petrographic Examination Results - Inferred Glacial Outwash Gravels

Borehole ID	Depth (m)	Petrographic Description (% By Mass)						
		Mafic Volcanic	Intermediate Volcanic	Felsic Porphyritic Volcanic	Plutonic Rock (medium grained)	Plutonic Rock (fine to very fine grained)	Chert/Quartzite	Sandstone
BH20-MOR-01	22.25 – 22.40	24.8	28.0	9.6	14.7	3.7	19.2	
BH20-MOR-03	4.72 – 4.88	24.0	27.7	24.7	16.8	5.3	0.8	0.7

5.3 Inferred Low Energy Glacial Outwash Deposits - Silt to Silty Clay

Intermixed with the glacial outwash sand and gravel deposits, were discrete layers of silt to silty clay. It is inferred that these deposits were a result of lower depositional energy environments such as back channels and deep pools along the glacial outwash plain. The inferred low energy glacial outwash deposits were encountered in boreholes BH20-MOR-01 to BH20-MOR-05 at depths of 3.7 to 6.7 mbgs, 3.7 to 4.0 mbgs, 15.4 to 22.3 mbgs, 7.0 to 10.4 mbgs, and 6.1 to 9.8 mbgs, respectively.

Recorded uncorrected SPT blow counts in these deposits ranged from 15 to over 50 blows per 300 mm. This corresponds to a very stiff to hard consistency. Nine natural water content determinations were conducted on selected samples of the inferred low energy glacial outwash deposits and were found to range from approximately 8 to 24%, with an average natural water content of approximately 16%.

Three Atterberg Limit determinations and one particle size analysis were conducted on selected samples of the inferred low energy glacial outwash deposits and the results are summarized in Table 6 and are presented graphically in APPENDIX B.

Two organic content determinations were conducted on selected samples of the inferred low energy glacial outwash deposits and were found to range from approximately 1.3 to 7.2%, with an average organic content of 4.3% of the sample's oven dried mass. One specific gravity determination was conducted on a sample of the inferred low energy glacial outwash deposits from BH20-MOR-05. A specific gravity of 2.73 was determined.

Table 6: Geotechnical Testing Summary – Inferred Low Energy Glacial Outwash Deposits

Borehole ID	Sample No.	Depth		Liquid Limit (LL)	Plasticity Limit (PL)	Plasticity Index (PI)	Natural Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
		Top (m)	Bottom (m)							
BH20-MOR-01	5	4.27	4.42	27	20	7	8.9			
BH20-MOR-03	8	6.55	6.71				25.6	0	0	100
BH20-MOR-03	23	17.98	18.29	NP	NP	NP	20.0			
BH20-MOR-05	11	8.53	8.69	29	13	16	10.6			

*NP – Non-Plastic Result

5.4 Inferred Glaciolacustrine Deposits – Brown to Maroon Silt to Silty Clay

Intermixed with the glacial outwash sand and gravel deposits, were discrete layers of inferred glaciolacustrine deposits characterised by distinctly brown to maroon varved silt to medium plasticity silty clay. The inferred glaciolacustrine deposits were encountered in boreholes BH20-MOR-01 to BH20-MOR-03 at depths of 31.4 to 48.8 mbgs, 8.0 to 25.3 mbgs, and 5.9 to 8.5 mbgs, respectively.

Recorded uncorrected SPT blow counts in these deposits ranged from 30 to over 50 blows per 300 mm. This corresponds to a very stiff to hard consistency. No data was recorded at BH20-MOR-01 as the inferred glaciolacustrine unit was encountered at a greater depth than the available SPT tooling stored onsite. Based on drilling observations at BH20-MOR-01, a very dense relative density was inferred. Thirteen natural water content determinations were conducted on selected samples of the inferred glaciolacustrine samples, and were found to range from approximately 21% to 27%, with an average natural moisture content of approximately 24%

Six particle size analyses and one Atterberg Limit determination were conducted on selected samples of the inferred glaciolacustrine deposits and the results are summarized in Table 7 and are presented graphically in APPENDIX B.

Two organic content determinations were conducted on samples of the inferred glaciolacustrine deposits from BH20-MOR-02. An average organic matter of 1.4% of the sample's oven dried mass was determined. One specific gravity determination was conducted on a sample of the inferred glaciolacustrine deposits from BH20-MOR-02. A specific gravity of 2.75 was determined.

Table 7: Geotechnical Testing Summary - Inferred Glaciolacustrine Deposits

Borehole ID	Sample No.	Depth		Liquid Limit (LL)	Plasticity Limit (PL)	Plasticity Index (PI)	Natural Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)	Silt (%)	Clay (%)
		Top (m)	Bottom (m)									
BH20-MOR-01	32	35.05	35.20				26.3	0	0	100	84	16
BH20-MOR-01	34	40.84	41.00				26.3	0	0	100	86	14
BH20-MOR-02	12	8.53	8.69				20.9	0	1	99	75	24
BH20-MOR-02	23	17.68	17.83				23.0	0	0	100	85	15
BH20-MOR-02	27	23.16	23.32				27.2	0	0	100	85	15
BH20-MOR-03	8	6.55	6.71	35	20	15	25.6	0	0	100	76	24

5.5 Inferred Glacial Till Deposits – Silty Clayey Sand to Silty Clay

Underlying the glacial outwash deposits and immediately overlying the bedrock, were inferred glacial till deposits characterised by broadly graded deposits comprising of silty sand, clayey sand, silt, clayey silt, and silty clay of low to medium plasticity with varying sand and gravel content. The inferred glacial till deposits were encountered in boreholes BH20-MOR-01 to BH20-MOR-06 at depths of 61.6 to 68.6 mbgs, 43.6 to 50.0 mbgs, 22.3 to 26.1 mbgs, 10.4 to 14.3 mbgs, 9.8 to 19.2 mbgs, and 0 to 1.7 mbgs, respectively.

Recorded uncorrected SPT blow counts in these deposits were above 50 blows per 300 mm. This corresponds to a hard consistency, although the presence of gravel can affect the recorded blow count, rendering it unrepresentative of the relative density. No data was recorded at BH20-MOR-01 as the inferred glacial till unit was encountered at a greater depth than the available SPT tooling stored onsite. Based on drilling observations at BH20-MOR-01, a very dense relative density was inferred. Thirteen natural water content determinations were conducted on selected samples of the inferred glacial till samples and were found to range from approximately 7 to 22%, with an average natural water content of approximately 12%.

Five particle size analyses and five Atterberg Limit determinations were conducted on selected samples of the inferred glacial till deposits and the results are summarized in Table 8 and are presented graphically in APPENDIX B. Note that the maximum particle size determined form the laboratory tests is limited by the dimensions of the sampling equipment (127 mm in the case of sonic samples and 51 mm for SPT samples).

Two organic content determinations were conducted on selected samples of the inferred glacial till deposits and were found to range from approximately 2.2 to 2.4%, with an average organic content of 2.3% of the sample's oven dried mass.

Table 8: Geotechnical Testing Summary - Inferred Glacial Till Deposits

Borehole ID	Sample No.	Depth		Liquid Limit (LL)	Plasticity Limit (PL)	Plasticity Index (PI)	Natural Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)	Silt (%)	Clay (%)
		Top (m)	Bottom (m)									
BH20-MOR-01	42	63.09	63.25				7.5	20	50	30		
BH20-MOR-02	46	48.16	48.31	41	19	22	14.9	34	20	46	26	20
BH20-MOR-03	27	23.47	23.62				15.3	27	20	53	44	9
BH20-MOR-04	13	8.53	8.69				20.1	25	53	22	16	6
BH20-MOR-04	17	12.34	12.50	33	16	17	21.7	2	46	52	33	19
BH20-MOR-05	17	12.98	13.11	25	12	13	8.7					
BH20-MOR-05	22	17.37	17.53	26	16	10	12.1					
BH20-MOR-06	1	0.61	0.76	20	16	4	17.4					

Cobbles were encountered during drilling. Although not encountered during the investigation, because of the depositional environment, the potential for boulders to be encountered within the glacial deposits should be anticipated.

5.6 Bedrock

Bedrock was encountered at boreholes BH20-MOR-02 to BH20-MOR-06 at depths of 50.0 mbgs (694.8 m geodetic), 26.1 mbgs (701.7 m geodetic), 14.3 mbgs (728.8 m geodetic), 19.2 mbgs (750.3 m geodetic), and 1.7 mbgs (776 m geodetic), respectively. The interpreted bedrock surface presented on Figure 4 and Figure 5 has been inferred based on interpolation between available borehole data and interpretation of collected geophysics data.

Detailed descriptions of the bedrock conditions encountered are presented in the record of Sonic Hole and Drill Hole sheets included in APPENDIX A. Further discussions of the bedrock conditions are discussed in the following subsections.

5.6.1 Geophysical Bedrock Interpretation

As mentioned above, confidence in the interpreted bedrock surface is greatest at the borehole locations and decreases with distance from the boreholes; beyond the boreholes, a variation in the interpreted geophysical bedrock surface shown on Figure 4 and 5 of ±2 m should be assumed. The interpreted bedrock surface on the west end of the crossing is within 1 to 3 metres below ground surface (mbgs) and begins to slope on a relatively consistent angle between BH20-MOR-06 and BH20-MOR-05, and beyond, to the west side of the river. Topographic relief between BH20-MOR-05 and BH20-MOR-04 is the primary reason that bedrock depths fluctuate between 16 and 35 mbgs, while the inferred bedrock surface slope remains fairly consistent. The bedrock surface slopes more steeply between BH20-MOR-04 and BH20-MOR-03 to a maximum inferred depth of 46 mbgs beneath the Morice River. East from the river, the bedrock depth remains between 40 and 48 mbgs until a sharp transition is identified between BH20-MOR-02 and BH20-MOR-01 where the bedrock profile has not been interpreted. It is assumed that this is the location of a steeply dipping bedrock interface where bedrock drops beyond the detectable range of the ERT and SRT datasets. It is noted that bedrock was also not encountered down to elevation 699.57 m in BH20-MOR-01.

5.6.2 Lithology

The bedrock encountered at boreholes BH20-MOR-02 to BH20-MOR-06 generally comprised fresh to weathered, medium strong to very strong conglomerate to coarse conglomeratic sandstone ranging from grey to green grey in colour with volcanic clasts. Sandstone was encountered below the inferred glacial till at BH20-MOR-02 and fresh to highly weathered claystone was encountered at BH20-MOR-03. Some red-grey staining of the conglomerate bedrock was observed at BH20-MOR-02 and BH20-MOR-04 at depths of 83.41 and 69.72 mbgs, respectively.

Petrographic examination conducted on two HQ core samples from boreholes BH20-MOR-04 and BH20-MOR-03 defined the rock as conglomerate and conglomeratic sandstone, respectively. The sandstone is defined as coarse grained with some coarse conglomeratic clasts with pebbles up to about 12 mm in diameter in a siliceous cement/matrix. Clasts are primarily composed of slightly to significantly altered volcanic rock. While pebbles in the coarse-grained conglomerate, in BH20-MOR-03, are primarily composed of slightly to significantly altered volcanic rocks up to 55 mm in diameter. The conglomerate bedrock is also composed of well-rounded gravel particles and sand-sized grains in a siliceous cement/matrix. Mohs hardness for both HQ core samples is estimated to be between 5.5 to 6.0.

5.6.3 Rock Quality Designation (RQD)

Rock quality designation (RQD) of the conglomerate and sandstone units ranged from 0 – 100%. Excluding heavily broken core zones where calculated RQD is less than 25%, the RQD for the conglomerate averaged 94.5%, respectively. Heavily broken core zones, where calculated RQD was less than 25%, were observed at the following depth ranges:

- BH20-MOR-02: from 52.4 to 53.92 mbgs (16% RQD), from 53.92 to 55.44 mbgs (13% RQD), and from 55.44 to 56.96 mbgs (0% RQD)
- BH20-MOR-03: from 33.83 to 35.05 mbgs (0% RQD)

It should be noted that the drilling subcontractor noted water circulation was lost to formation at 25.6 and 56.7 mbgs at BH20-MOR-04. This is likely a result of highly fractured bedrock zones not captured in collected drill core records.

Detailed descriptions of the collected RQD results are presented in the Record of Drill Hole sheets in APPENDIX B.

5.6.4 Rock Strength

Rock strengths were estimated in the Golder Burnaby Laboratory by UCS testing of collected rock core and in the Golder Terrace Laboratory by geotechnical examination and limited Point Load Test (PLT) testing of the collected rock core.

The unconfined compressive strength tests conducted on conglomerate samples yielded unconfined compressive strengths between 28.1 to 75.6 MPa. This corresponds to medium to strong rock designation. UCS test results are summarized in Table 9 and presented in detail in APPENDIX C.

Table 9: Geotechnical Testing Summary - Unconfined Compressive Strength

Borehole ID	Depth (m)	Stress (MPa)	Lithology
BH20-MOR-02	60.82 – 61.08	28.1	Conglomerate
BH20-MOR-02	36.57 – 36.85	75.6	Conglomerate
BH20-MOR-04	20.63 – 20.75	49.8[*1]	Conglomerate
BH20-MOR-05	30.96 – 31.14	N/A[*2]	Conglomerate
BH20-MOR-05	33.37 – 33.63	39.7	Conglomerate

[*1]Does not conform to ASTM length:diameter ratios as per Section 3.3.3

[*2]Sample broke during sample preparation.

Point load testing was completed to help evaluate rock strength indices within the collected rock core samples. Axial and diametral tests were attempted at specified depths along the collected rock core. Point Load Strength Index values (Is_{50}) were calculated in accordance with ASTM specification D5731 and are summarized in Table 10.

Several invalid test results were observed and excluded subsequently from the average results provided. It should be noted that PLT data is generally variable in nature and requires a large data set or correlated UCS rock samples to provide confidence in the PLT values. Detailed laboratory tests results are presented in APPENDIX C.

Table 10: Geotechnical Testing Summary – Point Load Index (Is_{50})

Lithology	Test	$Is_{(50)}$ Range (MPa)	Mean $Is_{(50)}$ (MPa)	Number of Tests	Standard Deviation
Conglomerate	Axial	0.14 – 6.94	2.19	73	1.3
	Diametral	0.16 – 6.42	2.49	76	1.54
Sandstone	Axial	0.87 – 2.35	1.62	3	1.04
	Diametral	0.66 – 2.57	1.56	4	0.94

5.6.5 Rock Abrasivity

Cerchar Abrasivity test results were cross-referenced against the Cerchar Abrasiveness Index described in Table 2 and the test results are summarized in Table 11. Cerchar abrasiveness testing resulted in a classification of low to medium abrasiveness and a CAI between 0.69 to 1.21. Detailed laboratory test results are presented in APPENDIX C.

Table 11: Geotechnical Testing Summary - Cerchar Abrasivity

Borehole ID	Depth (m)	Lithology	CAI_s (smooth cut surface)	CAI (natural surface)	Abrasiveness Classification
BH20-MOR-02	60.82 – 61.08	Conglomerate	0.31	0.79	Low abrasiveness
BH20-MOR-02	67.86 – 68.10	Conglomerate	0.21	0.69	Low Abrasiveness
BH20-MOR-02	80.16 – 80.40	Conglomerate	0.24	0.72	Low Abrasiveness
BH20-MOR-03	36.57 – 36.85	Conglomerate	0.62	1.09	Medium Abrasiveness
BH20-MOR-05	33.37 – 33.63	Conglomerate	0.74	1.31	Medium Abrasiveness
BH20-MOR-05	55.94 – 56.12	Sandstone	0.57	1.04	Medium Abrasiveness

5.6.6 Rock Dry Density

Select rock core samples from boreholes BH20-MOR-05 and BH20-MOR-06 were analyzed to determine sample dry density. Dry densities of 1976, 2067, and 1998 kg/m^3 were identified for conglomerate, sandstone, and mudstone samples, respectively.

5.6.7 Acid Rock Drainage and Metal Leaching Geochemical Testing

5.6.7.1 Acid Rock Drainage (ARD) Potential

The results of the acid base accounting (ABA) testing are presented in Table 1 in APPENDIX F and in the attached certificate of analysis (COA) in APPENDIX F.

Paste pHs of the samples ranged from 8.8 to 9.05, indicating alkaline initial conditions in the crushed rock samples.

Assessment of the ARD potential of the five samples based on both the bulk NPR and caNPR resulted in classification of the samples as *not potentially acidic drainage generating* (non-PAG). The ABA results indicated the sulphide sulphur concentrations were at or below the laboratory reporting limit of 0.01% for all five samples tested. The very low sulphide sulphur concentrations corroborate the non-PAG classification of the samples based on NPR.

A summary of the results is presented in Table 12.

Table 12: Summary of Acid Base Accounting Results

Location	Paste pH	Total Inorganic Carbon	Total Sulphur	Sulphide Sulphur	AP	Modified NP	Carbonate NP
Unit	-	%	%	%	*Equivalent kg $CaCO_3$/tonne*		
Location		*Min – Max (Average)*					
BH20-MOR-03 / 05	8.8 – 9.09 (8.96)	0.01 – 0.12 (0.06)	0.008 – 0.024 (0.0128)	<0.01 – 0.01 (0.01)	<0.3	13 – 28.6 (19.48)	0.8 – 10 (5)

5.6.7.2 Metal Leaching (ML) Potential

Total Metals

The results of the total metals analyses are presented in Table 2 in APPENDIX F and the attached certificate of analysis (COA) in APPENDIX F.

Total metal concentrations measured in the rock core samples were compared with the “normal trace element concentrations” of Price (1997), with a focus on metals of typical environmental concern such as arsenic, cadmium and copper.

Trace element concentrations in the samples were generally within the range of “normal” concentrations for basaltic rock. Only bismuth exceeded 5x normal concentrations outlined in Price (1997) in all samples. Bismuth exceeded the 10x normal concentration in only one sample. .

Shake Flask Extraction

The results of the SFE testing are provided in Table 3 in APPENDIX F and the attached certificate of analysis (COA) in APPENDIX F.

SFE testing provided concentrations of chemical parameters in leachates generated by contact between the rock sample and de-ionized water. The SFE results were compared to current approved and working British Columbia Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life. This comparison is conducted to identify potential geochemical parameters of concern present in the rock that may have the potential to affect contact water quality. The chemistry of the SFE leachates is not considered to be a simulation of actual anticipated surface water or groundwater quality resulting from contact between broken or crushed rock and site drainage. Actual water quality will depend on several factors including rock compositional variation, site hydrology, and rates of geochemical reactions.

Aluminum, cadmium, copper, iron, mercury and selenium were the sole parameters analyzed in the SFE leachates that were observed to exceed applicable water quality guidelines.

- Aluminum concentrations in SFE leachates ranged between 0.195 mg/L to 1.18 mg/L and exceeded the applicable WQG of 0.05 mg/L in all samples.
- Cadmium concentrations in SFE leachates ranged from 0.000003 mg/L to 0.000024 mg/L, with one sample exceeding the applicable WQG, which is a calculated guideline based on hardness.
- Copper concentrations in SFE leachates were observed to exceed the applicable WQG of 0.002 mg/L in one sample. Concentrations of copper ranged between <0.0002 mg/L to 0.0021 mg/L. One sample exceeded the 0.002 mg/L WQG.
- Iron concentrations in SFE leachates were observed to exceed the applicable WQG of 0.35 mg/L in one sample. Concentrations of iron ranged between 0.052 mg/L to 0.354 mg/L
- Mercury concentrations in SFE leachates were reported at 0.02 mg/L in two samples. It should be noted that mercury concentrations in all samples were at the laboratory method detection limit. In the analyses, the detection limit for mercury was higher than the applicable water quality guideline. Further, the applicable WQG guideline for mercury was developed to assess the methyl mercury component. Analysis of methyl mercury was not carried out on the SFE leachates, therefore, it was not possible to assess potential exceedances of the WQG guideline for mercury.
- Selenium concentrations in SFE leachates were observed to exceed the applicable WQG of 0.002 mg/L in one sample. Selenium concentrations ranged between 0.00017 mg/L to 0.003 mg/L.

No exceedances of applicable guidelines were identified for the other parameters included in the leachate analyses.

5.7 Groundwater Conditions

It was not feasible to record groundwater or seepage during drilling; however, the natural moisture content measurements on samples in the laboratory suggest that the fine-grained deposits likely are saturated. Moisture content determinations of samples of the cleaner granular soils are unreliable, and could reflect water injected as part of the drilling process. Seasonal fluctuations in groundwater levels should be expected in response to sustained periods of seasonal wet weather, snow melt, or other weather events. Perched water should be anticipated above the fine-grained deposits, and artesian conditions are possible within confined granular deposits at depth, although no evidence of this was observed during drilling.

5.7.1 Bathymetric Survey

A river-bottom bathymetric survey was conducted along the survey lines shown on the site plan (Figure 2). Data was collected at half-second intervals and smoothed during post-processing to remove any outliers. Strong river currents limited accessibility on the river to the lines shown. Bathymetry results were paired with overlapping and surrounding LiDAR data from the island in the middle of the river and the riverbanks to produce a single contoured dataset of the river bottom elevation. This contoured surface is presented in Figure 6 and includes an elevation profile extracted along the proposed Rev G centreline.

6.0 CLOSURE

We trust the foregoing is sufficient for your preliminary design requirements and look forward to receiving comments and refining the above geotechnical comments and recommendations as design progresses.

Should you have any questions or require clarification on the contents of this report, please contact the undersigned.

Golder Associates Ltd.

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Geochemist

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Principal, Senior Engineering Geologist

https://golderassociates.sharepoint.com/sites/108860/project files/5 technical work/7000 - morice river crossing/geotech/reporting/rev 1/submit/cgl4703-galv-gt-rp-0035 morice river crossing_rev 1.docx

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FIGURES

LEGEND

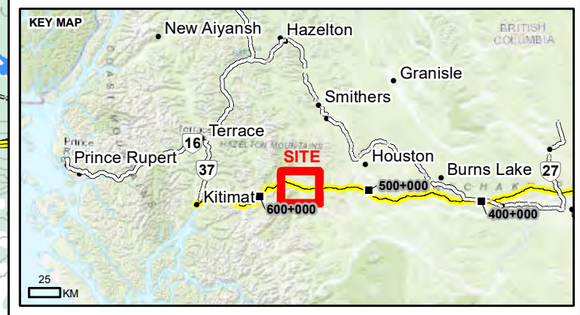
- SITE (MORICE RIVER CROSSING)

CGL PROJECT COMPONENT

- KILOMETRE POST (KP, REV G)
- PIPELINE CENTRELINE (REV G)
- ROAD (CS7 REV3)
- PROJECT FOOTPRINT (CS7 REV3)

BASE MAP FEATURE

- CONTOUR (m)
- WATERCOURSE
- WATERBODY
- WOODED AREA
- PARK / PROTECTED AREA



2 0 2

1:100,000 KILOMETRE

REFERENCE(S)

1. PROPOSED PROJECT FEATURES (CS7 REV3) AND CENTRELINE (REV G) PROVIDED BY CLIENT.
2. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE – BRITISH COLUMBIA

COORDINATE SYSTEM: NAD 1983 BC ENVIRONMENT ALBERS

CLIENT
COASTAL GASLINK

Coastal GasLink

PROJECT
MORICE RIVER CROSSING
GEOTECHNICAL AND GEOPHYSICAL INVESTIGATION

TITLE
KEY PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2021-04-29
DESIGNED	FC
PREPARED	JG
REVIEWED	AH
APPROVED	TF

PROJECT NO.	CONTROL	REV.	FIGURE
19122805	7000	1	1

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LEGEND

- BOREHOLE LOCATION

GEOPHYSICAL FIELD INVESTIGATION

- ERI SURVEY LINE
- SEISMIC SURVEY LINE
- SINGLE-BEAM BATHYMETRIC SURVEY

CGL PROJECT COMPONENT

- KILOMETRE POST (KP, REV G)
- PIPELINE CENTRELINE (REV G)
- ROAD (CS7 REV3)
- PROJECT FOOTPRINT (CS7 REV3)

BASE MAP FEATURE

- CONTOUR (m)
- UNPAVED ROAD
- WATERCOURSE
- WATERBODY

0 125 250

1:6,000 METRES

NOTE(S)

1. THE LOCATION OF BH20-MOR-03* IS APPROXIMATE.

REFERENCE(S)

1. PROPOSED PROJECT FEATURES (CS7 REV3) AND CENTRELINE (REV G) PROVIDED BY CLIENT.
2. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE – BRITISH COLUMBIA.

COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 9N

CLIENT
COASTAL GASLINK

Coastal GasLink

PROJECT
MORICE RIVER CROSSING
GEOTECHNICAL AND GEOPHYSICAL INVESTIGATION

TITLE
SITE PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2021-04-29
DESIGNED	FC
PREPARED	JG
REVIEWED	AH
APPROVED	TF

PROJECT NO.	CONTROL	REV.	FIGURE
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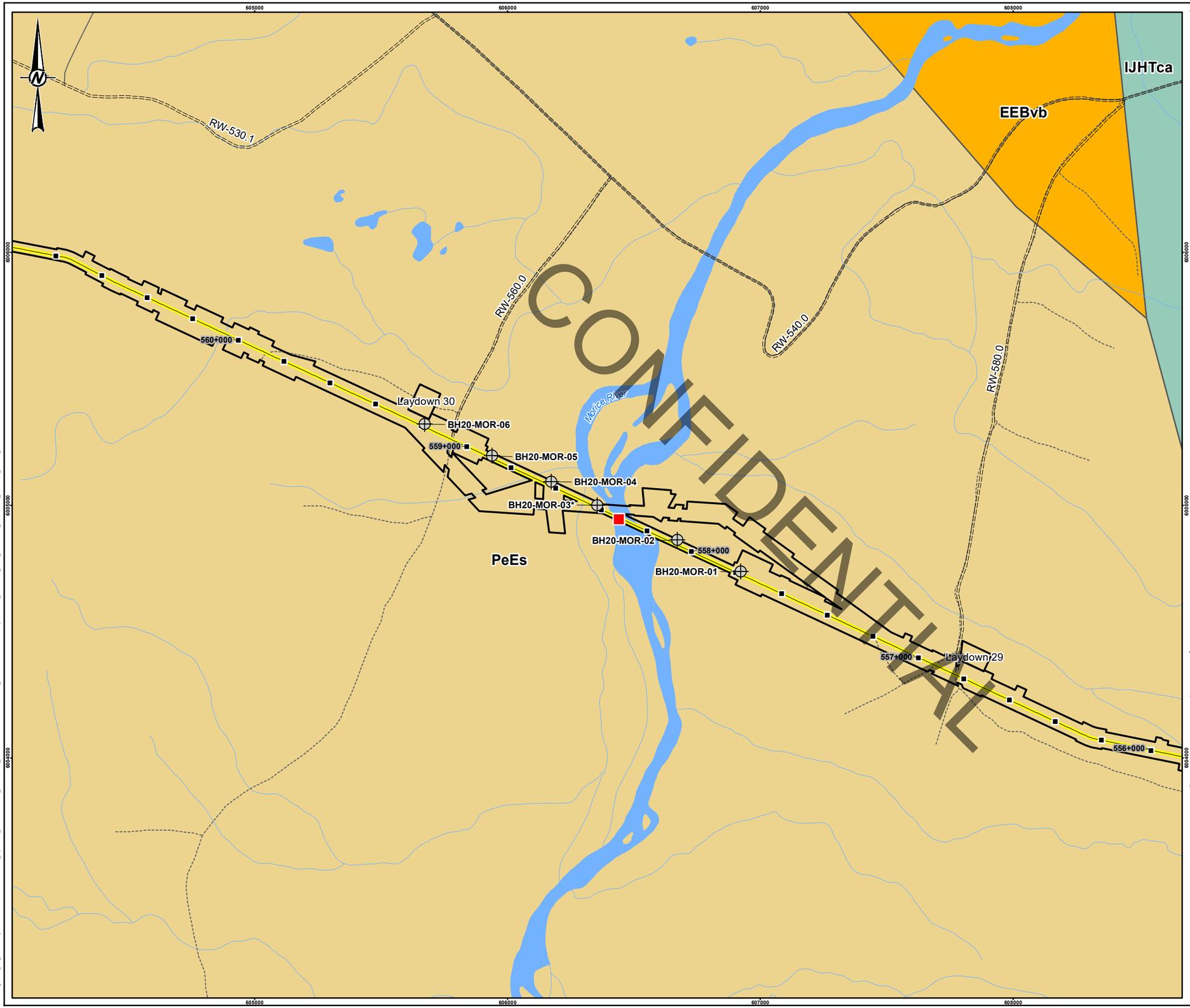

LEGEND

- SITE (MORICE RIVER CROSSING)
- BOREHOLE LOCATION

BEDROCK GEOLOGY

- EEBvb — *(PALEOGENE) - ENDAKO GROUP - BUCK CREEK FORMATION - PREDOMINANTLY APHANITIC ANDESITE AND BASALT FLOWS WITH MINOR DACITE; MAY BE CORRELATABLE WITH PARTS OF THE ENDAKO GROUP*
- PeEs — *(PALEOGENE) - SANDSTONE, SILTSTONE, CONGLOMERATE, SHALE, COALY SHALE, COAL, INTERBEDDED TUFF, TUFFACEOUS SILTSTONE AND FANGLOMERATE, CONTINENTAL, FLUVIAL ORIGIN*
- IJHTca — *(JURASSIC) - HAZELTON GROUP - TELKWA FORMATION - MAROON, GREEN, AND PURPLE SUBAERIAL ANDESITIC TO DACITIC FELDSPAR PHYRIC FLOWS, PYROCLASTIC AND EPICLASTIC ROCKS, AUGITE PHYRIC TO APHYRIC BASALT, BRECCIA, WELDED TUFF*

CGL PROJECT COMPONENT

- KILOMETRE POST (KP, REV G)
- PIPELINE CENTRELINE (REV G)
- ROAD (CS7 REV3)
- PROJECT FOOTPRINT (CS7 REV3)

BASE MAP FEATURE

- WATERCOURSE
- ROAD
- UNPAVED ROAD
- WATERBODY

0 250 500
1:15,000 METRES

NOTE(S)

1. THE LOCATION OF BH20-MOR-03* IS APPROXIMATE.

REFERENCE(S)

1. PROPOSED PROJECT FEATURES (CS7 REV1) AND CENTRELINE (REV G) PROVIDED BY CLIENT.
2. TRANSPORTATION FEATURES, WATER FEATURES AND GEOLOGY CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE – BRITISH COLUMBIA GEOLOGY - CUI, Y., MILLER, D., SCHIARIZZA, P., AND DIAKOW, L.J., 2017. BRITISH COLUMBIA DIGITAL GEOLOGY. BRITISH COLUMBIA MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES, BRITISH COLUMBIA GEOLOGICAL SURVEY OPEN FILE 2017-8, 9P. DATA VERSION 2019-12-19.
COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 9N

CLIENT
COASTAL GASLINK

Coastal GasLink

PROJECT
MORICE RIVER CROSSING
GEOTECHNICAL AND GEOPHYSICAL INVESTIGATION

TITLE
BEDROCK GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2021-04-29
DESIGNED	AH
PREPARED	JG
REVIEWED	AH
APPROVED	TF

PROJECT NO.		REV.	FIGURE
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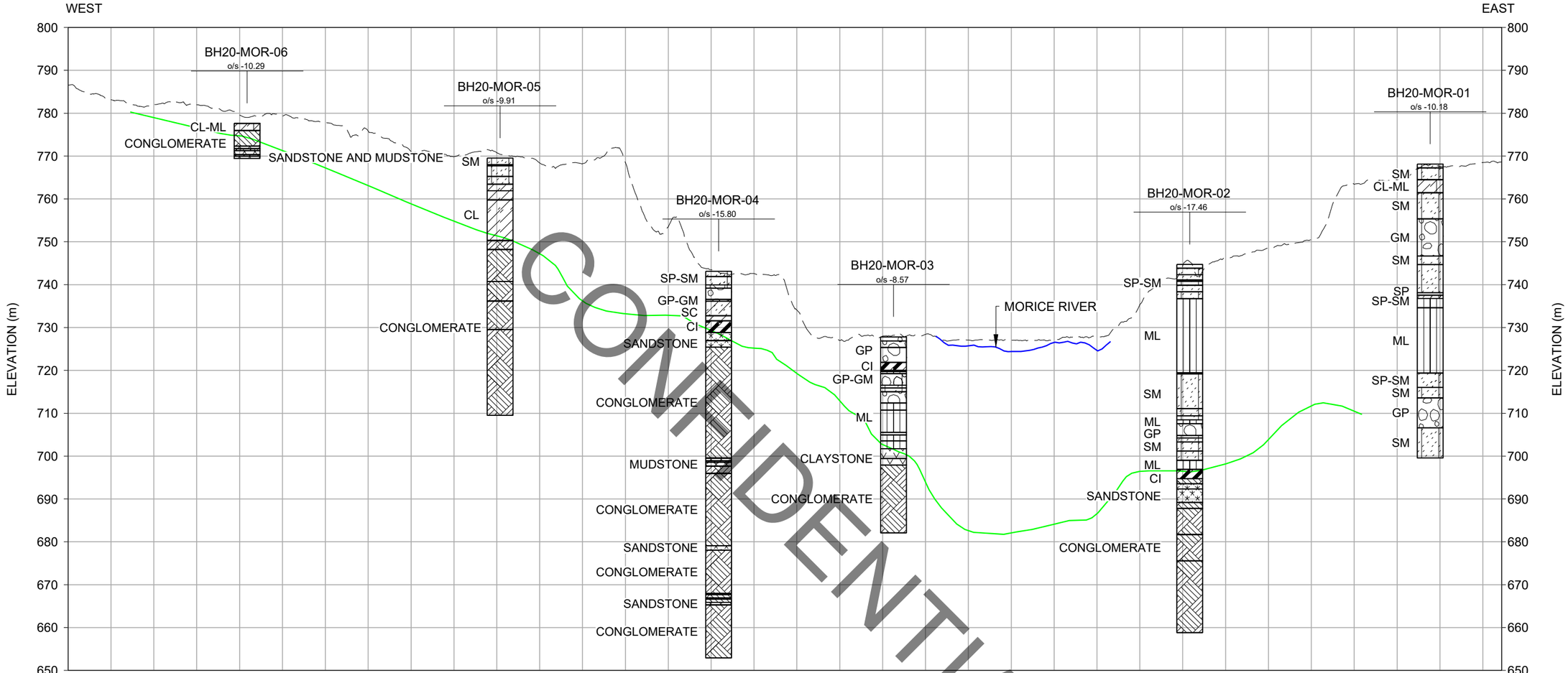

LEGEND

- INTERPRETED BEDROCK PROFILE FROM GEOPHYSICS
- GROUND SURFACE PROFILE
- GEOPHYSICS BATHYMETRY INTERPRETATION

TEST HOLE RECORD SHOWING SOIL CONDITIONS
(FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

BH20-MOR-05 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER
o/s +13.43 — DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO PIPELINE CENTERLINE SECTION IN METRES

SOIL LITHOLOGY

- FILL
- CI - SILTY CLAY
- CL - SILTY CLAY
- ML - CLAYEY SILT OR SILT
- SW - WELL GRADED SAND
- SM - SILTY SAND
- SP - POORLY GRADED SAND
- GC - CLAYEY GRAVEL
- MUDSTONE
- CONGLOMERATE
- SANDSTONE

* VARIOUS COMBINATIONS OF THE ABOVE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE STATED.
2. HORIZONTAL STATIONING REFERS TO CGL CHAINAGE.

REFERENCES

1. LiDAR DATA OBTAINED FROM CGL, RECEIVED 10 NOVEMBER 2020.

0 25 50
1:1,000 VERTICAL METRES

0 100 200
1:5,000 HORIZONTAL METRES

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-04-29
DESIGNED	A. HOLDIJK
PREPARED	J. FARAH/A. FARLOW
REVIEWED	A. HOLDIJK
APPROVED	T. FITZELL

PROJECT
MORICE RIVER CROSSING
GEOTECHNICAL INVESTIGATION

TITLE
MORICE RIVER CROSS-SECTION

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19122805	7000/7000	1	4

Request 1 OGC2021-011
Page 40

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

25 mm

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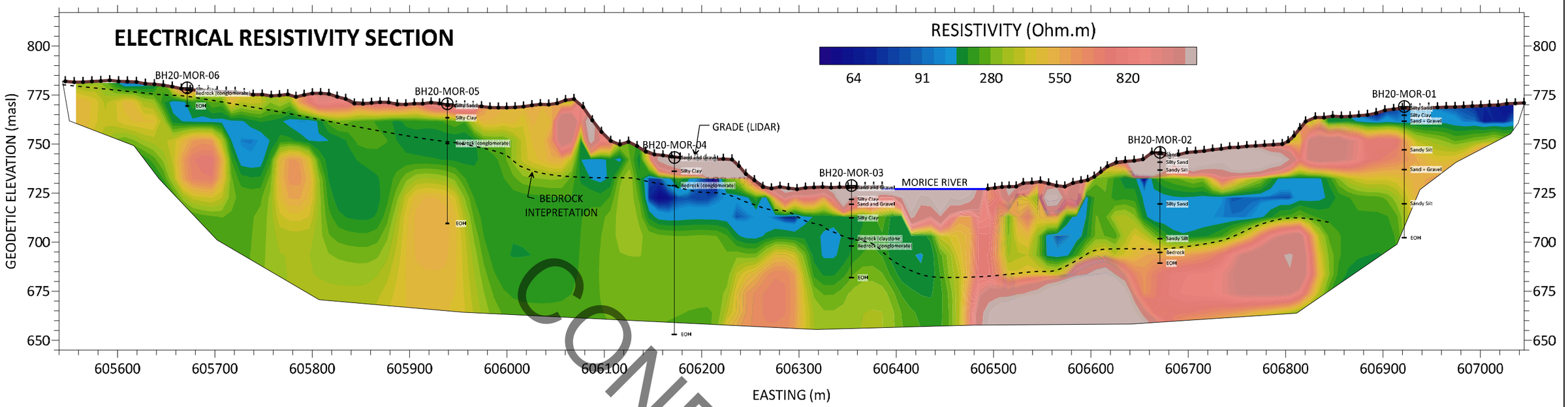
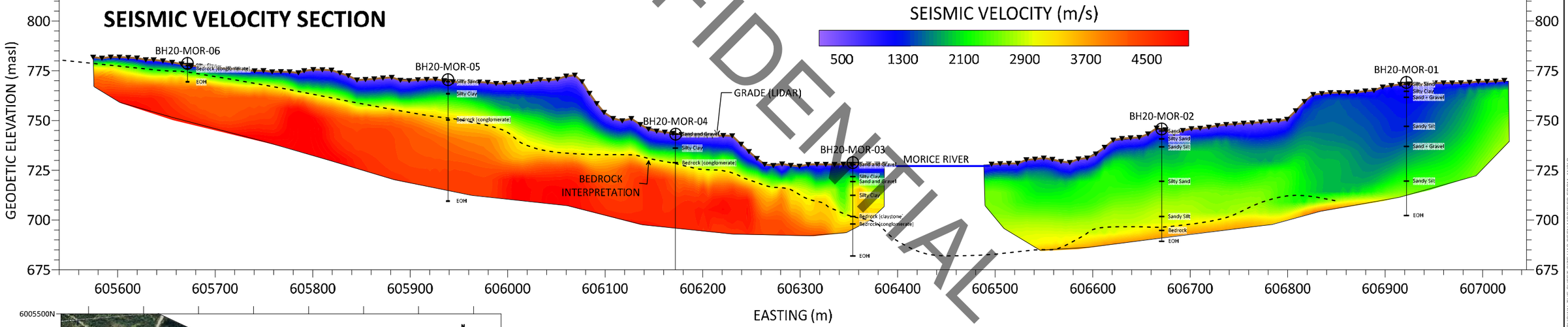
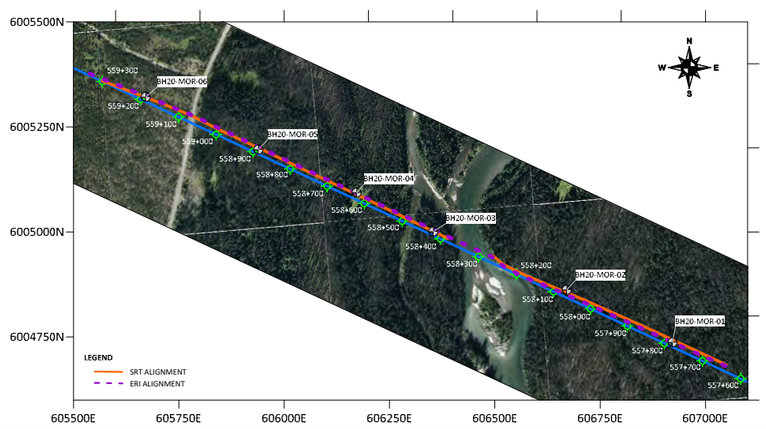
ELECTRICAL RESISTIVITY SECTION



SEISMIC VELOCITY SECTION





LEGEND

▼ GEOPHONE OR ELECTRODE LOCATION

NOTES:
1. ALL COORDINATES SHOWN IN NAD83 UTM ZONE 09N. ALL ELEVATIONS DISPLAYED IN GEODETIC ELEVATION FROM LIDAR DATA.
2. CROSS SECTION VERTICAL EXAGGERATION 2:1.
3. CROSS SECTION HORIZONTAL AXIS DISPLAYED IN PROJECTED EASTING VALUES AND NOT REPRESENTATIVE OF TRUE HORIZONTAL DISTANCES.
4. BEDROCK PROFILE IS A COMBINED INTERPRETATION OF SEISMIC AND ELECTRICAL SUBSURFACE CONTRASTS, CALIBRATED BY GEOTECHNICAL BOREHOLE INFORMATION.
5. ANY GEOTECHNICAL BOREHOLE INFORMATION PRESENTED IS A SUMMARY ONLY AND SHOULD NOT BE USED IN PLACE OF THE BOREHOLE LOGS PROVIDED IN THE REPORT.

PROJECT
MORICE RIVER CROSSING
GEOPHYSICAL INVESTIGATION

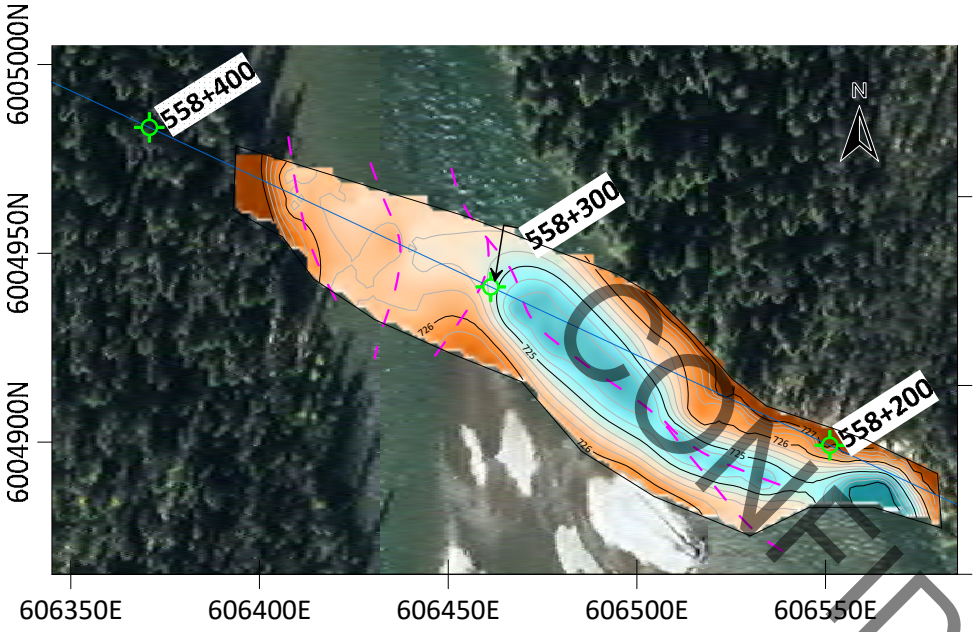
CLIENT
COASTAL GASLINK

TITLE
Modelled Resistivity and Seismic Sections

CONSULTANT
GOLDER

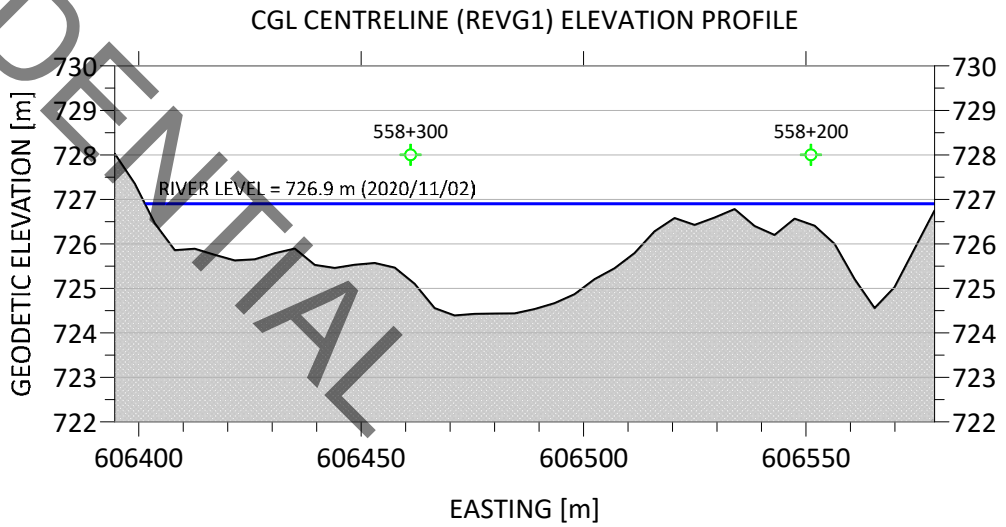
YYYY-MM-DD	2021-04-29
PREPARED	GJ
DESIGN	GJ
REVIEW	SM
APPROVED	SM

PROJECT No. 19122805-7000
Rev.
FIG. 5



RIVER BOTTOM GEODETIC ELEVATION (m)

724 725 726 727



NOTES:
1. SURVEY COVERAGE LIMITED DUE TO STRONG RIVER CURRENT AT TIME OF SURVEY. THIS DATASET IS SUBJECT TO INACCURACIES CAUSED BY INTERPOLATED DEPTHS IN AREAS OF SPARSE OR NO COVERAGE.
2. MAJOR RIVER BOTTOM CONTOURS EVERY 1 m. MINOR CONTOURS EVERY 0.25 m

MAP LEGEND

- CGL CENTRELINE REVG1
- SINGLE BEAM COVERAGE
- KP SLACKS REVG1

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-24
PREPARED	GJ
DESIGN	GJ
REVIEW	SM
APPROVED	SM

PROJECT
MORICE RIVER CROSSING
GEOPHYSICAL INVESTIGATION

TITLE
MORICE RIVER BATHYMETRY

PROJECT No.	PHASE	Rev.	FIG.
19122805	7000	1	6

ATTACHMENT

Important Information and Limitations of this Report

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This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. The validity of the report may be impacted by any change of site conditions, purpose, or development plans with the passage of time.

When applicable Golder will re-validate the information in the report by proposing a suitable method of validation that may include any or all of the following: 1) review of current site photos and other documentation, 2) engagement with Client team, 3) site visit, and 4) confirmation that the potential use of the report and its data is compatible with the scope and purpose of the investigation. Commencement of the validation proposal shall not proceed without written approval of Client.

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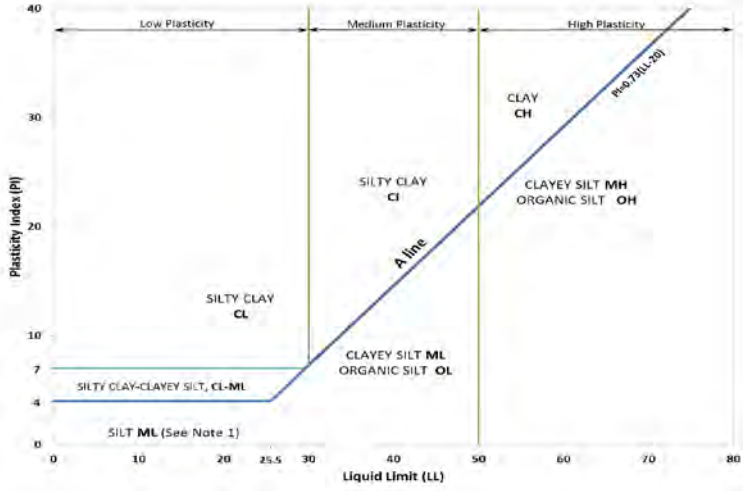
APPENDIX A

Record of Borehole Sheets

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 indicate a range of similar soil types within a stratum.

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)
> 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
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab 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 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 terms are based on SPT-'N' ranges as provided in Terzaghi, Peck and Mesri (1996) and correspond to typical average N_{60} values. Many factors affect the recorded SPT-'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), groundwater conditions, and grainsize. As such, the recorded SPT-'N' value(s) should be considered only an approximate guide to the compactness term. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

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'[1,2] (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.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

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.

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
$\sigma_1, \sigma_2, \sigma_3$	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

DESCRIPTION OF WEATHERED STATE

Term	Symbol	Description	Discoloration Extent	Fracture Condition	Surface Character
Unweathered	W1	No visible sign of rock material weathering.	None	Closed or Discolored	Unchanged
Slightly Weathered or Altered	W2	Discoloration indicates weathering of rock material on discontinuity surfaces. Less than 5% of rock mass altered.	<20% of fracture spacing on both sides of fracture	Discolored, may contain thin filling	Partial discoloration
Moderately Weathered or Altered	W3	Less than 50% of the rock material is decomposed and/or disintegrated to a soil or altered. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	>20% of fracture spacing on both sides of fracture	Discolored, may contain thick filling	Partial to complete discoloration, not friable except poorly cemented rocks
Highly Weathered or Altered	W4	More than 50% of the rock material is decomposed and/or disintegrated to a soil or is altered. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	Throughout	Filled with alteration minerals	Friable and possibly pitted
Completely Weathered or Altered	W5	100% of rock material is decomposed and/or disintegrated to soil or 100% of minerals have been replaced with alteration minerals. The original mass structure is still largely intact.	Throughout	Filled with alteration minerals	Resembles soil, or all original minerals have been replaced with alteration minerals
Residual Soil (applies to weathering only)	W6	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	Throughout	N/A	Resembles soil

Reference: Modified after Brown, 1981, "Rock Characterization Testing and Monitoring: ISRM Suggested Methods", International Society for Rock Mechanics

DESCRIPTION OF GRAIN/CRYSTAL SIZE

Grain Size	Terminology
> 60 mm	Very Coarse
2 – 60 mm	Coarse
0.06 – 2 mm	Medium
0.002 – 0.06 mm	Fine

DESCRIPTION OF ROCK STRENGTH

Grade	Description	Field Identification	Approx. Range of Uniaxial Compressive Strength (MPa)
G	Granular Soil	Cohesionless, friable, granular soil, sand.	0
S1	Very Soft Clay	Easily penetrated several centimetres by fist.	<0.025
S2	Soft Clay	Easily penetrated several centimetres by thumb.	0.025 – 0.05
S3	Firm Clay	Can be penetrated several centimetres with thumb with moderate effort. Crumbles under light pressure from a nail.	0.05 – 0.1 (<1.0 on Pocket Penetrometer)
S4	Stiff Clay	Readily indented by thumb, but penetrated only with great effort. Crumbles under moderate pressure from a nail.	0.10 – 0.25 (1.0 to 2.5 on Pocket Penetrometer)
S5	Very Stiff Clay	Readily indented by thumbnail	0.25 - 0.50
S6	Hard Clay	Indented with difficulty by thumbnail.	>0.50
R0	Extremely weak	Indented by thumbnail.	0.25 – 1.0 (>2.5 on Pocket Penetrometer)
R1	Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	1.0 - 5.0 (Maximum reading exceeded for Pocket Penetrometer)
R2	Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	5.0 – 25
R3	Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	25 – 50
R4	Strong	Specimen requires more than one blow of geological hammer to fracture it.	50 – 100
R5	Very strong	Specimen requires many blows of geological hammer to fracture it.	100 – 250
R6	Extremely strong	Specimen can only be chipped with geological hammer.	>250

Reference: Brown, 1981, "Rock Characterization Testing and Monitoring: ISRM Suggested Methods", International Society for Rock Mechanics

NOTE: *Materials having a uniaxial compressive strength of less than about 0.5 MPa and cohesionless materials should be classified using soil classification systems. (1 MPa = 145 psi)*

ADDITIONAL REMARKS AND MODIFIERS

Vein: A feature infilled with crystallized minerals. Open veins are described separately on the discontinuity log.

Sulphide mineralization: The presence of sulphide minerals, possibly including but not limited to pyrite, chalcopyrite and arsenopyrite.

OTHER ROCK LOG DEFINITIONS

Total Core Recovery (TCR): Records the total cumulative length of all core recovered in the core barrel and expressed as a percentage of the total length drilled.

Rock Quality Designation (RQD): The total cumulative length of sound core recovered in lengths greater than 10 cm, as measured along the centreline axis of the core between natural discontinuities, and expressed as a percentage per defined interval e.g. the total length of core run. The 10 cm index length is independent of core size, and is applicable to BQ, NQ, HQ, PQ, 4-inch, and 6-inch core sizes.

Alpha Angle: The maximum angle of dip measured between the discontinuity plane and the core axis (0° = parallel to core axis; 90° = perpendicular to core axis).

Broken Core: Broken core zones are characterized by core pieces that do not form full circumferential segments. Broken core generally consists of angular fragments and generally has the same intact rock strength as the surrounding core. Where core is broken in such a way that discontinuities cannot be recorded, an average estimate of the fragment size (the median dimension) should be recorded to allow for an estimated fracture count. The top and bottom depths of the broken core interval should be recorded on the field log.

Fault Zones: Faults are a fracture or zone along which there has been recognizable displacement. The walls may be polished or slickensided as a result of the shear displacement. Rock on either side of the fault may be shattered, broken, altered or weathered, resulting in fillings such as clay, silt, crushed/pulverized rock (breccia) and/or powder (gouge). In drill core, fault zones often have less than 100% recovery. The top and bottom depths of the fault or fault zone interval should be recorded on the field log.

Lost Core: Lost core can occur in zones of unconsolidated material, highly broken zones, fault zones, and zones where the core has been mechanically degraded from the drilling process or due to a drilling error. Zones of lost core may also occur due to natural voids in the subsurface. The top and bottom depths of the lost core interval should be recorded on the field log.

Geotechnical Interval: A geotechnical interval is a portion of core that has similar geotechnical properties. Geotechnical intervals are chosen based on lithology, strength index, weathering index, alteration index, or RQD. The RQD should be recorded for each geotechnical interval. On this project, the minimum length for a geotechnical interval is 15 cm.

ABBREVIATIONS FOR THE DESCRIPTION OF DISCONTINUITIES:

Type:		**Roughness:**	
BC	Broken Core	JN	Joint
FLT	Fault	VN	Vein (Open)
U	Undulating	SM	Smooth
ST	Stepped	Ro	Rough
IR	Irregular	VR	Very Rough

Infill Character:		
-: Clean	SA: Slightly Altered	CC: Continuously Coated (< 1 mm thickness)
ST: Staining Only	DC: Discontinuously Coated (≤ 2 mm thickness)	IN: Infilled (> 1 mm thickness)

Infilling / Coating Type:			
Br: Broken rock	Ca: Calcite	Ch: Chlorite	Cl: Clay
- : Clean	Fe: Iron	M: Silt	Su: Sulphide
Qz: Quartz			

DESCRIPTION OF DISCONTINUITIES:

Feature Type: Geological description of prominent and distinct discontinuities within the rock, indicating whether the discontinuity is a joint, shear, fault, vein, bedding, contact or foliation.

Shape: Planarity (or shape) of the discontinuity surface at the scale of the cored rock.

Roughness: Small scale roughness or “feel” of the discontinuity surface at the scale of the cored rock.

Infill Character and Type: Thickness, extent, and mineral or soil composition of the stain, alteration, discontinuous or complete coating or infilling.

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 1 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DATUM: Geodetic

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		768.15													
0	Hand Excavation	**(SM)** SAND and SILT, fine to coarse sand, some fine to coarse sub-rounded gravel; orange brown, with organics (rootlets); moist, inferred loose.		0.00	1	GS		1									
				767.24													
1		**(SM)** gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown; moist, very dense.		0.91													
2					2	SS	>50	2									
					3	GS											
3					4	SS	50										
				764.49				3									
4	Boart Longyear LS 250 Sonic (Casing:171 mm;)	**(CL-ML)** gravelly SILTY CLAY to CLAYEY SILT, fine to coarse sub-rounded to sub-angular gravel, some fine to medium sand; grey, with cobbles; w<PL, hard.		3.66	5	GS											
5					6	SS	>50	4									Grout
6					7	SS	>50										
				761.44				5									
7		**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, some plastic fines; maroon brown, with cobbles; moist, very dense.		6.71	8	GS											
8					9	SS	>50	6									
9								7									
					10	SS	>50										
10								8									

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

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

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

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DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■)	WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10			**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, some plastic fines; maroon brown, with cobbles; moist, very dense. *(continued)*			11	GS		8										
						12	SS	>50											
11									9										
12						13	SS	>50											
					755.35 12.80														
13			**(GM)** sandy SILTY GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey brown; moist, very dense.			14	GS		10										
						15	SS	>50											
14						16	GS		11		54	31	15	11	4				
15	Boart Longyear LS 250	Sonic (Casing:171 mm.)																	Grout
						17	SS	>50											
16									12										
17			- 0.1 m pocket of sand at approximately 17.5 m depth.			18	GS		13										
18						19	SS	>50											
19									14										
20									15										

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 3 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20	Boart Longyear LS 250 Sonic (Casing:171 mm.)	**(GM)** sandy SILTY GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey brown; moist, very dense. *(continued)*															
					20	GS		15									
21					21	SS	>50										
		- 100 mm in diameter cobble at approximately 21.3 m depth.		746.66 / 21.49													
22		**(SM)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, trace non-plastic fines; grey-brown; moist to wet, very dense.						16									
					22	GS											
23					23	SS	>50										
				744.68 / 23.47													
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey-brown; moist, very dense.						17									
24					24	GS											
					25	SS	>50										
25																	Grout
								18		35	49	16					
26					26	GS											
27																	
					27	SS	>50										
28		- 0.1 m pocket of sand at approximately 28.4 m depth.						19									
					28	GS											
29																	
30				738.13													

CONTINUED NEXT PAGE

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

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

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 4 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
30																		
			(SP) SAND, fine to coarse sand, trace fine to coarse sub-rounded to sub-angular gravel; grey brown; moist, inferred very dense.		30.02	29	GS		19									
					737.52													
31			**(SP-SM)** gravelly SAND, fine to coarse sand, fine to coarse, sub-rounded to sub-angular gravel, some non-plastic fines; grey-brown; moist, inferred very dense.		30.63	30	GS											
					736.76													
			(ML) SILT, some fine sand; purple grey to brown; moist, inferred very dense.		31.39				20									
33						31	GS											
					734.62													
			(ML) SILT; purple grey to brown, varved with silty clay; moist, inferred very dense.		33.53													
34																		
35		Boart Longyear LS 250				32	GS		21		0	0	100	84	16			Grout
36																		
37																		
38						33	GS		22									
39																		
									23									
40			*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 5 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
40																	
41	Boart Longyear LS 250 Sonic (Casing:152 mm.)	**(ML)** SILT; purple grey to brown, varved with silty clay; moist, inferred very dense. *(continued)*			34	GS		23		0	0	100	86	14			
42																	
43																	
44					35	GS		24									
45																	Grout
46																	
47					36	GS		25									
48																	
49					37	GS											
50				719.38 / 48.77													
		(SP-SM) SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, some non-plastic fines; grey brown; wet, inferred very dense.						26									

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 6 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
50	Boart Longyear LS 250 Sonic (Casing:152 mm.)	**(SP-SM)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, some non-plastic fines; grey brown; wet, inferred very dense. *(continued)*															
51					38	GS		26									
52				716.03													
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse, sub-rounded to sub-angular gravel; grey brown, with cobbles; wet, inferred very dense.		52.12													
53																	
54					39	GS		27		31	48	21					
				713.59													
55		**(GP)** GRAVEL and SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular, trace non-plastic fines; grey brown; wet, inferred very dense.		54.56													Grout
56					40	GS		28		57	38	5					
57																	
58																	
59								29									
					41	GS											
60		*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-01

SHEET 7 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 557+785
N: 6004737.320 E: 606921.850
Survey Provided by: McElhanney

DRILLING DATE: 23 to 30 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SOIL CORE: RUN No.	SOIL CORE: RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
60	Boart Longyear LS 250 Sonic (Casing:121 mm,)	**(GP)** GRAVEL and SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular, trace non-plastic fines; grey brown; wet, inferred very dense. *(continued)*						29									
61				706.58													
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey; wet, inferred very dense.		61.57													
62								30									
63					42	GS				21	49	30	22	8	○		
64																	Grout
65								31									
66								32									
67								33									
68		- Drilling rod broke while advancing to 68.58 m. Approximately 120 mm x 100 mm piece of broken steel rod lost down hole at approximately 68.58 m depth		699.57				34									
		End of Sonic Hole		68.58													
69		Drill steel lost down hole preventing further advancement.															
70																	

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

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

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 1 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RUN No.	RECOVERY %	GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0			Ground Surface		744.75													
		Hand Excavation	SUMP. Assumed minimal thickness of forest litter and top soil, underlain by SAND and Gravel.		0.00													
					743.84													
1	Heli Portable Sonic	Sonic (Casing:127 mm.)	**(SP-SM)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, some non-plastic fines; brown, with cobbles; moist to wet, very dense.		0.91	1	GS		1									
2						2	SS	>50								O		
					742.31													
			(SP) SAND, fine to coarse sand, trace fine sub-rounded to sub-angular gravel, trace non-plastic fines; brown; wet, compact.		2.44				2									
3						3	GS									O		
					741.09													
			(CL) SILTY CLAY, brown; w>PL, inferred stiff.		3.66	4	SS	15										
					740.79													
4			**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown, with cobbles; wet, inferred very dense.		3.96	5	GS		3									
						6	GS									O		
					739.87													
5			**(SP)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, trace non-plastic fines; brown; wet, very dense. - cobble at approximately 4.9 m depth.		4.88	7	SS	>50										Grout
						8	GS		4		44	54	2			O		
6					738.35													
			(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey; wet, very dense.		6.40	9	SS	>50										
7						10	GS		5									
					736.75	11	SS	>50										
8			**(ML)** SILT; brown, varved with silty clay; non-cohesive, moist, very dense.		8.00											O		
						12	GS		6		0	1	99	75	24			
9																		
						13	SS	>50	7									
10			*CONTINUED NEXT PAGE*															

GRADATION % — CLAY PARTICLE SIZE <= 0.002

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

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

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 2 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Heli Portable Sonic Sonic (Casing:127 mm)	**(ML)** SILT; brown, varved with silty clay; non-cohesive, moist, very dense. *(continued)*			14	GS		7							○		
11					15	SS	>50	8									
12					16	GS											
13					17	SS	>50	9							○		
					18	GS									○		
14					19	SS	>50	10									
15					20	GS											Grout
16					21	SS	>50	11									
17					22	GS											
18					23	GS		12		0	0	100	85	15	○		
19					24	SS	>50	13							○		
20		*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 3 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20	Heli Portable Sonic Sonic (Casing:127 mm.)	**(ML)** SILT; brown, varved with silty clay; non-cohesive, moist, very dense. *(continued)*															
21					25	GS		13									
22					26	SS	>50										
23					27	GS		14		0	0	100	74	26			
24																	
25					28	SS	>50										Grout
				719.45													
		(SM) SILTY SAND, fine to coarse sand; grey; wet, inferred very dense.			29	GS											
				719.15													
		(SM) SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey, with cobbles up to 120 mm in diameter; wet, very dense.		25.60				15									
26																	
27					30	GS											
					31	SS	>50										
28																	
					32	GS											
29								16									
30		*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 4 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
30	Heli Portable Sonic Sonic (Casing:127 mm.)	**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey, with cobbles up to 120 mm in diameter; wet, very dense. *(continued)*			33	GS		16									
31					34	SS	>50										
32								17									
33				711.07	35	GS											
34		**(SM)** gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to angular gravel; brown to grey, cobbles up to 100 mm in diameter; moist, very dense.		33.68	36	GS											
					37	SS	>50										
35																	Grout
				709.39				18									
36		**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to angular gravel; grey with multi-coloured rock, with cobbles up to 100 mm; moist, inferred very dense.		35.36													
				708.48													
		(ML) SILT and SAND, fine to medium sand; grey; non-cohesive, moist, very dense.		36.27	38	GS				0	48	52	50	2			
37					39	SS	>50										
				707.56													
		(GP) GRAVEL with cobbles up to 100 mm in diameter and boulders.		37.19													
38								19									
39																	
				704.82													
40		*CONTINUED NEXT PAGE*						20									

DEPTH SCALE
1 : 50

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GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 5 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
40	Heli Portable Sonic Sonic (Casing:127 mm.)	**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey; wet, inferred very dense. *(continued)*		39.93 / 704.21													
		(SM) SILTY SAND, fine to coarse sand, trace fine to coarse sub-rounded to sub-angular gravel; grey; wet, inferred very dense.		40.54 / 703.30	40	GS											
41								20									
		(SM) SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey; non-cohesive, wet, inferred very dense.		41.45 / 701.16	41	GS											
42																	
43																	
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel, trace plastic fines; grey; non-cohesive, wet, very dense.		43.59	42	GS		21									
44					43	SS	>50										
45																	Grout
					44	GS											
		(ML) gravelly SILT, fine to coarse sub-rounded to angular gravel, some fine sand; light grey; non-cohesive, moist, inferred very dense.		45.72 / 699.03	45	GS											
46								22									
47																	
		(CI) gravelly sandy SILTY CLAY, fine to coarse sand, fine to coarse gravel; green-grey; cohesive, w<PL, inferred hard.		47.85 / 696.90	46	GS				34	20	46	26	20			
48								23									
49					47	GS											
								24									
50				694.76													

CONTINUED NEXT PAGE

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen ■; 20 40 60 80
WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-02

SHEET 6 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 22 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
50	Sonic (Casing:127 mm;)	Slightly weathered (W2), grey, CONGLOMERATE. *(continued)*		49.99													
51				693.54				24									
52		Fresh to moderately weathered (W1-W3), grey, medium strong (R3), SANDSTONE. - slightly altered from 51.51 m to 51.82 m depth.		51.21													
				692.32													
		Bedrock Encountered. Refer to Record of DRILLHOLE log for continuation of rock description.		52.43													
53																	
54																	
55																	
56																	
57																	
58																	
59																	
60																	

SHEAR STRENGTH: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen ■; 20 40 60 80
WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-02

SHEET 7 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 29 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W1 W2 W3 W4) / ALTERATION (1 2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200) / POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
			Cont'd from Record of Sonic Hole.		692.32												
			Fresh (W1), grey, medium strong (R3), SANDSTONE with trace carbonaceous sediments.		52.43												
53						25											
																	53.69
54																	53.82
						26											
55																	55.00
					689.21												55.44
			Fresh (W1), green-grey, weak (R2), CONGLOMERATE, subrounded, moderately sorted, medium to coarse grained volcanic clasts up to 20 mm in diameter.		55.54												
56						27											
					687.79												
57			Fresh (W1), grey, medium strong to weak (R3-R2), CONGLOMERATE, subrounded to subangular, moderately sorted, fine to coarse volcanic clasts up to 40 mm in diameter.		56.96												
	Heli Portable Sonic	HQ-3 Coring				28											
58																	57.80
59						29											
60																	60.32
																	60.34
						30											
61																	
62						31											
			CONTINUED NEXT PAGE														

DEPTH SCALE
1 : 50

GOLDER

LOGGED: NH/BB/FC
REVIEWED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-02

SHEET 8 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 29 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DRILLING RIG: Heli Portable Sonic
DRILLING METHOD: HQ-3 Coring

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1) / WEATHERING (W1 W2 W3 W4) / ALTERATION (1 2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20) / RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90) / TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200) / POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
63	Fresh (W1), grey, medium strong (R3), CONGLOMERATE, subrounded to subangular, well sorted, fine grained volcanic clasts.		681.71 63.04	32							63.10 63.14
64											64.25 64.28
65				33							65.16 65.32
66											66.51 66.57
67				34							66.68 66.71 67.01 67.32
68				35				CON,UN,SM JN,UN,Ro			
69	Fresh (W1), grey to green-grey, medium strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, fine to coarse grained volcanic clasts.		675.59 69.16	36				JN,PL,SM			
70											
71				37							
72											

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: NH/BB/FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-02

SHEET 9 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 29 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DRILLING RIG: Heli Portable Sonic
DRILLING METHOD: HQ-3 Coring

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1) / WEATHERING (W1 W2 W3 W4) / ALTERATION (1 2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20) / RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90) / TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) 50 100 150 200 / POINT LOAD Is50 (MPa) Axial Diametral Lump Block 2 4 6 8
73	Fresh (W1), grey to green-grey, medium strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, fine to coarse grained volcanic clasts. *(continued)*			38				JN,CU,SM				
74				39								
75												
76				40								
77				41							76.95–77.08	
78												
79				42								
80												
81				43				JN,IR,VR			81.55–81.78	
82				44								
	CONTINUED NEXT PAGE											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: NH/BB/FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-02

SHEET 10 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+075
N: 6004862.530 E: 606670.860
Survey Provided by: McElhanney

DRILLING DATE: 29 November to 02 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W2 W3 W4)	INDICES: ALTERATION (2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0-30 30-60 60-90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200)	POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
83	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey to green-grey, medium strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, fine to coarse grained volcanic clasts. *(continued)*																
			- brown-red from 83.41 m to 83.61 m depth.			45													
84																			
						46													
85					658.83														
86			End of DRILLHOLE.		85.92														
87																			
88																			
89																			
90																			
91																			
92																			

DEPTH SCALE
1 : 50

GOLDER

LOGGED: NH/BB/FC

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-03

SHEET 1 OF 5

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+440
N: 6005000.640 E: 606354.010
Survey Provided by: McElhanney

DRILLING DATE: 13 to 15 December 2020
DRILLING CONTRACTOR: Mud Bay Drilling Co. Ltd.

DATUM: Ground Surface

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RUN No.	RECOVERY %	GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
			Ground Surface		727.80													
0		Hand Excavation	SUMP. Assumed minimal thickness of forest litter and top soil, underlain by SAND and GRAVEL.		0.00 / 726.89													
1	Heli Portable Sonic	Sonic (Casing:152 mm.)	**(GP)** GRAVEL and SAND, fine to coarse sand, fine to coarse sub-angular to rounded gravel; brown with cobbles up to 110 mm in diameter; non-cohesive, moist, inferred compact.		0.91	1	GS		1									
2					725.36													
3			**(GP)** sandy GRAVEL, fine to coarse sand, fine to coarse sub-angular to rounded gravel, trace non-plastic fines; grey-brown, with cobbles; non-cohesive, wet, very dense.		2.44	2	SS	>50	2									
						3	GS											
4						4	SS	>50										
5						5	GS		3		71	28	1					Grout
			- SAND and GRAVEL below 5.49 m depth.			6	SS	>50										
					721.86	7	GS											
6			**(CI)** SILTY CLAY; maroon-grey, varved with grey silty clay; cohesive, w>PL, hard.		5.94				4									
						8	GS				0	0	100	76	24			
7						9	SS	30										
					720.03	10	GS		5									
8			**(SM)** SILTY SAND, fine to coarse sand; grey; non-cohesive, wet, inferred dense.		7.77 / 719.72	11	GS											
			(ML) CLAYEY SILT; maroon-grey; cohesive, w>PL, inferred very stiff to hard.		8.08 / 719.27													
9			**(GP-GM)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-angular to rounded gravel, trace to some non-plastic fines; grey; non-cohesive, wet, very dense.		8.53	12	SS	94	6									
						13	GS											
10			*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-03

SHEET 2 OF 5

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+440
N: 6005000.640 E: 606354.010
Survey Provided by: McElhanney

DRILLING DATE: 13 to 15 December 2020
DRILLING CONTRACTOR: Mud Bay Drilling Co. Ltd.

DATUM: Ground Surface

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RUN No.	RECOVERY %	GRADATION % CLAY PARTICLE SIZE <= 0.002: GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Heli Portable Sonic Sonic (Casing:152 mm.)	**(GP-GM)** SAND and GRAVEL, fine to coarse sand, fine to coarse sub-angular to rounded gravel, trace to some non-plastic fines; grey; non-cohesive, wet, very dense. *(continued)*			14	SS	81	7							nat V. + Q - ● rem V. ⊕ U - ◐ Pocket Pen ■ 20 40 60 80		
11					15	GS									Wp W Wl NP - Non-Plastic 10 20 30 40		
				716.52													
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-angular to rounded gravel; grey; non-cohesive, wet, dense.		11.28													
				715.91	16	SS	39										
12		**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-angular to rounded gravel; grey; non-cohesive, wet, inferred dense.		11.89				8									
					17	GS											
				715.00													
13		**(GP)** GRAVEL and SAND, fine to coarse sand, fine to coarse sub-angular to rounded gravel, trace non-plastic fines; grey; non-cohesive, wet, very dense.		12.80	18	SS	>50										
								9									
14					19	GS				60	36	4					
					20	SS	>50										
15																	Grout
				712.41				10									
		(ML) SILT, some sand to sandy; grey, varved with silty clay; non-cohesive, wet, dense.		15.39	21	GS											
16					22	SS	42										
17				710.72													
		(ML) SILT; grey, varved with silty clay; non-cohesive, wet, hard.		17.07				11									
18					23	GS									NP		
19																	
					24	SS	>50										
20								12									

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-03

SHEET 3 OF 5

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+440
N: 6005000.640 E: 606354.010
Survey Provided by: McElhanney

DRILLING DATE: 13 to 15 December 2020
DRILLING CONTRACTOR: Mud Bay Drilling Co. Ltd.

DATUM: Ground Surface

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20		**(ML)** SILT; grey, varved with silty clay; non-cohesive, wet, hard. *(continued)*															
21					25	GS		12							○		
22				705.55													
		(SP) SAND, fine to medium sand, trace non-plastic fines; brown; non-cohesive, wet, inferred compact to dense.		22.25	26	SS	20										
23				704.94													
		(ML) gravelly sandy CLAYEY SILT, fine to coarse sub-angular to rounded gravel, fine to coarse sand; grey; cohesive, w<PL, inferred hard.		22.86	27	GS		13		27	20	53	44	9	○		
24				703.57													
	Heli Portable Sonic Sonic (Casing:152 mm)	**(ML)** sandy gravelly SILT, fine to coarse sand, fine to coarse sub-rounded to rounded gravel; grey; non-cohesive, wet, inferred very dense.		24.23													Grout
25					28	GS											
26				701.74				14									
		Highly weathered (W4), dark grey, fine grained, weak (R2), inferred CLAYSTONE.		26.06													
27								15									
28				699.45													
		Fresh to slightly weathered (W1-W2), grey, fine grained, medium strong (R3), CLAYSTONE.		28.35													
29								16									
				697.93	29	GS											
30		Bedrock Encountered. Refer to Record of DRILLHOLE log for continuation of rock description.		29.87													

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-03

SHEET 4 OF 5

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+440
N: 6005000.640 E: 606354.010
Survey Provided by: McElhanney

DRILLING DATE: 13 to 16 December 2020
DRILLING CONTRACTOR: Mud Bay Drilling Co. Ltd.

DATUM: Ground Surface

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.	Fault/Breccia/Gouge	Lost Core	UNCONFINED COMPRESSIVE STRESS (MPa) / POINT LOAD Is50 (MPa)
							INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1); WEATHERING (W1 W2 W3 W4); ALTERATION (1 2 3 4); RECOVERY: TOTAL CORE % (80 60 40 20); RQD % (80 60 40 20); FRACTURE INDEX PER; DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0 30 60 90); TYPE AND SURFACE DESCRIPTION; HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})			50 100 150 200; Axial, Diametral, Lump, Block; 2 4 6 8
			Cont'd from Record of Sonic Hole.		697.93					
30	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, strong (R4), CONGLOMERATE, subrounded to subangular, fine to coarse grained volcanic clasts up to 115 mm in diameter. *(continued)*		29.87	17				
31						18				
32			- coarse conglomeratic SANDSTONE with pebbles up to 12 mm diameter between 31.72 to 31.84 m depth.			19				
33						20				32.96 33.13
34										33.98 34.33
35						21				35.00 35.05
36						22				
37						23	<<			
38										
39						24	JN,PL,SM			
			CONTINUED NEXT PAGE							

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-03

SHEET 5 OF 5

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+440
N: 6005000.640 E: 606354.010
Survey Provided by: McElhanney

DRILLING DATE: 13 to 16 December 2020
DRILLING CONTRACTOR: Mud Bay Drilling Co. Ltd.

DATUM: Ground Surface

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1); WEATHERING (W2 W3 W4); ALTERATION (2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20); RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90); TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200); POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
			Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.											
40	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, strong (R4), CONGLOMERATE, subrounded to subangular, fine to coarse grained volcanic clasts up to 115 mm in diameter. *(continued) (continued)*			25								
41														
						26				JN,UN,Ro JN,UN,Ro				
42														
										JN,PL,SM				
43						27								
44														
						28								
45					682.11									
			End of DRILLHOLE.		45.69									
46														
47														
48														
49														

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC/CH
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-04

SHEET 1 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 05 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface		743.13													
	Hand Excavation	SUMP. Assumed minimal thickness of forest litter and top soil, underlain by gravelly SAND.		0.00													
1				741.91													
	Heli Portable Sonic Sonic (Casing:127 mm;)	**(SP-SM)** gravelly SAND, fine to coarse sand, fine to coarse sub-angular to sub-rounded gravel, some non-plastic fines; brown; non-cohesive, dry, dense.		1.22	1	GS		1									
2					2	SS	35								O		
3				739.93	3	GS		2									
		(GM) SILTY GRAVEL and SAND, fine to coarse sand, fine to coarse sub-angular to rounded gravel; brown; non-cohesive, wet, inferred dense.		3.20	4	GS									O		
				739.17													
4		**(GP)** GRAVEL and SAND, fine to coarse sand, fine to coarse sub-rounded to rounded gravel; brown; non-cohesive, wet, compact.		3.96	5	SS	29										
								3									
5					6	GS				53	47	0			O		Grout
					7	SS	27										
6					8	GS		4							O		
				736.58													
		(GP-GM) GRAVEL, fine to coarse sub-rounded to rounded gravel, some fine to coarse sand, trace to some non-plastic fines; brown; non-cohesive, wet, inferred compact to dense.		6.55	9	GS											
7				736.12													
		(SC) gravelly CLAYEY SAND, fine to coarse sand, fine to coarse sub-angular to sub-rounded gravel; grey-brown; non-cohesive, wet, hard. - chlorite alteration at approx. 7.6 m depth		7.01	10	SS	>50										
					11	GS		5									
8					12	GS											
					13	SS	>50			25	53	22	16	6		O	
9								6									
					14	GS									O		
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-04

SHEET 2 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 05 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Heli Portable Sonic Sonic (Casing:127 mm;)			732.77	15	SS	>50										
		(CL) sandy SILTY CLAY, fine to coarse sand, some fine to coarse sub-angular to sub-rounded gravel; grey, with weathered rock fragments; cohesive, w<PL, inferred hard.		10.36	16	GS		7									
11		- oxidation staining observed between 11.1 and 11.4 m depth.		731.55													
		(CI) SILTY CLAY and SAND, fine to coarse sand, trace fine to coarse sub-angular to sub-rounded gravel; grey; cohesive, w>PL, hard.		11.58													
12					17	GS		8		2	46	52	33	19			
13					18	SS	>50										
					19	GS		9									
14				728.80													
		Fresh (W1), grey, coarse grained, medium strong (R3), CONGLOMERATE.		14.33	20	SS	>50										
15					21	GS											Grout
16				726.98				10									
		Fresh (W1), grey, fine to coarse grained, medium strong (R3), SANDSTONE.		16.15	22	GS											
17				725.45													
				17.68													
18		Bedrock Encountered. Refer to Record of DRILLHOLE log for continuation of rock description.															
19																	
20																	

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen ■; 20 40 60 80
WATER CONTENT PERCENT: Wp W Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 3 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH R5 R4 R3 R2 R1	INDICES: WEATHERING W2 W3 W4	INDICES: ALTERATION 2 3 4	RECOVERY: TOTAL CORE % 80 60 40 20	RECOVERY: RQD % 80 60 40 20	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) 0–30 30–60 60–90	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Fault/Breccia/Gouge	Lost Core	Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) 50 100 150 200	POINT LOAD Is50 (MPa) Axial Diametral Lump Block 2 4 6 8
			Cont'd from Record of Sonic Hole.		725.45															
18	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, medium strong (R3), CONGLOMERATE, subrounded, moderately sorted, fine to coarse grained volcanic clasts up to 17 mm in diameter.		17.68	11													17.68 17.84	
19						12														
20						13								JN,UN,SM,CN						
21																				
22						14														
23																				
24						15														
25																				
26			- becomes weak (R2) slightly to moderately altered (A2-A3), fine grained, and yellow-grey from 26.08 to 26.24 m depth			16														
27						17								JN,IR,VR,IN,Fe, Cl, Gr						
			CONTINUED NEXT PAGE																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 4 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W1 W2 W3 W4) / ALTERATION (1 2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200) / POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
28	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, medium strong (R3), CONGLOMERATE, subrounded, moderately sorted, fine to coarse grained volcanic clasts up to 17 mm in diameter. *(continued)* - conglomerate becomes fine grained at 27.95 m depth. Maximum clast size increasing with depth. Coarse clasts at 28.49 m depth.			18											
29																	
30						19											
31																	⊕ ● ●
32						20											
33																	
34						21											
35																	
36						22											⊕ ● ●
37						23											
			CONTINUED NEXT PAGE														

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 5 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES | DRILLING RIG | DRILLING METHOD | DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | RUN No. | INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1), WEATHERING (W2 W3 W4), ALTERATION (2 3 4) | RECOVERY: TOTAL CORE % (80 60 40 20), RQD % (80 60 40 20) | FRACTURE INDEX PER | DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90), TYPE AND SURFACE DESCRIPTION | HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Fault/Breccia/Gouge | Lost Core / Broken Core | UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200) | POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)

38
39
40
41
42
43
44
45
46
47

Heli Portable Sonic
HQ-3 Coring

Fresh (W1), grey, medium strong (R3), CONGLOMERATE, subrounded, moderately sorted, fine to coarse grained volcanic clasts up to 17 mm in diameter. *(continued)*

JN,PL,SM,SO

699.63
Fresh (W1), massive, dark grey, weak (R2), MUDSTONE.
699.49
43.64
Fresh (W1), grey, fine to coarse grained, medium strong (R3), SANDSTONE with carbonaceous seam.
698.90
44.23
Fresh (W1), massive, grey, coarse grained, medium strong (R3), CONGLOMERATE.
698.54
44.59
Fresh (W1), grey, fine to coarse grained, medium strong (R3), SANDSTONE with carbonaceous seams.
697.68
45.45
Slightly weathered (W2), green-grey, weak (R2), CONGLOMERATE, subrounded, poorly sorted with volcanic clasts.
695.99
47.14

JN,IR,Ro,IN,Cl, Gr
JN,PL,SM,IN,Cl
JN,PL,Ro,IN,Br

42.59
43.04
43.59
43.64
46.08
46.38
46.86
46.91
47.60

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 6 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W2 W3 W4)	INDICES: ALTERATION (2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200)	POINT LOAD Is50 (MPa): Axial, Diametral, Lump, Block (2 4 6 8)
48	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, medium to coarse grained volcanic clasts up to 150 mm in diameter. *(continued)*			31												47.83	
49						32								JN,PL,Ro,IN,Cl				48.24 48.46 48.60 48.85	
50																			
51						33													
52																			
53						34													
54																			
55						35								JN,PL,SM,SO JN,PL,SM,SO					
56						36								JN,IR,IR,CN					
57						37													
			CONTINUED NEXT PAGE																

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
REVIEWED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 7 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	RUN No.
58	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, medium to coarse grained volcanic clasts up to 150 mm in diameter. *(continued)*			
59						38
60						39
61						
62						40
63						
64					679.10	41
			Fresh (W1), very thinly bedded to laminated, green-grey, fine to coarse grained, medium strong (R3), SANDSTONE. - becomes coarser between 64.58 to 64.66 m and 64.96 to 65.05 m depth.		64.03	
65					678.08	42
			Fresh (W1), grey to grey-green, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, volcanic clasts up to 75 mm in diameter.		65.05	
66						
67			- clasts become finer between 66.85 to 67.00 m depth.			43
			CONTINUED NEXT PAGE			

INDICES: ROCK STRENGTH (R5, R4, R3, R2, R1); WEATHERING (W2, W3, W4); ALTERATION (2, 3, 4)
RECOVERY: TOTAL CORE % (80, 60, 40, 20); RQD % (80, 60, 40, 20)
FRACTURE INDEX PER
DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0, 30, 60, 90); TYPE AND SURFACE DESCRIPTION
HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3})
Fault/Breccia/Gouge; Broken Core; Lost Core

UNCONFINED COMPRESSIVE STRESS (MPa) ▲ 50 100 150 200

POINT LOAD Is50 (MPa) ● Axial ⊕ Diametral + Lump ■ Block 2 4 6 8

63.58
63.68

DEPTH SCALE 1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

SHEET 8 OF 10

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DRILLING RIG: Heli Portable Sonic
DRILLING METHOD: HQ-3 Coring

Fresh (W1), grey to grey-green, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, volcanic clasts up to 75 mm in diameter. *(continued)*

- red-grey between 69.72 to 69.86 m depth.

667.97 — 75.16
Fresh (W1), dark grey, fine to coarse grained, medium strong (R3), SANDSTONE.
667.71 — 75.42
Fresh (W1), dark grey-green, medium strong (R3), CONGLOMERATE, subrounded, poorly sorted, medium to coarse grained volcanic clasts up to 100 mm in diameter.
666.96 — 76.17
Fresh (W1), dark grey, fine to coarse grained, medium strong (R3), SANDSTONE.
666.66 — 76.47
Fresh (W1), dark grey-green, medium strong (R3), CONGLOMERATE, subrounded, poorly sorted, medium to coarse grained volcanic clasts up to 100 mm in diameter.
665.88 — 77.25

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W2 W3 W4) / ALTERATION (2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³)	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200) / POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
			Fresh (W1), dark grey, fine to coarse grained, medium strong (R3), SANDSTONE. *(continued)*		665.29												
					77.84												
78			Fresh (W1), grey to green-grey, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, medium to coarse grained volcanic clasts up to 200 mm in diameter.			51											
79																	
80						52											
81																	
82						53											
83	Heli Portable Sonic	HQ-3 Coring															
84						54											
85						55											
86						56											
87																86.74 / 86.98	
			CONTINUED NEXT PAGE														

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-04

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+785
N: 6005093.480 E: 606172.250
Survey Provided by: McElhanney

DATUM: Geodetic

DRILLING DATE: 06 to 09 December 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH R5 R4 R3 R2 R1; WEATHERING W1 W2 W3 W4; ALTERATION 2 3 4	RECOVERY: TOTAL CORE % 80 60 40 20; RQD % 80 60 40 20	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) 0–30 30–60 60–90; TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) 50 100 150 200; POINT LOAD Is50 (MPa) Axial Diametral Lump Block 2 4 6 8
88	Heli Portable Sonic	HQ-3 Coring	Fresh (W1), grey to green-grey, medium strong to strong (R3-R4), CONGLOMERATE, subrounded to subangular, moderately sorted, medium to coarse grained volcanic clasts up to 200 mm in diameter. *(continued)*			57								
89						58								⊕
90					652.95									
			End of DRILLHOLE.		90.18									
91														
92														
93														
94														
95														
96														
97														

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-05

SHEET 1 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface		769.52													
	Boart Longyear LS 250 Sonic (Casing:152 mm.)	**(SM)** SILTY SAND and GRAVEL, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown, with oxidation and rootlets; non-cohesive, wet, inferred compact.		0.00	1	GS		1									
1				768.00													
		(SM) gravelly SAND and SILT, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown, with oxidation; non-cohesive, wet, compact.		1.52	2A												
				767.69	2B	SS	25										
2				1.83				2									
		(SM) gravelly SILTY SAND, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown; non-cohesive, wet, very dense.			3	GS				26	51	23	19	4			
3					4	SS	>100										
					5	GS		3									
4				765.25													
		(SM) gravelly SAND and SILT, fine to coarse sand, fine sub-rounded to sub-angular gravel; brown; non-cohesive, wet, inferred very dense.		4.27	6	GS											
5					7	GS		4									Grout
6				763.42													
		- cobble at 6.10 m depth.		6.10													
		(CL) gravelly sandy SILTY CLAY, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey; cohesive, w<PL, hard. - cobble at 6.70 m depth.			8	SS	>100	5									
7					9	GS		6									
				761.90													
		(CL) SILTY CLAY, some fine to coarse sand, some fine to coarse sub-rounded to sub-angular gravel; grey; cohesive, w<PL, hard.		7.62	10	SS	38										
8								7									
					11	GS											
9		- some sand to sandy below 9.14 m depth.			12	SS	77	8									
				759.77													
				9.75													
10		*CONTINUED NEXT PAGE*															

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen ■; 20 40 60 80
WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE
1 : 50

** Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.*

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-05

SHEET 2 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10		**(CL)** sandy gravelly SILTY CLAY, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; grey, with weathered rock fragments; cohesive, w<PL, hard. *(continued)*			13	GS		8									
					14	SS	>50										
11		- 150 mm in diameter cobble at 11.28 m depth.						9									
					15	GS		10									
12					16	SS	65										
13					17	GS		11									
					18	SS	54										
14																	
	Boart Longyear LS 250 Sonic (Casing:152 mm.)				19	GS		12									Grout
15																	
16					20	GS		13		22	35	43	26	17			
					21	SS	52										
17																	
					22	GS		14									
18																	
19					23	GS		15									
		inferred BEDROCK, highly to moderately weathered (W3-W4) , grey-green to grey, CONGLOMERATE.		750.32 / 19.20													
					24	GS											
20					25	SS	53	16									

CONTINUED NEXT PAGE

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

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

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS

LOGGED: FC

REVIEWED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-05

SHEET 3 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20	Boart Longyear LS 250 Sonic (Casing:152 mm;)	inferred BEDROCK, highly to moderately weathered (W3-W4) , grey-green to grey, CONGLOMERATE. *(continued)*					53	16									
21				748.18				17									
		Bedrock Encountered. Refer to Record of DRILLHOLE log for continuation of rock description.		21.34													
22																	
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	

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

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

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: FC
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-05

SHEET 4 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W1 W2 W3 W4) / ALTERATION (1 2 3 4)	RECOVERY: TOTAL CORE %	RECOVERY: RQD %	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) 0–30 30–60 60–90	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) 50 100 150 200	POINT LOAD Is50 (MPa) Axial Diametral Lump Block 2 4 6 8
			Cont'd from Record of Sonic Hole.		748.18													
22	Boart Longyear LS 250	HQ3 Coring	Fresh to slightly weathered (W1-W2), grey, coarse grained, strong (R3-R5), CONGLOMERATE with interbedded SANDSTONE.		21.34	18							JN,UN,SM,CT					
													JN,IR,SM,CT					
23						19							JN,IR,Ro,IN					
													JN,CU,SM,CT					
24						20							JN,IR,VR					
													FLT,IR,SM,IN					
25						21							JN,PL/UN,SM					
						22												
26						23							JN,PL,Ro,CT CON OR JN,UN/IR,SM/K					
27																		
28						24							JN,CU,Ro,CT					
					740.74													
29			Fresh (W1), grey, coarse grained, medium strong to strong (R3-R4), CONGLOMERATE with volcanic clasts.		28.78	25							CO,IR,Ro,PC,CI JN,CU,Ro,CT FLT,CU,Ro,IN			28.93 29.03		
30																		
						26							JN,UN,Ro					
31													UN,UN,SM/RO,PC,CI UN,IR,Ro,PC,CI			31.27 31.32		
			CONTINUED NEXT PAGE															

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC/BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-05

SHEET 5 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DRILLING RIG: Boart Longyear LS 250
DRILLING METHOD: HQ3 Coring

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	TYPE AND SURFACE DESCRIPTION
	Fresh (W1), grey, coarse grained, medium strong to strong (R3-R4), CONGLOMERATE with volcanic clasts. *(continued)*			
32			27	JN,UN,Ro,IN JN,CU,Ro,IN JN,PL,Ro,IN,CI
33		736.17		JN,UN,Ro,IN CO,IR,Ro
	Fresh (W1) bedded, grey, coarse grained, strong (R4/R5), CONGLOMERATE with volcanic clasts.	33.35	28	
34				JN,IR,Ro,IN
35			29	JN,PL,VR JN,UN,SM
36				JN,UN,Ro,CT
37			30	
38			31	JN,CU,SM,IN JN,CU,SM,IN
39				
40		729.52	32	JN,UN,SM,CT JN,IR,SM,IN
	Fresh (W1), bedded, grey, coarse grained, medium strong to very strong (R3-R5), CONGLOMERATE with volcanic clasts.	40.00		JN,UN,Ro,CT
41				JN,IR,VR,SO
			33	

Fault/Breccia/Gouge: 31.60 – 31.70; 32.64 – 32.86

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC/BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-05

SHEET 6 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH (R5 R4 R3 R2 R1)	INDICES: WEATHERING (W2 W3 W4) / ALTERATION (2 3 4)	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: RQD % (80 60 40 20)	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) (0–30 30–60 60–90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) (50 100 150 200)	POINT LOAD Is50 (MPa) (Axial, Diametral, Lump, Block) (2 4 6 8)
42	Boart Longyear LS 250	HQ3 Coring	Fresh (W1), bedded, grey, coarse grained, medium strong to very strong (R3-R5), CONGLOMERATE with volcanic clasts. *(continued)*										JN,PL,SM,SO					
43						34												
44													JN,CU,SM,IN					
45						35												
46													JN,CU,Ro,IN					
47						36												
48													JN,UN,Ro,IN					
49						37							JN,CU,SM,IN					
50													JN,CU,SM,IN					
51						38												
						39												

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC/BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF DRILLHOLE: BH20-MOR-05

SHEET 7 OF 7

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 558+900
N: 6005195.950 E: 605938.830
Survey Provided by: McElhanney

DRILLING DATE: 13 to 18 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

Refer to "Lithological and Geotechnical Soil and Rock Description Terminology" for accompanying legend and notes.

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	RUN No.	INDICES: ROCK STRENGTH R5 R4 R3 R2 R1	INDICES: WEATHERING W1 W2 W3 W4 / ALTERATION 2 3 4	RECOVERY: TOTAL CORE %	RECOVERY: RQD %	FRACTURE INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (alpha) 0–30 30–60 60–90	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	Fault/Breccia/Gouge	Lost Core / Broken Core	UNCONFINED COMPRESSIVE STRESS (MPa) 50 100 150 200 / POINT LOAD Is50 (MPa) Axial Diametral Lump Block 2 4 6 8
52	Boart Longyear LS 250	HQ3 Coring	Fresh (W1), bedded, grey, coarse grained, medium strong to very strong (R3-R5), CONGLOMERATE with volcanic clasts. *(continued)*			40											
53						41							JN,UN,Ro,IN JN,UN,Ro,IN			52.78 53.21	
54																	
55						42							JN,CU,Ro,IN				
56																	
57						43											
58						44										57.78 58.21	
59						45											
60					709.52	46											
61			End of DRILLHOLE.														

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC/BB
CHECKED: DG

REV: 1

PROJECT No.: 19122805 / 7000

RECORD OF SONIC HOLE: BH20-MOR-06

SHEET 1 OF 1

CLIENT: Coastal GasLink
PROJECT: Morice River Geotechnical Investigation
LOCATION: Houston BC, KP 559+200
N: 6005321.120 E: 605671.630
Survey Provided by: McElhanney

DRILLING DATE: 21 November 2020
DRILLING CONTRACTOR: Blue Max Drilling Inc.

DATUM: Geodetic

INCLINATION: -90°

*SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface		777.66													
	Boart Longyear LS 250 Sonic (Casing:152 mm;)	**(TOPSOIL)** Mulch		0.05													
		(CL-ML) gravelly sandy SILTY CLAY to CLAYEY SILT, low plasticity, fine to coarse sand, fine to coarse sub-rounded to sub-angular gravel; brown, with organics, with cobbles; cohesive, w>PL.			1	GS		1									
1																	
				775.98	2	SS	30	2	417								
		Fresh (W1), medium strong (R3), CONGLOMERATE.		1.68													
2								3									
					3	GS											
3																	
								4									Grout
4																	
				772.33													
5		Fresh (W1), fine to coarse grained, carbonaceous fragments, SANDSTONE.		5.33	4	GS		5									
				771.72													
6		Moderately weathered (W3), weak (R2), MUDSTONE.		5.94													
				771.26													
		Fresh (W1), fine to medium grained, with carbonaceous fragments, SANDSTONE.		6.40				6									
7				770.34													
		Fresh (W1), fine grained, maroon alteration, weak (R2), MUDSTONE.		7.32	5	GS											
				769.96													
		Fresh (W1), fine to coarse grained, iron oxide staining on joint surfaces, weak (R2), SANDSTONE.		7.70				7	117								
8					6	GS											
				769.43													
		End of Sonic Hole.		8.23													
9																	
10																	

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

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

DEPTH SCALE
1 : 50

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

GOLDER

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: BB
CHECKED: DG

REV: 1

APPENDIX B

Soil Laboratory Results

GOLDER

WATER CONTENT DETERMINATION

ASTM D 2216

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Lab Schedule No.:

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
BH20-MOR-01	4		3.05	3.66	11.2
BH20-MOR-01	5		4.27	4.42	8.9
BH20-MOR-01	9		7.62	8.05	10.8
BH20-MOR-01	16		14.33	14.48	2.6
BH20-MOR-01	26		25.91	26.06	8.8
BH20-MOR-01	31		32.92	33.07	21.4
BH20-MOR-01	32		35.05	35.20	26.3
BH20-MOR-01	34		40.84	41.00	26.3
BH20-MOR-01	35		44.20	44.35	22.4
BH20-MOR-01	41		59.44	59.59	7.7
BH20-MOR-01	42		63.09	63.25	7.5
BH20-MOR-02	2		1.83	2.44	7.0
BH20-MOR-02	3		2.90	3.05	7.4
BH20-MOR-02	6		4.42	4.57	4.2
BH20-MOR-02	8		5.64	5.79	6.7
BH20-MOR-02	9		6.40	6.53	18.6
BH20-MOR-02	12		8.53	8.69	20.9
BH20-MOR-02	14		10.21	10.36	21.8
BH20-MOR-02	17		12.50	12.98	26.3
BH20-MOR-02	18		13.56	13.72	22.5
BH20-MOR-02	23		17.68	17.83	23.0
BH20-MOR-02	24		18.59	19.05	23.5
BH20-MOR-02	26		21.64	22.17	25.5
BH20-MOR-02	27		23.16	23.32	27.2
BH20-MOR-02	30		26.82	26.97	8.5
BH20-MOR-02	33		30.02	30.18	5.6
BH20-MOR-02	35		32.61	32.77	4.9
BH20-MOR-02	36		33.68	33.83	4.1
BH20-MOR-02	38		36.58	36.73	18.2
BH20-MOR-02	41		42.06	42.21	14.4
BH20-MOR-02	45		46.02	46.18	8.9
BH20-MOR-02	46		48.16	48.31	14.9
BH20-MOR-02	47		49.07	49.23	13.6
BH20-MOR-03	5		4.72	4.88	2.9

SJ — Checked
1/29/2021 — Date

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GOLDER

WATER CONTENT DETERMINATION

ASTM D 2216

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Lab Schedule No.:

Sample Location	Sample No.	Specimen No.	Depth Interval		Water Content (%)
			Depth (m)	Bottom (m)	
BH20-MOR-03	**8**		6.55	6.71	**25.6**
BH20-MOR-03	**13**		9.30	9.45	**3.4**
BH20-MOR-03	**14**		10.06	10.64	**5.8**
BH20-MOR-03	**17**		12.34	12.50	**7.6**
BH20-MOR-03	**19**		13.87	14.02	**5.7**
BH20-MOR-03	**21**		15.85	16.15	**21.3**
BH20-MOR-03	**23**		17.98	18.29	**20.0**
BH20-MOR-03	**25**		21.03	21.34	**17.4**
BH20-MOR-03	**27**		23.47	23.62	**15.3**
BH20-MOR-04	**2**		2.44	3.05	**7.1**
BH20-MOR-04	**4**		3.51	3.66	**5.7**
BH20-MOR-04	**6**		4.88	5.03	**5.7**
BH20-MOR-04	**8**		6.10	6.25	**5.2**
BH20-MOR-04	**13**		8.53	8.69	**20.1**
BH20-MOR-04	**14**		9.30	9.45	**23.7**
BH20-MOR-04	**17**		12.34	12.50	**21.7**
BH20-MOR-05	**3**		2.44	2.59	**10.7**
BH20-MOR-05	**4**		3.05	3.51	**10.0**
BH20-MOR-05	**5**		3.66	3.81	**8.5**
BH20-MOR-05	**7**		5.18	5.33	**10.7**
BH20-MOR-05	**9**		7.01	7.16	**10.3**
BH20-MOR-05	**11**		8.53	8.69	**10.6**
BH20-MOR-05	**12**		9.14	9.75	**13.2**
BH20-MOR-05	**13**		10.21	10.36	**8.0**
BH20-MOR-05	**17**		12.98	13.11	**8.7**
BH20-MOR-05	**19**		14.48	14.63	**8.3**
BH20-MOR-05	**21**		16.76	16.86	**10.9**
BH20-MOR-05	**22**		17.37	17.53	**12.1**
BH20-MOR-05	**23**		18.90	19.05	**12.0**
BH20-MOR-06	**1**		0.61	0.76	**17.4**

SJ — Checked
1/29/2021 — Date

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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-02
Project:	Morice River Geotechnical Investigation	**Sample:**	14
Location:	Morice River, BC	**Depth (m):**	10.21 - 10.36
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C		
Furnace Temperature	440±40°C		

Moisture Content %	21.8	
Trial #	1	2
Ash Content %	98.6	98.6
Organic Matter %	1.4	1.4
Average Organic Matter %	**1.4**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 26, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd
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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-02
Project:	Morice River Geotechnical Investigation	**Sample:**	26
Location:	Morice River, BC	**Depth (m):**	21.64 - 22.17
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C		
Furnace Temperature	440±40°C		

Moisture Content %	25.5	
Trial #	1	2
Ash Content %	98.7	98.7
Organic Matter %	1.3	1.3
Average Organic Matter %	**1.3**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 26, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-02
Project:	Morice River Geotechnical Investigation	**Sample:**	33
Location:	Morice River, BC	**Depth (m):**	30.02 - 30.17
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	5.6	
Trial #	1	2
Ash Content %	99.5	99.5
Organic Matter %	0.5	0.5
Average Organic Matter %	**0.5**	

Note: moisture content as a percentage of oven-dried mass

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DC	January 26, 2021	SJ	January 29, 2021
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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-02
Project:	Morice River Geotechnical Investigation	**Sample:**	47
Location:	Morice River, BC	**Depth (m):**	49.07 - 49.23
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	13.6	
Trial #	1	2
Ash Content %	97.7	97.6
Organic Matter %	2.3	2.4
Average Organic Matter %	**2.4**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 26, 2021	SJ	January 29, 2021
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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-04
Project:	Morice River Geotechnical Investigation	**Sample:**	8
Location:	Morice River, BC	**Depth (m):**	6.10 - 6.25
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	5.2	
Trial #	1	2
Ash Content %	99.3	99.3
Organic Matter %	0.7	0.7
Average Organic Matter %	**0.7**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 26, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s): ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-04
Project:	Morice River Geotechnical Investigation	**Sample:**	14
Location:	Morice River, BC	**Depth (m):**	9.30 - 9.45
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	23.7	
Trial #	1	2
Ash Content %	92.9	92.7
Organic Matter %	7.1	7.3
Average Organic Matter %	**7.2**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 26, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-05
Project:	Morice River Geotechnical Investigation	**Sample:**	4
Location:	Morice River, BC	**Depth (m):**	3.05 - 3.51
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	10.0	
Trial #	1	2
Ash Content %	98.7	98.7
Organic Matter %	1.3	1.3
Average Organic Matter %	**1.3**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 27, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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MOISTURE, ASH, AND ORGANIC MATTER OF ORGANIC SOILS		Reference(s) ASTM D2974	
Client:	Coastal GasLink	**Borehole:**	BH20-MOR-05
Project:	Morice River Geotechnical Investigation	**Sample:**	21
Location:	Morice River, BC	**Depth (m):**	16.76 - 16.86
Project No.:	19122805-7000	**Lab ID No.:**	B20-443
Method:	Method A	**Other Remarks:**	
Oven Temperature	110±5°C	Gravel retained on 4.75 mm screen removed prior to testing.	
Furnace Temperature	440±40°C		

Moisture Content %	10.9	
Trial #	1	2
Ash Content %	97.8	97.8
Organic Matter %	2.2	2.2
Average Organic Matter %	**2.2**	

Note: moisture content as a percentage of oven-dried mass

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

DC	January 27, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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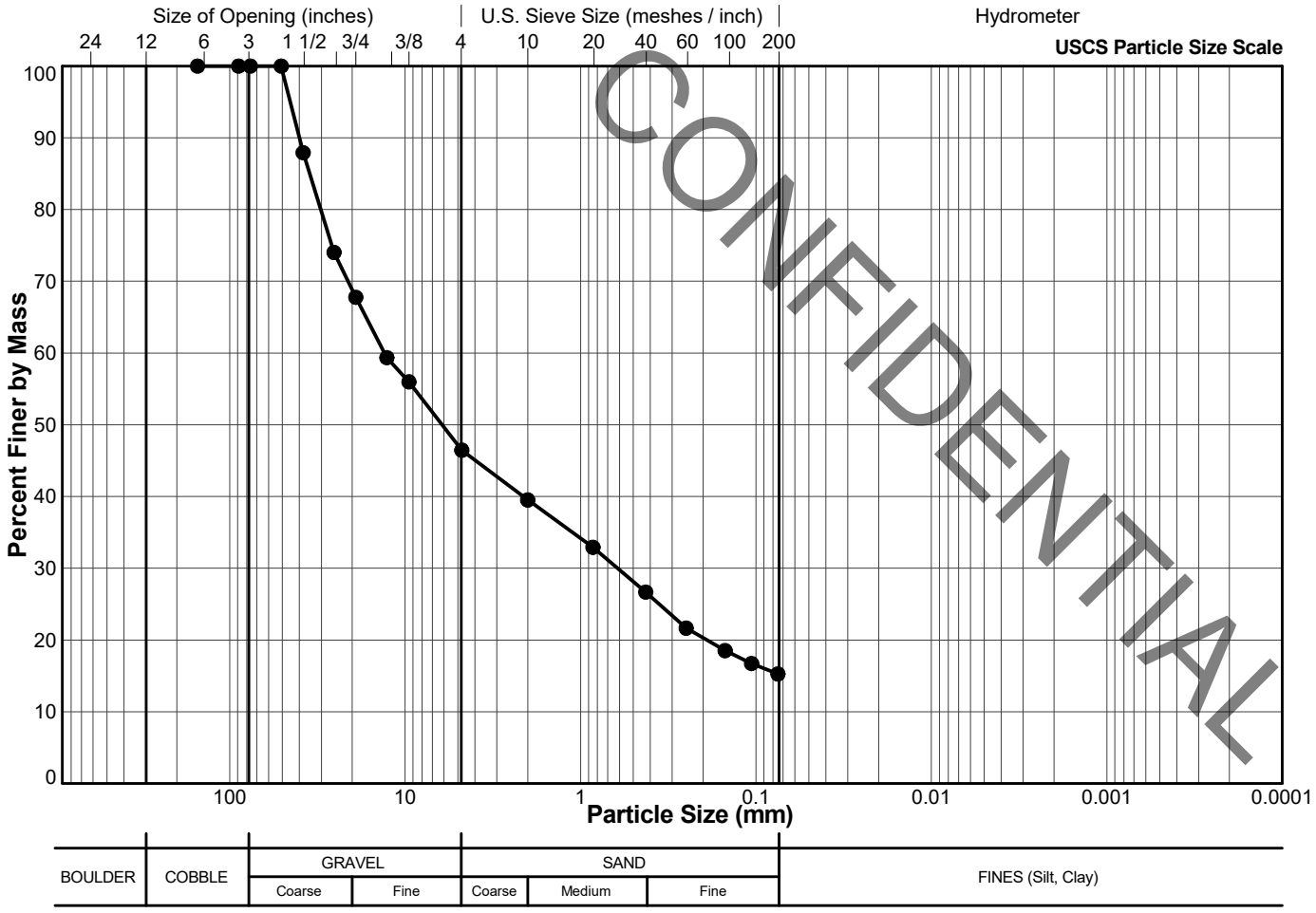
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 16
Depth Interval (m): 14.33 to 14.48
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		87.9
1"	25.4		74.0
3/4"	19.1		67.8
1/2"	12.7		59.4
3/8"	9.5		56.0
#4 US MESH	4.75		46.5
#10 US MESH	2		39.5
#20 US MESH	0.85		32.9
#40 US MESH	0.425		26.7
#60 US MESH	0.25		21.7
#100 US MESH	0.15		18.5
#140 US MESH	0.106		16.7
#200 US MESH	0.075		15.3

KS	1/4/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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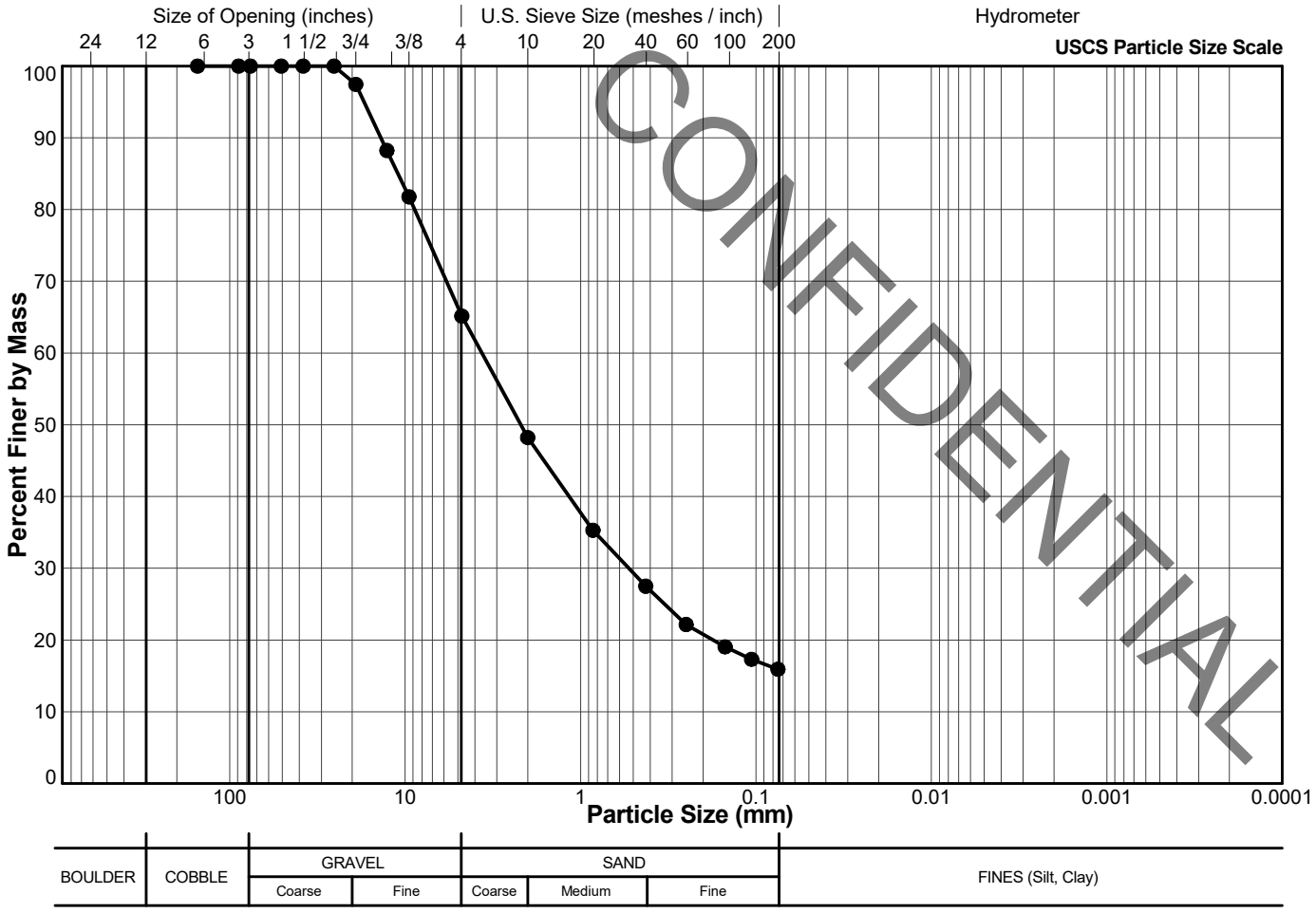
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 26
Depth Interval (m): 25.91 to 26.06
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		97.4
1/2"	12.7		88.2
3/8"	9.5		81.8
#4 US MESH	4.75		65.1
#10 US MESH	2		48.2
#20 US MESH	0.85		35.3
#40 US MESH	0.425		27.5
#60 US MESH	0.25		22.2
#100 US MESH	0.15		19.0
#140 US MESH	0.106		17.3
#200 US MESH	0.075		15.9

KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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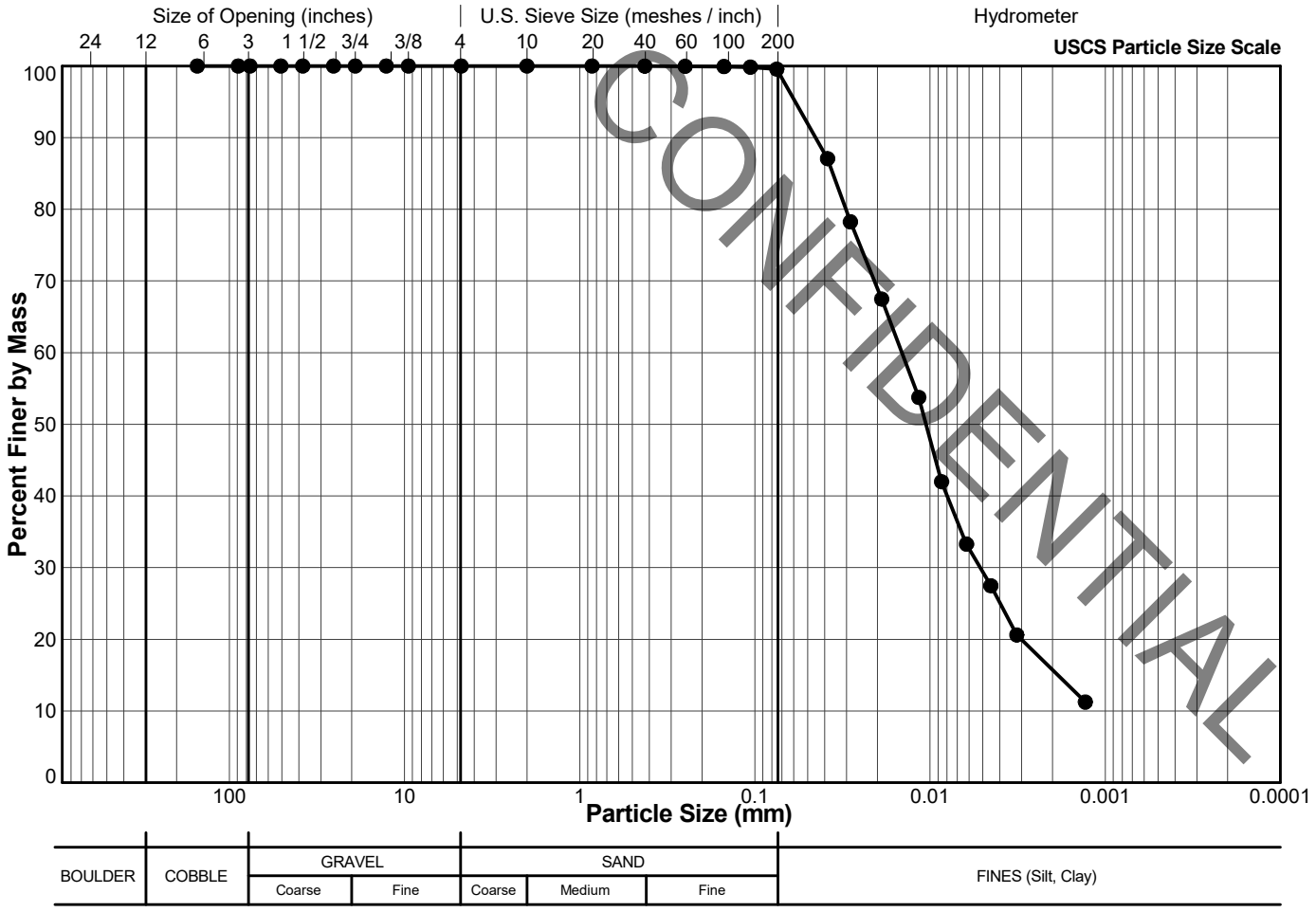
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 32
Depth Interval (m): 35.05 to 35.20
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		100.0
#60 US MESH	0.25		100.0
#100 US MESH	0.15		99.9
#140 US MESH	0.106		99.8
#200 US MESH	0.075		99.6
		0.0385	87.1
		0.0285	78.3
		0.0189	67.5
		0.0116	53.8
		0.0086	42.0
		0.0062	33.3
		0.0045	27.5
		0.0032	20.6
		0.0013	11.2

VN/KS	1/5/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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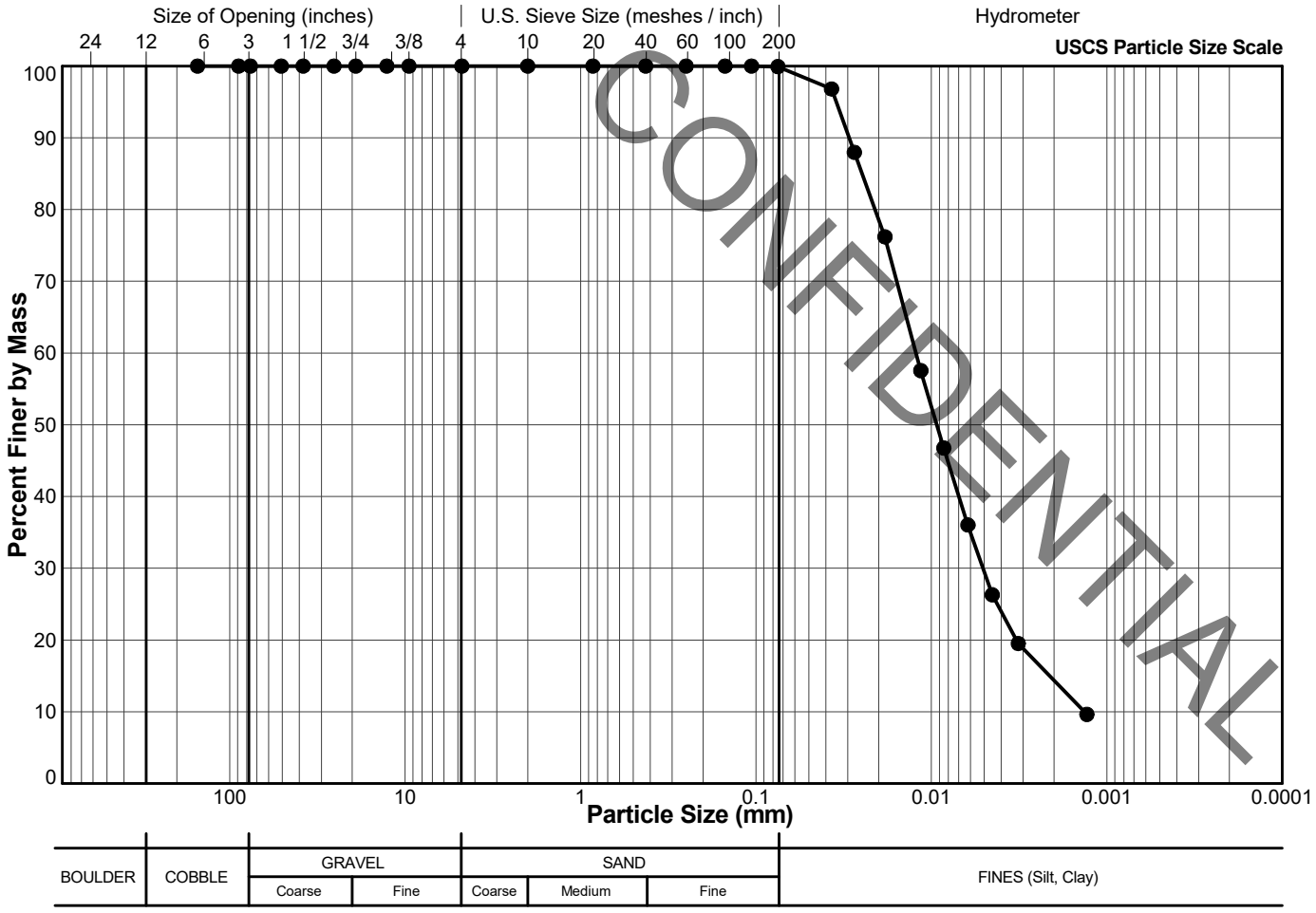
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 34
Depth Interval (m): 40.84 to 41.00
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		100.0
#60 US MESH	0.25		100.0
#100 US MESH	0.15		100.0
#140 US MESH	0.106		100.0
#200 US MESH	0.075		99.9
		0.0371	96.8
		0.0275	88.0
		0.0184	76.2
		0.0115	57.6
		0.0085	46.8
		0.0062	36.0
		0.0045	26.3
		0.0032	19.5
		0.0013	9.6

VN/KS	1/5/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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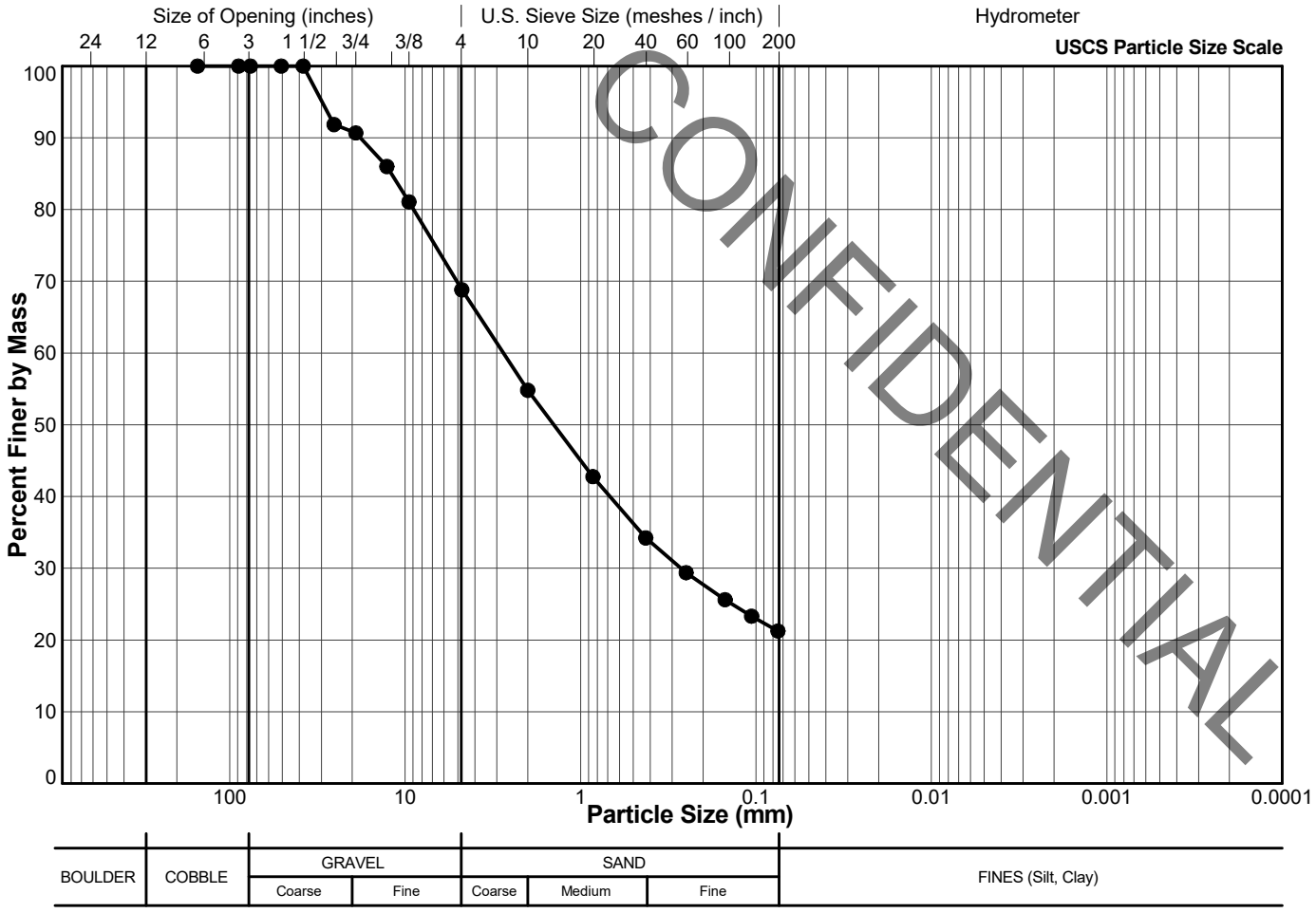
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 39
Depth Interval (m): 53.34 to 53.49
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		91.8
3/4"	19.1		90.7
1/2"	12.7		86.0
3/8"	9.5		81.1
#4 US MESH	4.75		68.8
#10 US MESH	2		54.8
#20 US MESH	0.85		42.8
#40 US MESH	0.425		34.2
#60 US MESH	0.25		29.4
#100 US MESH	0.15		25.6
#140 US MESH	0.106		23.3
#200 US MESH	0.075		21.3

KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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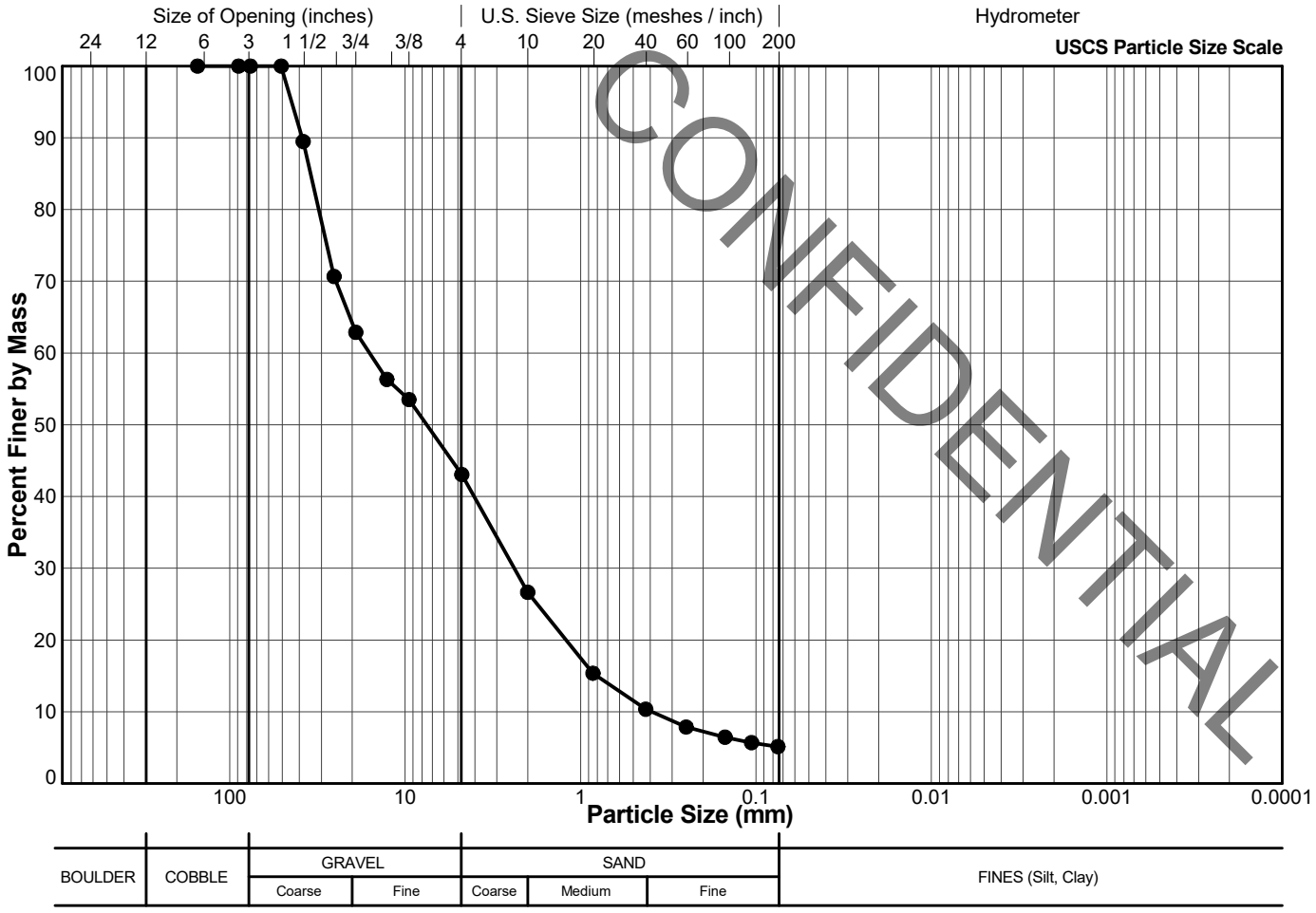
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 40
Depth Interval (m): 56.08 to 56.24
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		89.5
1"	25.4		70.7
3/4"	19.1		62.9
1/2"	12.7		56.3
3/8"	9.5		53.5
#4 US MESH	4.75		43.1
#10 US MESH	2		26.6
#20 US MESH	0.85		15.4
#40 US MESH	0.425		10.4
#60 US MESH	0.25		7.9
#100 US MESH	0.15		6.5
#140 US MESH	0.106		5.7
#200 US MESH	0.075		5.1

KS	1/4/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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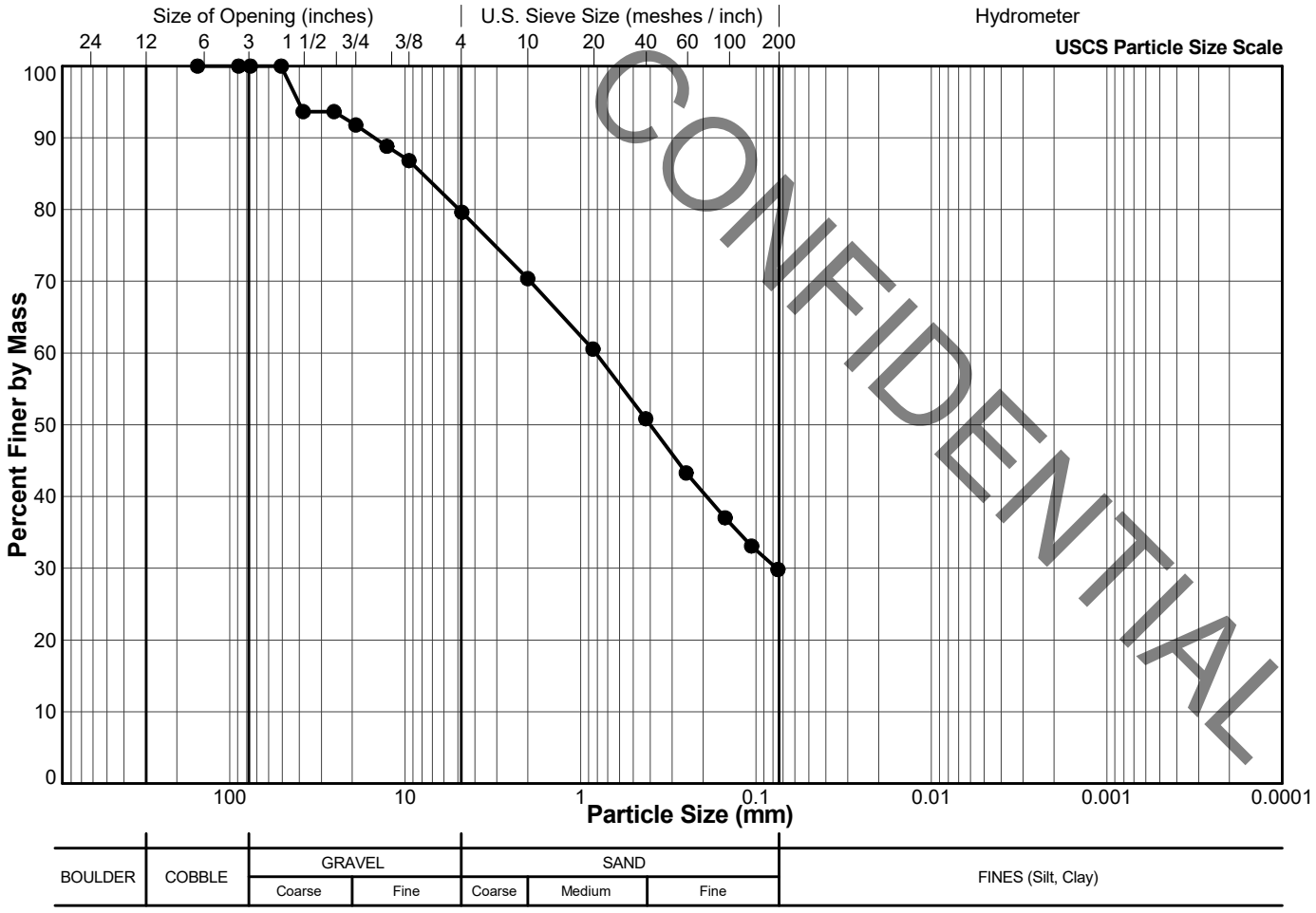
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-01
Sample No.: 42
Depth Interval (m): 63.09 to 63.25
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		93.7
1"	25.4		93.7
3/4"	19.1		91.8
1/2"	12.7		88.8
3/8"	9.5		86.8
#4 US MESH	4.75		79.6
#10 US MESH	2		70.4
#20 US MESH	0.85		60.6
#40 US MESH	0.425		50.8
#60 US MESH	0.25		43.3
#100 US MESH	0.15		37.0
#140 US MESH	0.106		33.1
#200 US MESH	0.075		29.8

KS	1/4/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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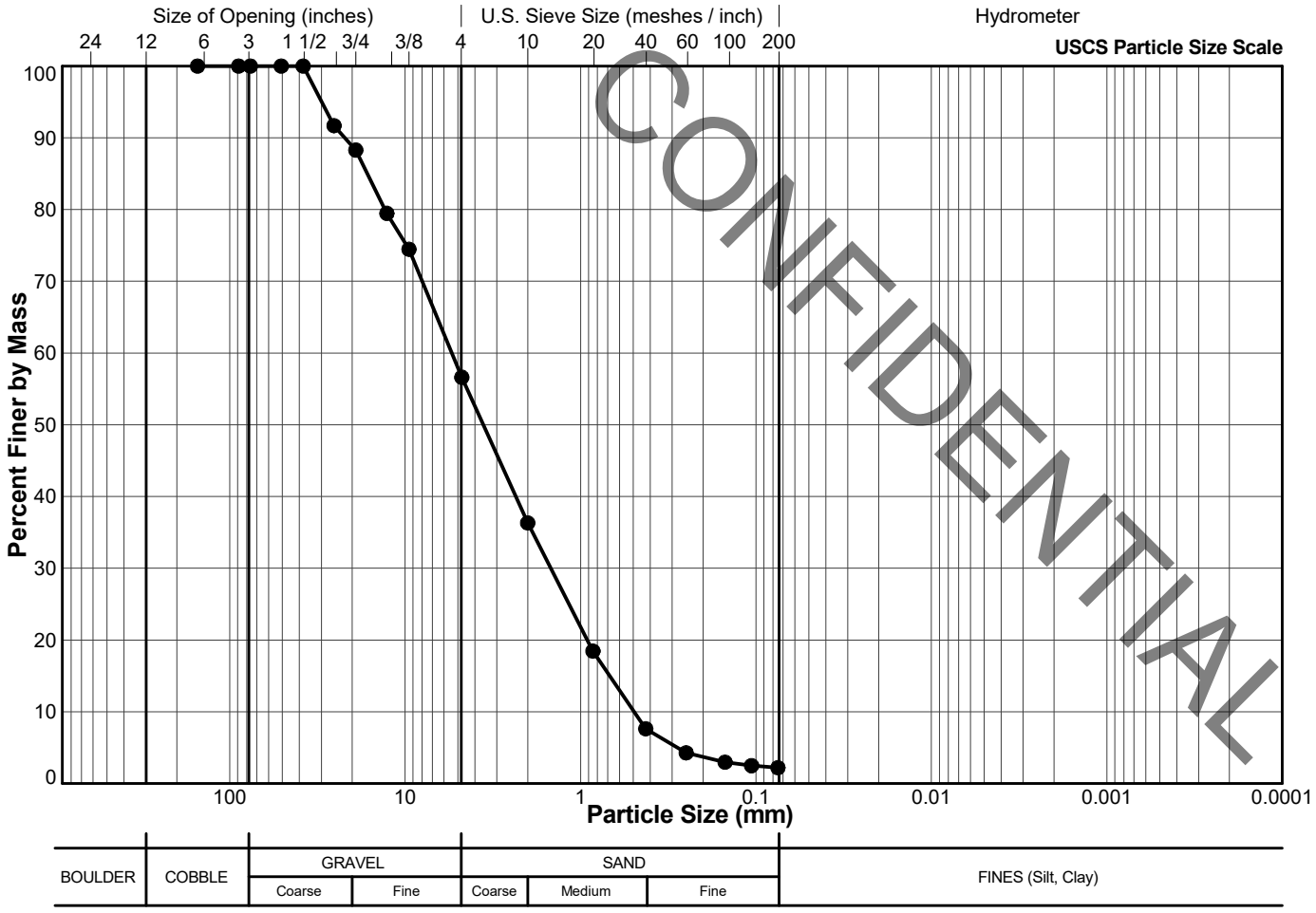
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 8
Depth Interval (m): 5.64 to 5.79
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		91.7
3/4"	19.1		88.3
1/2"	12.7		79.5
3/8"	9.5		74.5
#4 US MESH	4.75		56.6
#10 US MESH	2		36.3
#20 US MESH	0.85		18.5
#40 US MESH	0.425		7.6
#60 US MESH	0.25		4.3
#100 US MESH	0.15		3.0
#140 US MESH	0.106		2.5
#200 US MESH	0.075		2.2

KS	1/4/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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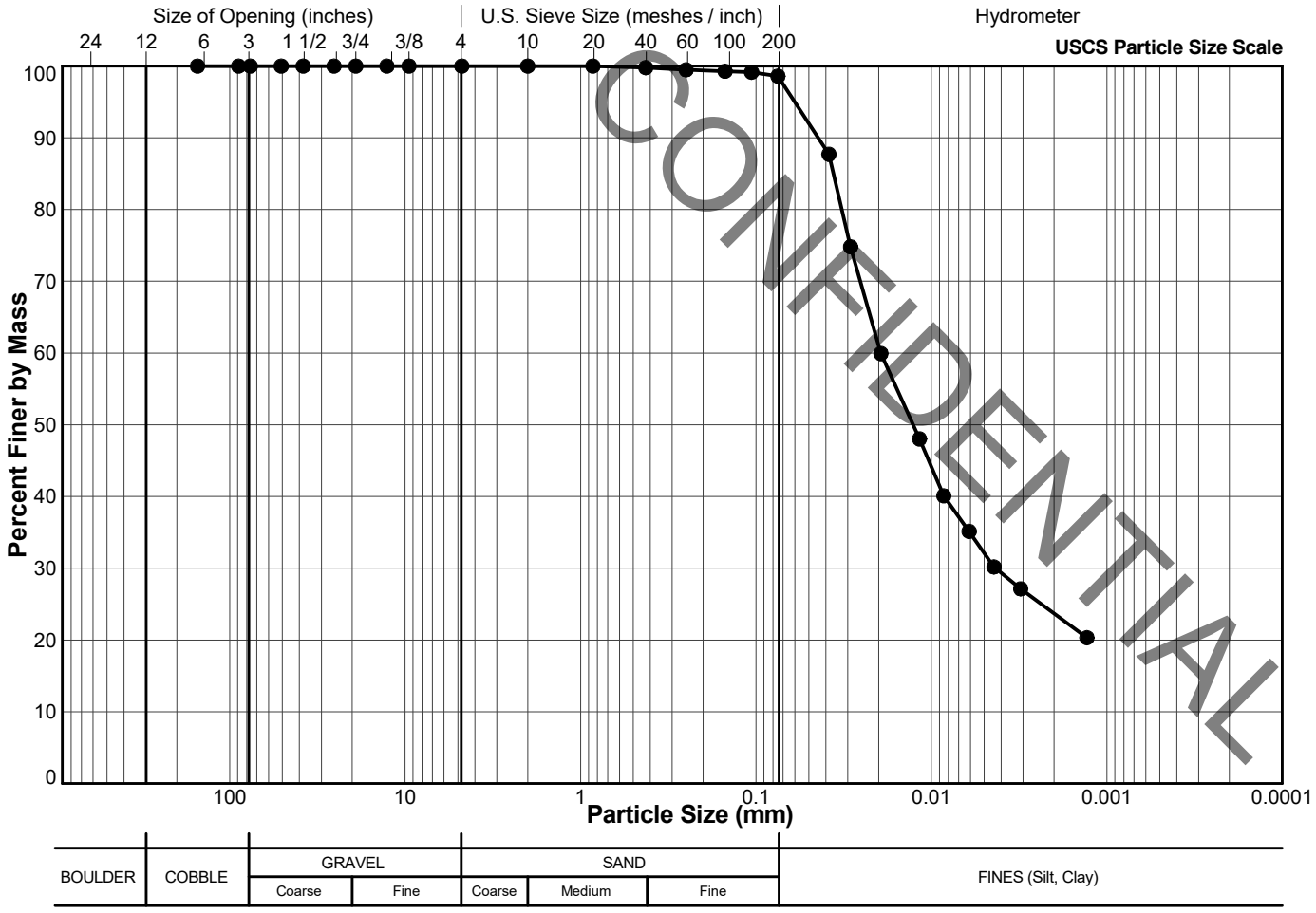
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 12
Depth Interval (m): 8.53 to 8.69
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		99.8
#60 US MESH	0.25		99.5
#100 US MESH	0.15		99.3
#140 US MESH	0.106		99.1
#200 US MESH	0.075		98.6
		0.0384	87.7
		0.0289	74.8
		0.0194	59.9
		0.0117	48.0
		0.0085	40.1
		0.0061	35.1
		0.0044	30.2
		0.0031	27.1
		0.0013	20.3

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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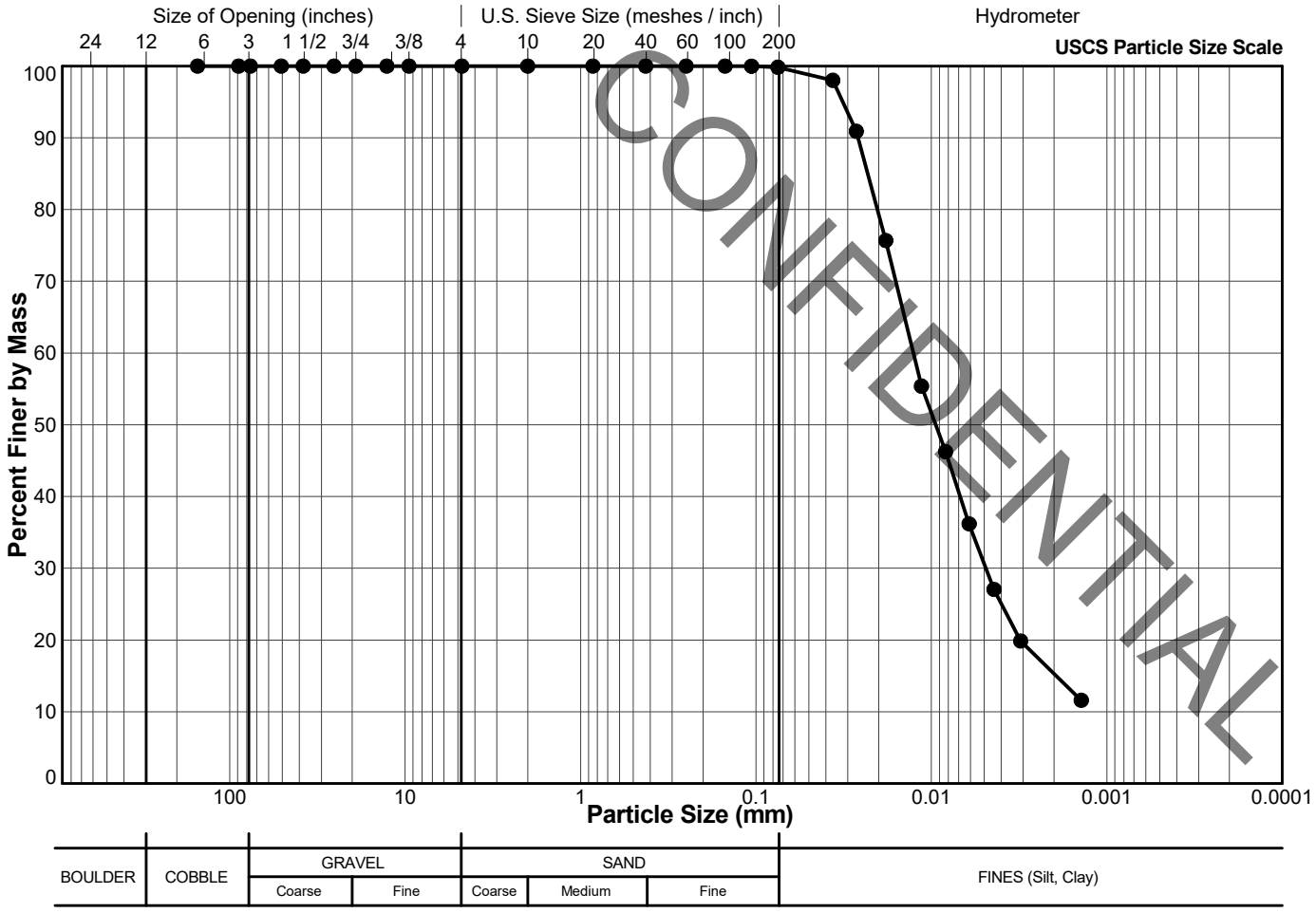
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 23
Depth Interval (m): 17.68 to 17.83
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		100.0
#60 US MESH	0.25		100.0
#100 US MESH	0.15		100.0
#140 US MESH	0.106		100.0
#200 US MESH	0.075		99.8
		0.0365	98.0
		0.0268	90.9
		0.0182	75.7
		0.0114	55.4
		0.0083	46.3
		0.0061	36.2
		0.0044	27.1
		0.0031	19.9
		0.0014	11.6

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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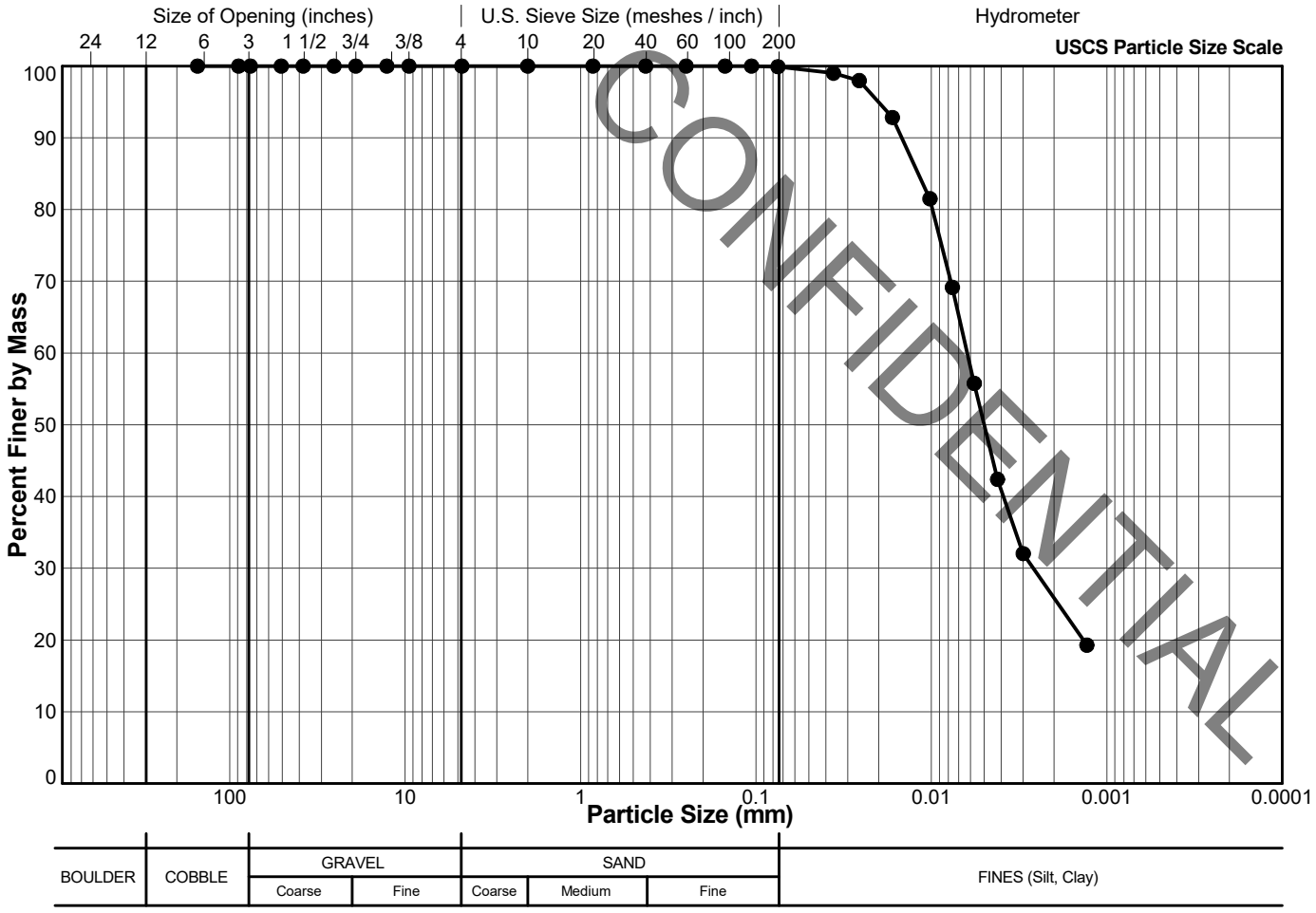
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 27
Depth Interval (m): 23.16 to 23.32
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		100.0
#60 US MESH	0.25		100.0
#100 US MESH	0.15		100.0
#140 US MESH	0.106		100.0
#200 US MESH	0.075		99.9
		0.0362	99.0
		0.0258	98.0
		0.0167	92.8
		0.0102	81.5
		0.0076	69.2
		0.0057	55.8
		0.0042	42.4
		0.0030	32.0
		0.0013	19.3

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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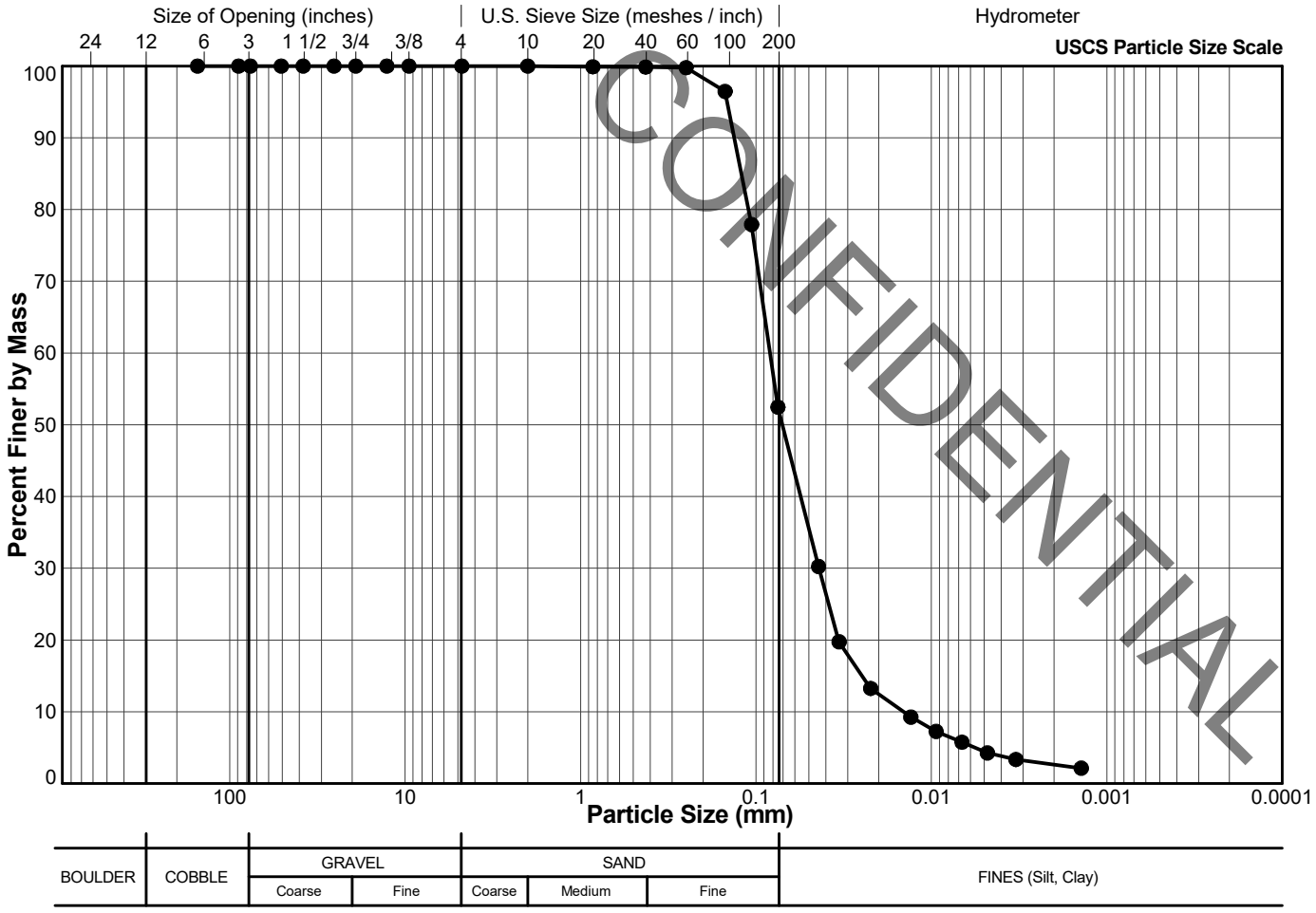
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 38
Depth Interval (m): 36.58 to 36.73
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		99.9
#40 US MESH	0.425		99.9
#60 US MESH	0.25		99.8
#100 US MESH	0.15		96.5
#140 US MESH	0.106		77.9
#200 US MESH	0.075		52.5
		0.0440	30.2
		0.0336	19.7
		0.0222	13.2
		0.0131	9.3
		0.0094	7.3
		0.0067	5.8
		0.0048	4.3
		0.0033	3.3
		0.0014	2.1

DC/KS	1/8/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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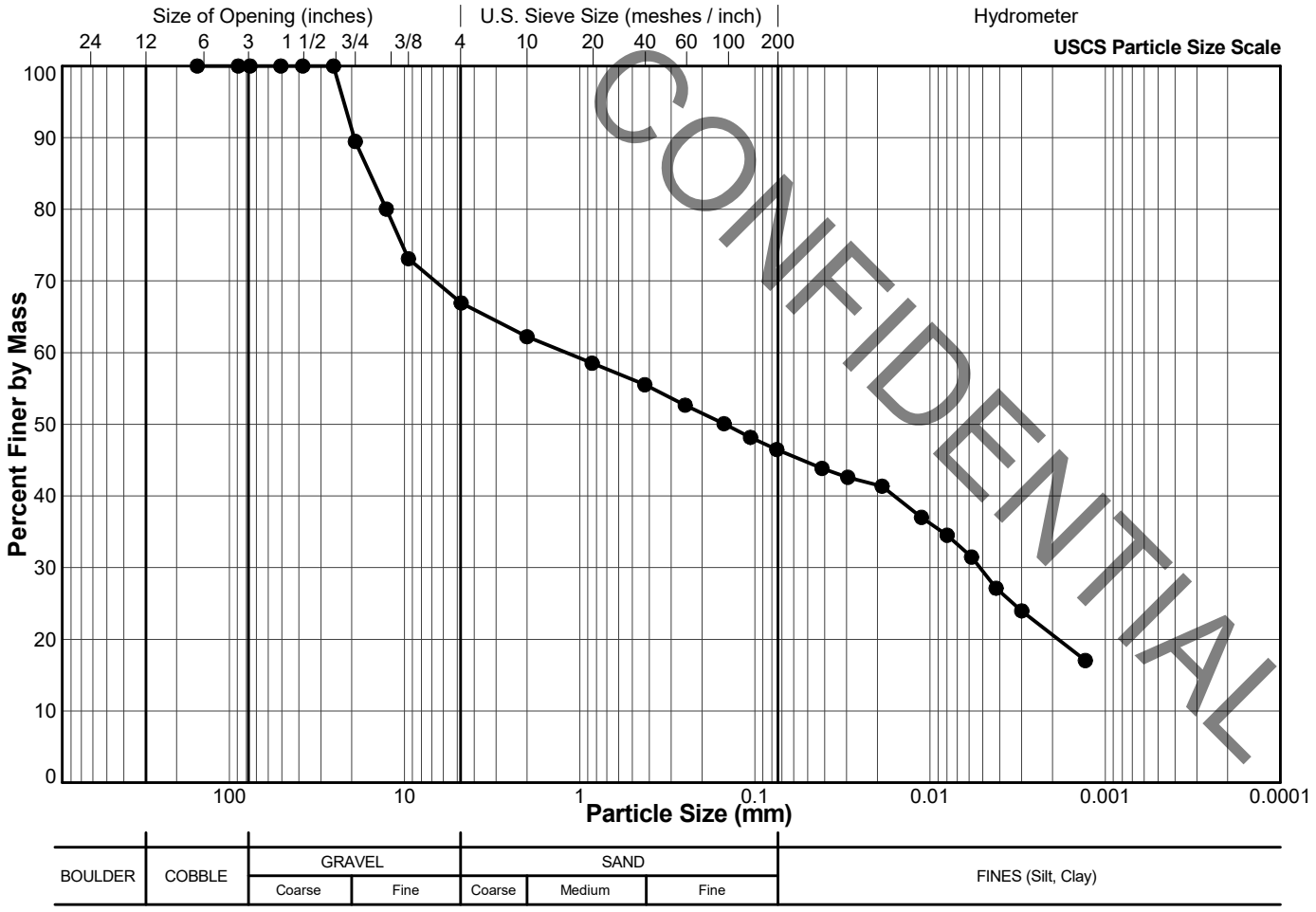
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-02
Sample No.: 46
Depth Interval (m): 48.16 to 48.31
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		89.5
1/2"	12.7		80.0
3/8"	9.5		73.1
#4 US MESH	4.75		66.9
#10 US MESH	2		62.2
#20 US MESH	0.85		58.5
#40 US MESH	0.425		55.5
#60 US MESH	0.25		52.7
#100 US MESH	0.15		50.1
#140 US MESH	0.106		48.2
#200 US MESH	0.075		46.5
		0.0414	43.8
		0.0295	42.6
		0.0188	41.4
		0.0112	37.0
		0.0080	34.5
		0.0058	31.5
		0.0042	27.1
		0.0030	24.0
		0.0013	17.0

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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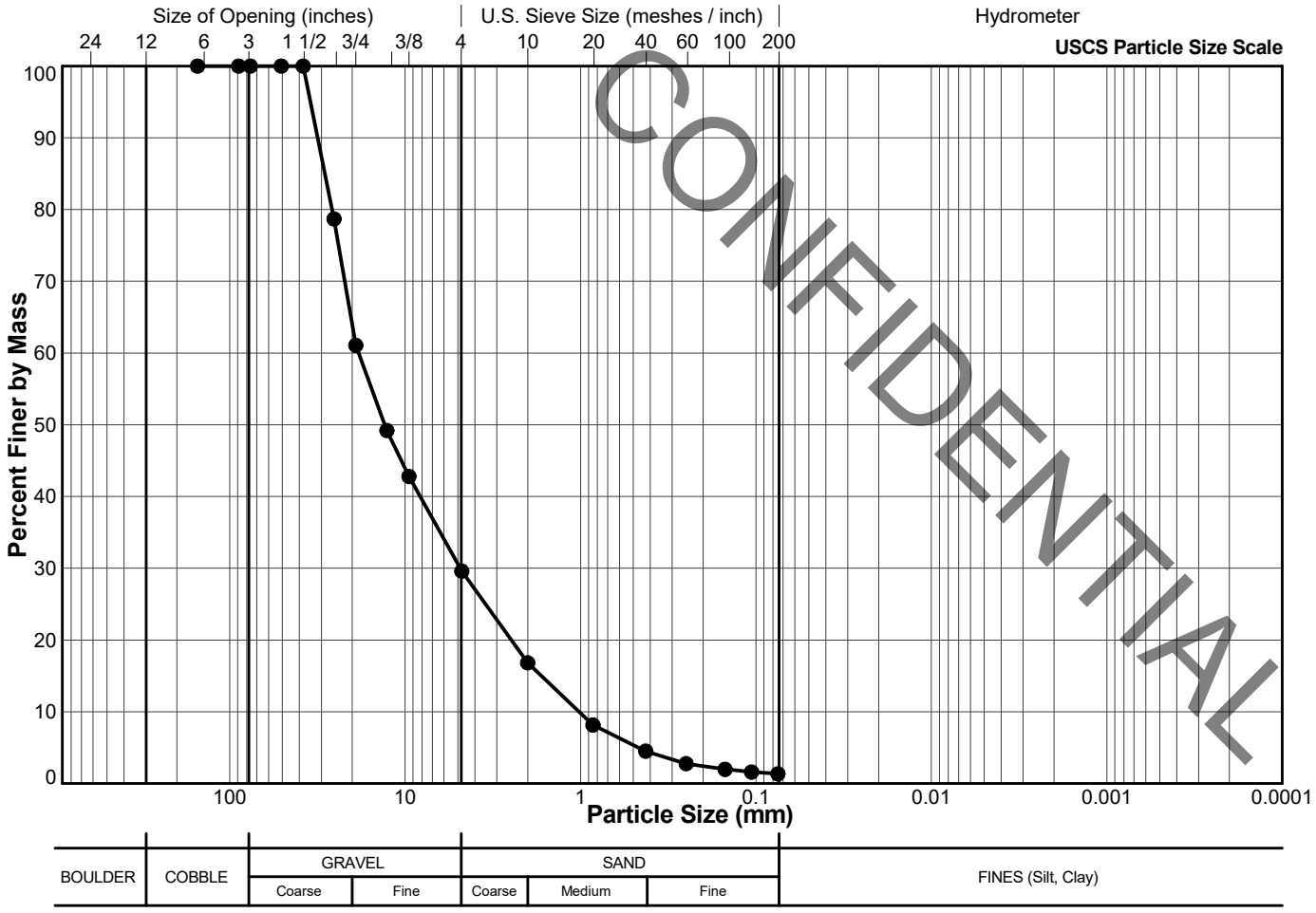
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-03
Sample No.: 5
Depth Interval (m): 4.72 to 4.88
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		78.7
3/4"	19.1		61.1
1/2"	12.7		49.2
3/8"	9.5		42.8
#4 US MESH	4.75		29.6
#10 US MESH	2		16.8
#20 US MESH	0.85		8.2
#40 US MESH	0.425		4.5
#60 US MESH	0.25		2.8
#100 US MESH	0.15		2.0
#140 US MESH	0.106		1.6
#200 US MESH	0.075		1.3

KS	1/5/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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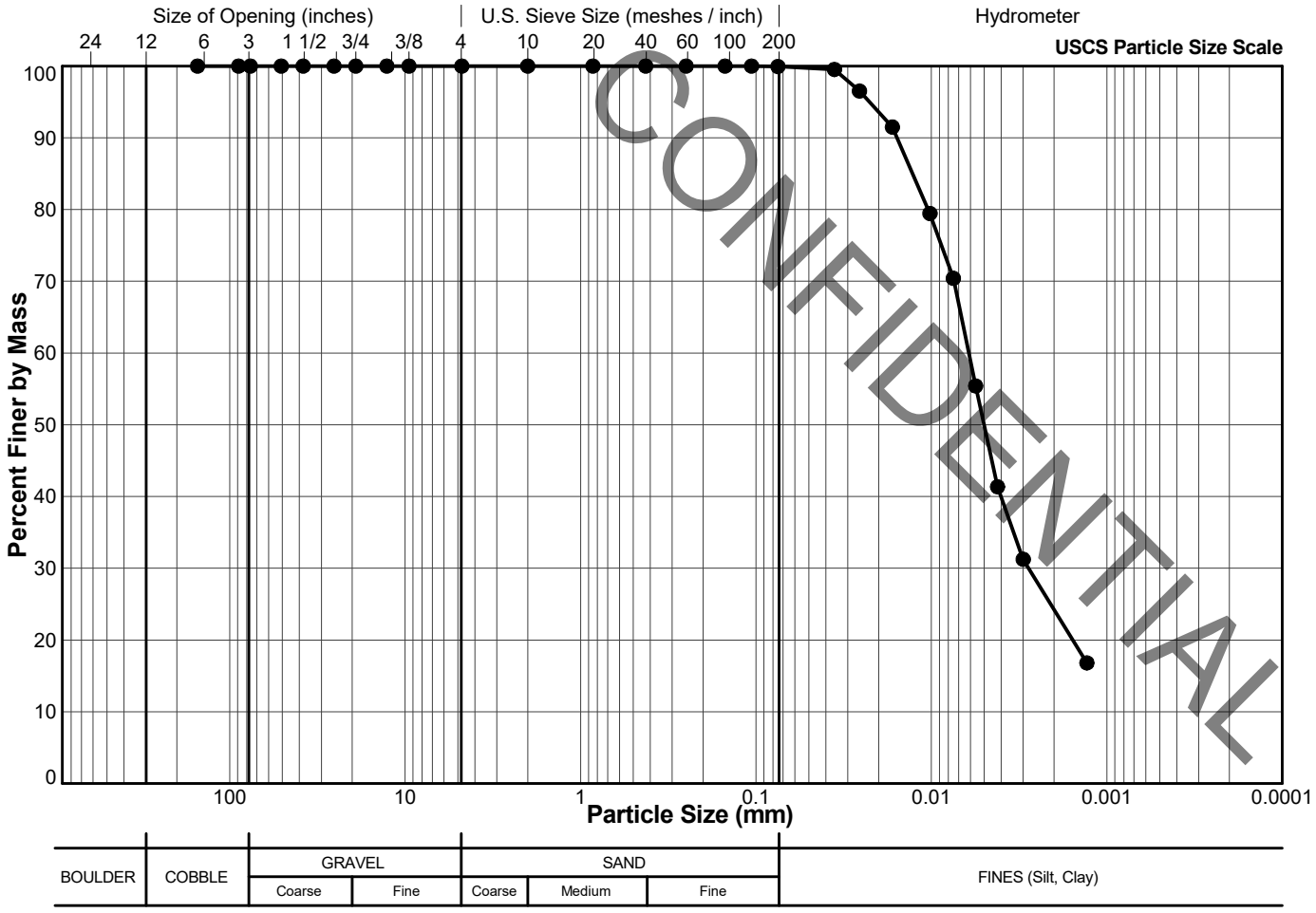
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-03
Sample No.: 8
Depth Interval (m): 6.55 to 6.71
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		100.0
#10 US MESH	2		100.0
#20 US MESH	0.85		100.0
#40 US MESH	0.425		100.0
#60 US MESH	0.25		100.0
#100 US MESH	0.15		100.0
#140 US MESH	0.106		100.0
#200 US MESH	0.075		99.9
		0.0357	99.5
		0.0257	96.5
		0.0167	91.5
		0.0102	79.4
		0.0075	70.4
		0.0056	55.4
		0.0042	41.4
		0.0030	31.3
		0.0013	16.8

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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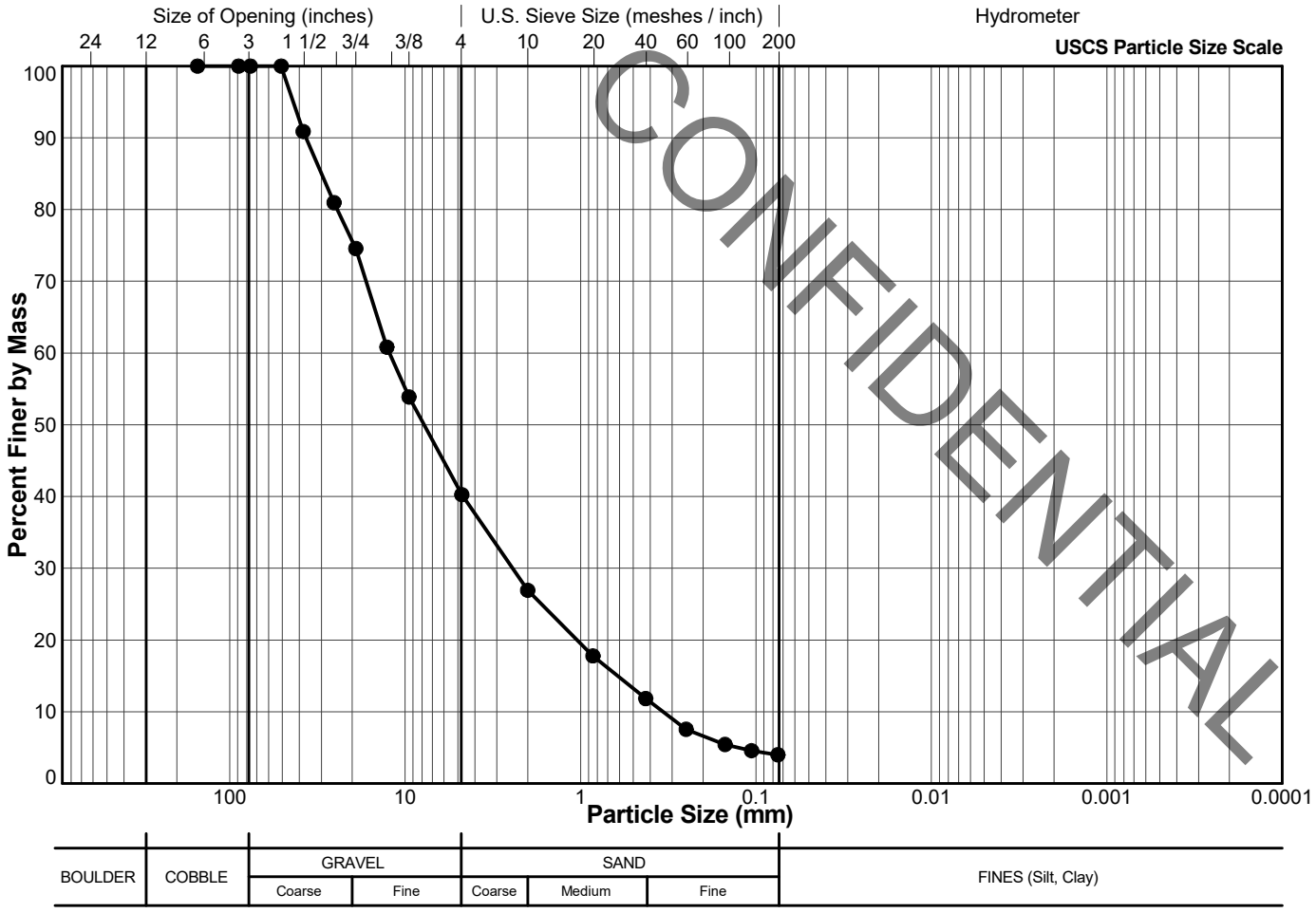
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-03
Sample No.: 19
Depth Interval (m): 13.87 to 14.02
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		90.9
1"	25.4		81.0
3/4"	19.1		74.6
1/2"	12.7		60.8
3/8"	9.5		53.9
#4 US MESH	4.75		40.3
#10 US MESH	2		26.9
#20 US MESH	0.85		17.8
#40 US MESH	0.425		11.8
#60 US MESH	0.25		7.6
#100 US MESH	0.15		5.4
#140 US MESH	0.106		4.6
#200 US MESH	0.075		4.0

KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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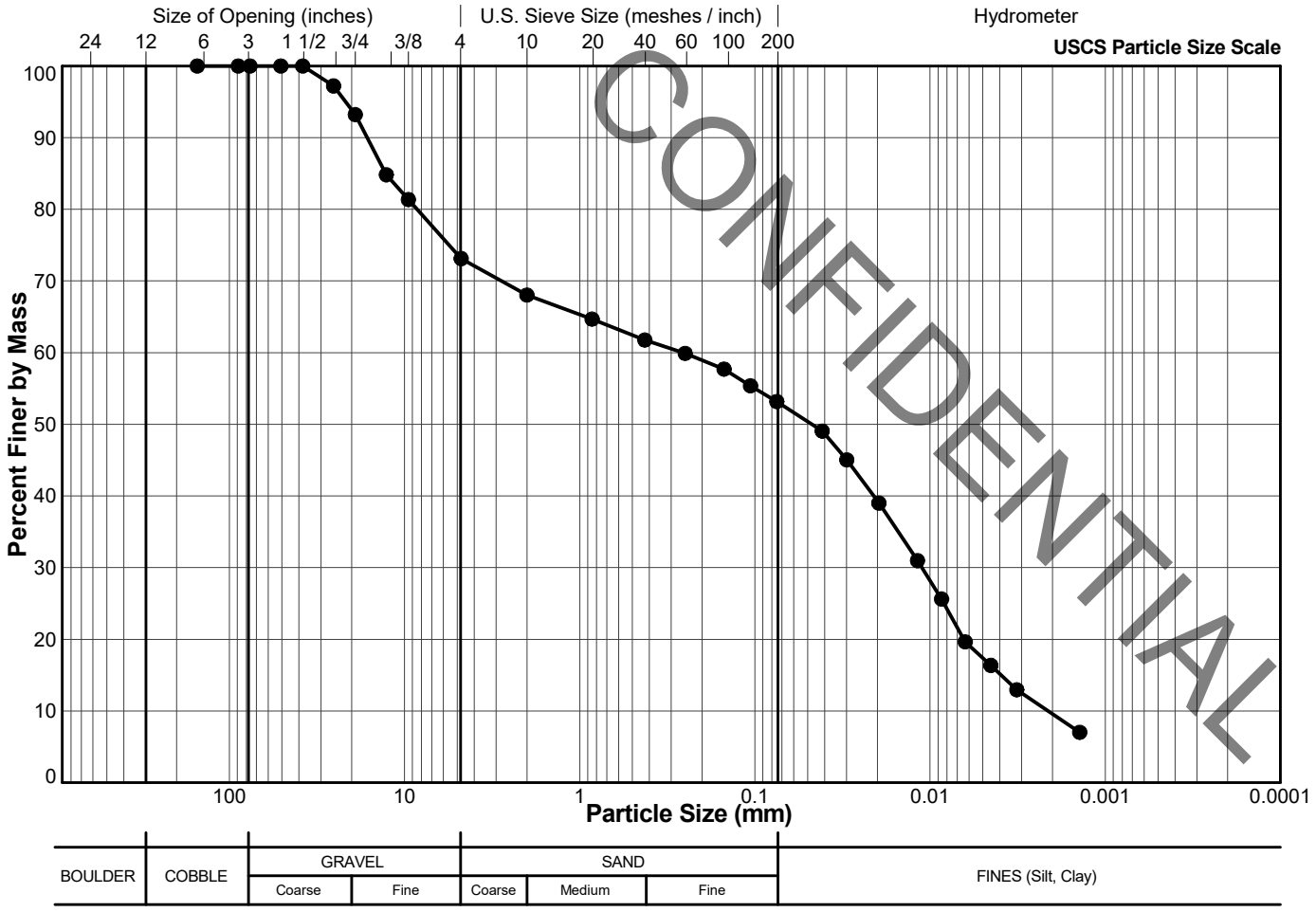
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-03
Sample No.: 27
Depth Interval (m): 23.47 to 23.62
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		97.2
3/4"	19.1		93.2
1/2"	12.7		84.8
3/8"	9.5		81.4
#4 US MESH	4.75		73.1
#10 US MESH	2		68.0
#20 US MESH	0.85		64.7
#40 US MESH	0.425		61.8
#60 US MESH	0.25		59.9
#100 US MESH	0.15		57.7
#140 US MESH	0.106		55.4
#200 US MESH	0.075		53.2
		0.0413	49.1
		0.0299	45.0
		0.0196	39.0
		0.0118	31.0
		0.0086	25.6
		0.0063	19.6
		0.0045	16.4
		0.0032	13.0
		0.0014	7.0

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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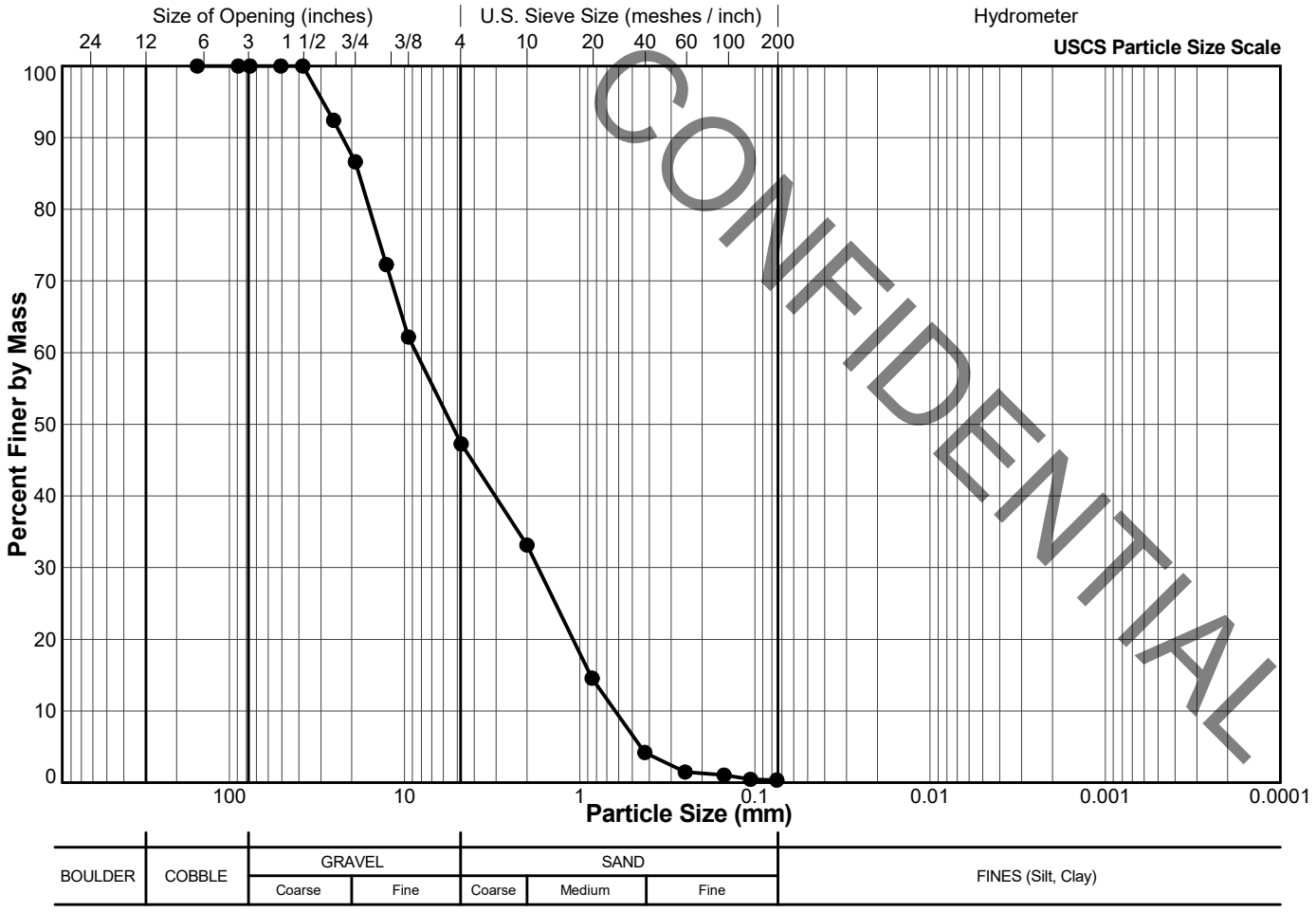
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-04
Sample No.: 6
Depth Interval (m): 4.88 to 5.03
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		92.4
3/4"	19.1		86.6
1/2"	12.7		72.3
3/8"	9.5		62.2
#4 US MESH	4.75		47.3
#10 US MESH	2		33.2
#20 US MESH	0.85		14.6
#40 US MESH	0.425		4.2
#60 US MESH	0.25		1.5
#100 US MESH	0.15		1.0
#140 US MESH	0.106		0.5
#200 US MESH	0.075		0.4

KS	1/4/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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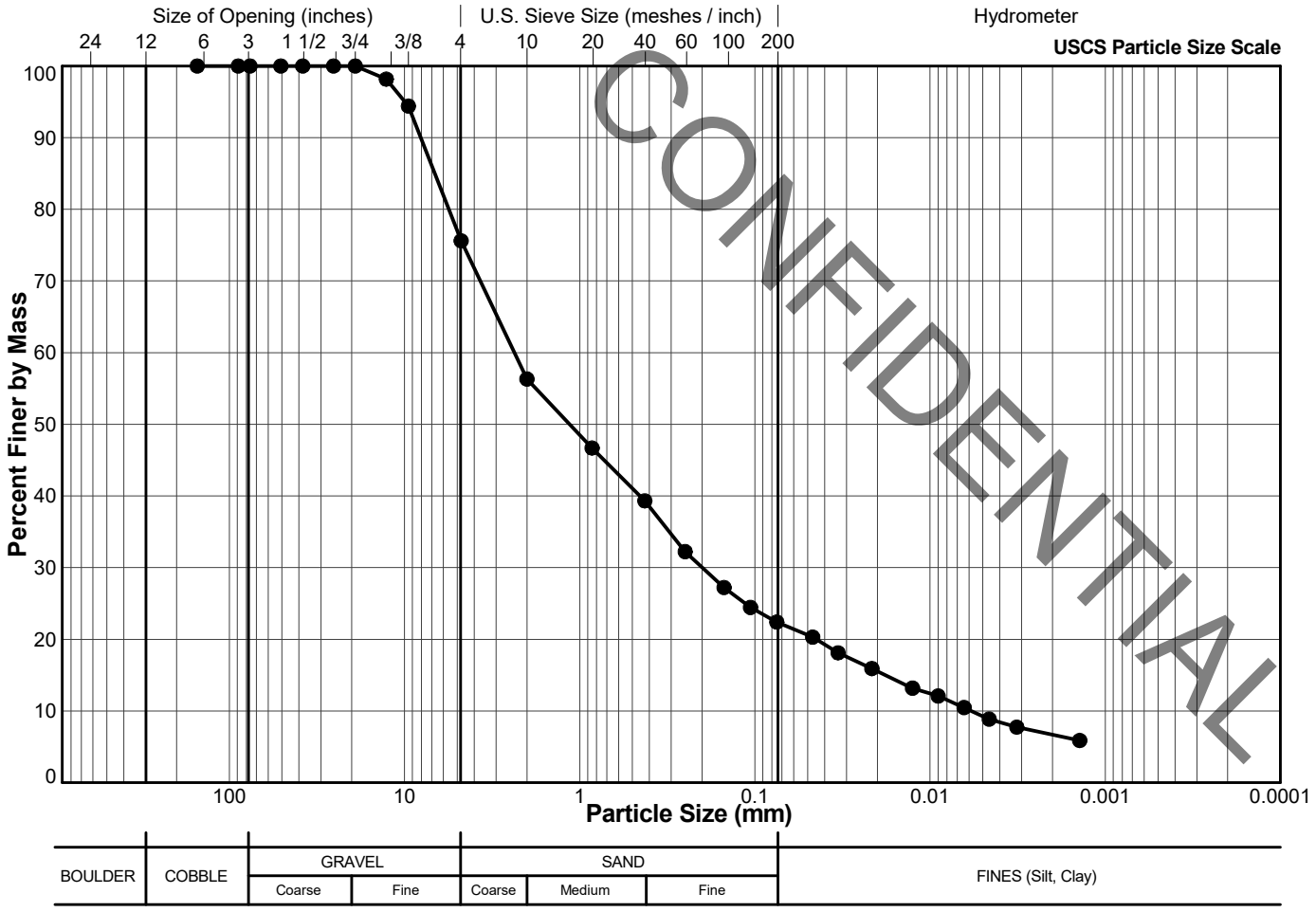
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-04
Sample No.: 13
Depth Interval (m): 8.53 to 8.69
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		98.2
3/8"	9.5		94.4
#4 US MESH	4.75		75.6
#10 US MESH	2		56.3
#20 US MESH	0.85		46.7
#40 US MESH	0.425		39.3
#60 US MESH	0.25		32.2
#100 US MESH	0.15		27.2
#140 US MESH	0.106		24.5
#200 US MESH	0.075		22.4
		0.0468	20.3
		0.0335	18.1
		0.0215	15.9
		0.0126	13.2
		0.0090	12.1
		0.0064	10.5
		0.0046	8.9
		0.0032	7.7
		0.0014	5.9

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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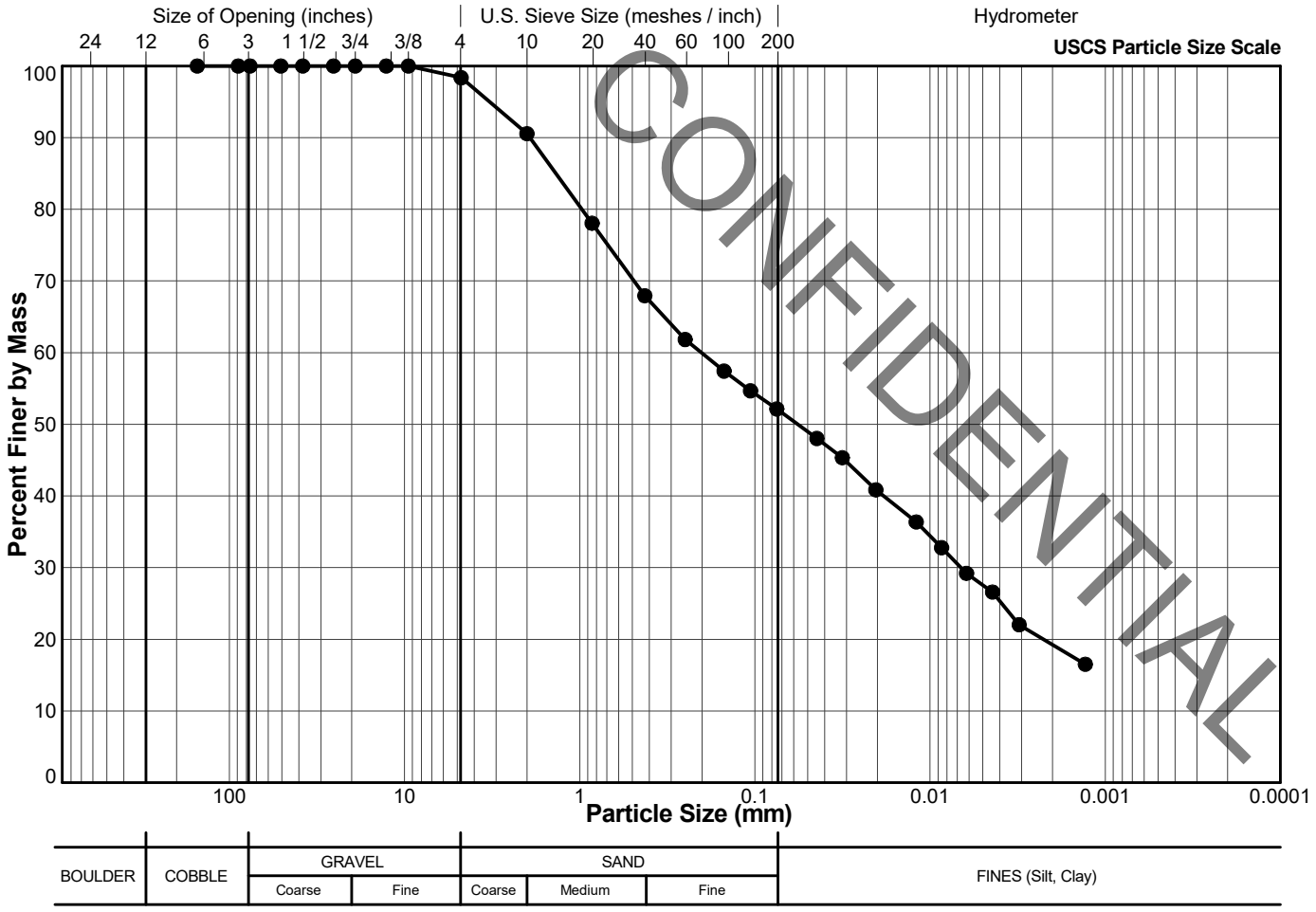
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-04
Sample No.: 17
Depth Interval (m): 12.34 to 12.50
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		100.0
3/4"	19.1		100.0
1/2"	12.7		100.0
3/8"	9.5		100.0
#4 US MESH	4.75		98.4
#10 US MESH	2		90.6
#20 US MESH	0.85		78.1
#40 US MESH	0.425		67.9
#60 US MESH	0.25		61.8
#100 US MESH	0.15		57.4
#140 US MESH	0.106		54.7
#200 US MESH	0.075		52.1
		0.0443	48.0
		0.0317	45.3
		0.0204	40.9
		0.0120	36.4
		0.0086	32.8
		0.0062	29.2
		0.0044	26.6
		0.0031	22.0
		0.0013	16.5

VN/KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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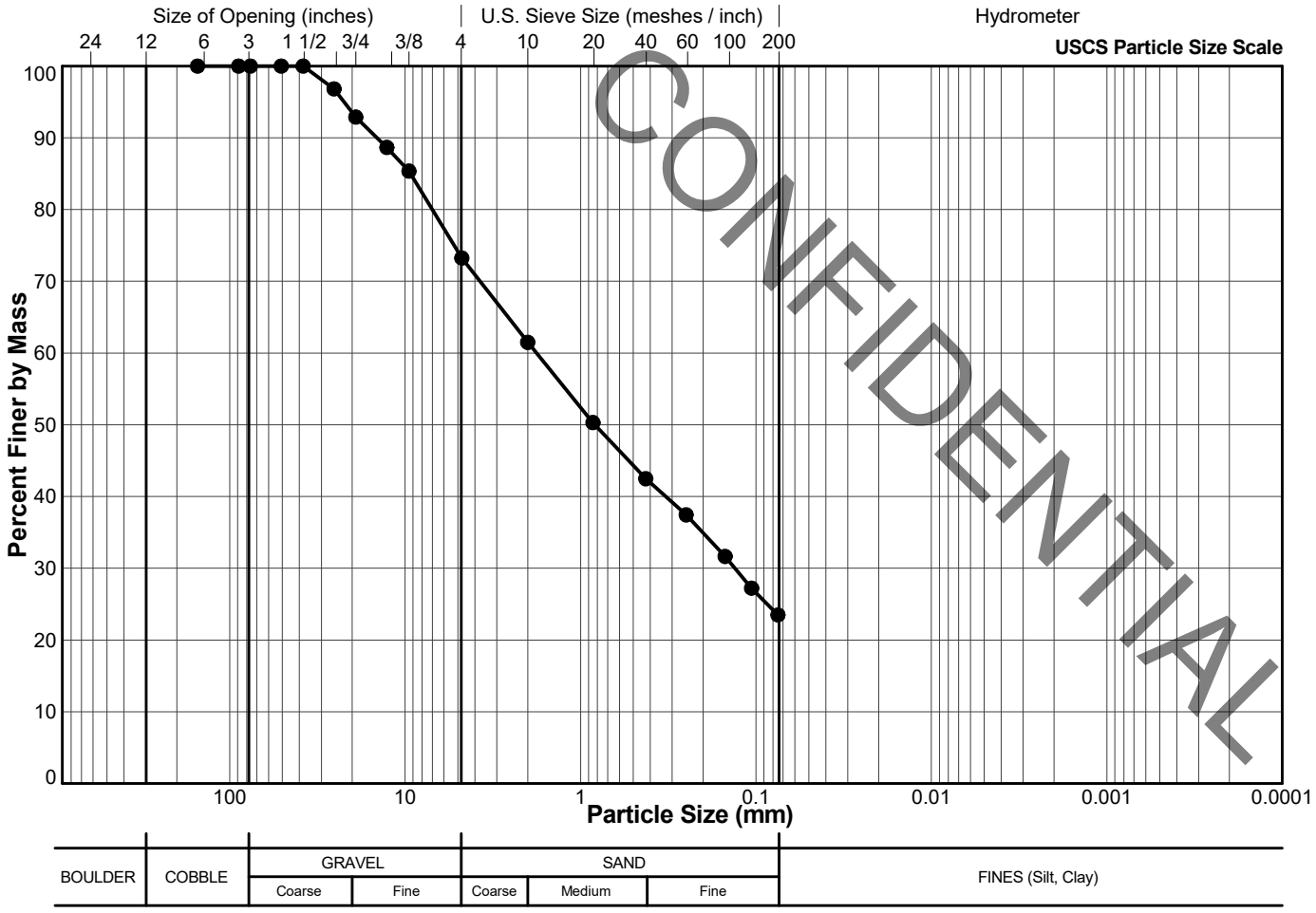
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D6913

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-05
Sample No.: 3
Depth Interval (m): 2.44 to 2.59
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		96.8
3/4"	19.1		92.9
1/2"	12.7		88.7
3/8"	9.5		85.4
#4 US MESH	4.75		73.2
#10 US MESH	2		61.5
#20 US MESH	0.85		50.3
#40 US MESH	0.425		42.5
#60 US MESH	0.25		37.4
#100 US MESH	0.15		31.7
#140 US MESH	0.106		27.2
#200 US MESH	0.075		23.5

KS	1/6/2021	SJ	1/11/2021
Tech	Date	Checked	Date

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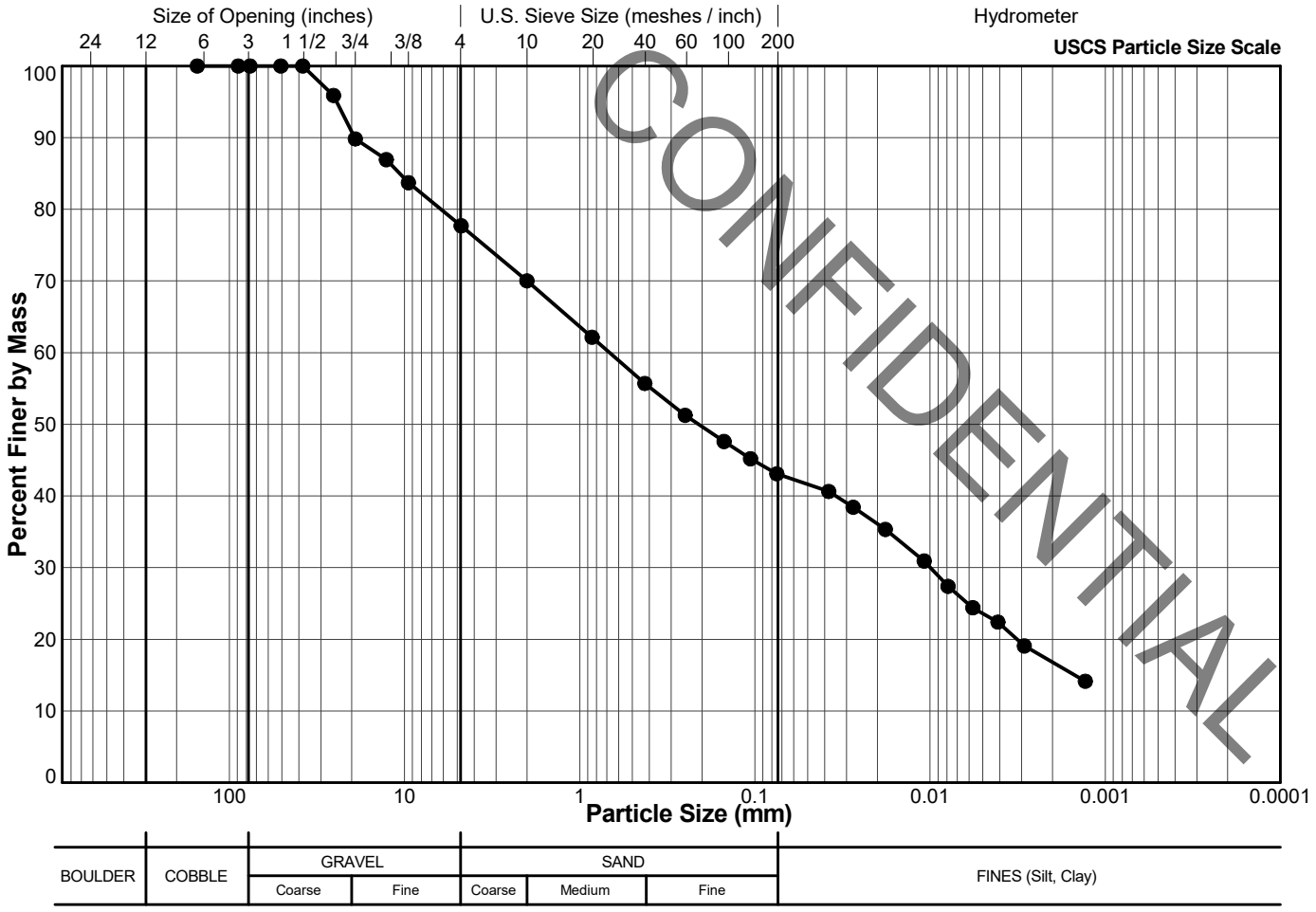
SUMMARY OF PARTICLE SIZE DISTRIBUTION

ASTM D 422

Client: Coastal GasLink
Project: Morice River Geotechnical Investigation
Location: Morice River, BC
Project No.: 19122805 **Phase:** 7000

Sample Location: BH20-MOR-05
Sample No.: 20
Depth Interval (m): 16.00 to 16.15
Lab Schedule No.:



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
6"	152.4		100.0
3.5"	88.9		100.0
3"	76.2		100.0
2"	50.8		100.0
1 1/2"	38.1		100.0
1"	25.4		95.9
3/4"	19.1		89.8
1/2"	12.7		86.9
3/8"	9.5		83.7
#4 US MESH	4.75		77.7
#10 US MESH	2		70.0
#20 US MESH	0.85		62.2
#40 US MESH	0.425		55.7
#60 US MESH	0.25		51.3
#100 US MESH	0.15		47.6
#140 US MESH	0.106		45.2
#200 US MESH	0.075		43.1
		0.0379	40.6
		0.0275	38.4
		0.0180	35.3
		0.0108	30.9
		0.0079	27.4
		0.0057	24.4
		0.0041	22.4
		0.0029	19.1
		0.0013	14.1

KS	1/25/2021	SJ	1/29/2021
Tech	Date	Checked	Date

National IM Server:GINT_GAL_NATIONALIM Unique Project ID:2660 Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) 2018 SJohn 29/1/21

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

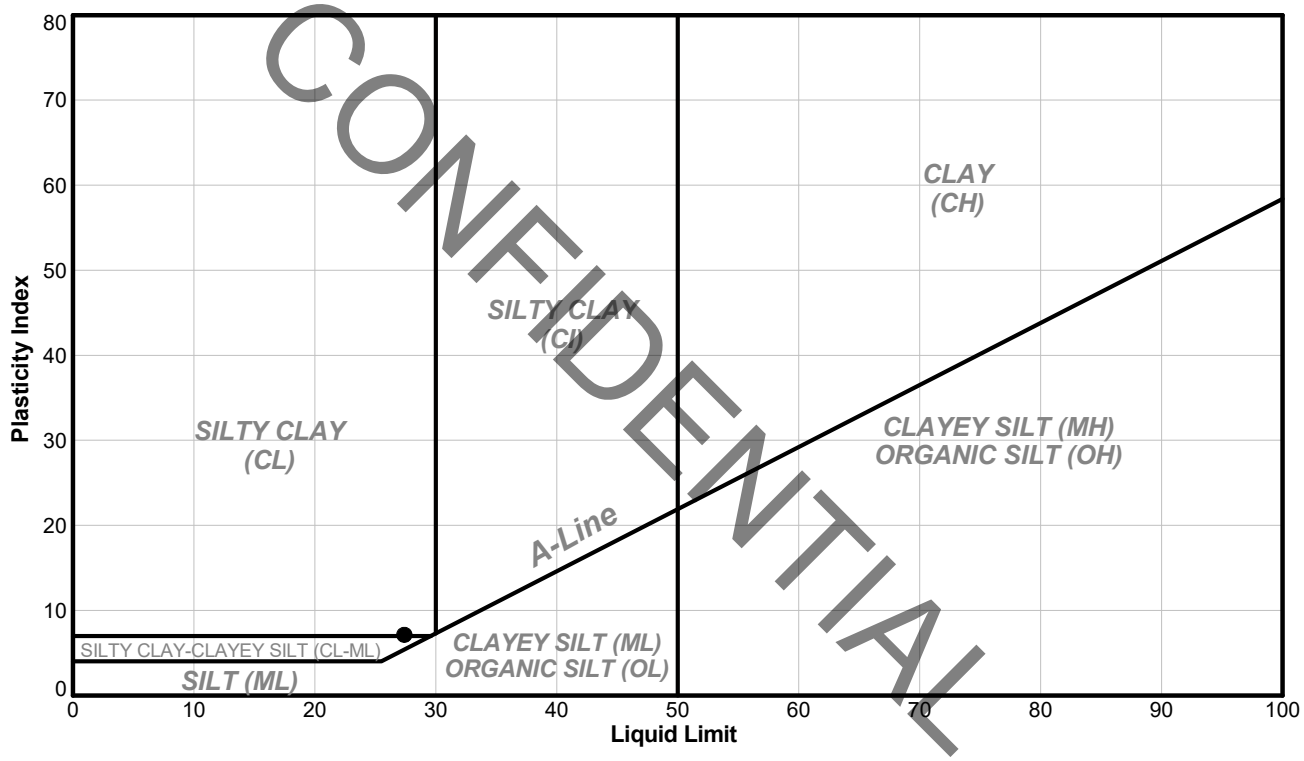
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-01**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**5**
Location:	Morice River, BC	**Depth Interval (m):**	4.27 to 4.42
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-01	5	4.27	4.42	ND	27	20	7.0	8.9	-1.6

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

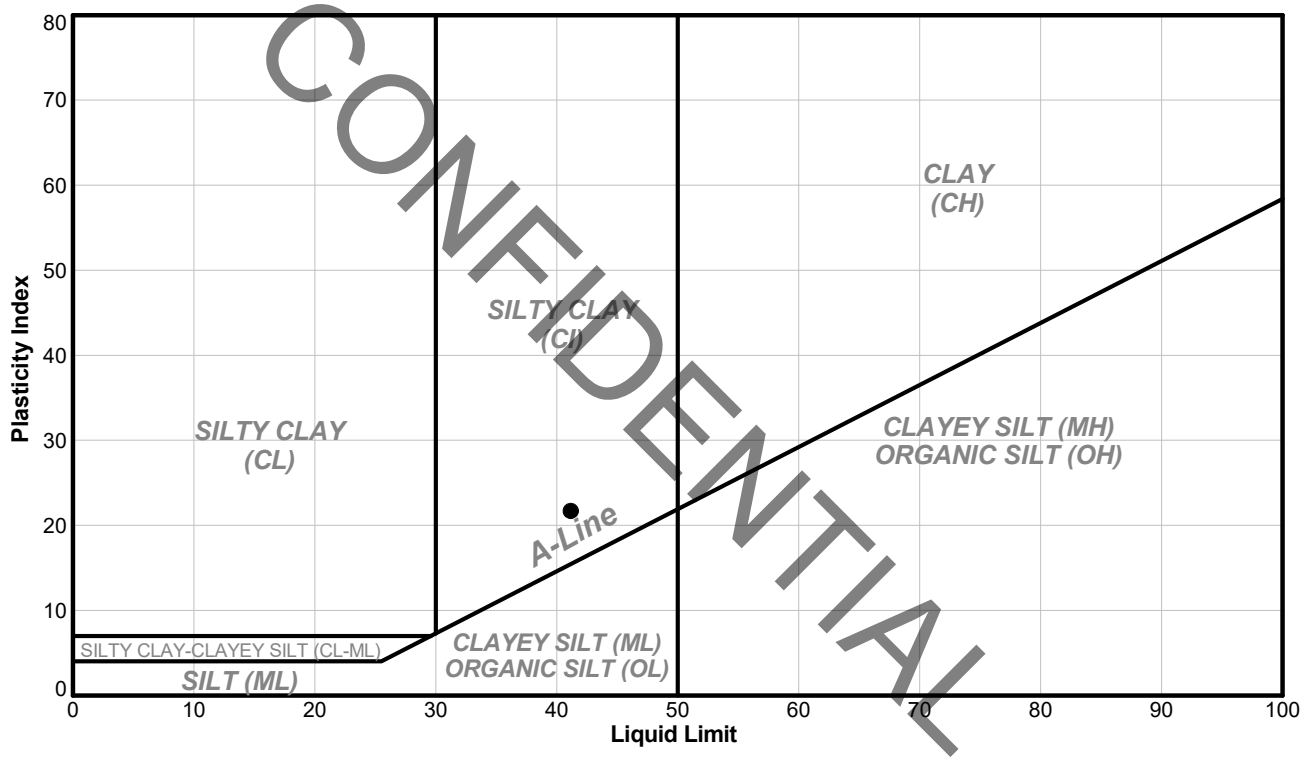
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-02**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**46**
Location:	Morice River, BC	**Depth Interval (m):**	48.16 to 48.31
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-02	46	48.16	48.31	56	41	19	22.0	14.9	-0.2

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

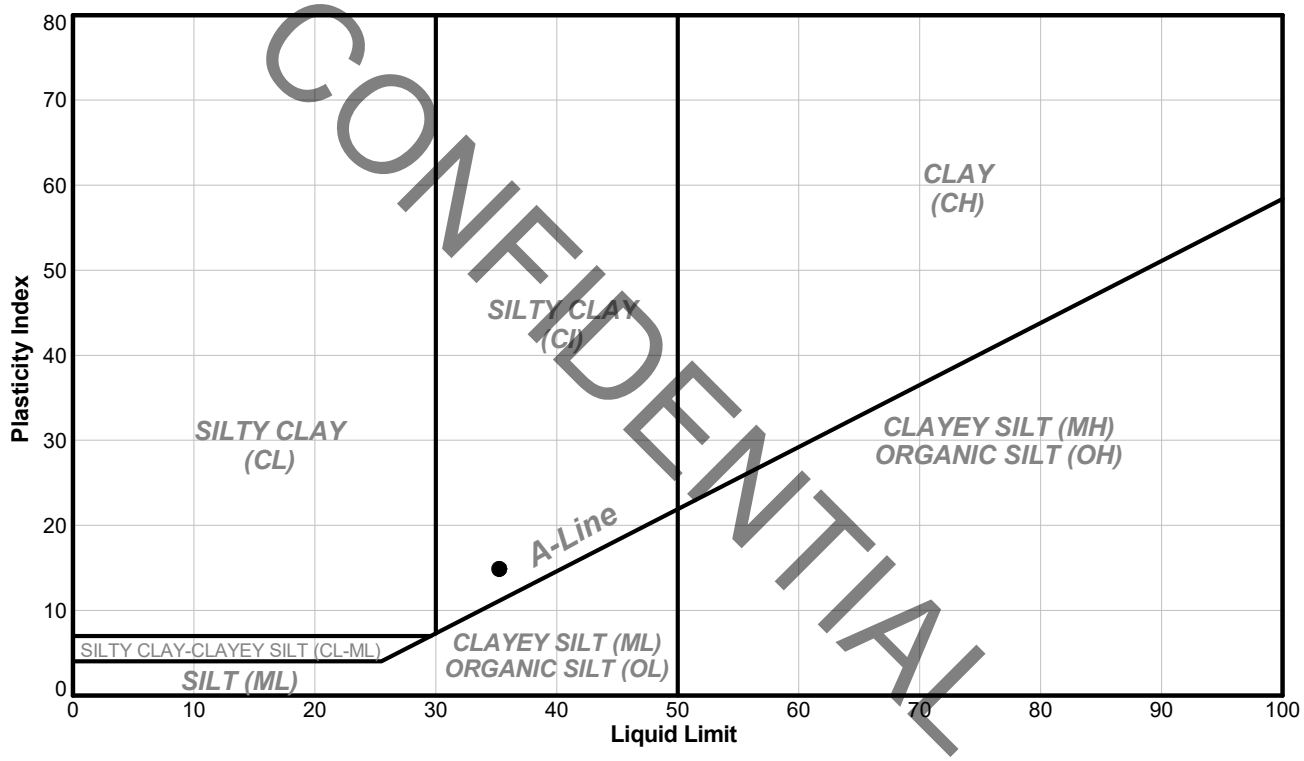
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-03**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**8**
Location:	Morice River, BC	**Depth Interval (m):**	6.55 to 6.71
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Wet**

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
●	BH20-MOR-03	8	6.55	6.71	100	35	20	15.0	25.6	0.4

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

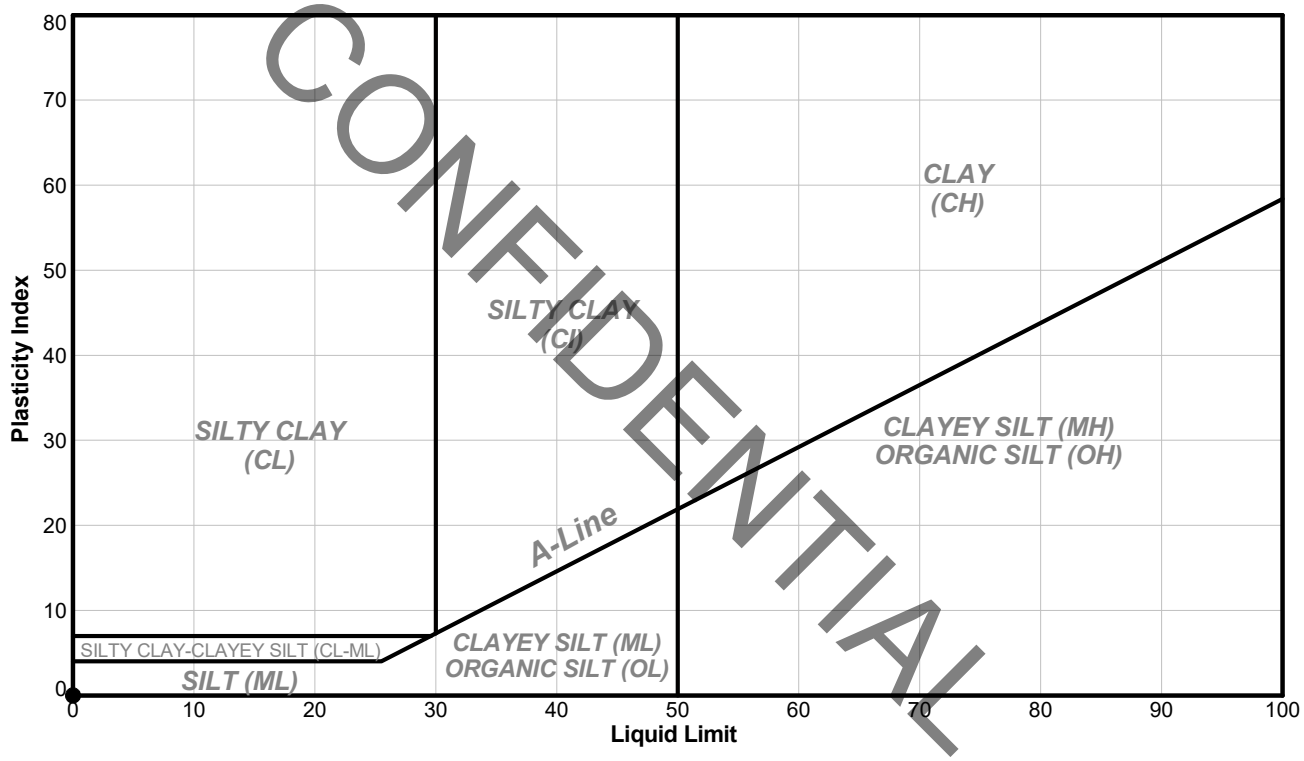
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-03**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**23**
Location:	Morice River, BC	**Depth Interval (m):**	17.98 to 18.29
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Wet**

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
●	BH20-MOR-03	23	17.98	18.29	ND	NP	NP	NP	20.0	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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

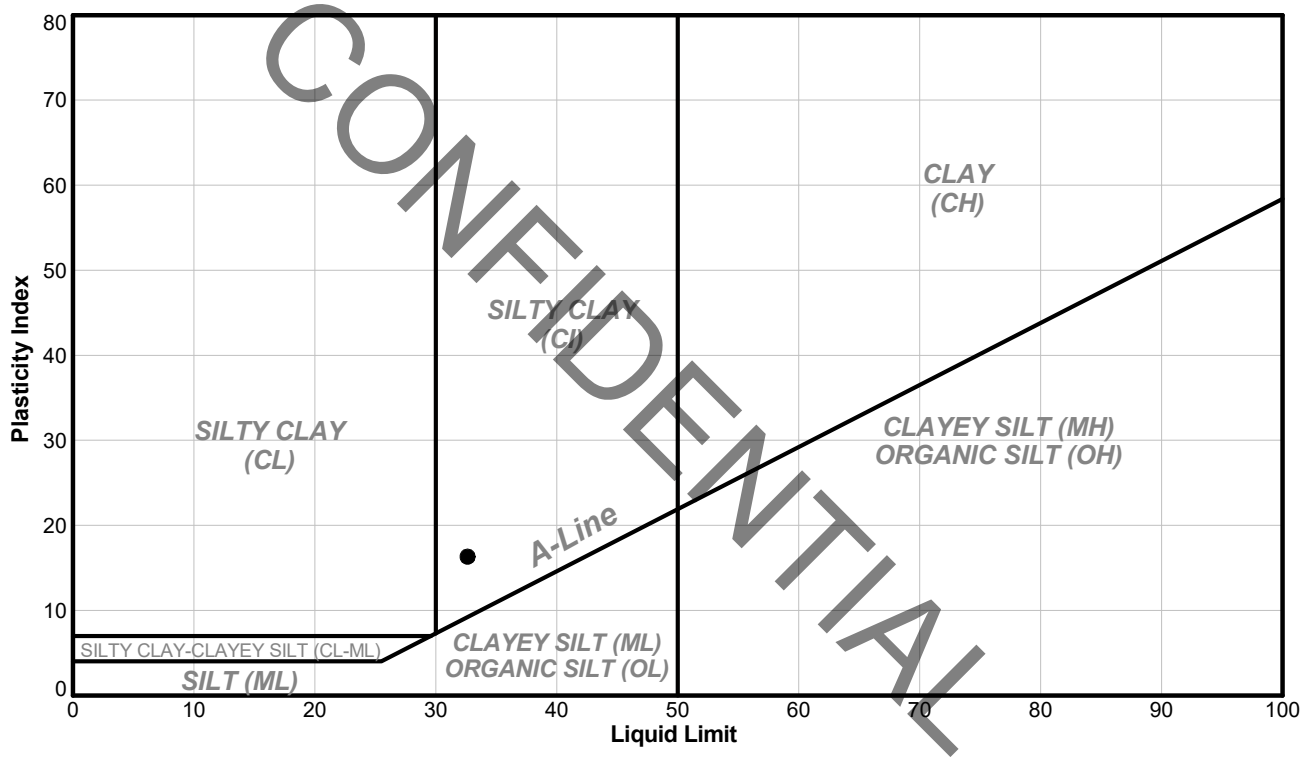
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-04**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**17**
Location:	Morice River, BC	**Depth Interval (m):**	12.34 to 12.50
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-04	17	12.34	12.50	68	33	16	17.0	21.7	0.3

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

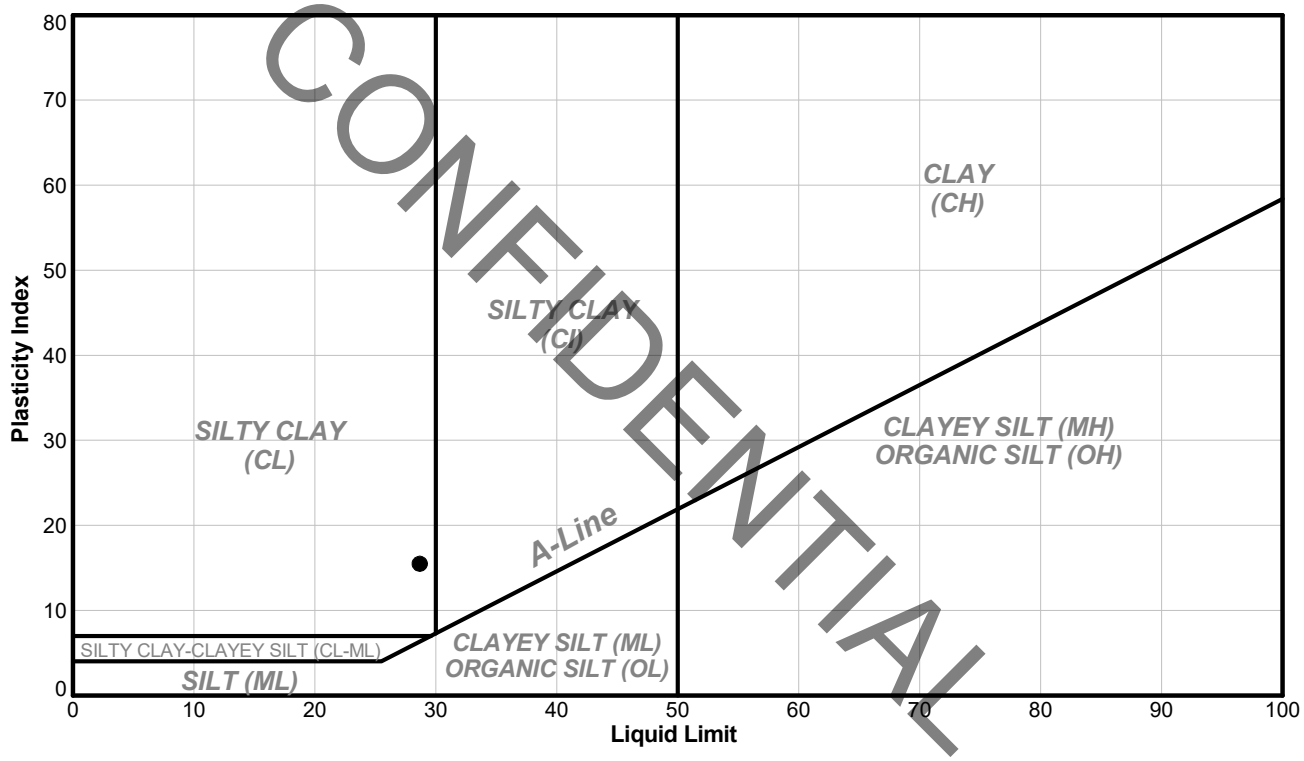
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-05**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**11**
Location:	Morice River, BC	**Depth Interval (m):**	8.53 to 8.69
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-05	11	8.53	8.69	ND	29	13	16.0	10.6	-0.1

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

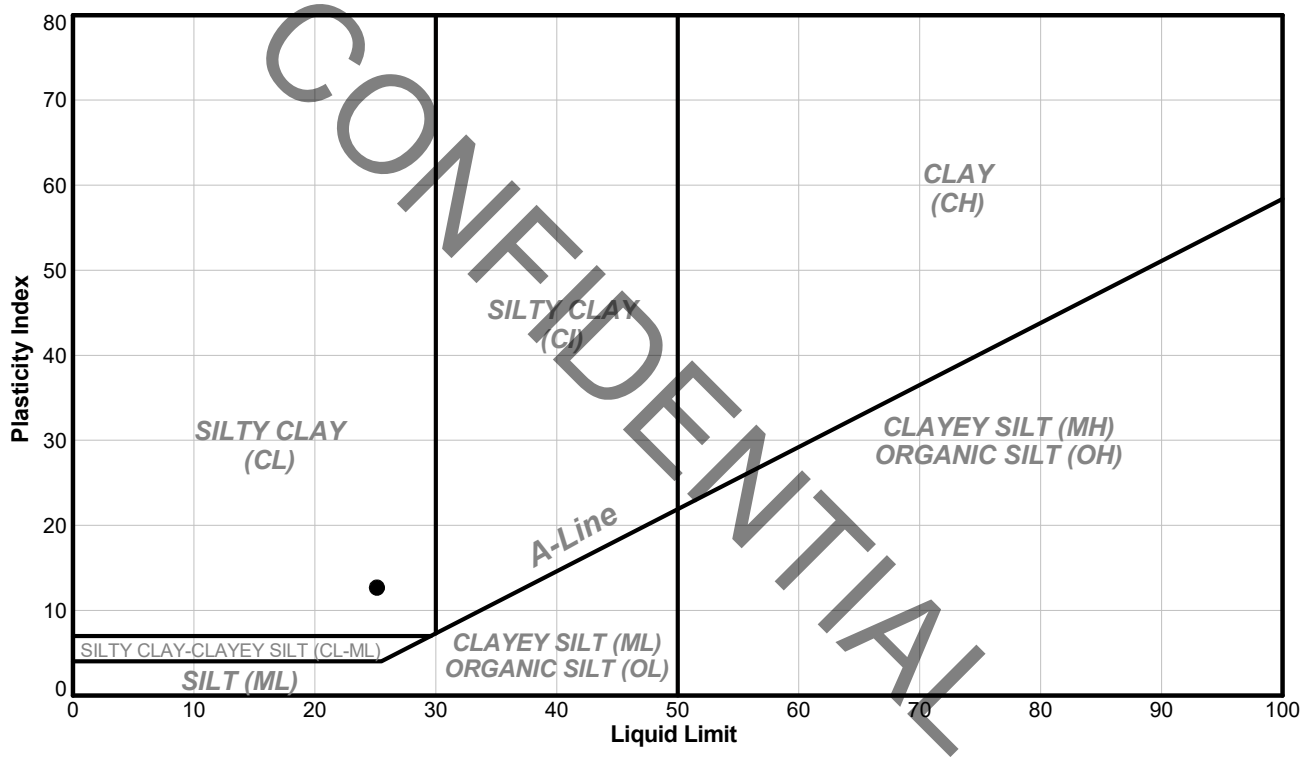
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-05**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**17**
Location:	Morice River, BC	**Depth Interval (m):**	12.98 to 13.11
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-05	17	12.98	13.11	ND	25	12	13.0	8.7	-0.3

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.

DC/VN	**1/11/2021**	**SJ**	**1/15/2021**
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

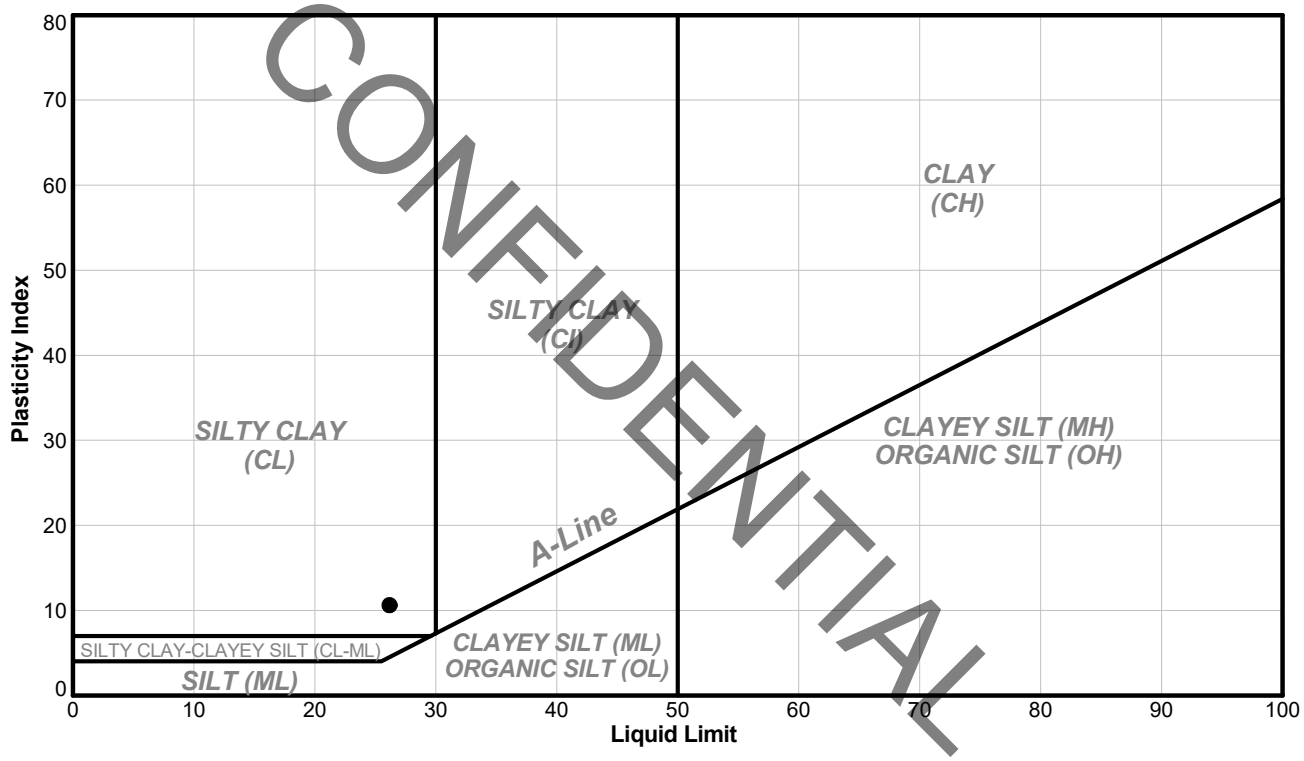
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-05**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**22**
Location:	Morice River, BC	**Depth Interval (m):**	17.37 to 17.53
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-05	22	17.37	17.53	ND	26	16	10.0	12.1	-0.4

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

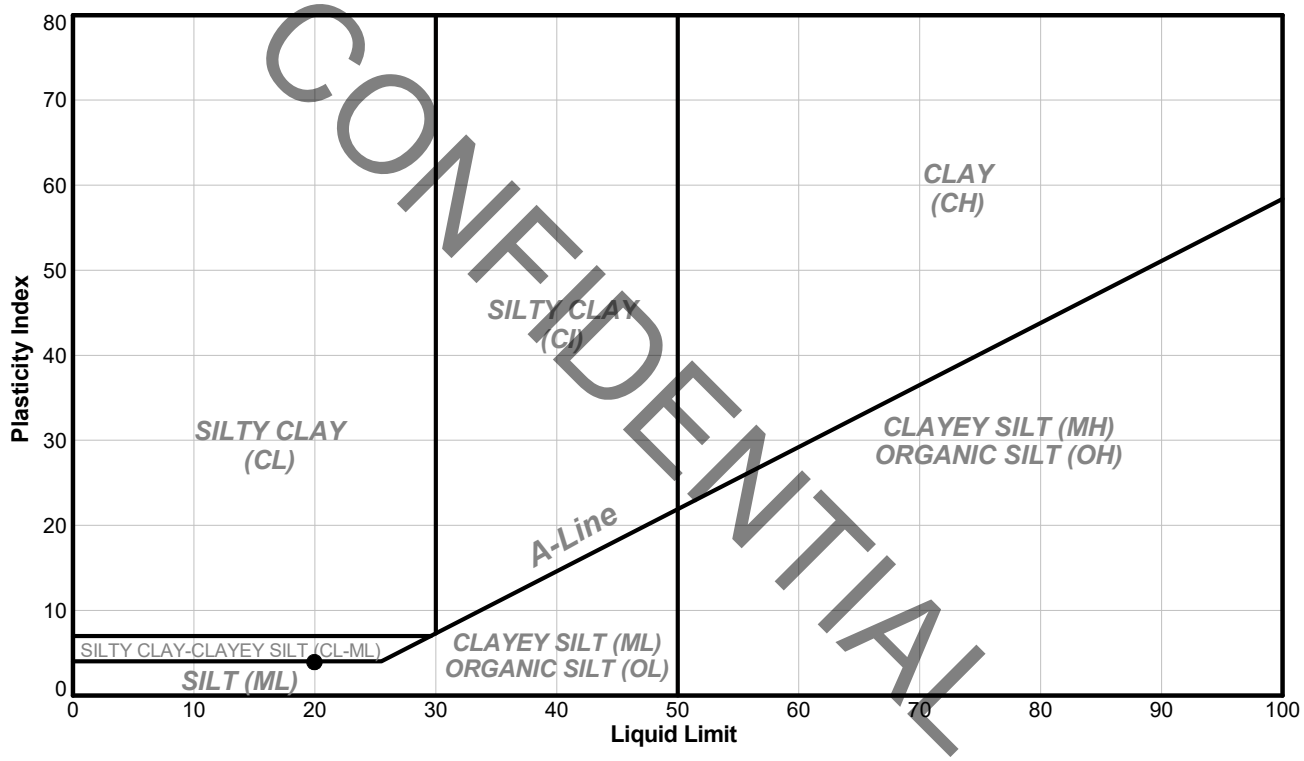
ASTM D 4318

Client:	Coastal GasLink	**Sonic Hole ID:**	**BH20-MOR-06**
Project:	Morice River Geotechnical Investigation	**Sample No.:**	**1**
Location:	Morice River, BC	**Depth Interval (m):**	0.61 to 0.76
Project No.:	19122805 **Phase:** 7000	**Lab Schedule No.:**	

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Air Dried**

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
●	BH20-MOR-06	1	0.61	0.76	ND	20	16	4.0	17.4	0.3

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.

DC/VN	1/11/2021	SJ	1/15/2021
Tech	Date	Checked	Date

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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122805-7000	**Borehole:**	BH20-MOR-01
Project:	Morice River Geotechnical Investigation	**Sample Number:**	9
Location:	Morice River, BC	**Depth (m):**	7.62 - 8.05
Client:	Coastal GasLink	**Lab Sch. No.:**	B20-443

Visual Description:

% Passing 4.75 mm	N/A
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dry Specimens

		Trial 1	Trial 2
Flask Number		250 - A	250 - B
Air Removal Method		Vacuum	Vacuum
Mass of Flask (g)	M_p	90.48	89.56
Mass of Flask + Dry Soil (g)		160.81	160.17
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	384.25	384.18
Test Temperature (°C)	T_t	18.70	18.70
Mass of Flask + Water (g)	$M_{rw,t}$	339.67	339.39
Tare Number		9D	10D
Mass of Tare + Dry Soil (g)		256.43	254.32
Mass of Tare (g)		186.07	183.75
Mass of Oven Dry Soil (g)	M_S	70.36	70.57
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.73	2.74
Specific Gravity at 20ºC	$G_{20ºC}$	2.73	2.74

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.73

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

DC	January 25, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122805-7000	**Borehole:**	BH20-MOR-02
Project:	Morice River Geotechnical Investigation	**Sample Number:**	24
Location:	Morice River, BC	**Depth (m):**	18.59 - 19.05
Client:	Coastal GasLink	**Lab Sch. No.:**	B20-443

Visual Description:

% Passing 4.75 mm	N/A
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dry Specimens

		Trial 1	Trial 2
Flask Number		250 - C	250 - D
Air Removal Method		Vacuum	Vacuum
Mass of Flask (g)	M_p	90.73	90.43
Mass of Flask + Dry Soil (g)		141.23	141.08
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	372.18	372.17
Test Temperature (°C)	T_t	18.70	18.70
Mass of Flask + Water (g)	$M_{rw,t}$	339.96	339.91
Tare Number		13D	14D
Mass of Tare + Dry Soil (g)		233.05	235.49
Mass of Tare (g)		182.45	184.65
Mass of Oven Dry Soil (g)	M_S	50.60	50.84
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.75	2.74
Specific Gravity at 20ºC	$G_{20ºC}$	2.75	2.74

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.75

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

DC	January 25, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
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Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D854

Project No.:	19122805-7000	**Borehole:**	BH20-MOR-05
Project:	Morice River Geotechnical Investigation	**Sample Number:**	12
Location:	Morice River, BC	**Depth (m):**	9.14 - 9.75
Client:	Coastal GasLink	**Lab Sch. No.:**	B20-443

Visual Description:

% Passing 4.75 mm	N/A
Excluded Material Description	

Specific Gravity of Fine Fraction Method B - Oven Dry Specimens

		Trial 1	Trial 2
Flask Number		250 - E	250 - F
Air Removal Method		Vacuum	Vacuum
Mass of Flask (g)	M_p	87.16	90.70
Mass of Flask + Dry Soil (g)		157.57	160.84
Mass of Flask + Soil + Water (g)	$M_{rws,t}$	379.91	384.28
Test Temperature (°C)	T_t	18.70	18.70
Mass of Flask + Water (g)	$M_{rw,t}$	335.34	339.91
Tare Number		18D	19D
Mass of Tare + Dry Soil (g)		254.45	252.43
Mass of Tare (g)		184.11	182.44
Mass of Oven Dry Soil (g)	M_S	70.34	69.99
Temperature Coefficient	K	1.00	1.00
Specific Gravity at Test Temperature	G_t	2.73	2.73
Specific Gravity at 20ºC	$G_{20ºC}$	2.73	2.73

AVERAGE SPECIFIC GRAVITY OF TRIALS	2.73

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

DC	January 25, 2021	SJ	January 29, 2021
TESTED BY	DATE	CHECKED BY	DATE

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APPENDIX C

Rock Laboratory Results

PETROGRAPHIC EXAMINATION OF ROCK

CSA A23.2-15A/ASTM C295

Coastal GasLink Ltd.
450 – 1 Street SW
Calgary, Alberta T2P 5H1

January 25, 2021
Project number: 19122805-7000

PROJECT: Morice River Crossing – Rock and Sediment Evaluation

Source:	BH20-MOR-01	**Sample:**	Gravel fraction of Sample #22: 22.25 – 22.40 m

Date sampled: 24 November 2020 **Sampled by:** Golder

PETROGRAPHIC DESCRIPTION	% BY MASS
Mafic volcanic – mostly porphyritic, occasional breccia, rare aphanitic, red, brown, black, dark grey, dark brown, mostly hard, strong, a few are altered and are weathered and are softer and of moderate to low strength. Subangular to subrounded shapes.	24.8
Intermediate volcanic – porphyritic, breccias, rare aphanitic, green, brown, grey. Strong, hard, but some weathered/softer varieties.	28.0
Felsic porphyritic volcanic – rare breccia, light grey, light green, cream, beige, moderately to very hard, dense, strong	9.6
Plutonic rock – granite-diorite, medium-grained, generally fresh. Brown, red, white-black, grey. Strong, dense, rare deeply weathered and weaker.	14.7
Plutonic rock – fine-grained-very fine-grained, strong, dense, grey	3.7
Chert/Quartzite – very fine-grained, hard, conchoidal fracture, brown, beige, dark grey, dense, strong	19.2
TOTAL	**100.0**

Photo 1:

Sample slightly wetted to enhance characteristics. Note range of colours, textures and lithologies. Shapes range from angular to well-rounded.

Photo 2: Detail of rock particles.	

F. Shrimer, P. Geo.

Reviewed by:

J. Taylor, M. Sc.

PETROGRAPHIC EXAMINATION OF ROCK

CSA A23.2-15A/ASTM C295

Coastal GasLink Ltd.
450 – 1 Street SW
Calgary, Alberta T2P 5H1

January 25, 2021
Project number: 19122805-7000

PROJECT: Morice River Crossing – Rock and Sediment Evaluation

Source:	BH20-MOR-03	**Sample:**	Gravel fraction of Sample #5: 4.72 – 4.88 m

Date sampled: 13 December 2020 **Sampled by:** Golder

PETROGRAPHIC DESCRIPTION	% BY MASS
Mafic volcanic – mostly porphyritic, occasional breccia, rare aphanitic, red, brown, black, dark grey, dark brown, mostly hard, strong, a few are altered and are weathered and are softer and of moderate to low strength. Subangular to subrounded shapes.	24.0
Intermediate volcanic – porphyritic, breccias, rare aphanitic, green, brown, grey. Strong, hard, but some weathered/softer varieties.	27.7
Felsic porphyritic volcanic – rare breccia, light grey, light green, cream, beige, moderately to very hard, dense, strong	24.7
Plutonic rock – granite-diorite, medium-grained, generally fresh. Brown, red, white-black, grey. Strong, dense, rare deeply weathered and weaker.	16.8
Plutonic rock – fine-grained-very fine-grained, strong, dense, grey	5.3
Chert/Quartzite – very fine-grained, hard, conchoidal fracture, brown, beige, dark grey, dense, strong	0.8
Sandstone – quartz-rich and lithic sandstone varieties, brown, dense, strong.	0.7
TOTAL	**100.0**

Photo 1: Sample slightly wetted to enhance characteristics. Note range of colours, textures and lithologies. Shapes range from angular to well-rounded.	

F. Shrimer, P. Geo.

Reviewed by:

J. Taylor, M. Sc.

PETROGRAPHIC EXAMINATION OF ROCK
ASTM C295/C1721

Coastal GasLink Ltd.
450 – 1 Street SW
Calgary, Alberta T2P 5H1

January 21, 2021
Project number: 19122805-7000

PROJECT: Morice River Crossing – Rock and Sediment Evaluation

Source:	BH20-MOR-03	**Sample:**	#31: 31.72 – 31.84 m

Date sampled: 15 December 2020 **Sampled by:** Golder

.

SAMPLE	**BH20-MOR-03 Sample 31 @ 31.72 – 31.84 m**	
SAMPLE TYPE	Rock core sample	
ROCK NAME	**Coarse conglomeratic Sandstone**	
DESCRIPTION	Coarse-grained sandstone with coarser conglomeratic clasts, with pebbles up to about 12 mm diameter. Coarser grains are well-rounded; particles become more angular with decreasing particle size. Clasts (sand- and gravel-sized) are dominantly composed of slightly to significantly altered volcanic rocks (estimate 75%), with lesser amounts of quartzite, possible chert, and very fine-grained granitic rock. The clasts are generally of medium to coarse sand sizes (i.e., 1-5 mm) with about 30% gravel-sized clasts (i.e., >5 mm).. The cement/matrix is siliceous and may consist of common opal. Some zoned composition of the cement is observed in some portions of the sample, where crystalline quartz appears in the centre of an area of cement. The siliceous matrix is generally a fairly uniform light cream-beige colour. The Mohs hardness of the cement ranges from an estimated value of about “6” to “7”. Individual rock particles are of variable Mohs hardness, with altered igneous rocks being in the “5” to “6” range, and siliceous and/or less altered rocks having Mohs hardness values in the “6” to “7” range.	
MAJOR CONSTITUENTS	Volcanic clasts: 75%	Quartzite and/or chert clasts: 10%
	Fine-grained granitoid clasts: 7%	Siliceous (possibly opal) matrix: 6%
ESTIMATED OVERALL MOHS HARDNESS	5.5 - 6.0	
HCl RESPONSE	none	
MAGNET RESPONSE	none	

Note: Percentages of constituents are visual estimates.

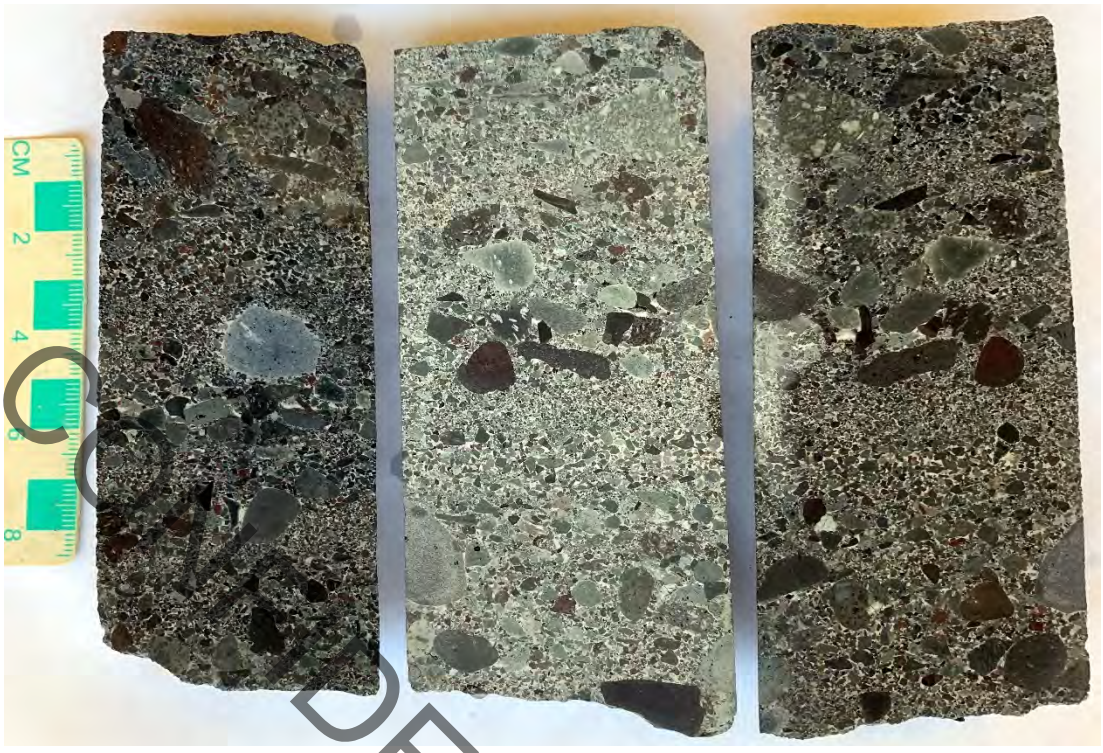
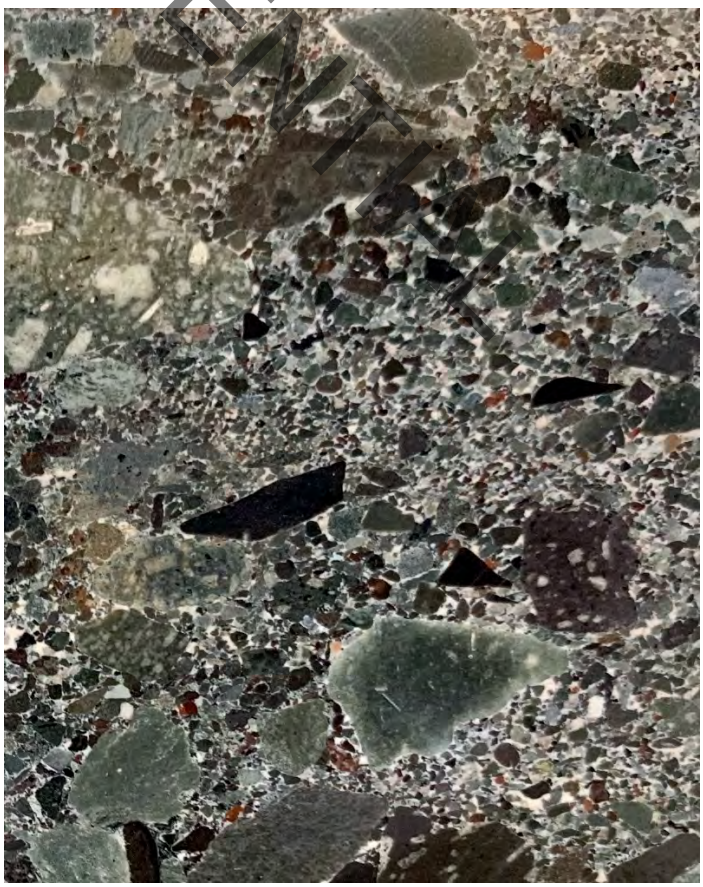
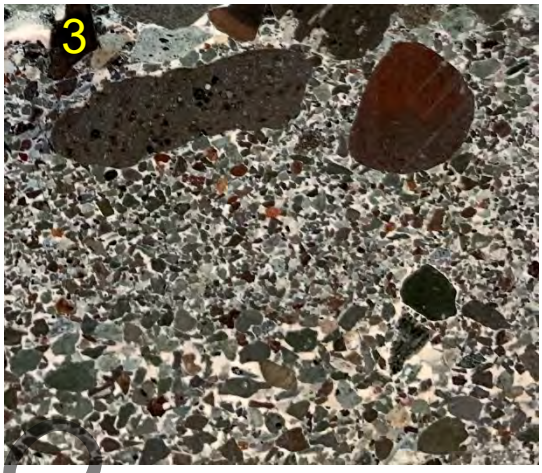
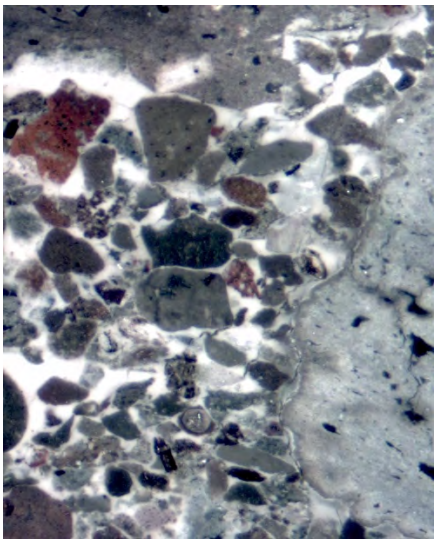
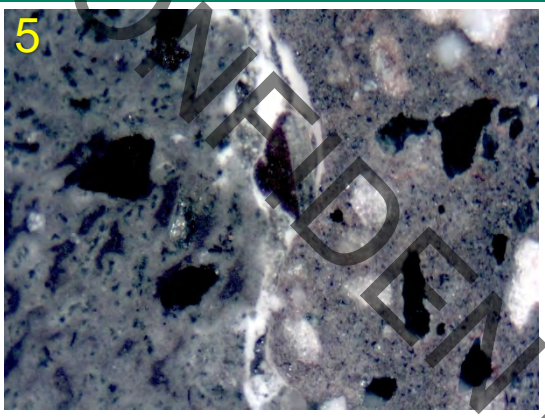
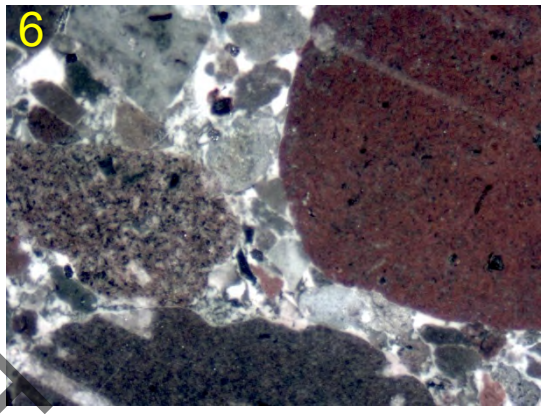
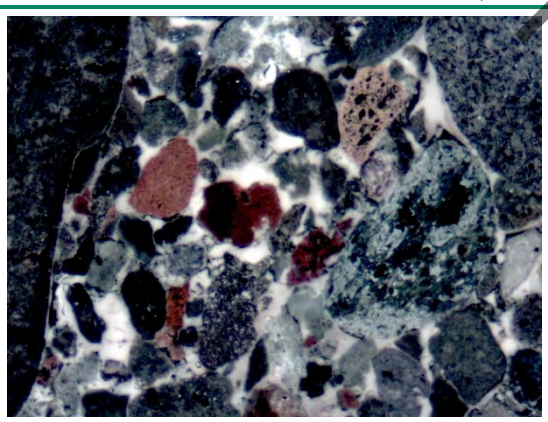
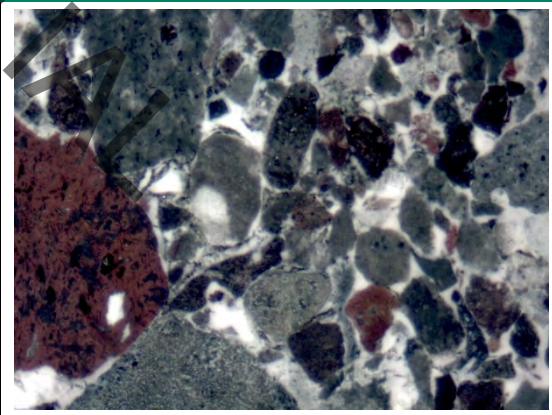
Photo 1: Sample after cutting and polishing of middle section. Outer portions have been wetted to enhance view.	
Photo 2: Detail of rock showing range of grain sizes and crude stratification of grains. Field of view about 50 mm in length.	

Photo 3: Crude sorting of grains by size. View is about 40 mm across. **Photo 4:** View illustrating light-coloured siliceous/opal cement enclosing clasts of varying size and lithology. Mag. 10x, field of view 8.4 mm		
Photo 5: Two volcanic clasts. Mag. 10x, FOV = 8.4 mm **Photo 6:** General view of rock, mag. 10x, fov is 8.4 mm.		
Photo 7: Numerous mostly volcanic grains in silica/opal cement. Mag. 10x, FOV = 8.4 mm **Photo 8:** Range of volcanic grains dominate the view. mag. 10x, fov is 8.4 mm		

F. Shrimer, P. Geo.

Reviewed by:

J. Taylor, M. Sc.

PETROGRAPHIC EXAMINATION OF ROCK

ASTM C295/C1721

Coastal GasLink Ltd.
450 – 1 Street SW
Calgary, Alberta T2P 5H1

January 21, 2021
Project number: 19122805-7000

PROJECT: Morice River Crossing – Rock and Sediment Evaluation

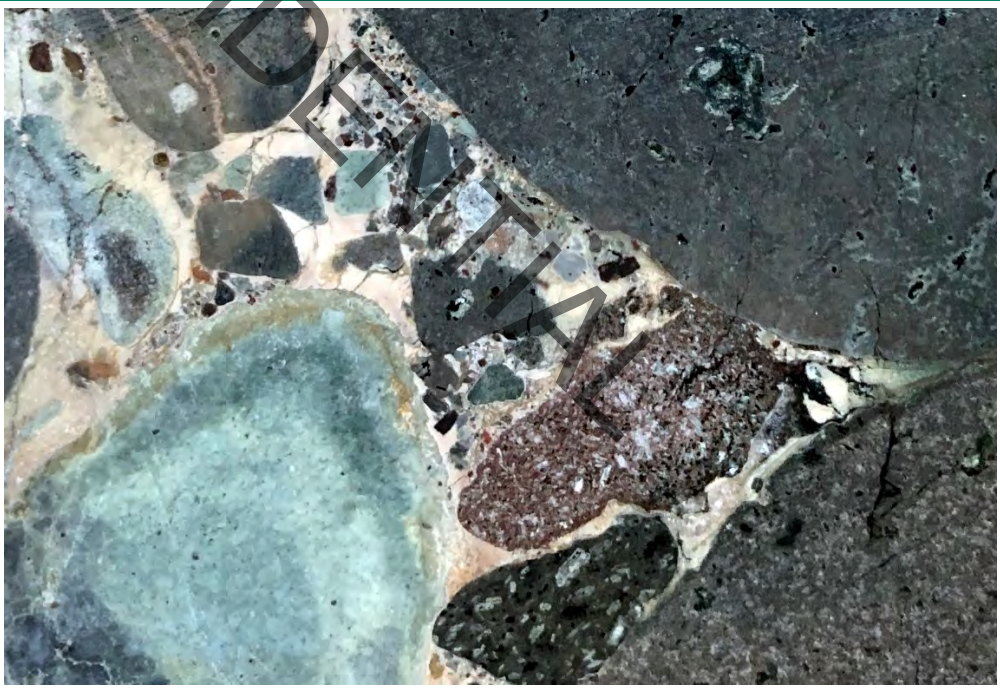
Source:	BH20-MOR-04	**Sample:**	#29: 62.03 – 62.23 m

Date sampled: 09 December 2020 **Sampled by:** Golder

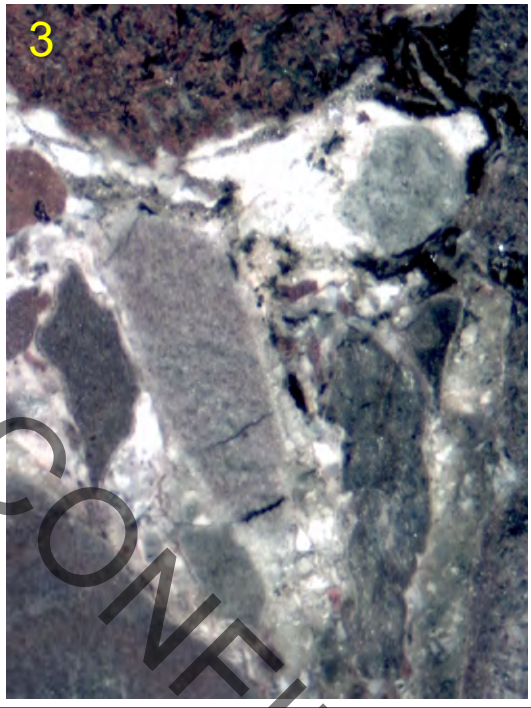
.

SAMPLE	**BH20-MOR-04 Sample 29 @ 62.03 – 62.23 m**	
SAMPLE TYPE	Rock core sample	
ROCK NAME	**Coarse-grained Conglomerate**	
DESCRIPTION	Coarse conglomerate, with pebbles up to 55 mm diameter. Pebbles are dominantly composed of slightly to significantly altered volcanic rocks (estimate 75%), with lesser amounts of quartzite, possible chert, and very fine-grained granitic rock. The gravel particles are well-rounded. As the clasts become smaller in size, their angularity increases. The clasts are generally of gravel sizes (i.e., >5 mm) and contain very few sand-sized grains. The cement/matrix is siliceous and may be common opal, with some gradational composition evident in some portions of the sample, where crystalline quartz appears in the centre of an area of matrix. The siliceous matrix is generally a fairly uniform light cream-beige colour, with a Mohs hardness that ranges from an estimated “6” to “7”. Many of the volcanic particles exhibit some degree of alteration, with chlorite, clay and minor iron-oxides being dominant alteration products. The altered rocks have apparent lower Mohs hardness.	
MAJOR CONSTITUENTS	Volcanic clasts: 70%	Quartzite and/or chert clasts: 10%
	Fine-grained granitoid clasts: 7%	Sand-sized clasts: 7%
	Siliceous (possibly opal) matrix: 6%	
ESTIMATED OVERALL MOHS HARDNESS	5.5 – 6.0	
HCl RESPONSE	none	
MAGNET RESPONSE	none	

Note: Percentages of constituents are visual estimates.

Photo 1 – Sample cut, with middle section polished for examination.	
Photo 2 – Detail of sample showing rounded multi-lithic gravel clasts with minimal sand-sized grains enclosed in siliceous cream-coloured matrix. Field of view is approximately 65 mm across.	

Photos 3 and 4:
An array of primarily volcanic rock types are set in siliceous cement. Note zonation within the cement shows some crystalline quartz. Both views are at a magnification of 10x with a field of view of 8.4 mm in length.



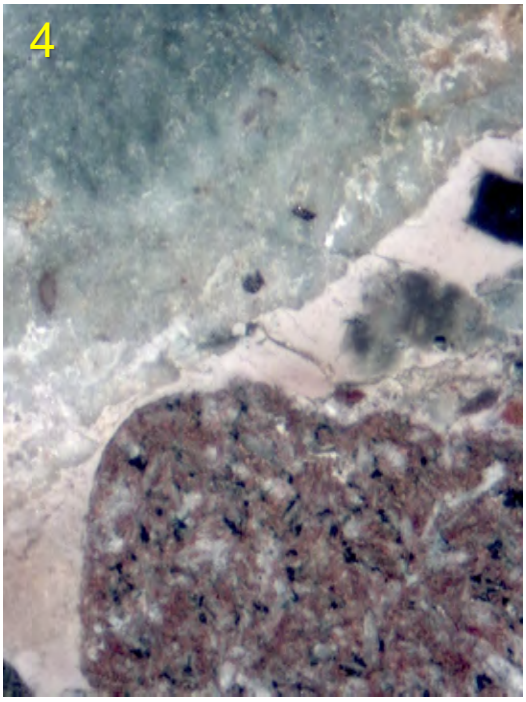
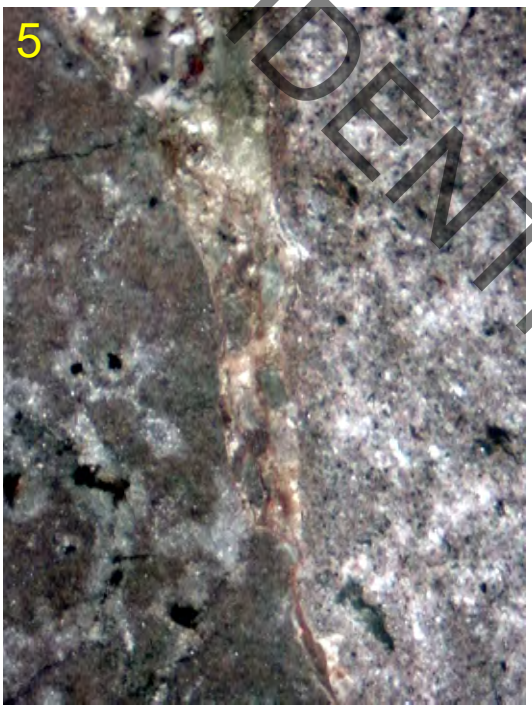


Photo 5:
Volcanic porphyry on left portion of view and fine-grained granitoid on right portion of view. Magnification 10x, FOV 8.4 mm.

Photo 6:
White-cream-coloured siliceous (possibly opaline) cement encloses the sand and gravel clasts. Note grey linear marks are the result of scratch tests using a steel implement. H = 6.5-7.



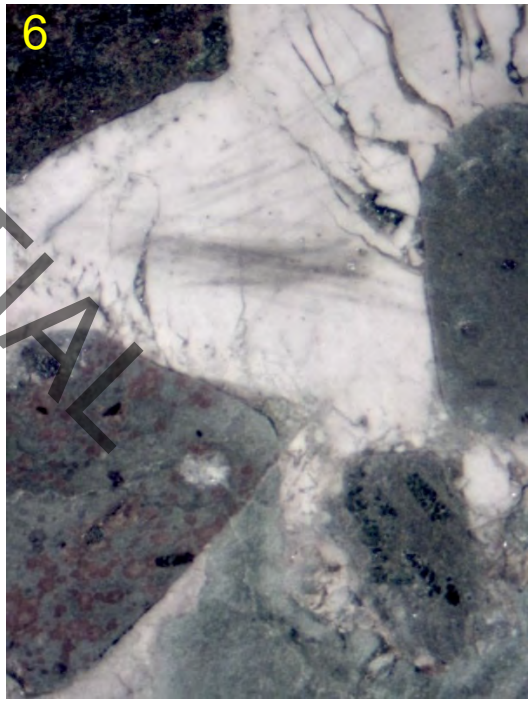
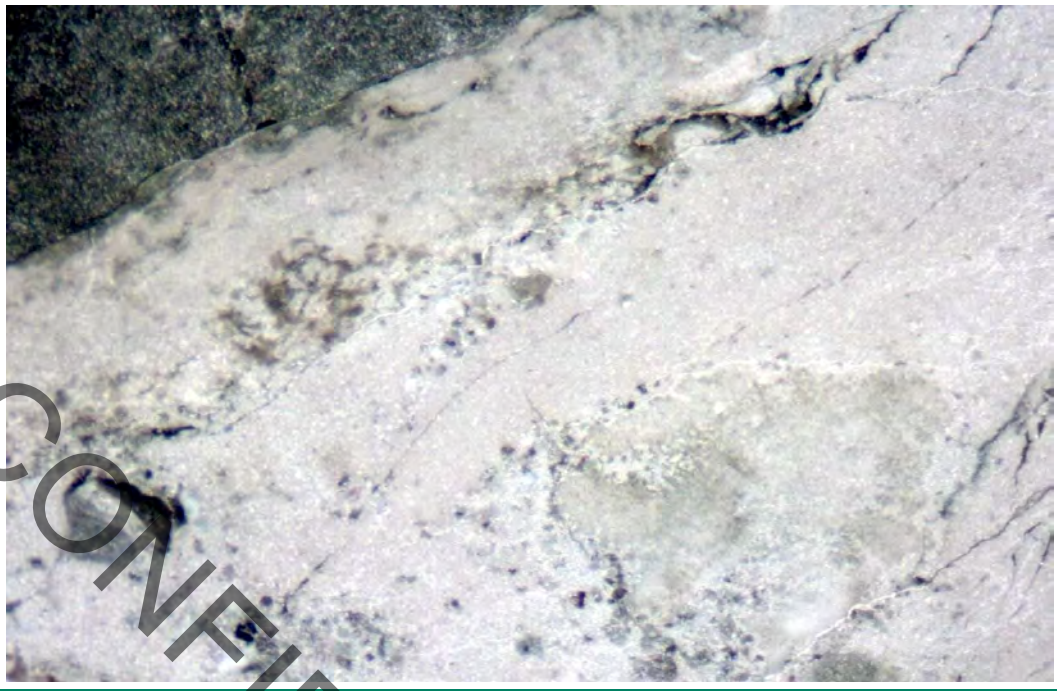
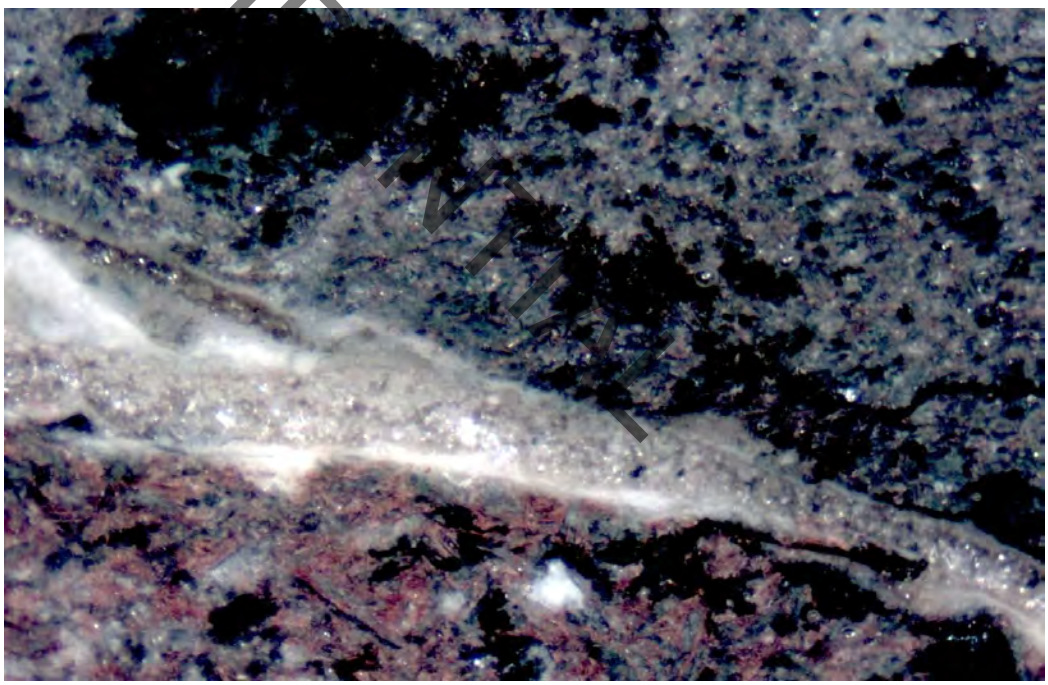


Photo 7: Detail of siliceous cement showing inclusions and layering. Magnification 15x, field of view 6.2 mm.	
Photo 8: Detail of cement showing development of crystalline quartz. Magnification 25x, field of view 4.0 mm.	

F. Shrimer, P. Geo.

Reviewed by:

J. Taylor, M. Sc.

Laboratory Determination of Uniaxial Compressive Strength of Intact Rock Core Specimens

Summary of Test Results

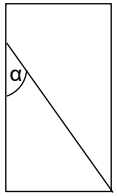
ASTM D7012 Method C

Project No.: 19122805/7000
Project: Morice River Crossing Geotechnical Investigation
Location: Morice River, BC
Client: Coastal GasLink
Lab ID No: B20-443

Failure Modes
(1) Simple Extension
(2) Multiple Extension
(3) Multiple Fracturing
(4) Multiple Shear
(5) Single Shear
(6) Spalling
(7) Other

* Wet density based on as received moisture

Note: Alpha angle, α, measured relative to the core axis



No.	Borehole #	Sample #	Depth (m)	Dia (mm)	Ht (mm)	Area (cm^2)	Volume (cm^3)	Mass (g)	* Wet Density (kg/m^3)	Moisture (%)	Dry Density (kg/m^3)	Maximum Load (kN)	Stress σ_u (MPa)	Rock Type	Failure Mode Type	Failure Mode α (deg)
1	BH20-MOR-02	48	60.82-61.08	60.97	125.08	29.20	365.18	821.90	2251	2.68	2192	82.00	28.1	Conglomerate	3/6	
2	BH20-MOR-03	32	36.57-36.85	60.30	130.10	28.56	371.54	924.30	2488	1.01	2463	215.90	75.6	Conglomerate	3/6	
3	BH20-MOR-04	24	20.63-20.75	60.88	118.24	29.11	344.19	847.30	2462	4.20	2363	145.10	49.8	Conglomerate	3/6	
4	BH20-MOR-05	27	30.96-31.14	Sample broke during preparation. Not suitable for testing.										Conglomerate		
5	BH20-MOR-05	29	33.37-33.63	60.84	130.79	29.07	380.23	883.80	2324	1.74	2285	115.40	39.7	Conglomerate	6/3	

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

EF	January 5, 2021	GP	January 7, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

GOLDER

Uniaxial Compressive Strength of Intact Rock Core Specimens (Method C)

ASTM D7012

Project No.:	19122805/7000	**Borehole:**	BH20-MOR-02
Project:	Morice River Crossing Geotechnical Investigation	**Sample Number:**	48
Location:	Morice River, BC	**Depth (m):**	60.82-61.08
Client:	Coastal GasLink	**Lab ID No:**	B20-443

Testing Results

Max Load (kN)	**82.00**
Stress σ_u (MPa)	**28.1**
Pace Rate (kN/s)	1.25
Lithology	Conglomerate (fine)

Sample Measurements

Diameter	(mm)	60.97
Height	(mm)	125.08
Area	(cm²)	29.20
Volume	(cm³)	365.18
Mass	(g)	821.90
Moisture Content	(%)	2.68
Wet Density	(kg/m³)	2251
Dry Density	(kg/m³)	2192

BEFORE TEST

Failure Mode

Type: **3/6**

α angle: _____

* Degrees measured with respect to core axis.

The impact of any pre-existing feature on the test results will be noted in the comments, if applicable.

Notes

- Water content as received
- Wet density based on as received moisture

Mode:

(1) Simple Extension
(2) Multiple Extension
(3) Multiple Fracturing
(4) Multiple Shear
(5) Single Shear
(6) Spalling
(7) Other

AFTER TEST

Comments

Sample failed through matrix

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

EF	January 5, 2021	GP	January 7, 2021
TESTED BY	DATE	CHECKED BY	DATE

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GOLDER

Uniaxial Compressive Strength of Intact Rock Core Specimens (Method C)

ASTM D7012

Project No.:	19122805/7000	**Borehole:**	BH20-MOR-03
Project:	Morice River Crossing Geotechnical Investigation	**Sample Number:**	32
Location:	Morice River, BC	**Depth (m):**	36.57-36.85
Client:	Coastal GasLink	**Lab ID No:**	B20-443

Testing Results

Max Load (kN)	**215.90**
Stress σ_u (MPa)	**75.6**
Pace Rate (kN/s)	1.25
Lithology	Conglomerate (medium)

Sample Measurements

Diameter	(mm)	60.30
Height	(mm)	130.10
Area	(cm²)	28.56
Volume	(cm³)	371.54
Mass	(g)	924.30
Moisture Content	(%)	1.01
Wet Density	(kg/m³)	2488
Dry Density	(kg/m³)	2463

BEFORE TEST

Failure Mode

Type: **3/6**

α angle: _____

* Degrees measured with respect to core axis.

The impact of any pre-existing feature on the test results will be noted in the comments, if applicable.

Notes

- Water content as received
- Wet density based on as received moisture

Mode:

(1) Simple Extension
(2) Multiple Extension
(3) Multiple Fracturing
(4) Multiple Shear
(5) Single Shear
(6) Spalling
(7) Other

AFTER TEST

Comments

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

EF	January 5, 2021	GP	January 7, 2021
TESTED BY	DATE	CHECKED BY	DATE

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GOLDER

Uniaxial Compressive Strength of Intact Rock Core Specimens (Method C)

ASTM D7012

Project No.:	19122805/7000	**Borehole:**	BH20-MOR-04
Project:	Morice River Crossing Geotechnical Investigation	**Sample Number:**	24
Location:	Morice River, BC	**Depth (m):**	20.63-20.75
Client:	Coastal GasLink	**Lab ID No:**	B20-443

Testing Results

Max Load (kN)	**145.10**
Stress σ_u (MPa)	**49.8**
Pace Rate (kN/s)	1.25
Lithology	Conglomerate (fine-medium)

Sample Measurements

Diameter	(mm)	60.88
Height	(mm)	118.24
Area	(cm²)	29.11
Volume	(cm³)	344.19
Mass	(g)	847.30
Moisture Content	(%)	4.20
Wet Density	(kg/m³)	2462
Dry Density	(kg/m³)	2363

BEFORE TEST

Failure Mode

Type: **3/6**

α angle: _____

* Degrees measured with respect to core axis.

The impact of any pre-existing feature on the test results will be noted in the comments, if applicable.

Notes

- Water content as received
- Wet density based on as received moisture

Mode:

(1) Simple Extension
(2) Multiple Extension
(3) Multiple Fracturing
(4) Multiple Shear
(5) Single Shear
(6) Spalling
(7) Other

AFTER TEST

Comments

Sample does not conform to ASTM requirements and results may differ from those obtained from test specimens that meet requirements. Sample legth:diameter less than 2:1.

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

EF	January 5, 2021	GP	January 7, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

GOLDER

Uniaxial Compressive Strength of Intact Rock Core Specimens (Method C)

ASTM D7012

Project No.:	19122805/7000	**Borehole:**	BH20-MOR-05
Project:	Morice River Crossing Geotechnical Investigation	**Sample Number:**	29
Location:	Morice River, BC	**Depth (m):**	33.37-33.63
Client:	Coastal GasLink	**Lab ID No:**	B20-443

Testing Results

Max Load (kN)	**115.40**
Stress σ_u (MPa)	**39.7**
Pace Rate (kN/s)	1.25
Lithology	Conglomerate (medium)

Sample Measurements

Diameter	(mm)	60.84
Height	(mm)	130.79
Area	(cm²)	29.07
Volume	(cm³)	380.23
Mass	(g)	883.80
Moisture Content	(%)	1.74
Wet Density	(kg/m³)	2324
Dry Density	(kg/m³)	2285

BEFORE TEST

Failure Mode

Type: **6/3**

α angle: _____

* Degrees measured with respect to core axis.

The impact of any pre-existing feature on the test results will be noted in the comments, if applicable.

Notes

- Water content as received
- Wet density based on as received moisture

Mode:

(1) Simple Extension
(2) Multiple Extension
(3) Multiple Fracturing
(4) Multiple Shear
(5) Single Shear
(6) Spalling
(7) Other

AFTER TEST

Comments

Sample failed primarily through matrix

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

EF	January 5, 2021	GP	January 7, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

GOLDER

Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+075
Client:	Coastal GasLink
Borehole:	BH20-MOR-02

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where W = $(W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
1	D	84.0	60.0	60.7	2.7	3684.5	0.7	1.1	0.8	CON	Valid, failed through matrix and fine to coarse grained clasts
2	D	83.1	50.0	60.7	6.8	3684.5	1.9	1.1	2.0	CON	Valid, failed through matrix
3	A	83.1	36.1	60.7	5.9	2790.0	2.1	1.0	2.2	CON	Valid, failed through matrix and medium to coarse grained clasts
4	A	83.9	52.8	60.7	5.9	4080.7	1.4	1.1	1.6	CON	Valid, failed through matrix and medium to coarse grained clasts
5	A	84.0	46.4	60.7	4.6	3586.1	1.3	1.1	1.4	CON	Valid, failed through matrix and medium to coarse grained clasts
6	A	84.0	39.0	60.7	2.5	3014.1	0.8	1.0	0.9	CON	Valid, failed through matrix and medium to coarse grained clasts
7	D	79.0	-	-	-	-	-	-	-	CON	Invalid, chipping
8	A	79.1	45.4	60.7	5.2	3508.8	1.5	1.1	1.6	CON	Valid, failed through matrix
9	D	74.4	45.0	60.7	21.7	3684.5	5.9	1.1	6.4	CON	Valid, failed through matrix
10	D	74.5	91.0	60.7	20.5	3684.5	5.6	1.1	6.1	CON	Valid, failed through matrix
11	D	74.5	50.0	60.7	6.7	3684.5	1.8	1.1	2.0	CON	Invalid, failed alng existing microfracture
12	A	74.5	57.5	60.7	9.6	4443.9	2.2	1.1	2.5	CON	Valid, failed through matrix
13	D	69.0	-	-	-	-	-	-	-	CON	Invalid, insufficient specimen length
14	D	69.0	35.0	60.7	2.0	3684.5	0.5	1.1	0.6	CON	Valid, failed through matrix
15	A	69.0	43.8	60.7	7.8	3385.1	2.3	1.1	2.5	CON	Valid, failed through matrix
16	A	69.1	46.5	60.7	7.4	3593.8	2.1	1.1	2.2	CON	Valid, failed through matrix
17	D	67.8	130.0	60.7	1.1	3684.5	0.3	1.1	0.3	CON	Valid, failed through matrix and medium to coarse grained clasts
18	D	67.7	70.0	60.7	7.5	3684.5	2.0	1.1	2.2	CON	Valid, failed through matrix and medium to coarse grained clasts
19	A	67.8	32.0	60.7	8.5	2473.1	3.4	1.0	3.4	CON	Valid, failed through matrix and medium to coarse grained clasts
20	D	64.4	160.0	60.7	4.3	3684.5	1.2	1.1	1.3	CON	Valid, failed through matrix and medium to coarse grained clasts
21	A	64.5	28.0	60.7	9.4	2164.0	4.3	1.0	4.2	CON	Valid, failed through coarse clast
22	D	55.3	175.0	60.7	2.9	3684.5	0.8	1.1	0.9	SS	Valid, failed through matrix
23	D	55.4	120.0	60.7	8.7	3684.5	2.4	1.1	2.6	SS	Valid, failed through matrix
24	A	55.4	48.0	60.7	8.0	3709.7	2.2	1.1	2.4	SS	Valid, failed through matrix

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

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3202 Munroe Street, Terrace, British Columbia Canada, V8G 5L3

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Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+440
Client:	Coastal GasLink
Borehole:	BH20-MOR-03

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where W = $(W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
1	A	44.2	20.2	60.7	5.3	1561.2	3.4	0.9	3.0	CON	Valid, failed through matrix and fine to coarse grained clasts
2	A	44.1	-	-	-	-	-	-	-	CON	Invalid, chipping
3	A	44.1	29.2	60.7	1.8	2256.7	0.8	1.0	0.8	CON	Valid, failed through matrix
4	D	42.1	45.0	60.7	13.2	3684.5	3.6	1.1	3.9	CON	Valid, failed through matrix
5	A	42.0	35.7	60.7	2.5	2759.1	0.9	1.0	0.9	CON	Valid, failed through matrix
6	A	42.0	54.4	60.7	7.9	4204.3	1.9	1.1	2.1	CON	Valid, failed through matrix
7	D	38.0	35.0	60.7	6.7	3684.5	1.8	1.1	2.0	CON	Valid, failed through matrix
8	D	38.1	35.0	60.7	13.1	3684.5	3.6	1.1	3.9	CON	Valid, failed through matrix and fine to coarse grained clasts
9	A	38.1	28.0	60.7	7.4	2164.0	3.4	1.0	3.3	CON	Valid, failed through matrix and fine to coarse grained clasts
10	A	38.0	-	-	-	-	-	-	-	CON	Invalid, chipping
11	D	30.2	44.0	60.7	9.8	3684.5	2.6	1.1	2.9	CON	Valid, failed through matrix and fine to coarse grained clasts
12	D	30.3	-	-	-	-	-	-	-	CON	Invalid, chipping
13	A	30.2	33.0	60.7	9.0	2550.4	3.5	1.0	3.5	CON	Valid, failed through matrix and fine to coarse grained clasts
14	D	38.1	100.0	60.7	13.0	3684.5	3.5	1.1	3.9	CON	Valid, failed through matrix
15	D	38.2	-	-	-	-	-	-	-	CON	Invalid, chipping
16	A	38.5	-	-	-	-	-	-	-	CON	Invalid, chipping
17	A	38.5	56.1	60.7	9.8	4338.8	2.2	1.1	2.5	CON	Valid, failed through matrix and fine to coarse grained clasts
18	D	40.9	140.0	60.7	8.3	3684.5	2.3	1.1	2.5	CON	Valid, failed through matrix and fine to coarse grained clasts
19	D	41.1	140.0	60.7	20.1	3684.5	5.4	1.1	5.9	CON	Valid, failed through matrix and fine to coarse grained clasts
20	A	41.1	-	-	-	-	-	-	-	CON	Invalid, chipping
21	A	39.5	75.0	60.7	0.7	5796.4	0.1	1.2	0.1	CON	Valid, failed through matrix
22	D	44.2	100.0	60.7	4.7	3684.5	1.3	1.1	1.4	CON	Valid, failed through matrix and fine to medium grained clasts
23	A	44.4	30.0	60.7	6.2	2318.6	2.7	1.0	2.6	CON	Valid, failed through matrix and fine to medium grained clasts
24	D	44.9	140.0	60.7	8.2	3684.5	2.2	1.1	2.4	CON	Valid, failed through matrix and fine to medium grained clasts

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

Golder Associates Ltd.

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Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+785
Client:	Coastal GasLink
Borehole:	BH20-MOR-04

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where W = $(W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
1	D	89.4	80.0	60.7	10.8	3684.5	2.9	1.1	3.2	CON	Valid, failed through matrix and medium to coarse grained clasts
2	D	85.4	44.0	60.7	16.5	3684.5	4.5	1.1	4.9	CON	Valid, failed through matrix and medium to coarse grained clasts
3	D	85.5	200.0	60.7	6.3	3684.5	1.7	1.1	1.9	CON	Valid, failed through matrix and coarse grained clasts
4	D	82.4	70.0	60.7	2.4	3684.5	0.7	1.1	0.7	CON	Valid, failed through coarse grained clasts
5	D	82.4	65.0	60.7	8.0	3684.5	2.2	1.1	2.4	CON	Valid, failed through coarse grained clasts
6	A	82.5	44.0	60.7	13.3	3400.6	3.9	1.1	4.2	CON	Valid, failed through coarse grained clasts
7	A	78.0	51.8	60.7	3.1	4003.4	0.8	1.1	0.8	CON	Valid, failed through matrix and coarse grained clasts
8	D	81.0	230.0	60.7	6.2	3684.5	1.7	1.1	1.8	CON	Valid, failed through matrix and medium to coarse grained clasts
9	D	76.0	115.0	60.7	8.2	3684.5	2.2	1.1	2.4	CON	Valid, failed through matrix
10	A	72.0	46.0	60.7	8.6	3555.1	2.4	1.1	2.6	CON	Valid, failed through matrix
11	A	78.0	51.0	60.7	7.4	3941.6	1.9	1.1	2.1	CON	Valid, failed through matrix
12	D	78.9	220.0	60.7	14.3	3684.5	3.9	1.1	4.2	CON	Valid, failed through matrix
13	D	72.1	120.0	60.7	20.5	3684.5	5.6	1.1	6.1	CON	Valid, failed through matrix and coarse grained clasts
14	A	72.0	55.0	60.7	3.2	4250.7	0.8	1.1	0.9	CON	Valid, failed through matrix and coarse grained clasts
15	D	76.3	160.0	60.7	1.3	3684.5	0.4	1.1	0.4	CON	Valid, failed through matrix and coarse grained clasts
16	A	76.2	-	-	-	-	-	-	-	SS	Invalid, chipping
17	D	76.3	80.0	60.7	2.3	3684.5	0.6	1.1	0.7	SS	Valid, failed through matrix
18	D	56.5	-	-	-	-	-	-	-	CON	Invalid, chipping
19	A	56.4	-	-	-	-	-	-	-	CON	Invalid, chipping
20	D	53.5	70.0	60.7	11.2	3684.5	3.0	1.1	3.3	CON	Valid, failed through matrix and medium to coarse grained clasts
21	A	54.0	25.0	60.7	3.4	1932.1	1.7	0.9	1.6	CON	Valid, failed through matrix and medium to coarse grained clasts
22	D	62.0	110.0	60.7	5.2	3684.5	1.4	1.1	1.5	CON	Valid, failed through matrix
23	D	62.0	50.0	60.7	6.6	3684.5	1.8	1.1	1.9	CON	Valid, failed through matrix
24	A	62.0	25.0	60.7	7.5	1932.1	3.9	0.9	3.7	CON	Valid, failed through matrix
25	A	62.0	25.0	60.7	3.6	1932.1	1.9	0.9	1.8	CON	Valid, failed through matrix
26	D	68.0	140.0	60.7	4.6	3684.5	1.2	1.1	1.4	CON	Valid, failed through matrix and coarse grained clasts
27	A	68.0	-	-	-	-	-	-	-	CON	Invalid, chipping
28	D	68.8	-	-	-	-	-	-	-	CON	Invalid, chipping
29	D	67.9	140.0	60.7	5.6	3684.5	1.5	1.1	1.7	CON	Valid, failed through matrix and coarse grained clasts
30	D	52.3	190.0	60.7	5.7	3684.5	1.5	1.1	1.7	CON	Valid, failed through matrix and medium to coarse grained clasts
31	D	52.3	92.0	60.7	6.0	3684.5	1.6	1.1	1.8	CON	Valid, failed through matrix and medium to coarse grained clasts
32	D	49.3	180.0	60.7	6.2	3684.5	1.7	1.1	1.8	CON	Valid, failed through matrix and coarse grained clasts
33	D	49.3	81.0	60.7	4.8	3684.5	1.3	1.1	1.4	CON	Valid, failed through matrix and coarse grained clasts
34	A	49.2	26.0	60.7	2.4	2009.4	1.2	1.0	1.1	CON	Valid, failed through coarse grained clasts
35	D	49.3	200.0	60.7	3.1	3684.5	0.8	1.1	0.9	CON	Valid, failed through coarse grained clasts
36	D	44.6	105.0	60.7	7.2	3684.5	2.0	1.1	2.1	SS	Valid, failed through matrix
37	A	44.7	46.0	60.7	2.9	3555.1	0.8	1.1	0.9	SS	Valid, failed through matrix

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

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Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+785
Client:	Coastal GasLink
Borehole:	BH20-MOR-04

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where W = $(W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
38	D	31.0	145.0	60.7	4.8	3684.5	1.3	1.1	1.4	CON	Valid, failed through matrix and medium to coarse grained clasts
39	A	31.0	60.0	60.7	6.8	4637.1	1.5	1.1	1.7	CON	Valid, failed through matrix
40	D	31.0	-	-	-	-	-	-	-	CON	Invalid, chipping
41	A	31.0	30.0	60.7	7.8	2318.6	3.3	1.0	3.3	CON	Valid, failed through matrix and medium to coarse grained clasts
42	D	38.5	-	-	-	-	-	-	-	CON	Invalid, chipping
43	D	38.5	110.0	60.7	17.3	3684.5	4.7	1.1	5.1	CON	Valid, failed through matrix and medium to coarse grained clasts
44	D	35.5	110.0	60.7	7.1	3684.5	1.9	1.1	2.1	CON	Valid, failed through matrix and medium to coarse grained clasts
45	A	35.5	38.0	60.7	9.8	2936.9	3.3	1.0	3.4	CON	Valid, failed through matrix and medium to coarse grained clasts
46	A	35.5	52.0	60.7	10.8	4018.9	2.7	1.1	3.0	CON	Valid, failed through matrix and medium to coarse grained clasts
47	D	43.3	170.0	60.7	5.0	3684.5	1.4	1.1	1.5	CON	Valid, failed through matrix and coarse grained clasts
48	D	43.4	60.0	60.7	7.3	3684.5	2.0	1.1	2.2	CON	Valid, failed through matrix and coarse grained clasts
49	A	43.3	41.0	60.7	6.9	3168.7	2.2	1.1	2.3	CON	Valid, failed through matrix and medium to coarse grained clasts
50	A	43.4	27.0	60.7	7.3	2086.7	3.5	1.0	3.3	CON	Valid, failed through matrix and medium to coarse grained clasts
51	D	20.2	90.0	60.7	0.6	3684.5	0.2	1.1	0.2	CON	Valid, failed through matrix and medium to coarse grained clasts
52	A	20.1	40.0	60.7	2.5	3091.4	0.8	1.0	0.8	CON	Valid, failed through matrix
53	A	20.2	24.0	60.7	7.7	1854.9	4.1	0.9	3.9	CON	Valid, failed through matrix
54	D	26.3	140.0	60.7	11.5	3684.5	3.1	1.1	3.4	CON	Valid, failed through matrix and medium to coarse grained clasts
55	D	26.4	60.0	60.7	19.3	3684.5	5.2	1.1	5.7	CON	Valid, failed through matrix and medium to coarse grained clasts
56	A	26.4	60.0	60.7	1.5	4637.1	0.3	1.1	0.4	CON	Valid, failed through matrix and medium to coarse grained clasts
57	D	22.0	-	-	-	-	-	-	-	CON	Invalid, chipping
58	D	22.2	200.0	60.7	15.1	3684.5	4.1	1.1	4.5	CON	Valid, failed through matrix and fine to coarse grained clasts
59	D	22.2	120.0	60.7	8.4	3684.5	2.3	1.1	2.5	CON	Valid, failed through matrix and fine to coarse grained clasts
60	A	22.3	40.0	60.7	5.4	3091.4	1.8	1.0	1.8	CON	Valid, failed through matrix and fine to coarse grained clasts

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

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Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+900
Client:	Coastal GasLink
Borehole:	BH20-MOR-05

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where W = $(W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
1	D	59.8	201.8	60.7	3.3	3684.5	0.9	1.1	1.0	CON	Valid, failed through matrix
2	A	59.9	141.8	60.7	5.0	10959.1	0.5	1.4	0.6	CON	Valid, failed through matrix
3	A	59.9	50.5	60.7	4.7	3902.9	1.2	1.1	1.3	CON	Valid, failed through matrix
4	D	58.6	80.0	60.7	3.9	3684.5	1.0	1.1	1.1	CON	Valid, failed through matrix
5	A	58.6	51.3	60.7	8.4	3964.8	2.1	1.1	2.4	CON	Valid, failed through matrix
6	D	58.7	50.0	60.7	9.1	3684.5	2.5	1.1	2.7	CON	Valid, failed through matrix
7	A	58.7	45.7	60.7	9.1	3532.0	2.6	1.1	2.8	CON	Valid, failed through matrix
8	A	58.2	61.6	60.7	4.8	4760.8	1.0	1.2	1.2	CON	Valid, failed through matrix
9	D	54.3	75.0	60.7	0.9	3684.5	0.2	1.1	0.3	CON	Valid, failed thorugh existing micro defect
10	A	54.2	70.8	60.7	2.3	5471.8	0.4	1.2	0.5	CON	Valid, failed through matrix
11	A	54.3	51.8	60.7	6.8	4003.4	1.7	1.1	1.9	CON	Valid, failed through matrix
12	A	50.2	35.3	60.7	9.3	2728.2	3.4	1.0	3.5	CON	Valid, failed through matrix
13	D	48.6	-	-	-	-	-	-	-	CON	Invalid, chipping
14	D	44.5	55.0	60.7	8.6	3684.5	2.3	1.1	2.6	CON	Valid, failed through matrix
15	D	44.5	45.0	60.7	10.5	3684.5	2.9	1.1	3.1	CON	Valid, failed through matrix and fine to medium grained clasts
16	D	44.4	40.0	60.7	12.4	3684.5	3.4	1.1	3.7	CON	Valid, failed through matrix
17	A	44.4	42.0	60.7	10.8	3246.0	3.3	1.1	3.5	CON	Valid, failed through matrix
18	A	44.5	40.9	60.7	4.9	3161.0	1.6	1.1	1.6	CON	Valid, failed through matrix
19	A	44.6	-	-	-	-	-	-	-	CON	Invalid, chipping
20	D	41.7	65.0	60.7	6.3	3684.5	1.7	1.1	1.9	CON	Valid, failed through matrix
21	A	41.7	55.6	60.7	3.2	4297.1	0.8	1.1	0.9	CON	Valid, failed through coarse grained clasts
22	D	41.7	115.0	60.7	10.3	3684.5	2.8	1.1	3.1	CON	Valid, failed through matrix and fine to medium grained clasts
23	A	41.6	55.7	60.7	13.7	4304.8	3.2	1.1	3.6	CON	Valid, failed through matrix and fine to medium grained clasts
24	D	35.6	70.0	60.7	10.4	3684.5	2.8	1.1	3.1	CON	Valid, failed through matrix and fine to coarse grained clasts
25	D	35.6	65.0	60.7	8.1	3684.5	2.2	1.1	2.4	CON	Valid, failed through matrix and fine to coarse grained clasts
26	D	35.5	60.0	60.7	12.9	3684.5	3.5	1.1	3.8	CON	Valid, failed through matrix and fine to coarse grained clasts
27	A	35.6	57.7	60.7	8.0	4459.4	1.8	1.1	2.0	CON	Valid, failed through matrix and fine to coarse grained clasts
28	A	35.5	52.2	60.7	10.5	4034.3	2.6	1.1	2.9	CON	Valid, failed through matrix and fine to coarse grained clasts
29	A	35.5	-	60.7	-	-	-	-	-	CON	Invalid, chipping
30	D	33.7	50.0	60.7	2.8	3684.5	0.8	1.1	0.8	CON	Valid, failed thorugh existing micro defect
31	D	33.7	-	60.7	-	-	-	-	-	CON	Invalid, chipping
32	D	33.8	55.0	60.7	5.9	3684.5	1.6	1.1	1.7	CON	Valid, failed through matrix
33	A	33.8	38.3	60.7	5.0	2960.0	1.7	1.0	1.8	CON	Valid, failed through matrix
34	A	33.7	44.2	60.7	22.1	3416.0	6.5	1.1	6.9	CON	Valid, failed through matrix and fine to coarse grained clasts
35	A	33.7	45.7	60.7	3.9	3532.0	1.1	1.1	1.2	CON	Valid, failed through matrix
36	D	30.6	42.5	60.7	2.1	3684.5	0.6	1.1	0.6	CON	Valid, failed through matrix
37	A	30.6	35.5	60.7	2.2	2743.6	0.8	1.0	0.8	CON	Valid, failed through matrix

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

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Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Summary of Test Results

ASTM D5731

Project No.:	19122805/7000
Project:	Morice River Crossing Geotechnical Investigation
Location:	Houston BC, KP 558+900
Client:	Coastal GasLink
Borehole:	BH20-MOR-05

Load Configurations and Specimen Shape Requirement

(D)	Diametral Test, L > 0.5D
(A)	Axial Test, 0.3W < D < W
(B)	Block Test, L > 0.5D & 0.3W < D < W
(L)	Irregular Lump Test, L > 0.5D & 0.3W < D < W where $W = (W_1 + W_2)/2$

Test #	Type	Depth (m)	Length, L (mm)	Diameter, D (mm)	Load, P (kN)	De^2 (mm^2)	I_s (MPa)	F	I_{s50} (MPa)	Rock Type	Remarks
38	A	30.6	37.8	60.7	1.1	2921.4	0.4	1.0	0.4	CON	Valid, failed through matrix
39	A	30.6	37.4	60.7	0.8	2890.5	0.3	1.0	0.3	CON	Valid, failed through matrix
40	A	30.7	21.7	60.7	1.7	1677.1	1.0	0.9	0.9	CON	Valid, failed through matrix
41	A	30.7	24.3	60.7	2.1	1878.0	1.1	0.9	1.1	CON	Valid, failed through matrix
42	D	26.6	50.0	60.7	12.6	3684.5	3.4	1.1	3.7	CON	Valid, failed through matrix
43	D	26.5	45.0	60.7	7.4	3684.5	2.0	1.1	2.2	CON	Valid, failed through matrix
44	A	26.6	34.4	60.7	10.8	2658.6	4.1	1.0	4.1	CON	Valid, failed through matrix
45	A	26.5	37.3	60.7	11.8	2882.8	4.1	1.0	4.2	CON	Valid, failed through matrix
46	A	26.5	26.9	60.7	6.6	2079.0	3.2	1.0	3.1	CON	Valid, failed through matrix
47	A	22.4	-	-	-	-	-	-	-	CON	Invalid test, chipping
48	A	22.4	-	-	-	-	-	-	-	CON	Invalid test, chipping

Rock Types: Conglomerate (CON), Sandstone (SS)

A.Holdijk	2021-JAN-12	F.Champagne
TESTED BY	DATE	CHECKED BY

Golder Associates Ltd.

3202 Munroe Street, Terrace, British Columbia Canada, V8G 5L3

www.golder.com

Laboratory Determination of Abrasiveness of Rock Using the CERCHAR Method

Summary of Test Results

ASTM D7625

Project No.:	19122805/7000	**Apparatus Type:**	West Cerchar
Project:	Morice River Crossing Geotechnical Investigation	**Model:**	GCTS RAA-100
Location:	Morice River, BC	**Stylus Hardness:**	Rockwell Hardness HRC55
Client:	Coastal Gaslink	**Stylus Diameter:**	9.53mm
Lab ID No:	B20-443		

Borehole	Sample	Depth	Lithology	Moisture (%)	Test Surface	Cerchar (CAI_s)	Cerchar (CAI)	Abrasiveness Classification	Photo Reference	Comments
BH20-MOR-02	48	60.82-61.08	Conglomerate	6.45	Saw Cut	0.31	0.79	Low abrasiveness	1 & 2	
BH20-MOR-02	49	67.86-68.10	Conglomerate	7.99	Saw Cut	0.21	0.69	Low abrasiveness	3 & 4	
BH20-MOR-02	51	80.16-80.40	Conglomerate	3.27	Saw Cut	0.24	0.72	Low abrasiveness	5 & 6	
BH20-MOR-03	32	36.57-36.85	Conglomerate	4.06	Saw Cut	0.62	1.09	Medium abrasiveness	7 & 8	
BH20-MOR-05	29	33.37-33.63	Conglomerate	4.20	Saw Cut	0.74	1.21	Medium abrasiveness	9 & 10	
BH20-MOR-05	31	55.94-56.12	Sandstone	1.00	Saw Cut	0.57	1.04	Medium abrasiveness	11 & 12	

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

EF	December 24, 2020	GP	December 28, 2020
TESTED BY	DATE	CHECKED BY	DATE

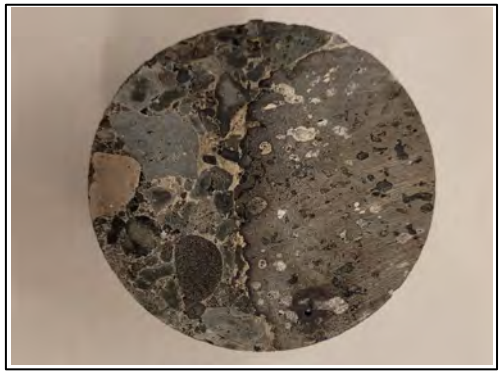
Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

Laboratory Determination of Abrasiveness of Rock Using the CERCHAR Method

Summary of Test Results

ASTM D7625

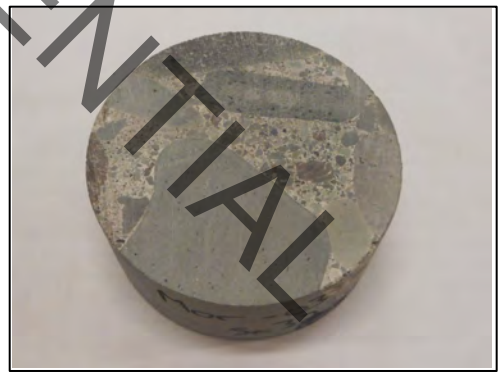
Project No.:	19122805/7000	**Apparatus Type:**	West Cerchar
Project:	Morice River Crossing Geotechnical Investigation	**Model:**	GCTS RAA-100
Location:	Morice River, BC	**Stylus Hardness:**	Rockwell Hardness HRC55
Client:	Coastal Gaslink	**Stylus Diameter:**	9.53mm
Lab ID No:	B20-443		

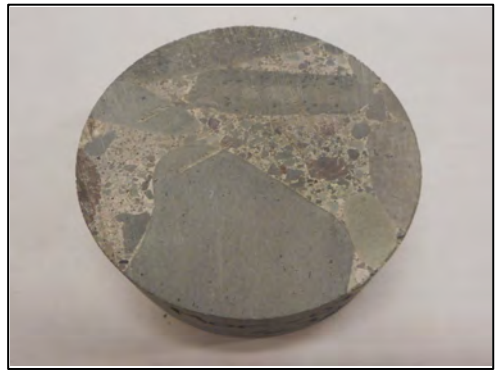


Photos 1 & 2: BH20-MOR-02 Sa 48 Cerchar before and after testing

Photos 3 & 4: BH20-MOR-02 Sa 49 Cerchar before and after testing

Photos 5 & 6: BH20-MOR-02 Sa 51 Cerchar before and after testing





Photos 7 & 8: BH20-MOR-03 Sa 32 Cerchar before and after testing

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

EF	December 24, 2020	GP	December 28, 2020
TESTED BY	DATE	CHECKED BY	DATE

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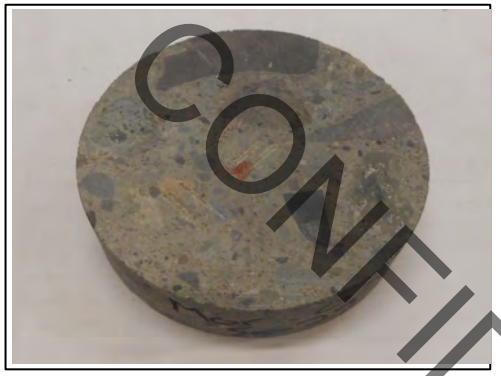
Laboratory Determination of Abrasiveness of Rock Using the CERCHAR Method

Summary of Test Results

ASTM D7625

Project No.:	19122805/7000	**Apparatus Type:**	West Cerchar
Project:	Morice River Crossing Geotechnical Investigation	**Model:**	GCTS RAA-100
Location:	Morice River, BC	**Stylus Hardness:**	Rockwell Hardness HRC55
Client:	Coastal Gaslink	**Stylus Diameter:**	9.53mm
Lab ID No:	B20-443		



Photos 9 & 10: BH20-MOR-05 Sa 29 Cerchar before and after testing

Photos 11 & 12: BH20-MOR-05 Sa 31 Cerchar before and after testing

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

EF	December 24, 2020	GP	December 28, 2020
TESTED BY	DATE	CHECKED BY	DATE

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Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

GOLDER

Porosity, Density & Absorption Determination Using Saturation and Buoyancy Techniques

ISRM Suggested Methods

Project No.: 19122805/7000
Project: Morice River Crossing Geotechnical Investigation
Location: Morice River, BC
Client: Coastal Gaslink Ltd.
Lab ID No: B20-443

Borehole	BH20-MOR-05	BH20-MOR-06	BH20-MOR-06			
Sample Number	* 24	4	5			
Depth (m)	19.35-19.51	5.49-5.79	7.32-7.47			
Porosity (%)	--	18.49	20.85			
Dry Density (kg/m^3)	1976	2067	1998			
Absorption (%)	--	8.93	10.41			

Borehole						
Sample Number						
Depth (m)						
Porosity (%)						
Dry Density (kg/m^3)						
Absorption (%)						

Borehole						
Sample Number						
Depth (m)						
Porosity (%)						
Dry Density (kg/m^3)						
Absorption (%)						

Borehole						
Sample Number						
Depth (m)						
Porosity (%)						
Dry Density (kg/m^3)						
Absorption (%)						

* Sample BH20-MOR-05 Sa 24 was more soil like and not suitable for SSD method. Wax method used instead. Porosity and absorption not calculated.

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

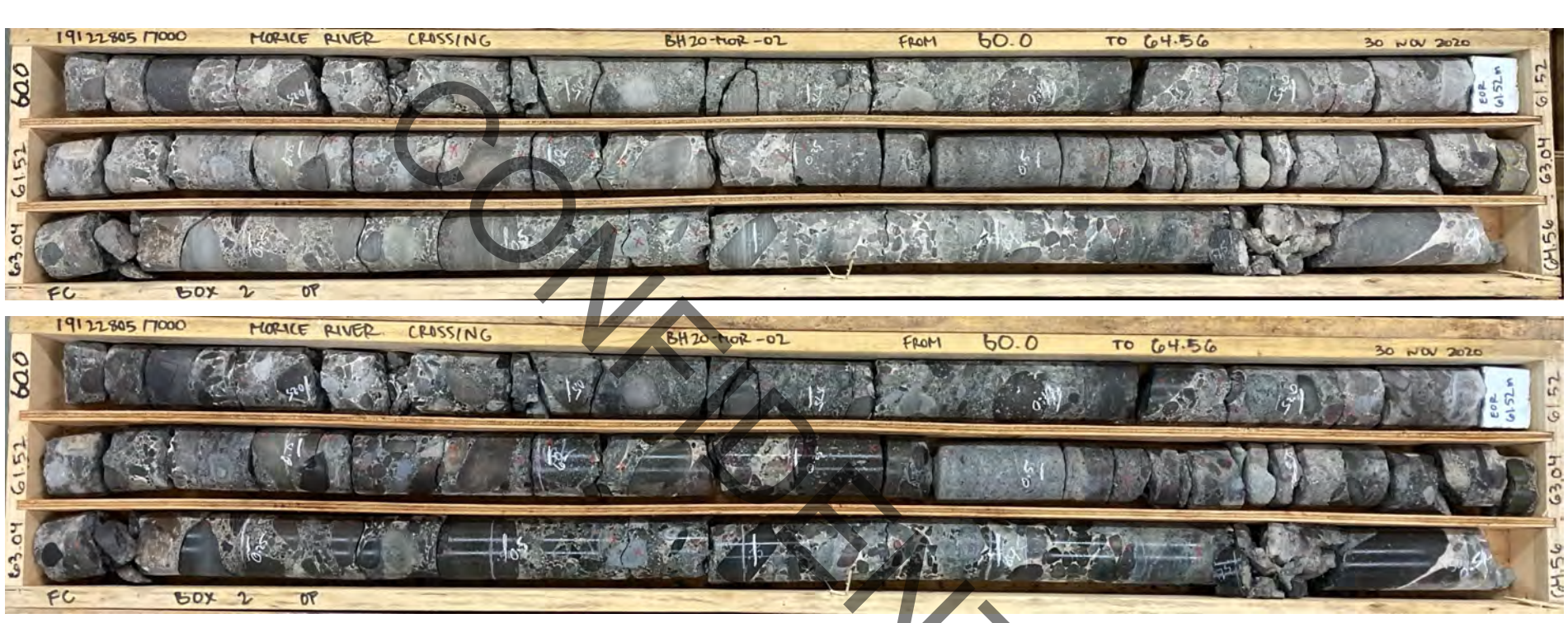
G. Patton	February 2, 2021	D. Lim	February 4, 2021
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

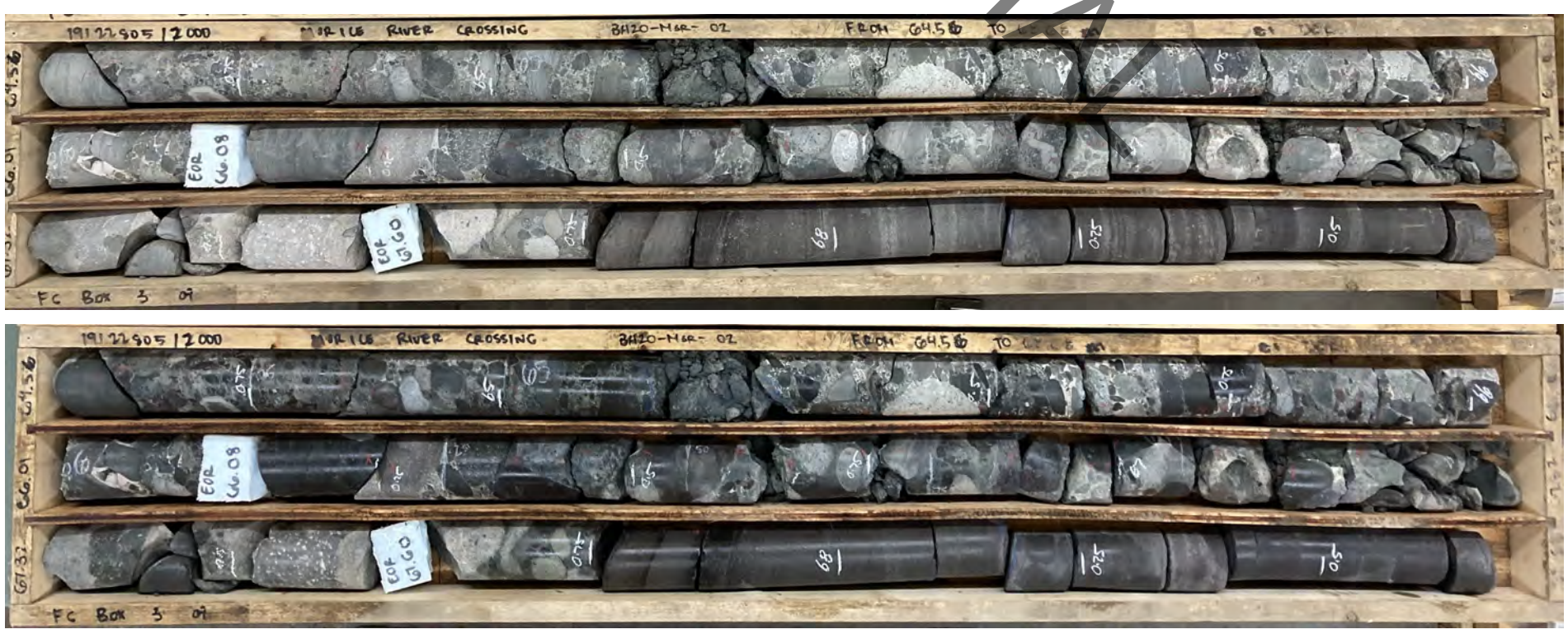
APPENDIX D

Rock Core Photographs

BH20-MOR-02 BOX 1/7 52.4 m to 60.0 m



BH20-MOR-02 BOX 2/7 60.0 m to 64.56 m



BH20-MOR-02 BOX 3/7 64.56 m to 68.68m

CLIENT
COASTAL GASLINK

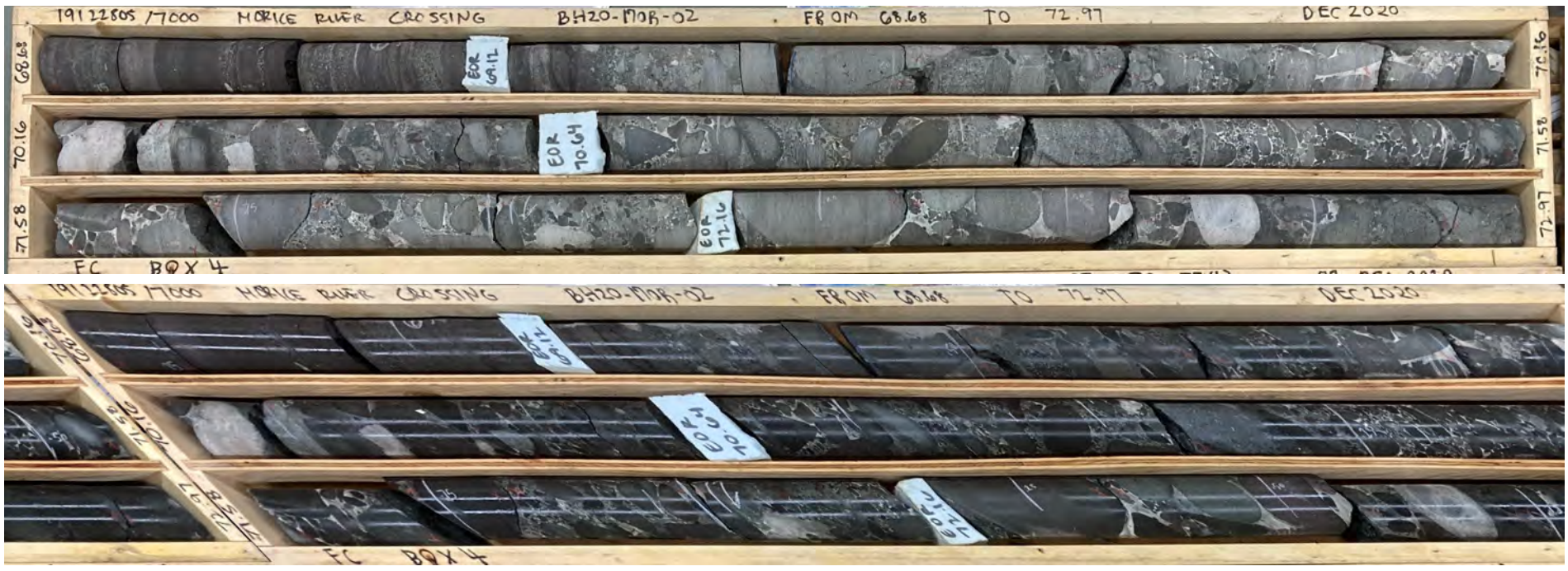
CONSULTANT
GOLDER

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-02 BOXES 1-3

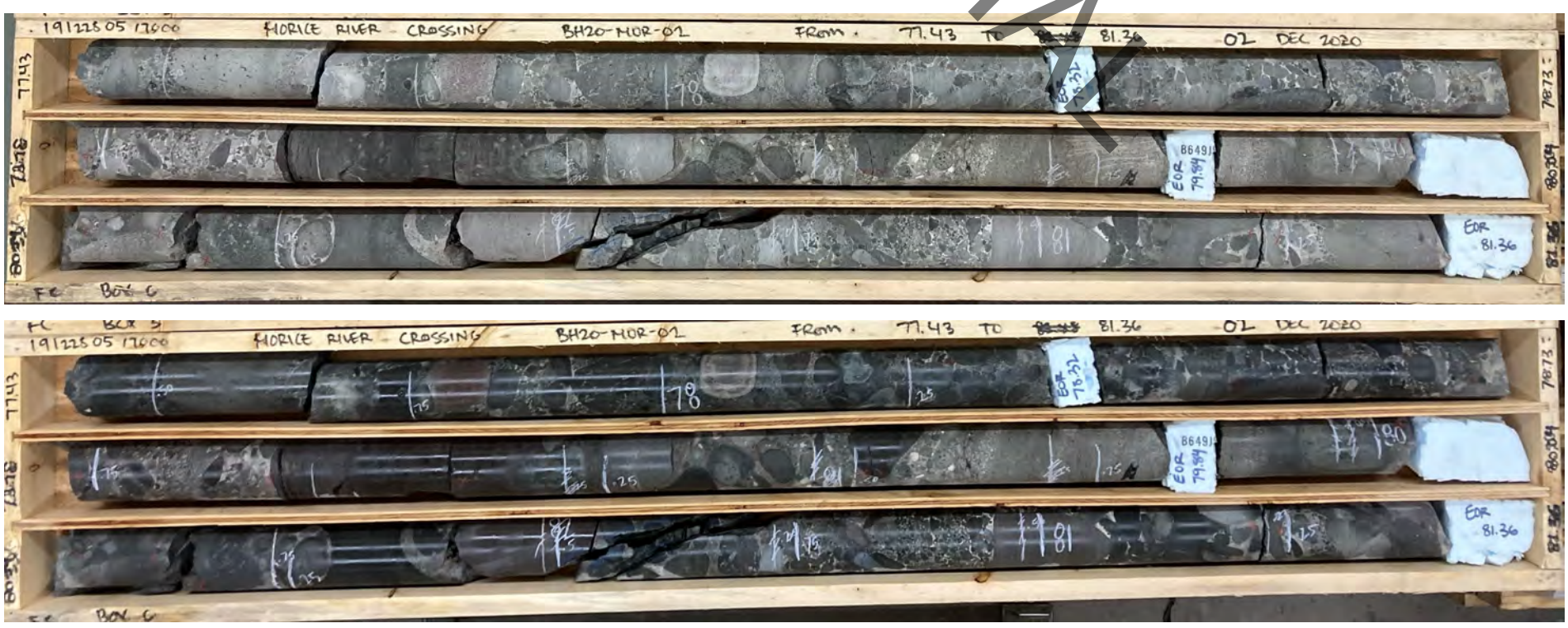
YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-02 BOX 4/7 68.68 m to 72.97 m

BH20-MOR-02 BOX 5/7 72.97 m to 77.43 m



BH20-MOR-02 BOX 6/7 77.43 m to 81.36 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-02 BOXES 4-6

PROJECT No	Phase	Task	Rev	FIGURE
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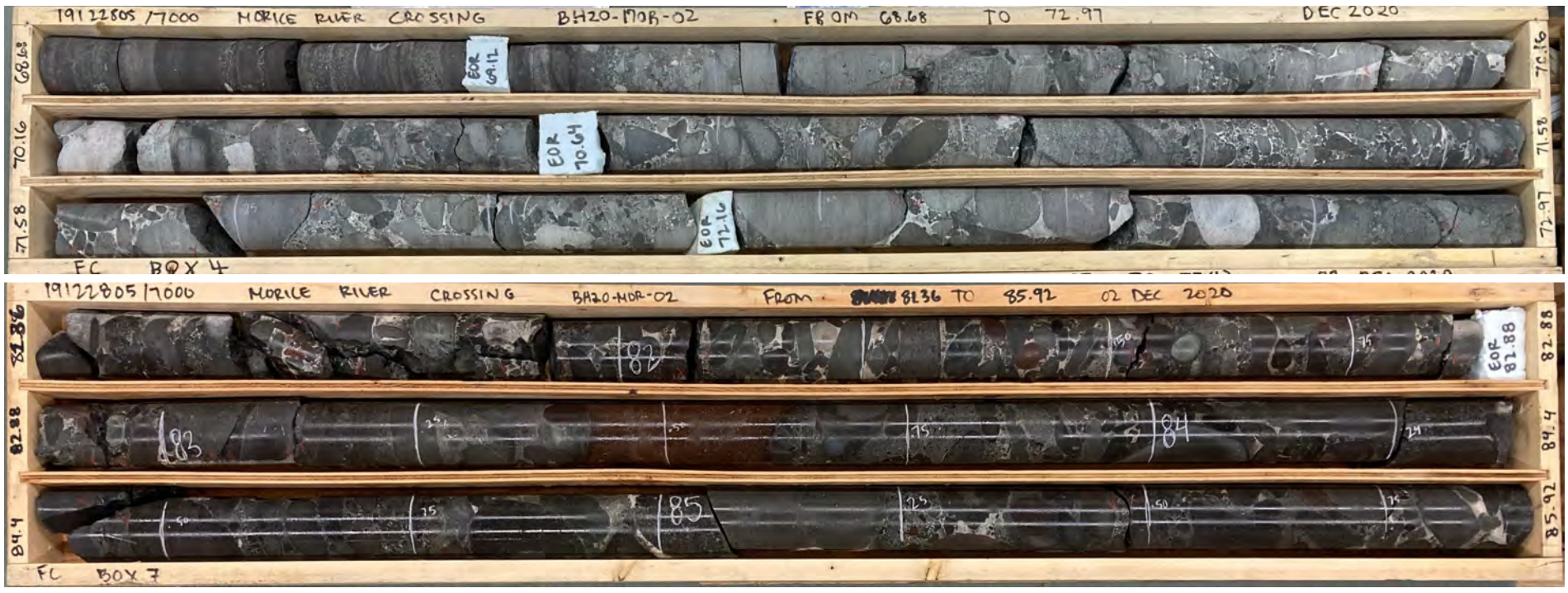


BH20-MOR-02 BOX 7/7 81.36 m to 85.92 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

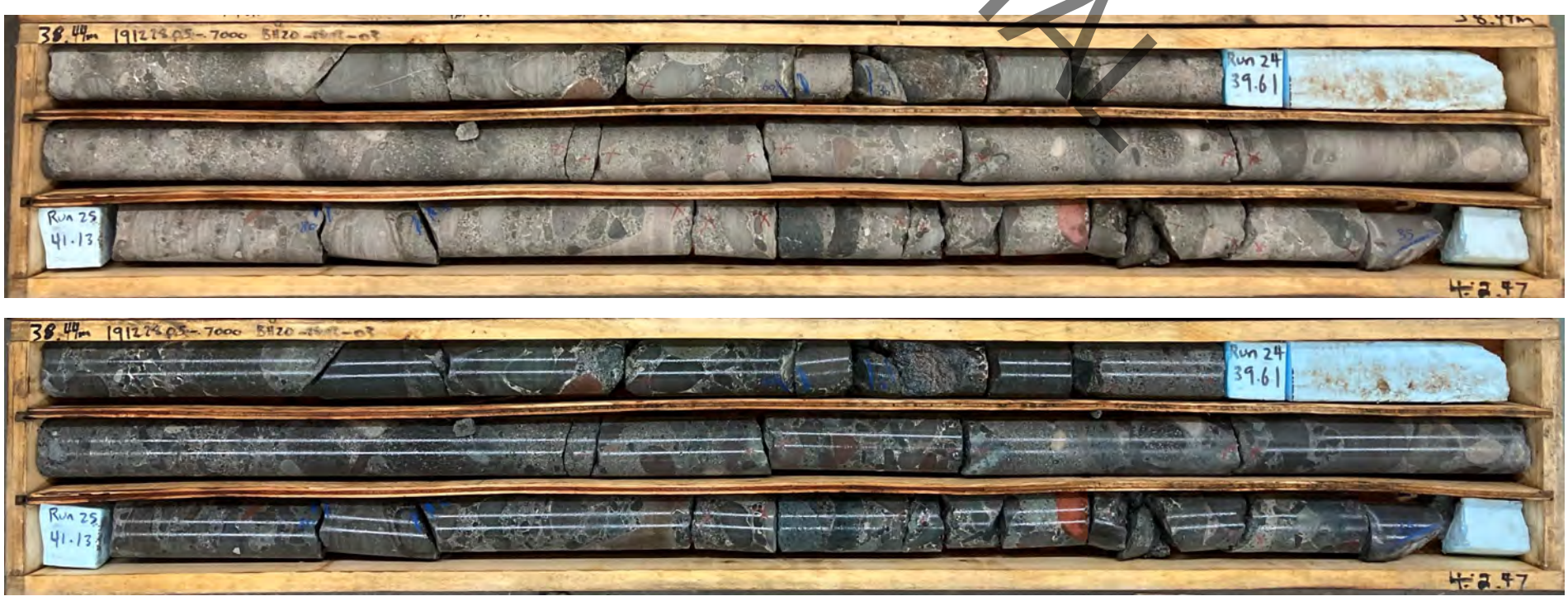
PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-02 BOX 7

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

BH20-MOR-03 BOX 1/3 29.57m to 35.15 m

BH20-MOR-03 BOX 2/4 35.15 m to 38.44 m



BH20-MOR-03 BOX 3/4 38.44 m to 42.47 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-03 BOXES 1-3

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

BH20-MOR-03 BOX 1/3 29.57m to 35.15 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

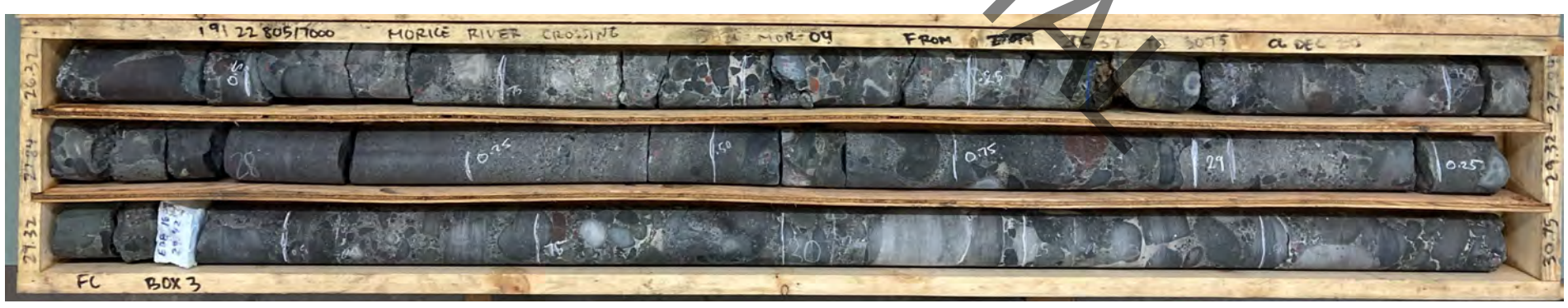
PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-03 BOX 4

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

BH20-MOR-04 BOX 1/17 17.68 m to 21.94 m

BH20-MOR-04 BOX 2/17 21.94 m to 26.32 m



BH20-MOR-04 BOX 3/17 26.32 m to 30.75 m

CLIENT
COASTAL GASLINK

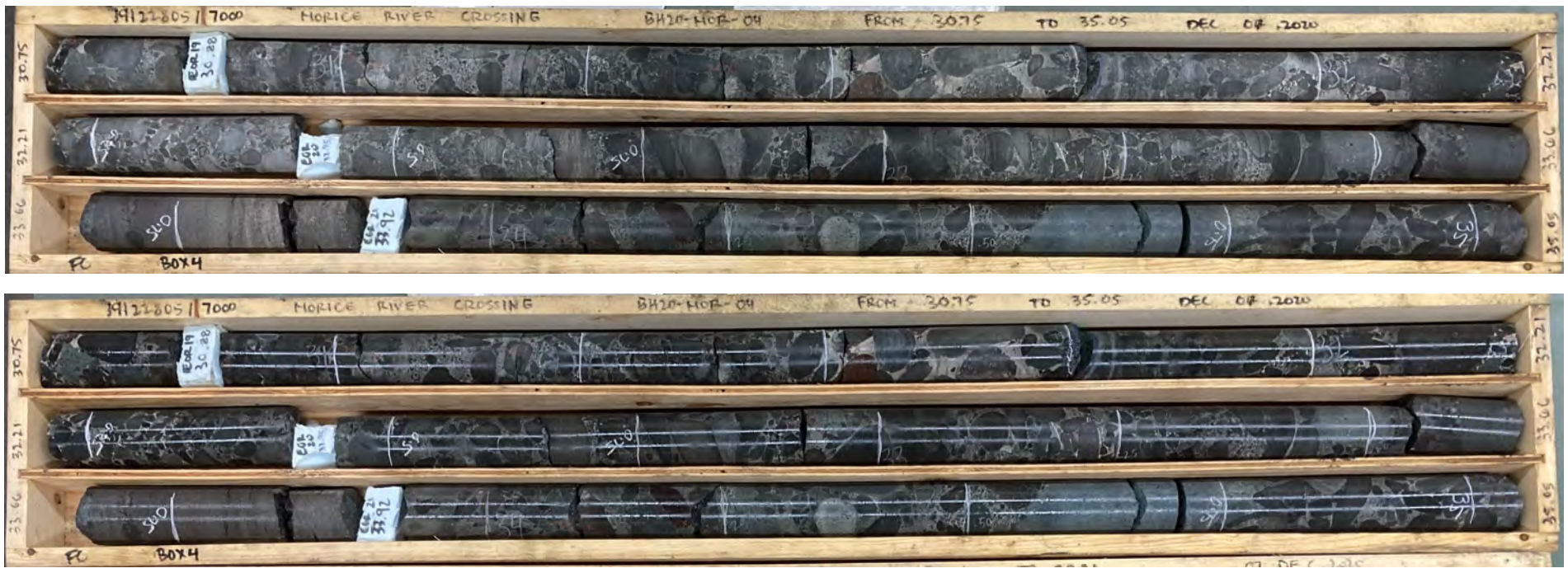
CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

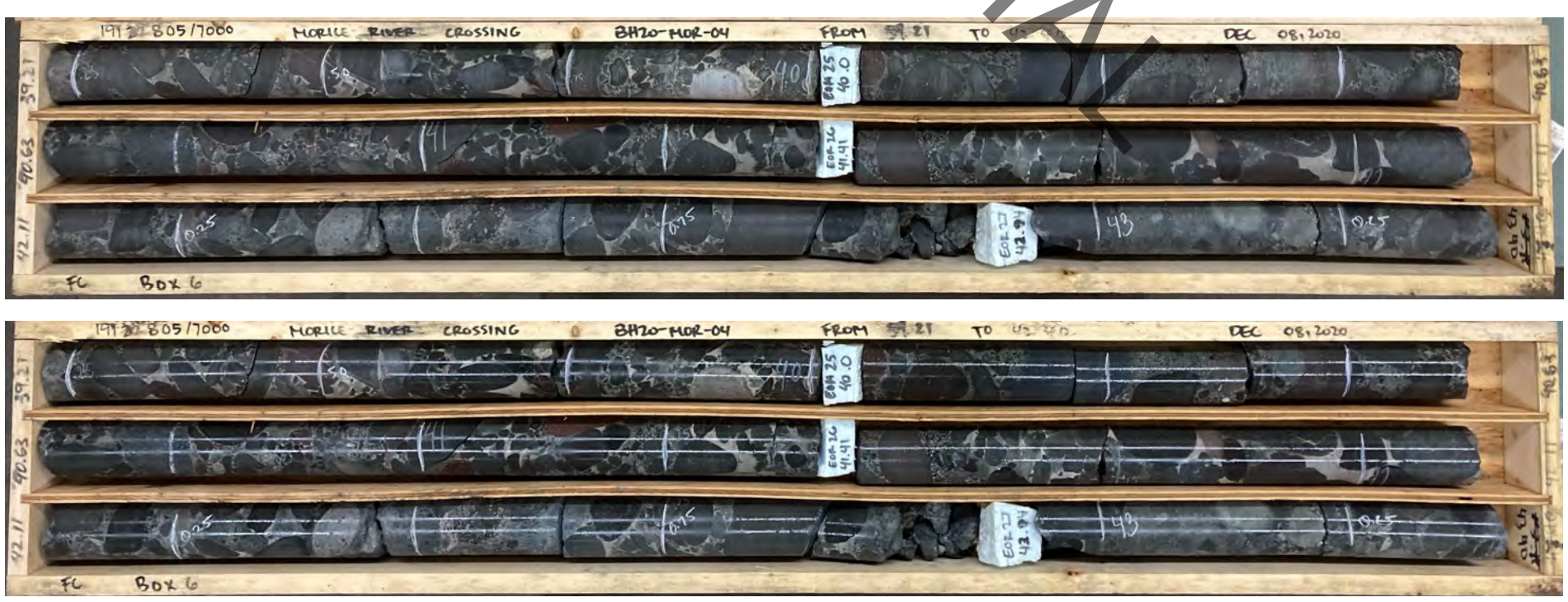
TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 1-3

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-04 BOX 4/17 30.75 m to 35.05 m

BH20-MOR-04 BOX 5/17 35.05 m to 39.21 m



BH20-MOR-04 BOX 6/17 39.21 m to 43.40 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 4-6

PROJECT No	Phase	Task	Rev	FIGURE
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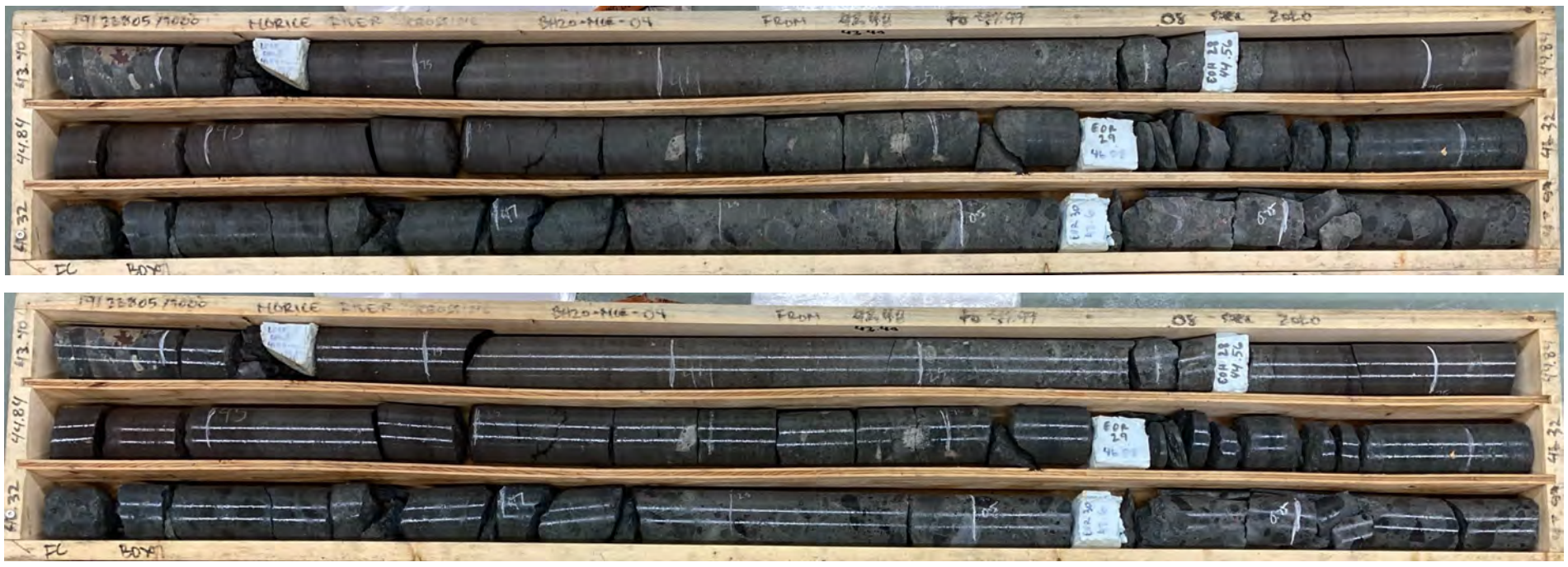
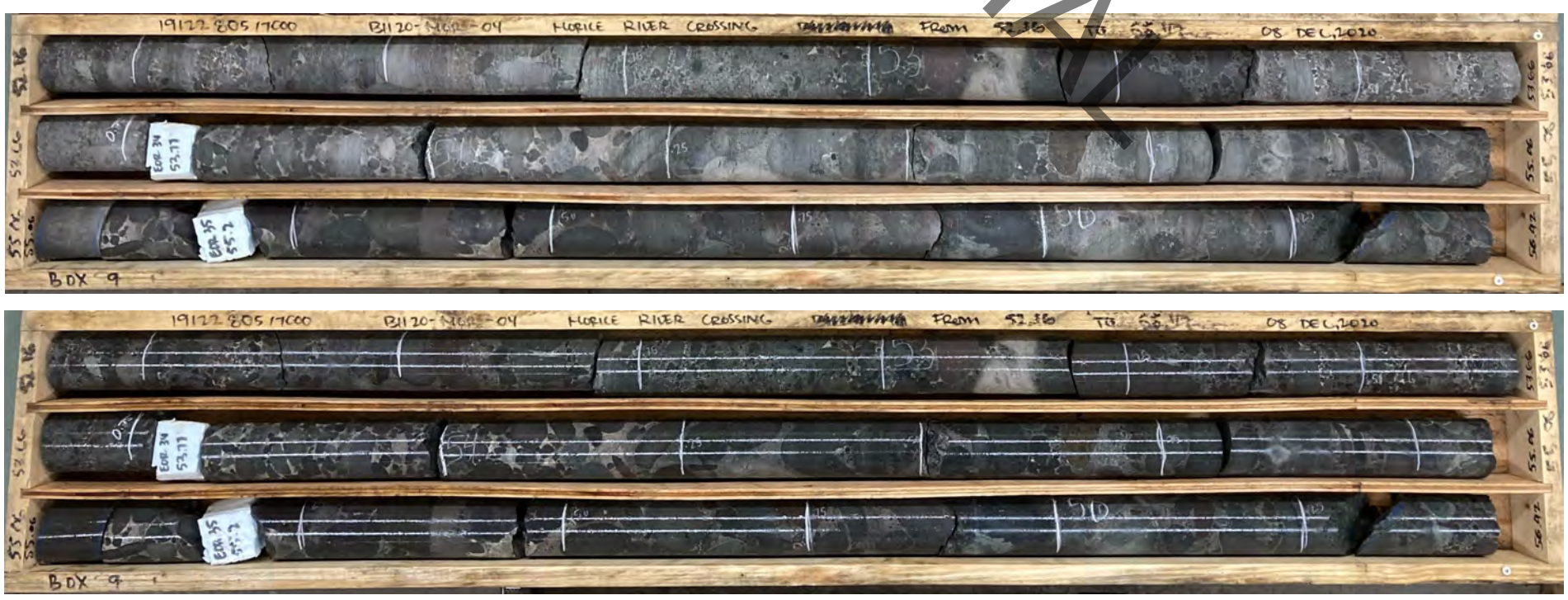


BH20-MOR-04 BOX 7/17 43.40 m to 47.99 m

BH20-MOR-04 BOX 8/17 47.99 m to 52.16 m



BH20-MOR-04 BOX 9/17 52.16 m to 56.42 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

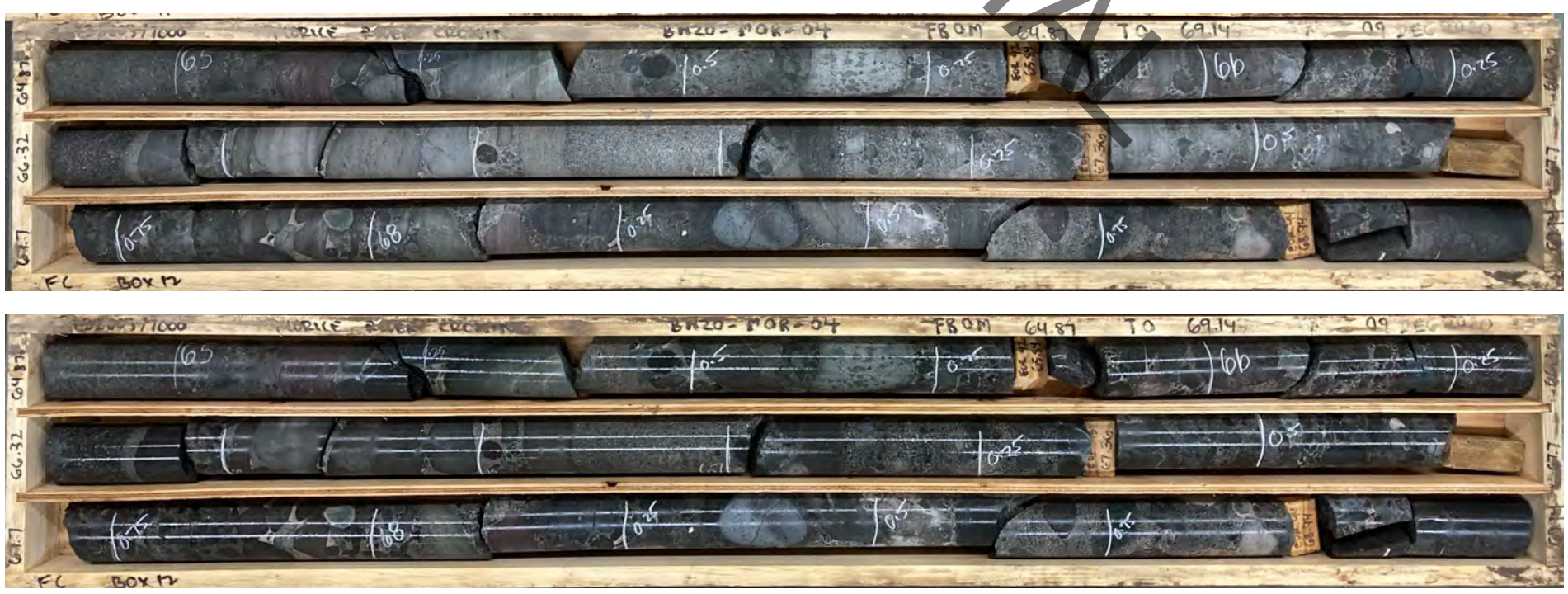
PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 7-9

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

BH20-MOR-04 BOX 10/7 56.42 m to 60.66 m

BH20-MOR-04 BOX 11/7 60.66 m to 64.87 m



BH20-MOR-04 BOX 12/7 64.87 m to 69.14 m

CLIENT
COASTAL GASLINK

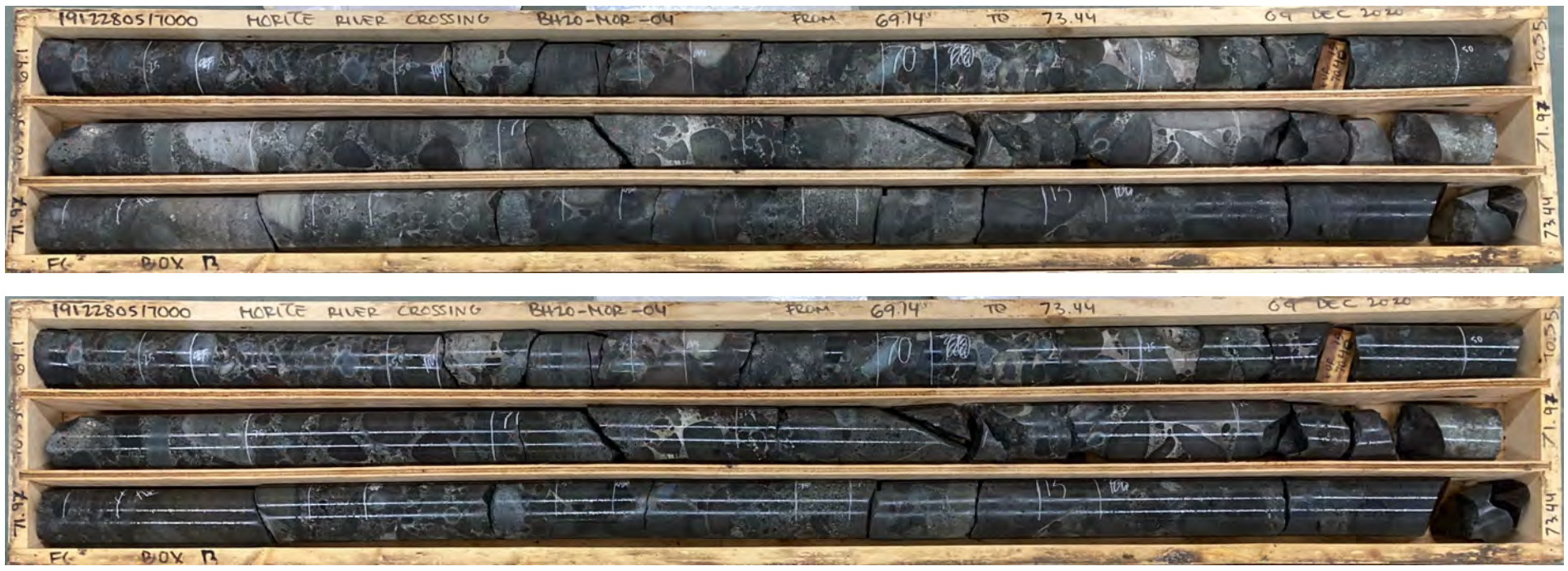
CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

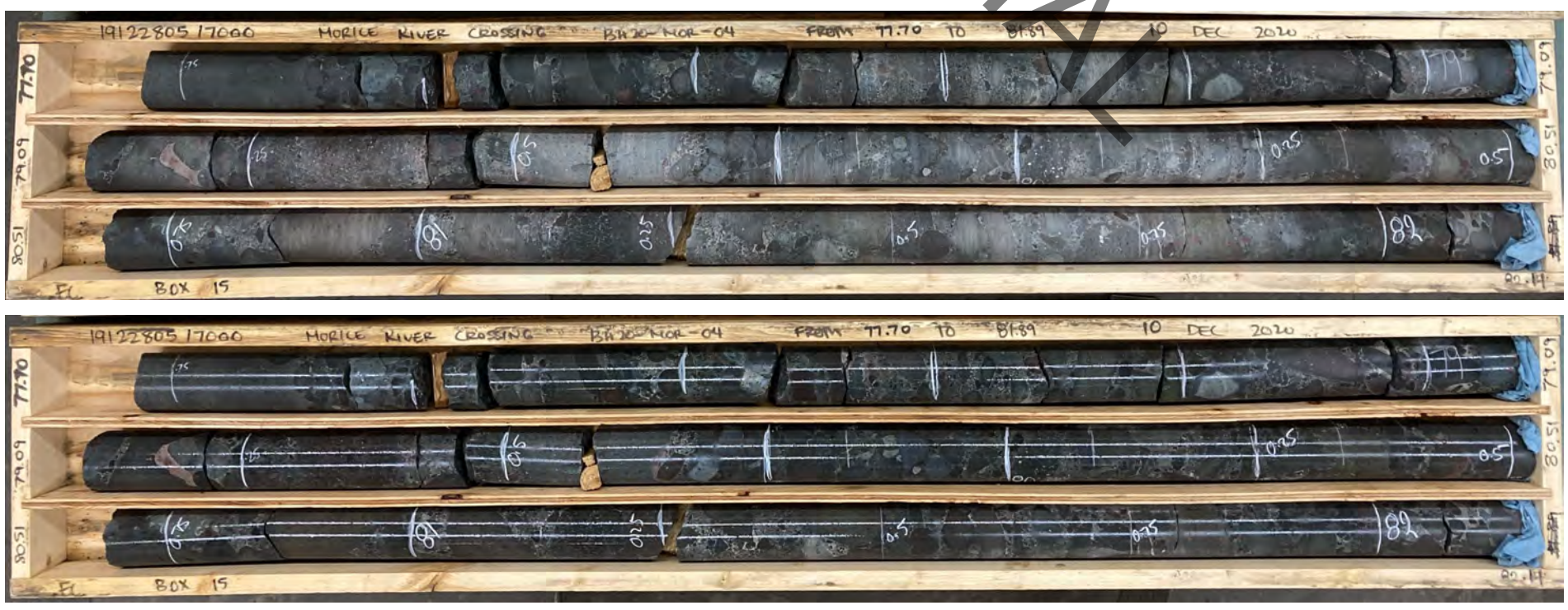
TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 10-12

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-04 BOX 13/17 69.14 m to 73.44 m

BH20-MOR-04 BOX 14/17 73.44 m to 77.70 m



BH20-MOR-04 BOX 15/17 77.70 m to 82.14 m

CLIENT
COASTAL GASLINK

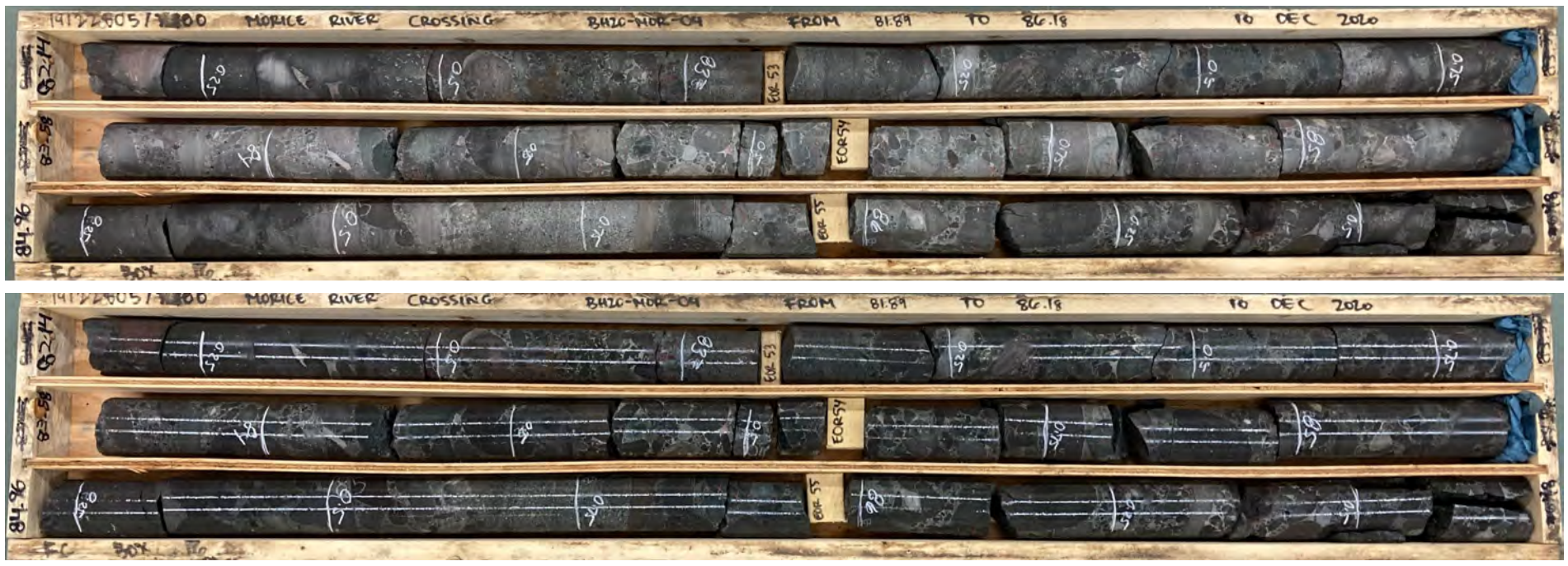
CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 13-15

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-04 BOX 16/17 82.14 m to 86.68 m

BH20-MOR-05 BOX 17/17 86.68 m to 90.68 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-04 BOXES 16-17

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

BH20-MOR-05 BOX 1/10 21.34 m to 24.95 m

BH20-MOR-05 BOX 2/10 24.65 m to 29.02 m

BH20-MOR-05 BOX 3/10 29.02 m to 33.35 m

CLIENT
COASTAL GASLINK

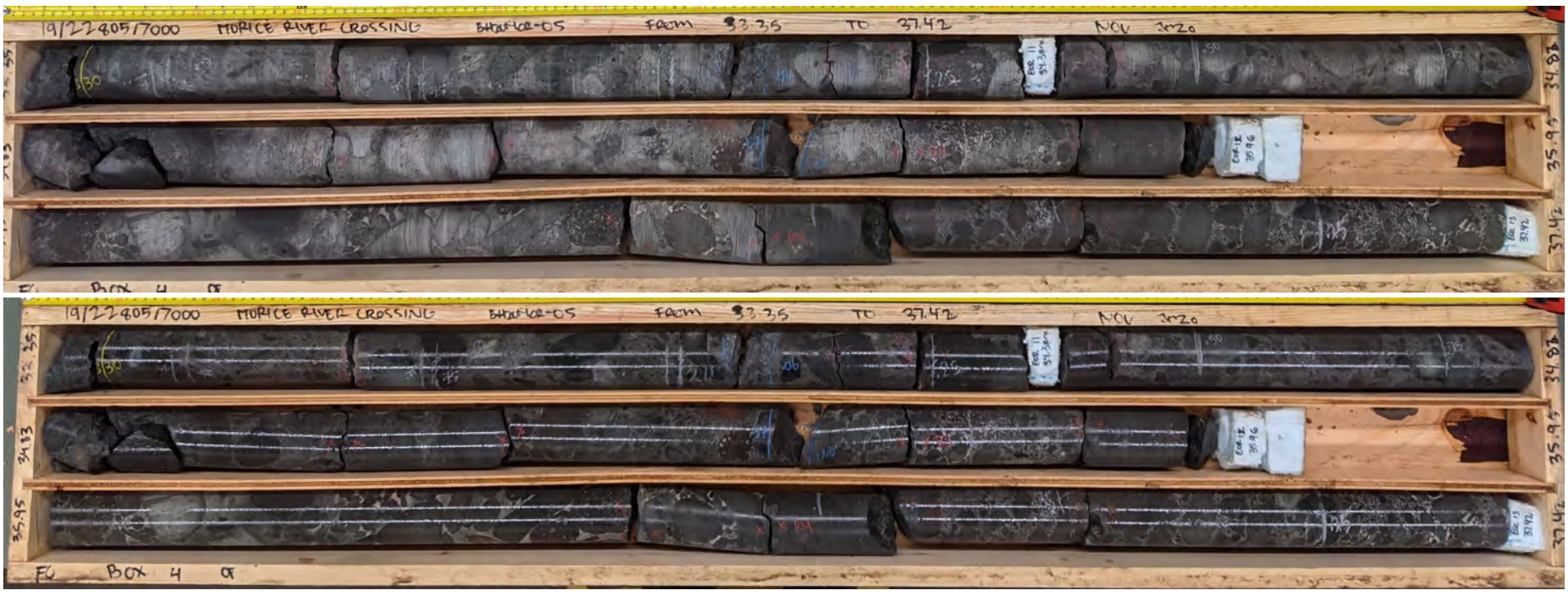
CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

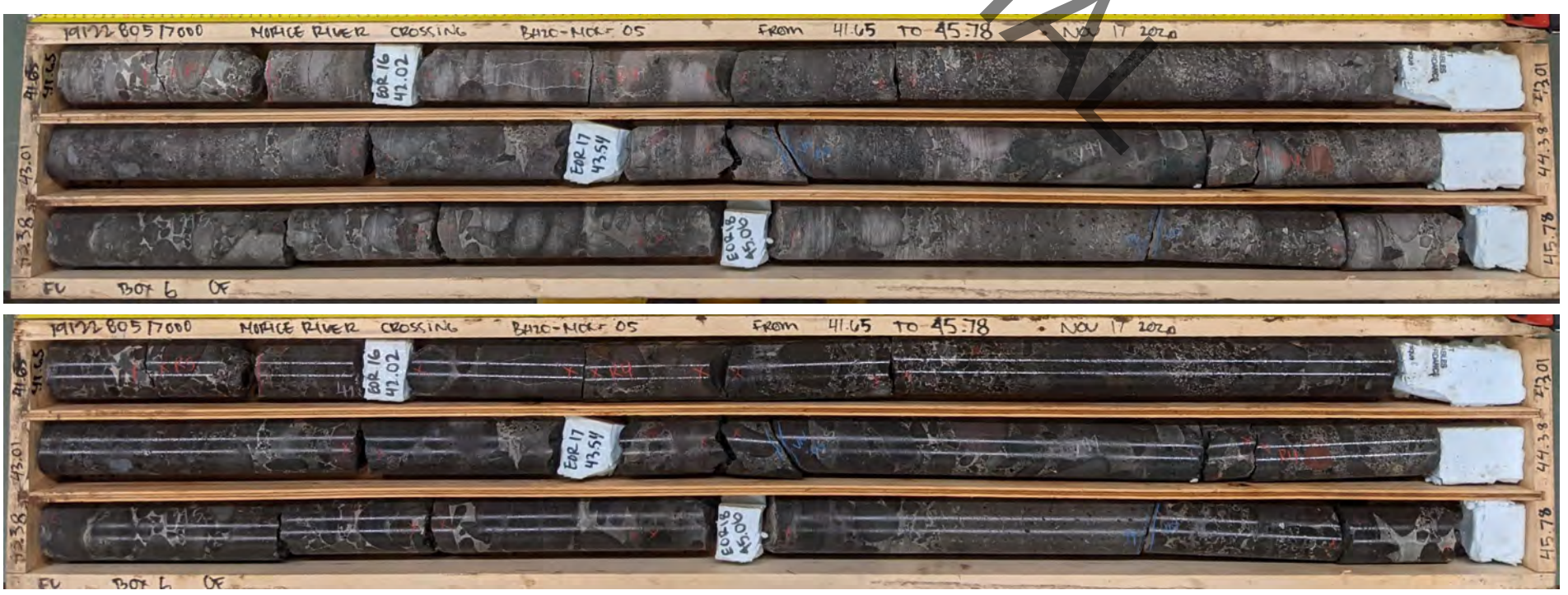
TITLE
CORE PHOTOGRAPHS: BH20-MOR-05 BOXES 1-3

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-05 BOX 4/10 33.35 m to 37.42 m

BH20-MOR-05 BOX 5/10 37.42 m to 41.65 m



BH20-MOR-05 BOX 6/10 41.65 m to 45.78 m

CLIENT
COASTAL GASLINK

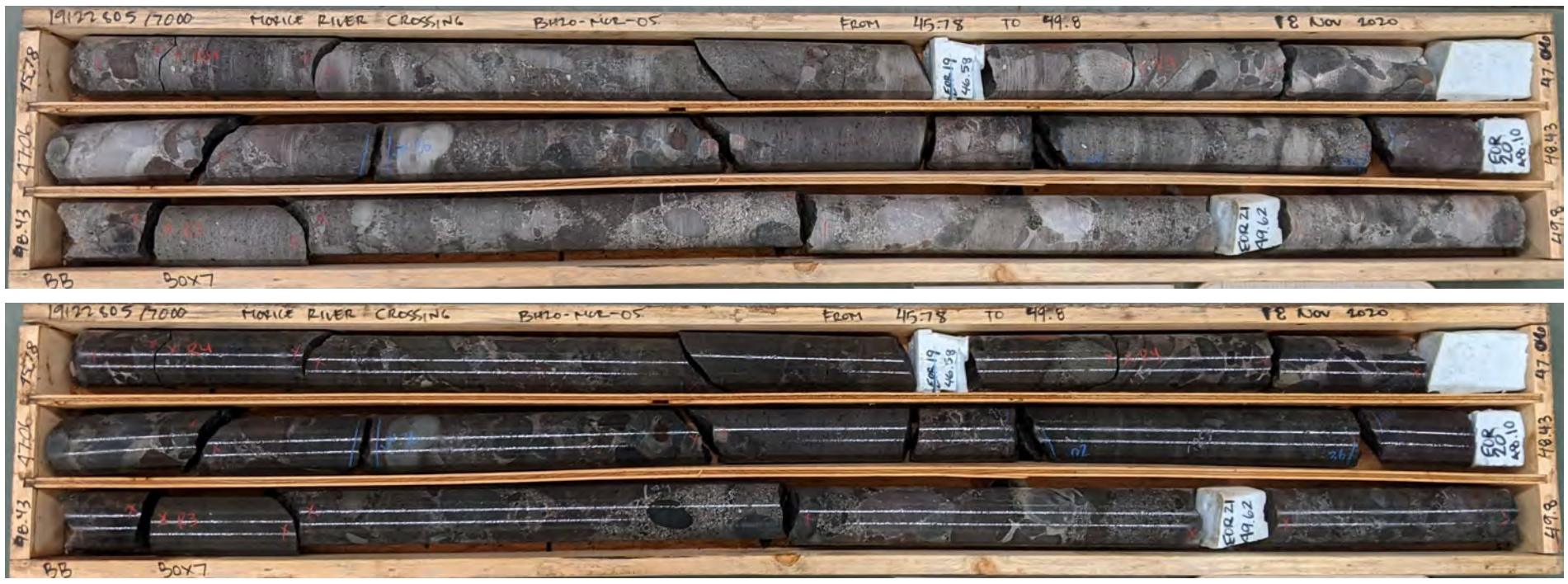
CONSULTANT
GOLDER

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-05 BOXES 4-6

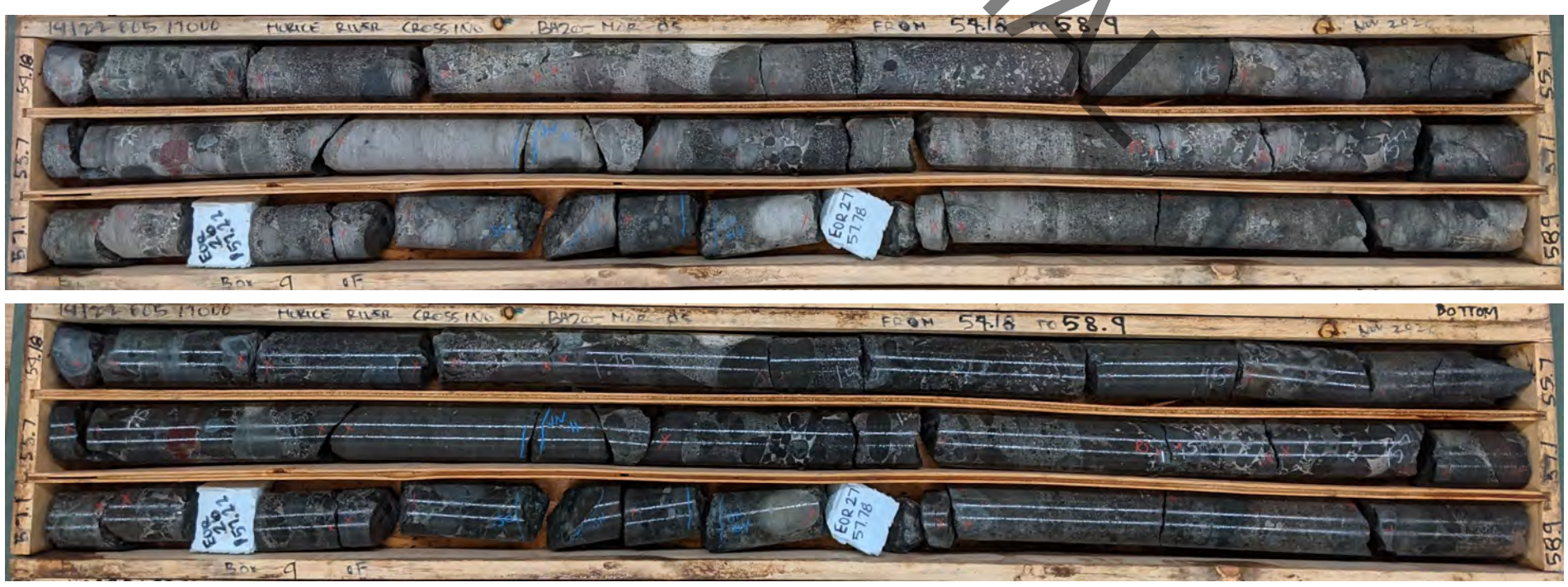
YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**



BH20-MOR-05 BOX 7/10 45.78 m to 49.8 m

BH20-MOR-05 BOX 8/10 49.8 m to 54.18 m



BH20-MOR-05 BOX 9/10 54.18 m to 58.9 m

CLIENT	COASTAL GASLINK
CONSULTANT	GOLDER
PROJECT	MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION
TITLE	CORE PHOTOGRAPHS: BH20-MOR-05 BOXES 7-9

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT No	Phase	Task	Rev	FIGURE
19122805	7000	7000	1	CORE PHOTO

BH20-MOR-05 BOX 10/10 58.9 m to 60.0 m

CLIENT
COASTAL GASLINK

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-12
PREPARED	FC
DESIGN	FC
REVIEW	AH
APPROVED	TF

PROJECT
MORICE RIVER CROSSING GEOTECHNICAL INVESTIGATION

TITLE
CORE PHOTOGRAPHS: BH20-MOR-05 BOX 10

PROJECT No	Phase	Task	Rev	FIGURE
19122805	**7000**	**7000**	**1**	**CORE PHOTO**

APPENDIX E

Geophysical Methods

1.0 METHOD

1.1 Seismic Refraction Tomography

In the seismic refraction method, an acoustic wave is generated at the surface which propagates radially into the subsurface. On encountering boundaries between media having contrasting mechanical properties, including density, elasticity, and consequently seismic velocity, the incident wave pulse is partially reflected and partially transmitted into underlying strata, as shown in Plate 1. The ray-path of the incident-transmitted pulse is bent, or refracted, at the boundary in accordance with Snell's Law. In particular, if seismic velocity increases across the boundary, the ray path is refracted towards the boundary. As the angle of incidence increases, so does the angle of refraction until for some critical incidence angle, dependant on the relative seismic velocity, the refracted wave pulse travels parallel to the boundary and acts as a moving source of secondary wave pulses which propagate upward into overlying strata as reflected head waves. The refraction head waves ultimately reach the surface where their arrival is detected by a linear array of geophones. By measuring the elapsed time between initial pulse generation at the shot-point and subsequent arrival of critically refracted head waves at successively more distant geophones, relatively straight-forward calculations yield estimates of layer velocities and thicknesses. In general, seismic interpretation methods assume the existence of relatively shallow–dipping layered geology with increasing layer velocities at increasing depth.

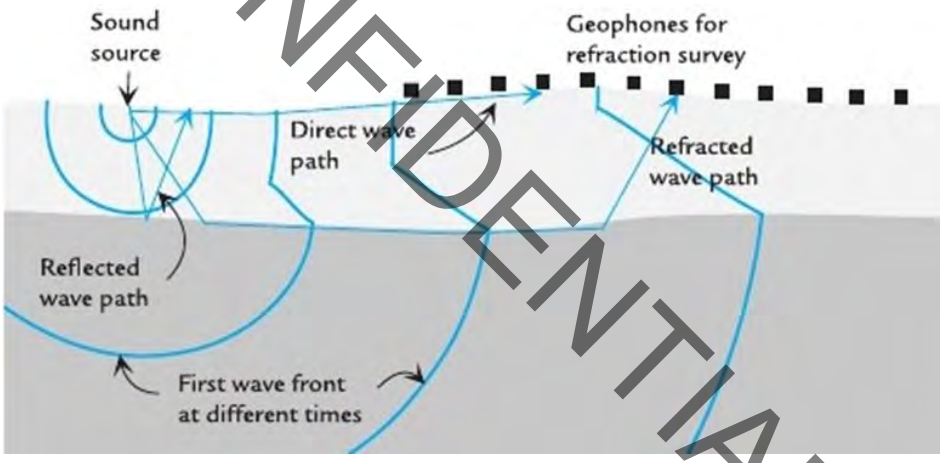


Plate 1: Seismic Refraction Method

Ranges of velocities of compressional p-waves for representative earth materials are listed in Table 1.

Table 1: Approximate Range of Seismic P-Wave Velocity of Common Geological Materials (Redpath, 1973 & Reynolds, 2011)

Material	Seismic Velocity Range [m/sec]
Air	330
Water	1,450 to 1,530
Soil	100 to 500
Unconsolidated Gravel, Rubble, or Sand (dry)	468 to 915
Sand (dry, loose)	200 to 1,000
Sand (water saturated, loose)	1,500 to 2,000
Sand and Gravel	400 to 2,300
Clay	610 to 1,830
Sandstone	1,400 to 4,500
Shale	2,000 to 4,100
Limestone	2,140 to 6,100

Seismic velocity generally increases with increasing density. The main factors controlling seismic velocity are porosity, soil/rock type, grain-size, compaction, water content, and temperature.

Typically, seismic depth determinations are accurate to within 10% to 20%, subject to the assumptions of refraction techniques including:

- Layered subsurface;
- Generally, layer slope variations of less than 20°; and
- Velocities increase with depth and relatively gradual changes in layer topography.

1.2 Electrical Resistivity Tomography

The resistivity of soil and rock depends in part on the constituent materials, as shown in Table 2. Typically, grain-size, porosity, rock-type, temperature, ice content, and water saturation are the primary factors controlling resistivity. Coarse-grained sediments such as sands and gravels are resistive compared to fine-grained sediments such as clays and silts. Fresh water saturation within clay-free soils reduces resistivity in accordance with Archie's Law, e.g. water saturated sands have a lower resistivity than dry sand. Increasing the concentration of total dissolved solids (TDS), particularly salts and metals, in groundwater normally reduces resistivity significantly. Variations in the electrical properties of different geological formations often enables effective geological mapping using electrical geophysical survey methods.

Table 2: Resistivity and Conductivity Ranges of Common Geological Materials (Milsom 2001 & Reynolds 2011)

Material	Resistivity (Ohm-m)	Conductivity (mS/m)
Fresh Water	2,000	0.5
Sea Water	0.033	30,000
Dry Sandy Soil	80 – 1,050	1 - 12.5
Sandy Clay/Clayey Sand	30 - 215	4.7 - 33
Gravel (dry)	1,400	0.7
Gravel (saturated)	100	10
Silts	10 - 1,000	1 - 100
Clays	1 - 100	10 - 1,000
Granite	1,000 - 100,000	0.01 - 1
Limestone	500 - 2,000	0.5 - 2
Sandstone	100 – 500	2 - 10
Shale	10 - 1,000	1 - 100
Mudstone	20 – 60	17 - 50
Dry Salt	1,000 - 100,000	0.01 - 1
Permafrost	1,000 – 10,000	0.1 - 1
Ice	100,000	0.01

The ERT method measures the electrical resistivity of the subsurface, both laterally and vertically, to infer rock/soil types and stratigraphy. Ground resistivity is measured by applying a direct current to the ground using two current electrodes and measuring the potential difference, or voltage, between two potential electrodes (Plate 2). The depth of investigation is largely a function of electrode separation, with larger electrode separations providing information to a greater depth.

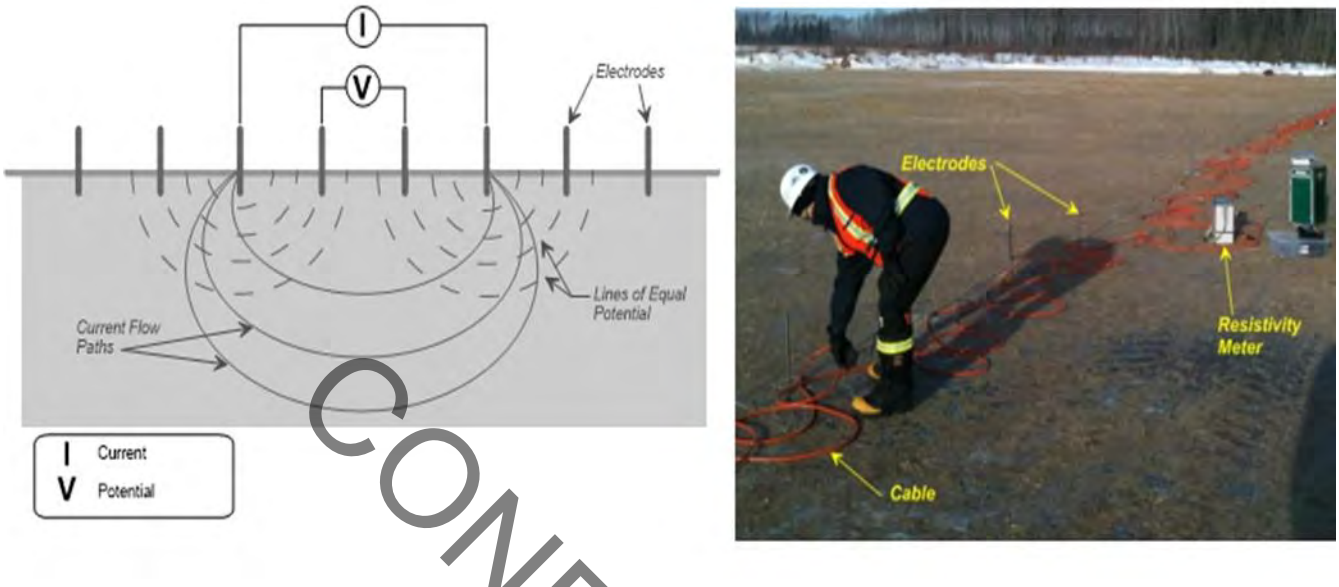


Plate 2: ERT Method

Multiple stainless-steel electrodes are positioned along a survey line and connected to the resistivity meter by a series of cables with multiple connection points. Software controlling the resistivity meter uses multiple electrodes to collect measurements at various user-specified separations, providing high-density data along the entire length of the profile. The Wenner-Schlumberger array type was used to collect data for this project. The Wenner-Schlumberger array type maintains the potential electrodes at a fixed midpoint, while iteratively increasing the current electrode spacing on either side of the potential electrode midpoint. This process is repeated for all user-specified combinations of potential electrode midpoints and current electrode separations. The Wenner-Schlumberger array generally provides deep penetration relative to electrode spacing and results in a good compromise between delineating horizontal structures and steeply dipping structures in the subsurface.

2.0 DATA PROCESSING

2.1 Seismic Refraction Data Processing

Seismic refraction data were processed using SeisImager, a commercial software package from Geometrics Inc. First break picks were completed manually in the PickWin software package and input into the PlotRefa SeisImager module to model the subsurface velocity structure along the profile. Plate 3 shows a typical seismic refraction record collected at a similar river crossing site.

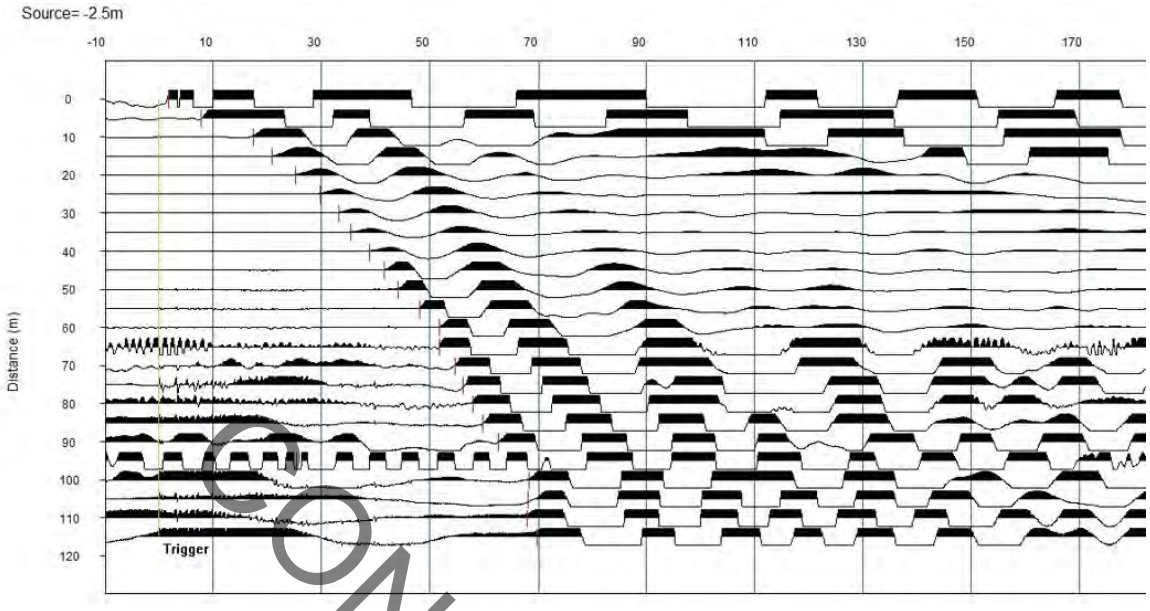


Plate 3: Seismic Refraction Record Example

Each horizontal trace along the vertical distance axis corresponds to a geophone spaced at 5 m intervals, the horizontal axis is time (measured in milliseconds) and the black wavelets in the seismic record correspond to acoustic energy arrivals at the geophones from the detonation of the seismic impact source. The picked first arrival times are indicated by red ticks. Geophones further from the seismic source have later arrival times. The travel time data were translated into velocity models using tomographic i.e. “imaging by sections” inversion process. The tomographic method uses an initial velocity model and traces travel time rays through the model. The calculated travel time are compared to the measured travel times and the velocity model is iteratively modified to minimize the difference between the model’s theoretical travel times and the travel times measured from the field data. Plate 4 shows an example of a tomographic model (red dots) versus actual travel time data (blue lines) collected at a similar river crossing. A significant difference in the resulting tomographic model compared to layer-based algorithms is that sharp interfaces are often vertically smoothed into artificial “transition zones” across actual geological interfaces. However, tomographic inversion can improve definition of lateral changing velocities in the subsurface as well as “velocity inversions”, or low velocity zones, which are typically not imaged by traditional layer modelling.

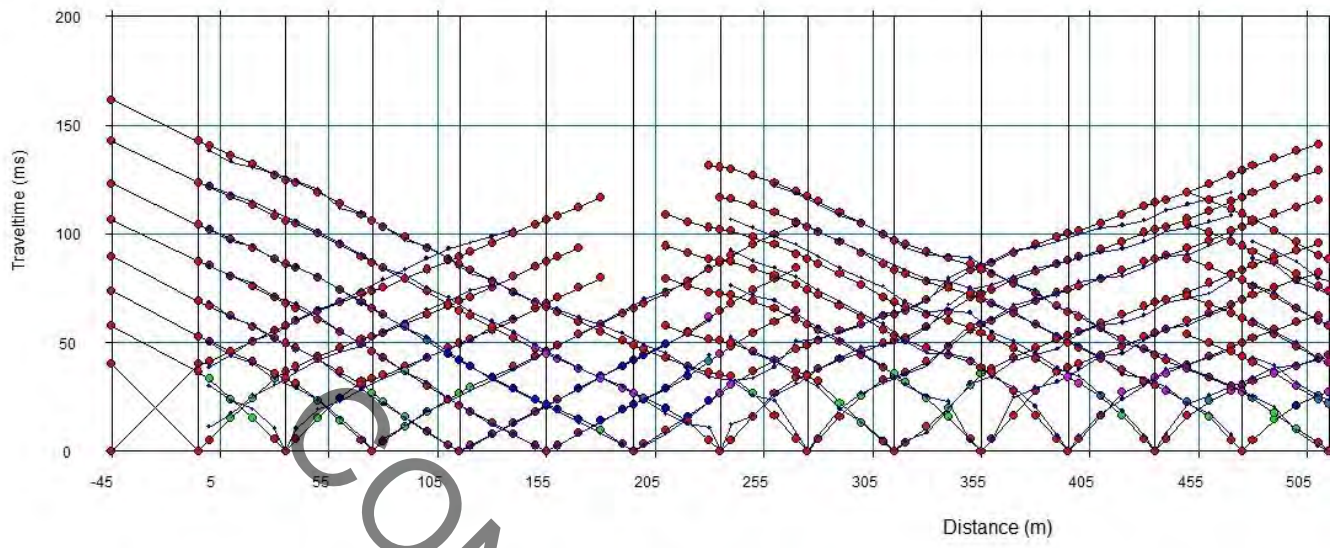


Plate 4: Tomographic Model Example

As stated, the seismic refraction survey method assumes that velocities increase with depth. If instead, a low velocity layer underlies a higher velocity later, the lower layer may not be correctly resolved using this approach. Similarly, thin layers may remain undetected by the seismic refraction survey method.

2.2 Electrical Resistivity Processing

ERT data sets were initially downloaded and edited using IRIS Instruments Prosys II v3.09 software. LiDAR elevation data were then added to the ERT data sets using Prosys.

Resultant processed ERT data sets were then imported into RES2DINV v4.06 (Geotomo Software), where any remaining outlying data points were removed. A least-squares finite-element inversion (Loke & Barker 1996) was applied to the edited data to convert apparent resistivity data to “true” resistivity resolved at “true” depth, taking into consideration the topography.

The resultant resistivity and seismic velocity models were then plotted as cross-sections using the Golden Software Surfer v16.6 mapping program.

3.0 REFERENCES

Redpath, Bruce B. 1973. Technical Report E-73-4 Seismic Refraction Exploration for Engineering Site Investigations. Prepared for U.S. Army Engineer Waterways Experiment Station, Explosive Excavation Research Laboratory. Livermore, California.

Loke, M. H., and R. D. Barker, Rapid least-squares inversion of apparent resistivity pseudo-sections using quasi-Newton method: Geophysical Prospecting, 48, 181-152, 1996.

Milsom, J. & Erikson, A., 2011. Field Geophysics, 4th ed., John Wiley & Sons Ltd, p.10 & p.187.

Reynolds, J., 2011. An Introduction to Applied and Environmental Geophysics, 2nd ed., John Wiley & Sons Ltd, p.291.

4.0 LIMITATIONS OF GEOPHYSICAL METHODS

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 practicing in Canada, subject to the time limits and physical constraints applicable to the work described in this report. No other warranty, express or implied, is made. The work completed, as documented in this report, is subject to the Terms and Conditions submitted to the Client.

This report has been prepared for the specific site, objective, development and/or purpose described to Golder by the Client, and is subject to the scope of work, financial and scheduling constraints of the assignment and the agreement entered into with the Client. The factual data, interpretations and recommendations pertain to this specific project, as described in this report, are based on the information obtained during the assessment by Golder on the dates cited in the report and are not applicable to any other project or site location. The validity of this report is affected by any change of site conditions, purpose, development plans or significant delay from the date of this report to initiating or completing the project. If changes or delays occur, Golder cannot be responsible for the use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The inferences concerning the site conditions contained in this report are based on information obtained during the assessment conducted by Golder personnel, and are based solely on the condition at the time of the assessment, supplemented by historical and/or other information obtained by Golder, as described in this report. The conclusions presented in this report represent the judgment of the assessor, and are based on observations and measurements made, and on-site conditions observed on the date(s) cited in this report. Due to the nature of the investigation, and the limited data available, the assessor cannot warrant against undiscovered features that may impact the project, nor variations in subsurface conditions between measuring points.

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It is a fundamental assumption for geophysical survey techniques that there will be sufficient physical property contrast between the media being investigated. However, physical properties can vary in the field such that media and subsurface bodies may not be sufficiently in contrast with their surroundings and result in uncertainty with respect to data interpretation. It is recommended that subsurface conditions interpreted through geophysical survey techniques be verified by physical sampling and/or inspection, in order to confirm and calibrate the data interpretation. Once verification data are available through future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the interpretations, conclusions and recommendations of this report, and to provide amendments, as required.

APPENDIX F

ARD/ML Geochemical Analysis Results

Table 1: Acid Base Accounting Results

Object ID	Sample Identifier	Laboratory ID	Paste pH	Fizz Test	TIC	C(T)	S(T)	$S(SO_4)$	$S(S^{-2})$	Insoluble S	AP	Modified (Bulk) NP	$CaCO_3$ NP	Bulk NPR	Carbonate NPR	FINAL CLASSIFICATION [1]
						%								(NPR)	(CaNPR)	
					%						(eq. kg $CaCO_3$/tonne)					
7-N-13	BH20-MOR-05 59.33 - 59.7m	13385-01	8.96	None	**0.05**	0.047	0.008	*<0.01*	*<0.01*	*<0.01*	*<0.3*	17.3	4.2	*NA*	*NA*	Non-PAG
7-N-14	BH20-MOR-05 50.44 0 50.83 m	13385-02	9.05	None	**0.01**	0.011	0.013	*<0.01*	0.01	0.01	*<0.3*	13	0.8	*NA*	*NA*	Non-PAG
7-N-19	BH20-MOR-03 41.13 to 41.34m	13553-01	8.80	Slight	**0.12**	0.114	0.011	*<0.01*	*<0.01*	*<0.011*	*<0.3*	23.5	10.0	*NA*	*NA*	Non-PAG
7-N-20	BH20-MOR-05 31.32 to 31.49m	13553-02	8.97	None	**0.07**	0.062	0.024	*<0.01*	*<0.01*	*<0.024*	*<0.3*	28.6	5.8	*NA*	*NA*	Non-PAG
7-N-21	BH20-MOR-05 40.35 to 40.5m	13553-03	9.03	None	**0.05**	0.049	0.008	*<0.01*	*<0.01*	*<0.008*	*<0.3*	15	4.2	*NA*	*NA*	Non-PAG

Note:
S = Sulphur
SO_4 = Sulphate
S^{-2} = Sulphide
AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from the measured sulphide-sulphur content.
NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.
NET NP = NP - AP
Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.
Sulphate Sulphur determined by 25% HCl Leach with S by ICP Finish
Sulphide Sulphur determined by Sobek 1:7 Nitric Acid Leach with S by ICP Finish
Insoluble S is acid insoluble S (Total S - (Sulphate S + Sulphide S)).
Bold values indicate concentrations that exceed limits set in the ARCRP. Limits for Sulphide Sulphur set at 0.1%; Limit for Paste pH set at <5.5.
PAG = Potentially Acid Generating
[1] Final classification of PAG or Non-PAG is derived from ARCRP Section 4.1 and 6.0. Determination of classification is based on Carbonate NPR, Paste pH, and sulphide sulphur.

Table 2: ICP Metal Results

Object ID	Sample Identifier	Laboratory ID	Normal Trace Element Group	Ag	Al	Ba	Ca	Cr	Cu	Fe	K	Li	Mg	Mn	Na	Ni	P	S	Sr
		Unit		ppm	%	ppm	%	ppm	ppm	%	%	ppm	%	ppm	%	ppm	%	%	ppm
		Limit of Detection		*0.01*	*0.01*	*5*	*0.01*	*1*	*0.5*	*0.01*	*0.01*	*1*	*0.01*	*2*	*0.01*	*0.5*	*0.005*	*0.01*	*0.5*
Normal Trace Element Concentrations [1]			**Normal Trace Element Multiplier**	*1*	*2*								*10*	*11*	*12*	*13*	*14*	*15*	*16*
Basaltic Rocks			1x	0.11	7.8	330	7.6	170	87	8.65	0.83	17	4.6	1500	18000	130	0.11	0.03	465
			5x	**0.55**	**39**	**1650**	**38**	**850**	**435**	**43.25**	**4.15**	**85**	**23**	**7500**	**90000**	**650**	**0.55**	**0.15**	**2325**
			10x	1.1	78	3300	76	1700	870	86.5	8.3	170	46	15000	180000	1300	1.1	0.3	4650
Object ID	**Sample Identifier**	**Laboratory ID**	**Normal Trace Element Group**	**Ag**	**Al**	**Ba**	**Ca**	**Cr**	**Cu**	**Fe**	**K**	**Li**	**Mg**	**Mn**	**Na**	**Ni**	**P**	**S**	**Sr**
7-N-13	BH20-MOR-05 59.33 - 59.7m	13385-01	Basaltic Rocks	0.05	2.02	142	1.11	50	27.3	4.36	0.15	10	1.43	870	0.16	55	0.14	*<0.01*	191
7-N-14	BH20-MOR-05 50.44 0 50.83 m	13385-02	Basaltic Rocks	0.06	0.97	80	0.77	35	13.5	3.74	0.15	5	0.75	728	0.13	18	0.17	0.02	40.9
7-N-19	BH20-MOR-03 41.13 to 41.34m	13553-01	Basaltic Rocks	0.03	1.62	269	1.31	55	15.8	3.89	0.14	7	0.99	578	0.17	24	0.18	*<0.01*	389
7-N-20	BH20-MOR-05 31.32 to 31.49m	13553-02	Basaltic Rocks	0.04	3.54	54	1.61	71	44.6	4.43	0.07	19	1.72	590	0.25	54	0.13	0.01	86.1
7-N-21	BH20-MOR-05 40.35 to 40.5m	13553-03	Basaltic Rocks	0.03	1.39	240	0.99	36	20.5	3.67	0.14	9	1.13	755	0.14	23	0.17	*<0.01*	189

Notes:

1. "Normal" trace element concentrations as presented in Price, 199

9.99 indicate Normal trace element concentration expressed as order of magnitude.

NA = No data available

Underlined values indicate sample concentrations greater than the normal concentration

Bold values indicate sample concentrations greater than five times the normal concentration

Highlighted values indicate sample concentration greater ten times the normal concentration.

ppm = parts per million

Table 2: ICP Metal Results con't

Object ID	Sample Identifier	Laboratory ID	Normal Trace Element Group	Ti	V	Zn	Zr	As	Be	Bi	Cd	Ce	Co	Cs	Ga	Ge	Hf	Hg	In
		Unit		%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
		Limit of Detection		*0.01*	*1*	*1*	*0.5*	*1*	*0.1*	*0.02*	*0.01*	*0.05*	*0.1*	*0.05*	*0.1*	*0.1*	*0.05*	*0.01*	*0.02*
Normal Trace Element Concentrations [1]			**Normal Trace Element Multiplier**	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*
Basaltic Rocks			1x	1.38	250	105	140	2	1	0.007	0.22	48	48	1.1	17	1.3	2	0.09	0.22
			5x	**6.9**	**1250**	**525**	**700**	**10**	**5**	**0.035**	**1.1**	**240**	**240**	**5.5**	**85**	**6.5**	**10**	**0.45**	**1.1**
			10x	13.8	2500	1050	1400	20	10	0.07	2.2	480	480	11	170	13	20	0.9	2.2
Object ID	**Sample Identifier**	**Laboratory ID**	**Normal Trace Element Group**	**Ti**	**V**	**Zn**	**Zr**	**As**	**Be**	**Bi**	**Cd**	**Ce**	**Co**	**Cs**	**Ga**	**Ge**	**Hf**	***Hg***	**In**
7-N-13	BH20-MOR-05 59.33 - 59.7m	13385-01	Basaltic Rocks	0.26	99	83	56.7	7	0.8	**0.06**	0.09	64.61	16.6	0.66	10.7	0.3	1.54	*<0.01*	0.04
7-N-14	BH20-MOR-05 50.44 0 50.83 m	13385-02	Basaltic Rocks	0.32	96	78	52.3	1	0.7	**0.09**	0.03	67.59	12	0.53	8.8	0.6	1.42	0.03	0.04
7-N-19	BH20-MOR-03 41.13 to 41.34m	13553-01	Basaltic Rocks	0.25	89	95	44.8	3	0.8	**0.07**	0.1	82.06	10.1	0.65	10.2	0.5	1.35	*<0.01*	0.04
7-N-20	BH20-MOR-05 31.32 to 31.49m	13553-02	Basaltic Rocks	0.11	133	84	39.8	1	1.2	**0.07**	0.13	76.17	20.3	1.4	12.2	0.2	1.56	*<0.01*	0.04
7-N-21	BH20-MOR-05 40.35 to 40.5m	13553-03	Basaltic Rocks	0.31	90	105	58.1	2	0.8	**0.07**	0.06	92.03	10.7	0.52	9.6	0.5	1.64	0.01	0.05

Notes:

1. "Normal" trace element concentrations as presented in Price, 199

9.99 indicate Normal trace element concentration expressed as order of magnitude.

NA = No data available

Underlined values indicate sample concentrations greater than the normal concentration

Bold values indicate sample concentrations greater than five times the normal concentration

Highlighted values indicate sample concentration greater ten times the normal concentration.

ppm = parts per million

Table 2: ICP Metal Results con't

Object ID	Sample Identifier	Laboratory ID	Normal Trace Element Group	La	Lu	Mo	Nb	Pb	Rb	Sb	Sc	Se	Sn	Ta	Tb	Te	Th	Tl	U
		Unit		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
		Limit of Detection		*0.1*	*0.01*	*0.05*	*0.05*	*0.2*	*0.2*	*0.05*	*0.1*	*1*	*0.3*	*0.05*	*0.02*	*0.05*	*0.1*	*0.02*	*0.05*
Normal Trace Element Concentrations [1]			**Normal Trace Element Multiplier**	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*
Basaltic Rocks			1x	15	0.6	1.5	19	6	30	0.2	30	0.05	1.5	1.1	0.8	NA	4	0.21	1
			5x	**75**	**3**	**7.5**	**95**	**30**	**150**	**1**	**150**	**0.25**	**7.5**	**5.5**	**4**	**NA**	**20**	**1.05**	**5**
			10x	150	6	15	190	60	300	2	300	0.5	15	11	8	NA	40	2.1	10
Object ID	**Sample Identifier**	**Laboratory ID**	**Normal Trace Element Group**	**La**	**Lu**	**Mo**	**Nb**	**Pb**	**Rb**	**Sb**	**Sc**	**Se**	**Sn**	***Ta***	**Tb**	**Te**	**Th**	**Tl**	**U**
7-N-13	BH20-MOR-05 59.33 - 59.7m	13385-01	Basaltic Rocks	35.1	0.29	1.26	0.59	8.3	10.2	0.11	13.8	*<1*	1.1	*<0.05*	0.81	*<0.05*	4.9	0.04	1.55
7-N-14	BH20-MOR-05 50.44 0 50.83 m	13385-02	Basaltic Rocks	35.5	0.26	2.11	1.09	8.6	10	0.16	7.3	*<1*	0.9	*<0.05*	0.72	*<0.05*	5.1	0.08	2.51
7-N-19	BH20-MOR-03 41.13 to 41.34m	13553-01	Basaltic Rocks	40.1	0.21	0.97	0.47	9.2	8.3	0.06	9.4	*<1*	1	*<0.05*	0.7	*<0.05*	4.6	0.05	2.08
7-N-20	BH20-MOR-05 31.32 to 31.49m	13553-02	Basaltic Rocks	34.8	0.22	0.61	0.05	9.7	6.7	*<0.05*	11.2	*<1*	1.1	*<0.05*	0.65	*<0.05*	5.4	0.04	2.08
7-N-21	BH20-MOR-05 40.35 to 40.5m	13553-03	Basaltic Rocks	43.7	0.23	0.99	0.75	9.7	7.6	0.05	10.8	*<1*	1	*<0.05*	0.79	*<0.05*	6.4	0.04	2.42

Notes:

1. "Normal" trace element concentrations as presented in Price, 199

9.99 indicate Normal trace element concentration expressed as order of magnitude.

NA = No data available

Underlined values indicate sample concentrations greater than the normal concentration

Bold values indicate sample concentrations greater than five times the normal concentration

Highlighted values indicate sample concentration greater ten times the normal concentration.

ppm = parts per million

Table 2: ICP Metal Results con't

Object ID	Sample Identifier	Laboratory ID	Normal Trace Element Group	W	Y	Yb
		Unit		ppm	ppm	ppm
		Limit of Detection		*0.1*	*0.05*	*0.1*
Normal Trace Element Concentrations [1]			**Normal Trace Element Multiplier**	*49*	*50*	*51*
Basaltic Rocks			1x	0.7	21	2.1
			5x	**3.5**	**105**	**10.5**
			10x	7	210	21
Object ID	**Sample Identifier**	**Laboratory ID**	**Normal Trace Element Group**	***W***	**Y**	**Yb**
7-N-13	BH20-MOR-05 59.33 - 59.7m	13385-01	Basaltic Rocks	0.4	22.52	1.9
7-N-14	BH20-MOR-05 50.44 0 50.83 m	13385-02	Basaltic Rocks	0.6	18.76	1.7
7-N-19	BH20-MOR-03 41.13 to 41.34m	13553-01	Basaltic Rocks	0.2	19.49	1.5
7-N-20	BH20-MOR-05 31.32 to 31.49m	13553-02	Basaltic Rocks	*<0.1*	19.75	1.5
7-N-21	BH20-MOR-05 40.35 to 40.5m	13553-03	Basaltic Rocks	0.2	21.01	1.7

Notes:
1. "Normal" trace element concentrations as presented in Price, 199
9.99 indicate Normal trace element concentration expressed as order of magnitude.
NA = No data available
Underlined values indicate sample concentrations greater than the normal concentration
Bold values indicate sample concentrations greater than five times the normal concentration
Highlighted values indicate sample concentration greater ten times the normal concentration.
ppm = parts per million

Table 3: Shake Flask Extraction

Object ID	BC WQG [1] Aquatic Life (Freshwater)	MCV	7-N-13	7-N-14	7-N-19	7-N-20	7-N-21
Sample Identifier			BH20-MOR-05	BH20-MOR-05	BH20-MOR-03	BH20-MOR-05	BH20-MOR-05
			59.33 - 59.7m	50.44 0 50.83 m	41.13 to 41.34m	31.32 to 31.49m	40.35 to 40.5m
Laboratory ID			13385-01	13385-02	13553-01	13553-02	13553-03
Physical Parameter							
pH (pH units)	6.5 to 9.0		8.56	8.51	8.09	8.74	8.74
Hardness (as CaCO3 equivalents)			4.2	3.3	5.7	5.1	3
Redox (mV)			362.79	347.16	242.18	235.83	251.46
Conductivity (µS/cm)			163.85	121.54	160.49	371.17	183.46
Acidity (to pH 4.5 as CaCO3 equivalents)			#N/A	#N/A	0	0	0
Total Acidity (to pH 8.3 as CaCO3 equivalents)			#N/A	#N/A	1.05	0	0
Alkalinity (as CaCO3 equivalents)			56.61	48.16	62.32	150.14	72.65
Chloride	150		*< 1*	*< 1*	2	*< 1*	*< 1*
Fluoride	0.4 - 1.04 [a]	max, H	**0.45**	0.26	0.17	**0.88**	0.28
Sulphate	128 - 429 [b]	H	3	3	4	2	5
Ion Balance							
Major Anions (meq/L)			1.22	1.04	1.40	3.09	1.57
Major Cations (meq/L)			1.80	1.38	1.73	3.65	1.92
Difference (meq/L)			-0.58	-0.34	-0.34	-0.56	-0.35
Balance (%)			-19.3%	-14.0%	-10.8%	-8.2%	-10.1%
Dissolved Metals							
Aluminum	0.05 [c]	d	**0.792**	**0.818**	**1.07**	**0.195**	**1.18**
Antimony	0.009 [d]	W, V, t	*< 0.0009*	*< 0.0009*	*< 0.0009*	*< 0.0009*	*< 0.0009*
Arsenic	0.005		0.0013	0.0016	0.002	0.0024	0.0011
Barium	1	W, t	0.00161	0.00133	0.0013	0.00059	0.0009
Beryllium	0.00013	W, t	0.00001	*< 0.000007*	*< 0.000007*	*< 0.000007*	*< 0.000007*
Bismuth			0.000007	*< 0.000007*	*< 0.000007*	*< 0.000007*	*< 0.000007*
Boron	1.2	t	0.105	0.055	0.066	0.3	0.059
Cadmium	0.000006 - 0.000123 [e]	H, d	0.000013	**0.000024**	0.000007	0.000005	0.000003
Calcium			1.43	1.18	2.18	1.98	1.12
Chromium	0.001 (VI) / 0.0089 (III) [f]	W, V, t	0.00066	0.00011	0.0004	0.0003	0.0005
Cobalt	0.004	t	0.000155	0.000064	*< 0.000004*	*< 0.000004*	*< 0.000004*
Copper	0.002 [g]	H, t	**0.0021**	0.0004	*< 0.0002*	*< 0.0002*	0.0007
Iron	0.35	max, d	**0.354**	0.172	0.052	0.06	0.072
Lead	0.0041 - 0.0046 [h]	H, t	0.00009	0.00006	0.00005	0.00006	0.00005
Lithium			0.0093	0.0042	0.011	0.0031	0.0058
Magnesium			0.158	0.088	0.064	0.044	0.061
Manganese	0.6 - 0.8 [i]	H, t	0.00633	0.00275	0.0014	0.0012	0.0016
Mercury	0.00001125	MeHg, t	**0.02**	**0.02**	*< 0.01*	*< 0.01*	*< 0.01*
Molybdenum	≤1		0.0151	0.0239	0.0068	0.0133	0.0028
Nickel	0.025 [j]	W, H, t	0.0005	*< 0.0001*	0.0001	0.0001	*< 0.0001*
Phosphorus			0.015	0.011	0.006	*< 0.003*	0.013
Potassium			0.167	0.318	0.108	0.166	0.105
Selenium	0.002	d	0.00028	0.00017	0.00043	**0.003**	0.00089
Silicon			3.42	2.55	2.36	4.68	2.67
Silver	0.00005 [k]	H, t	*< 0.00005*	*< 0.00005*	*< 0.00005*	*< 0.00005*	*< 0.00005*
Sodium			36.9	27.7	34	79	39.4
Strontium			0.00298	0.00238	0.0069	0.006	0.0031
Sulphur			*< 1*	*< 1*	*< 1*	*< 1*	1
Thallium	0.0008	W, t	*< 0.000005*	*< 0.000005*	*< 0.000005*	*< 0.000005*	*< 0.000005*
Tin			0.00028	0.00024	0.00007	0.00007	0.00012
Titanium			0.0223	0.00499	0.0028	0.0051	0.0036
Uranium	0.0085	W, t	0.00163	0.00705	0.00416	0.00661	0.00478
Vanadium			0.0302	0.0508	0.0338	0.302	0.0389
Zinc	0.033 [l]	H, t	*< 0.002*	*< 0.002*	*< 0.002*	*< 0.002*	*< 0.002*
Zirconium			*< 0.002*	*< 0.002*	*< 0.002*	*< 0.002*	*< 0.002*
Tellurium							
Thorium							

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
1. Criteria from "British Columbia Approved Water Quality Guidelines (Criteria)", 2006 Edition (updated March 2018) and "Working Water Quality Guidelines for British Columbia (June 2017)" (W). Guidelines are for long-term average water quality; short-term maximum water quality guidelines (max) are displayed where no long-term average water quality guideline exists. Screening is for dissolved metals (d); where critieria for dissovled metals were unavailable, the criteria for total metals (t) was applied. Criteria include chloride (Cl), hardness (H), and pH (pH) dependent guidelines. Accessed June 8, 2019. Available online at: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines.

(a) Fluoride guideline = 0.4 where H≤10; (-51.73+92.57 $\log_{10}$ [H])*0.01 where H>10
(b) Sulfate guideline = 128 where H<30; 218 where 31<H<75; 309 where 76<H<180; 429 where 181<H<250; Note *site-specific assessment may be required where H>250
(c) Aluminum guideline = 0.05 where pH≥6.5; $e^{[1.6-3.327(pH)+0.402(pH)^{\wedge}2]}$ where pH<6.5
(d) Guideline is for Antimony (III)
(e) Cadmium guideline = $e^{(0.736(lnH)-4.943)}$/1000
(f) (VI) indicates the guideline for hexavalent chromium; (III) indicates the guideline for trivalent chromium
(g) Copper guideline = ≤0.002 where H≤50; 0.04(H)/1000 where H>50
(h) Lead guideline = no guideline where H≤8; (3.31+e[1.273(lnH)-4.704])/1000 where H>8
(i) Manganese guideline = (0.0044(H) + 0.605)
(j) Nickel guideline = 0.025 where H≤60; e(0.76(lnH)+1.06)/1000 where 60<H<180; 0.150 where H≥180
(k) Silver guideline = 0.00005 where H≤100; 0.0015 where H>100
(l) Zinc guideline = 0.0075 where H≤90; (7.5+[0.75(H-90)])/1000 where H>90
m bgs = metres below ground surface; mV = milliVolts; and µS/cm = microSiemens per centimetre
Italics indicate laboratory detection limit greater than the applicable guidelines.

Value Exceeds BC WQGs for the protection of Freshwater Aquatic Life

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