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Qulliq Energy Corporation

GEOTECHNICAL INVESTIGATION

Proposed Power Plant Location in Zone 17W
Igloolik, Nunavut – Option 02

FEBRUARY 2021

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FINAL REPORT

Englobe

Prepared by:

Jason Thai, E.I.T.
Project Coordinator
Geotechnical Department

REGISTERED PROFESSIONAL ENGINEER
K. CHANDRA PRAKASH
LICENSEE
NT/NU

Reviewed by:

Kiran Chandra Prakash, M.Eng., P.Eng.
Geotechnical Engineer – Project Manager
Geotechnical Department

Approved by:

Philippe Gingras, P.Eng.
Department Director – Western Canada

Production Team

Englobe Corp.

Department Director – Western Canada	Philippe Gingras, P.Eng.
Geotechnical Engineer – Project Manager	Kiran Chandra Prakash, M.Eng., P.Eng.
Geotechnical Project Coordinator	Jason Thai, E.I.T.
Word Processing and Editing	Amanda Bruneski, Production Assistant
Geomatics/CAD Technician	Drew Wilson, B.Com.

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00	2021-02-12	Final Report

Property and Confidentiality

Executive Summary

Englobe Corp. (Englobe) was retained by Quilliq Energy Corporation (QEC) to complete environmental site assessments, topographic surveys, and geotechnical investigations in the communities of Cambridge Bay, Igloolik, and Gjoa Haven to evaluate possible location options for proposed power plants. Written authorization to proceed was received through contract no: 2020084 on August 28, 2020.

This report covers the geotechnical investigation for Igloolik – Site Option 02 (the Site). The information gathered from this investigation will aid in the detailed engineering design for the new power plant.

After obtaining public and private service clearances, eight (8) boreholes were drilled to depths ranging from 6.0 to 11.5 metres below ground surface (mbgs).

The general stratigraphy encountered on the Site was sands and gravels with some fines, underlain by highly weather limestone bedrock.

Rock socketed piles are considered a feasible foundation option for the Site due to the presence of bedrock, which started at depths ranging from 4.0 to 10.0 mbgs.

The site classification for seismic site response C (Very Dense Soil and Soft Rock) must be used for foundation supported on soil for earthquake load and effects in accordance with Table 4.1.8.4.-A of the 2015 National Building Code of Canada.

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1 Introduction

Englobe Corp. (Englobe) was retained by Qulliq Energy Corporation (QEC) to conduct environmental site assessments, topographic surveys, and geotechnical investigations in the communities of Cambridge Bay, Igloolik, and Gjoa Haven to evaluate possible location options for proposed power plants.

Written authorization to proceed was received through contract no: 2020084 on August 26, 2020. This report covers the geotechnical investigation for Igloolik – Site Option 02 (the Site). The information gathered from this investigation will aid in the detailed engineering design for the new power plant.

The geotechnical investigation was required to evaluate and confirm the existing surface and subsoil conditions for the Site so that a suitable location can be selected and suitable foundations for a new power plant can be designed.

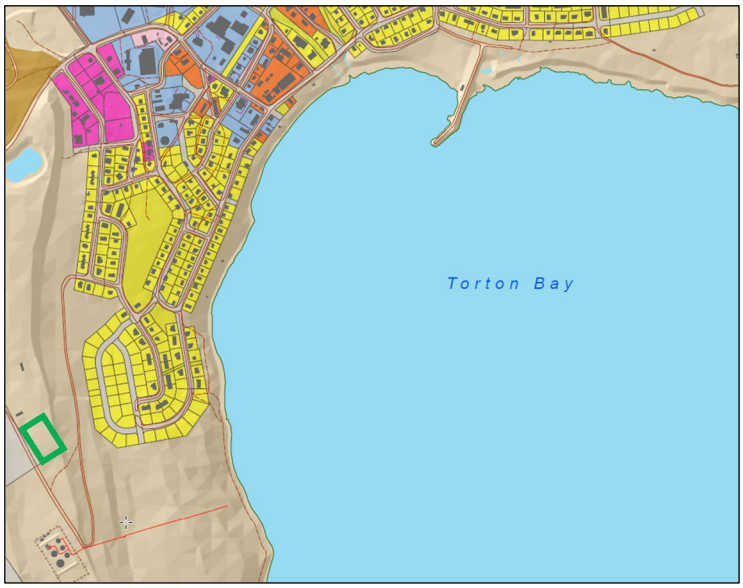
The Site is located approximately 1 km southwest of the community, approximately 200 metres east of the local airport, and 200 metres north from an existing tank farm. The Site is bounded by road R36 Plan 4573 to the southwest, and undeveloped lands zoned as restricted industrial on all other sides. The Site surface condition is generally even, gently sloping to the east toward Igloolik. Figures are provided in Appendix 1.

The Site has not been previously occupied by any residential, industrial, or commercial buildings.

The area required for new power plants and the auxiliary components in each community is approximately 6,000 m^2 and it is understood that a one-story building will act as a replacement for an aging diesel power generation facility that is currently located in the center of the community.

The area of the proposed Site is shown below.

Area of the Proposed Site Option 02



2 Background Information

2.1 Hamlet of Igloolik

The Hamlet of Igloolik is located on Igloolik Island in Foxe Basin, in the Qikiqtaaluk Region of Nunavut. It is bounded by Foxe Basin to the southeast, and a mix of rocky flat-topped hills, joined by lowland plains where low bedrock outcrops are covered by old, raised beaches, overall sloping toward the southeast. The population of Igloolik is approximately 1682, as of the 2016 census.

2.2 Permafrost and Climate

Igloolik lies within the zone of continuous permafrost. Areas within zones of continuous permafrost generally have Mean Annual Air Temperatures (MAAT) of less than -8°C with Igloolik having a MAAT of approximately -13.3°C (Climate Atlas of Canada). The active layer thickness is estimated to be approximately 1.5 m. Surface drainage is poorly to moderately developed with surface ice encountered during the investigation. Table 1 below shows historical and projected climate indices.

Table 1 Climate Indices for Igloolik, Nunavut

Parameter	Historical Average (1976-2005)(1)	Projected Future Average (2051-2080)(1)
Mean Annual Air Temperature (°C)	-13.3	-10.1 to -10.5
Freezing Index (C degree days)	5311	3386 to 4006
Thawing Index (C degree days)	857	760 to 953
Annual Precipitation (mm)	227	273 to 295

1. Referenced from Climate Atlas of Canada (climateatlas.ca)

2.3 Geology

The bedrock geology of Igloolik is generally comprised of Precambrian rocks flanked by Paleozoic sediments, specifically dolomite, which forms most of the cliffs and underlies the lowlands, and limestone, which lies on top of the dolomite and forms the uppermost part of the buttes strewn across the island. Bedrock outcrops are common in and around the Hamlet.

The surficial geology of the Igloolik area generally comprises of either till, marine vaneer, or gravel and shingle beaches, which generally consist of sand and gravel varying in thicknesses between 1 metre to over 5 metres in depth over the bedrock.

3 Scope of Work

The scope of work for the geotechnical assessment is described in detail in Qulliq Energy Corporation's Contract No.: 2020084. The geotechnical scope of services includes:

- Completion of local service clearances and obtainment of authorization from QEC;
- Drilling a total of eight (8) boreholes;
- Geotechnical and environmental laboratory testing on selected soil samples obtained during the geotechnical investigation;
- Desktop review to determine the suitability of site options for the proposed development;
- Desktop review of local borrow sites for granular materials; and,
- Preparation of a geotechnical report summarizing the results of the geotechnical field and laboratory testing program and providing geotechnical comments and preliminary recommendations for the design of suitable foundations, and general earthworks including soil backfill and compaction, site drainage, and construction considerations.

3.1 Field Investigation

After obtaining public and private service clearances, eight (8) boreholes were drilled to depths ranging from 6.0 to 11.5 metres below ground surface (mbgs). The boreholes were drilled in various vacant areas according to the Borehole Location Plan (Figure 2) in Appendix 1.

All boreholes were advanced between September 17 and 18, 2020; using a track-mounted air rotary drill rig supplied by Canadrill Ltd. and operated under the continuous supervision of qualified Englobe personnel.

Disturbed subsoil samples were collected from the auger cuttings. The recovered subsoil samples were visually examined in the field and then preserved and transported to Englobe's Material Testing laboratory in Edmonton, Alberta for further examination and testing. The Borehole Logs are provided in Appendix 2.

3.2 Laboratory Testing

In the laboratory, each soil sample was examined as to its visual and textural characteristics by the project engineer. Moisture content determinations were carried out on selected recovered samples. In addition, four (4) grain size analysis (ASTM D422) were conducted for selected soil samples. The geotechnical laboratory results are provided in Appendix 3.

In addition to geotechnical laboratory testing, two (2) soil samples were collected and submitted to a chemical laboratory for analysis of soluble sulphate content. The chemical analysis test results are provided in Appendix 4.

The number and type of test conducted are summarized in Table 2.

Table 2 Summary of Laboratory Tests Completed

Name of Test	Number of Tests Completed	Sample Type	Laboratory	ASTMs Completed
Moisture Content	28	Soil	Englobe	-
Grain Size Analysis	4	Soil	Englobe	ASTM D422
Water Soluble Sulphate	2	Soil	AGAT	-

3.3 Site Suitability

The Site is generally considered suitable for development, as it was gently sloping with only some pockets of surface water, but with no other disturbance from equipment or vehicle storage.

3.4 Borrow Material Sites

Several borrow sites were identified through a review of the following reports and documents:

1. "Granular Resource Evaluation, Igloolik, N.W.T.", prepared by Granular Program Technical Services Division, Department of Government Services and Public Works, Government of the Northwest Territories, Yellowknife, dated January 1993.
2. "Quarry Administration Agreement, Hamlet of Igloolik, Nunavut", Government of Nunavut, dated August 2013.

After a review of these reports and documents, a number of prospective borrow sites were identified in the figure below.

Aerial view of potential borrow sites (2013)

From the Quarry Administration Agreement, there are a number of possible borrow sites (from Granular Sites E1 to E5, and N1 to N4 as seen above), from which all grades of granular material can be imported from, as noted from the recommendations of the 1993 report.

Permits are required for the exploration and recovery of material from these borrow pits from the Government of Nunavut and the Hamlet of Igloolik.

4 Results

4.1 Summary of Borehole Coordinates and Depths

The borehole locations were provided through a topographic survey performed by Sub-Arctic Geomatics. Table 3 summarizes borehole coordinates and depths.

Table 3 Summary of Borehole Coordinates and Depths

Borehole No.	Coordinates[1]		Ground Elevation (MAMSL[2])	Borehole Depth (mbgs[3])	Bottom of Borehole Elevation[4] (MAMSL[2])
	Northing	Easting			
BH20-01	7695730.64	468092.30	43.87	8.0	35.87
BH20-02	7695753.23	468136.25	43.60	8.0	35.60
BH20-03	7695722.79	468139.02	43.01	9.0	34.01
BH20-04	7695708.12	468114.20	44.40	8.0	36.40
BH20-05	7695684.19	468124.71	42.58	10.5	32.08
BH20-06	7695698.13	468150.80	42.15	8.5	33.65
BH20-07	7695673.56	468169.36	41.60	9.0	32.60
BH20-08	7695654.36	468133.24	42.30	11.5	30.80

1. NAD 83(CSRS)/UTM Zone 17N
2. Metres above mean sea level (MAMSL)
3. Metres below ground surface (mbgs)
4. Calculated from ground elevations and borehole depths

4.2 Subsoil Conditions

Detailed descriptions of the subsoil conditions encountered in each borehole are presented in the Borehole Log Sheets provided in Appendix 2. The generalized stratigraphy is briefly described in this section. Classification and identification of soils have been based on the commonly accepted methods employed in the practice of geotechnical engineering. The stratigraphic boundaries shown on the Borehole Log Sheets represent transitions between soil types rather than distinct lithological boundaries. It must be recognized that subsurface conditions often vary both with depth and laterally between individual borehole locations.

The general subsoil conditions are outlined briefly below.

4.2.1 Sands and Gravels

Various sands and gravels, with some fines (e.g., sandy gravels, gravelly sands, sands and gravels) were encountered at the surface at all borehole locations and extended to depths

ranging from 4.0 to 10.0 metres below ground surface. The in-situ moisture content of these materials ranged from approximately 1 to 9% but were generally between 2 and 4%.

4.2.2 Bedrock

Highly weather limestone bedrock was encountered at the bottom of all boreholes, starting from depths ranging between 4.0 and 10.0 mbgs, and extending to depths ranging from 6.0 to 11.5 mbgs, the maximum depths of drilling.

5 Geotechnical Recommendations and Considerations

The geotechnical recommendations provided in this section are from the interpretation of the geotechnical data obtained during the investigation and recommendations for geotechnical aspects of the design of foundations and general Site development. The recommendations provided are intended to support the design of the development. Where comments are made on construction, they are provided to highlight aspects of construction that could affect the design of the project. It must be noted that information regarding construction must be interpreted to accommodate any change for designs, construction methods, costs, and scheduling.

5.1 Limit States Design

The following sections provide geotechnical design parameters in Limit States Design (LSD) format as per the National Building Code of Canada ([NBCC], 2015) and CFEM (2006). The following resistance factors (Φ) have been applied to determine factored design resistance values:

- Shallow Foundations:
  - Resistance to axial load – compression: Φ = 0.5
- Deep Foundations:
  - Resistance to axial load – compression: Φ = 0.4
  - Resistance to axial load – uplift: Φ = 0.3

5.2 Foundation Considerations

Rock-socketed piles are considered a feasible foundation type at this Site considering the geotechnical conditions encountered. Having more than one foundation type within the same structure is not recommended.

5.2.1 Deep Foundations

Considering the prevailing subsurface conditions encountered in the exploratory boreholes, rock-socketed steel piles are considered a feasible deep foundation option for this project.

Pile foundation design parameters provided below are based on the soil classification, geotechnical analyses, and Englobe's previous experience with similar formations. Although

cobbles and boulders were not encountered during drilling, they may exist on Site and could pose problems during the installation of piles. Therefore, the variability of ground conditions, the suggested pile type, and the installation method must be evaluated by a qualified piling contractor with experience in similar soil conditions and confirmed by Englobe before construction. Although no significant seepage sloughing was encountered during the geotechnical drilling, pile casing is required during the drilling of the piles.

Higher geotechnical resistance factors can be utilized if additional field testing is conducted prior to or during pile installation by qualified geotechnical personnel, such as static load testing or dynamic testing through Pile Dynamics Analysis (PDA) testing.

5.2.1.1 Rock-Socketed Piles

Rounded hollow structural sections (HSS) socketed into competent bedrock are considered a feasible foundation option for the proposed development. Based on the results of the geotechnical investigation conducted, typical end bearing values for the design of rock socketed piles are provided in Table 4. The suggested design values have been estimated based on current conventional engineering practices, as described in Section 18.6.3.3 of the CFEM (2006), by accounting for the ultimate values of frictional resistance along the shaft and end bearing values in soil. A geotechnical resistance factor (ϕ) of 0.4 must be applied for axial compression loading based on static parameters. The geotechnical resistance factor for uplift loading (ϕ) at ULS is 0.3.

Table 4 Suggested Rock Socketed Pile Parameters

Soil Description	Approximate Depth of Soil (mbgs)	Unfactored ULS End Bearing[1] (kPa)
Sands and Gravels	0 – 10.0	-
Bedrock[2]	Deeper than 10.0	3,000

[1] Provided that the base of all drilled piles can be cleaned effectively to remove all disturbed material below the toe of the pile. Contractor needs to develop and use effective means for base cleaning to the satisfaction of the Geotechnical Engineer, for each and every pile during pile installations.
[2] The bedrock depth should be confirmed by a geotechnical engineer prior to pile installation as the depth to the top of the bedrock surface varied between 4.0 and 10.0 mbgs.

The piles should be grouted a minimum of 2 metres into competent bedrock, with the annulus, the space between the pile and borehole, being at least 25 mm. It is recommended that the side and base of piles be free of water and loose material before placing grout. Inspection by geotechnical engineering personnel during pile installation is required to ensure that the recommended design values are obtained. The inspection must also include the assurance that the as-built pile installations are in accordance with the pile designs as approved by the geotechnical and structural engineers.

The following must be considered in the design of rock-socketed piles:

- Skin friction must not be considered in the design.
- Rock-socketed piles must bear on sound and clean bedrock and no less than 2.0 m below the bearing strata.
- Rock-socketed caissons must be inspected to confirm the removal of loose, disturbed soil and debris prior to placing concrete and steel.
- The lower portion of the HSS shall be free of paint, lacquer, oil, grease, dirt, or excessive rust to ensure proper bonding.

- Piles should be installed open-ended in predrilled holes with casing, which shall be at least 50 mm in diameter larger than the pile and be completely clean prior to placement of grout.
- Grout must be placed as soon as practical after boring to minimize seepage and caving problems.
- The grout should be SikaGrout Arctic-100 or an approved substitute.
- The piles should be grouted up to 1.0 m below the ground surface.
- The remaining space inside the pile and annular space should be filled with dry sand or drill cuttings with the maximum particle size limited to 1/3 of the annulus spacing.
- The National Building Code of Canada (2015) specifies full-time continuous field review, by a suitably qualified individual, during the installation of all deep foundation elements.

5.2.1.2 Pile Group

Piles must generally be spaced a minimum of 3 times pile diameters (centre-to-centre) apart to act as a single pile and ultimately minimize group effects. If the piles are spaced closer, pile design parameters must be reduced to account for group effects. The ultimate axial resistance must be reduced by a group factor of 1.0 for piles spaced 3 pile diameters or greater, and 0.85 for piles spaced at 1.25 pile diameters.

Reduction factors for other pile spacings may be interpolated from the values above. These factors are for preliminary design only. Group reduction factors are also affected by ground conditions, pile dimensions and loads, construction method, and pile group layout. Upon request, Englobe would be pleased to assist with pile group design when further information becomes available.

5.2.2 Structural Slab

A structurally supported floor slab system must be considered for an allowance of an airgap to mitigate permafrost degradation.

A void form of 100 mm below the slab is required to impede the transfer of heat from inside the building to subgrade.

5.2.3 Air Gap for Piles

An air gap of at least 450 mm high is recommended between the final finished grade and the underside of the structurally supported floor. This will provide airflow to prevent transfer of heat from the building to the ground and allow for surface drainage and snow to pass under the structure.

5.3 Seismic Considerations

The 2015 National Building Code of Canada (the Code) stipulates that a building should be designed to withstand a minimum live load due to an earthquake.

In this regard, due to the shallow depth of the site, classification for seismic site response C (Very Dense Soil and Soft Rock) should be used for foundation supported on soil for earthquake load and effects in accordance with Table 4.1.8.4.A of the 2019 National Building Code of Canada.

Ground motion is generally given in terms of probability of exceedance, which is the likelihood of expected horizontal acceleration being exceeded during a particular time period. The probability used in the 2015 National Building Code of Canada is equivalent to a 2% probability of exceedance over 50 years.

Using the 2015 National Building Code Seismic Hazard Calculation online calculator, the Peak Ground Acceleration for the Site is 0.034g, where g is 9.81 m/s^2, and the Peak Ground Velocity is 0.030 m/s for an assumed site Class C and 2% probability of exceedance in 50 years. The seismic hazard is also described by spectral acceleration values at periods of 0.2, 0.5, 1.0, 2.0, 5.0, and 10.0 seconds. Spectral acceleration is a measure of ground motion that takes into account the sustained seismic energy at a particular period. The detailed spectral accelerations are provided in Appendix 5.

6 Site Conditions – Grading and Drainage

6.1 Subgrade Preparation

All organic topsoil, loose-fill, and other deleterious materials must be stripped and stockpiled away from the Site. Staining and root intrusion from the overlying organic material and roots may be encountered during excavation within the competent subsurface mineral soils. A representative of the geotechnical consultant must inspect the Site during stripping/excavation to verify the depth of organic soils which must be removed. Any fill placed to fill the Site or replace unsuitable materials must adhere to the requirements provided in Table 5.

Table 5 Compaction Requirements for Site Preparation

Area	Recommended Materials	Compaction Requirement		
		SPMDD(1) (%)	OMC(2) (%)	Maximum Lift Thickness (mm)
Building Areas	Granular materials	98	±2	200
Traffic Areas	Granular materials	98	±2	200
Landscape Area	Granular materials	90	±2	300

1. SPMDD – Standard Proctor Maximum Dry Density
2. OMC – Optimum Moisture Content

Construction is recommended during the thawing season. Care must be taken to not cause excessive disturbance to the subgrade during construction. Backfill materials should not be frozen prior to placement and compaction. In addition, the subgrade must be protected from wetting or drying, both before and after the placement of granular base material or concrete. Subgrade surfaces that can dry or become wet must be scarified, moisture conditioned, and re-compacted.

Full-time monitoring and compaction testing must be provided during any fill placement or proof-rolling to confirm that the compaction specifications are being achieved.

6.2 Snow Drift and Fencing

Snow drifting and accumulation are a concern for this Site as snow acts as insulation during the winter months reducing the freezing of the active layer thereby increasing its thickness if excess snow is not removed or prevented from accumulating. Due to this, the Site must have snow fences installed around the perimeter of the Site and any excess snow should be removed and stored in a designated location. This snow must be placed where meltwater will not be an issue and must not be placed within 4 m of a building or structure.

6.3 Site Drainage

Excess water must be drained from the Site as quickly as possible both during and after construction. The finished grade must be laid out, so surface water is drained away from the proposed structure by the shortest route. Roof and other drains must discharge well away from the structure, at least 3.0 m from the exterior of the structure.

As the final Site grading is not known at this time, final grades must be sloped so that surface water is directed away from the building footprint and towards existing Site drainage pathways. It is recommended that the final surface grades be sloped no less than 2%. Surface drainage must be controlled by ensuring a minimum grade away from the foundation of 5% for a minimum distance of 5.0 m. Surface water must be directed away from all buildings and structures. Runoff from the roof must be directed a minimum distance of 3.0 m from the perimeter of the building to reduce the potential of excessive moisture near the foundation.

6.4 Excavations

No excavations are permitted in and around the building. The geotechnical engineer must be contacted if any underground structures are to be accommodated.

6.5 Cement Type

Two (2) soil samples were collected and submitted to AGAT Laboratories in Edmonton, Alberta for soluble sulphate analyses. The complete test results are presented in Appendix 4 while the results are summarized in Table 6. Refer to CSA A23.1-19 Table 3 for additional requirements.

Table 6 Chemical Analyses Results

Borehole	Depth Below Ground Surface (m)	Sulphate Content (%)	Degree of Exposure[1]	Cement Type[2]
BH20-02	3.0	0.015	Minimal	GU
BH20-07	1.5	0.019	Minimal	GU

[1] Based on Englobe's review of Table CSA A23.1 - Table 3 (Canadian Standards Association, Concrete Materials, and Methods of Concrete Construction)
[2] Cement Type GU: General Use; MS: Moderate Sulphate resistant; HS: High Sulphate resistant

The results from chemical analysis revealed a "minimal" potential for sulphate attack on concrete in contact with native soils. Therefore, all concrete in contact with the native soils at this Site can be made from GU cement, possessing a minimum 30-day compressive strength of 30 MPa. It must be noted that no concrete batching plant currently exists in this community.

6.6 Design Review and Construction Monitoring

It is recommended that Englobe's geotechnical engineer review the design drawings before they are finalized. The review will identify any deviations from the recommendations which are provided in this report.

Also, it is recommended that a qualified geotechnical engineer or technologist monitors the pile installation. This is a crucial step during construction, as it confirms the pile lengths, depth of competent bedrock, groundwater, and permafrost conditions.

7 Closing Remarks

The comments provided in this report have been developed for the use of Quilliq Energy Corporation. It should be noted that on the borehole logs, the soil boundaries indicated are inferred from non-continuous sampling and observations during drilling and should not be interpreted as exact planes of geological change. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design. In addition, the subsoil and groundwater conditions have been determined at the borehole locations only.

The recommended bearing capacity has been calculated by Englobe from the information obtained from the borehole data.

If the soils or permafrost conditions are different from the information provided in this report, Englobe should be contacted immediately and recommendations provided herein will be revised, if necessary.

It is further noted that permafrost active layer depths should be expected to vary, perhaps significantly, from those observed at the time of this investigation.

8 References

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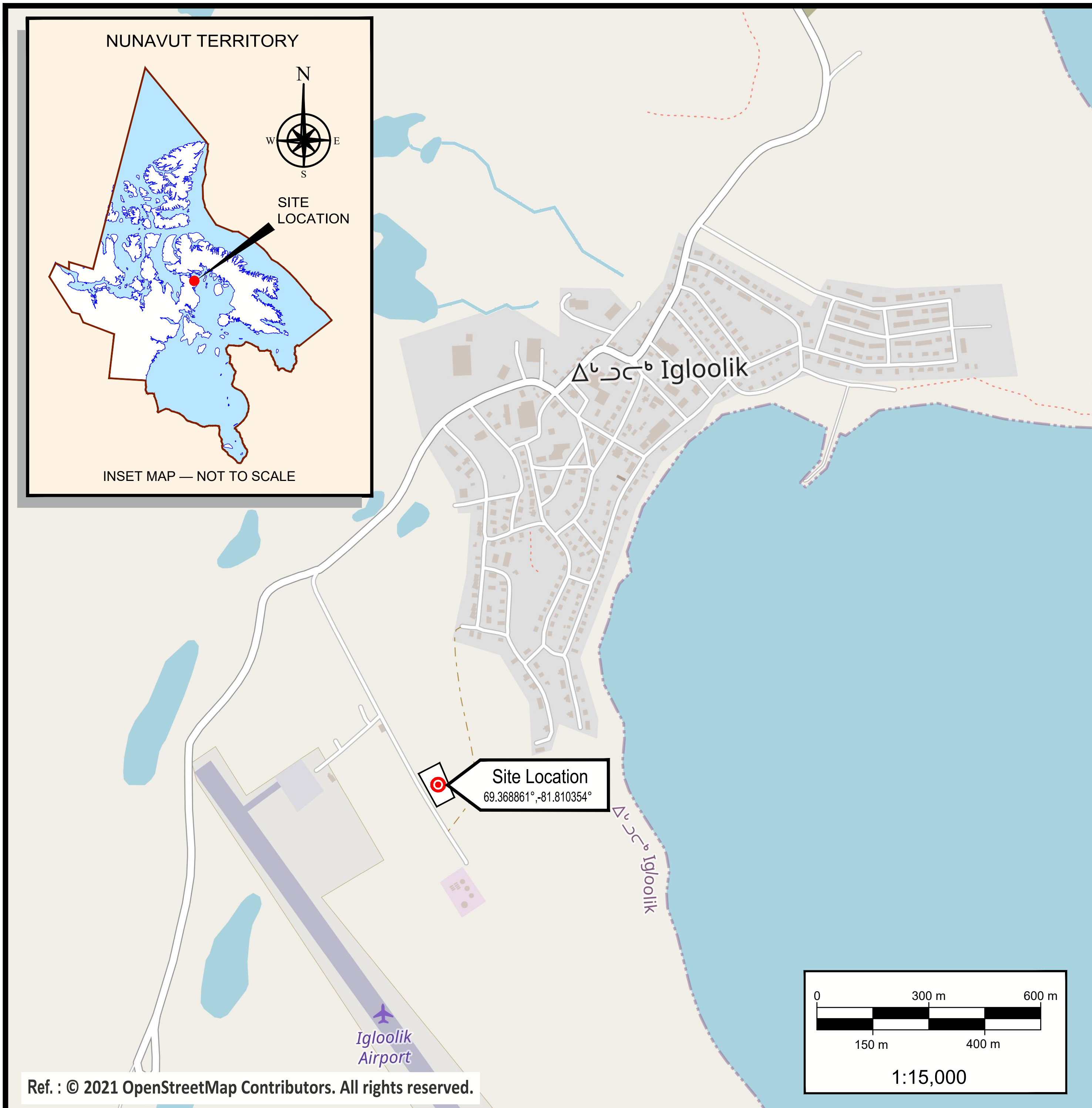
PILE DESIGN IN PERMAFROST. 1981. J.S. Weaver and N.R. Morgenstern.

Appendix 1 Figures

Figure 1: Site Location
Figure 2: Aerial Photograph showing Borehole Locations



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No.	Version	Date	By	Check.	Appr.

Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

Englobe

16114, 114 Avenue NW
Edmonton, Alberta
T5M 2Z5
780-481-1416

GEOTECHNICAL INVESTIGATION
PROPOSED POWER PLANT LOCATION
Igloolik, Nunavut

SITE LOCATION – OPTION 02

Discipline : Geotechnical	Prepared by : K. BUDD	Checked by : K. BUDD	
Scale : 1:15,000	Drawn by : D. WILSON	Approved by : P. GINGRAS	
Date : February 2021	Figure no. : FIGURE 1		
Layout : LS-OPTION 02	Paper size : LETTER (8.5" x 11")	Registration no. : ---	

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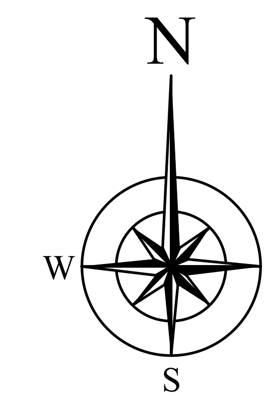

LEGEND

- Proposed Site (5,915 m^2)
- Borehole
- Geodetic Coordinate (Typical; see table)

Location	Northing	Easting	Elevation (masl)
A	7695762.40	468139.94	43.45
B	7695734.14	468082.85	43.83
C	7695644.79	468130.20	42.35
D	7695669.01	468178.04	41.90
BH20-01	7695730.64	468092.30	43.87
BH20-02	7695753.23	468136.25	43.60
BH20-03	7695722.79	468139.02	43.01
BH20-04	7695708.12	468114.20	44.40
BH20-05	7695684.19	468124.71	42.58
BH20-06	7695698.13	468150.80	42.15
BH20-07	7695673.56	468169.36	41.60
BH20-08	7695654.36	468133.24	42.30

Datum is NAD83(CSRS) / UTM zone 17N

No.	Version	Date	By	Check.	Appr.
B	FINAL	2021-02-12	D.W.	K.B.	P.G.
A	PRELIMINARY	2021-01-18	D.W.	K.B.	P.G.

Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

Englobe Corp.
16114, 114 Avenue NW
Edmonton, Alberta
T5M 2Z5
780-481-1416

0 10 20 30 40 m

1:1,000

GEOTECHNICAL INVESTIGATION PROPOSED POWER PLANT LOCATION

Igloolik, Nunavut

Aerial Photograph showing Borehole Locations (Option 02)

Discipline : Geotechnical		Prepared by : K. BUDD	Checked by : K. BUDD
Scale : 1:1,000		Drawn by : D. WILSON	Approved by : P. GINGRAS
Date : February 2021		Figure no. : FIGURE 2	
Layout : OPTION 02 - BH	Paper size : ANSI full bleed B (11.00 x 17.00 Inches)	Registration no. : ---	

Resp.	Project	Otp	Project/ Disc	Phase/ Type	Electronic ref./ Drawing no.	Rev.
140	P0023273.000-0100-0000	---	---	---	P0023273.000-0100-0000-PL-GEO-IGLOOLIK.dwg	---

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Appendix 2 Borehole Logs

SYMBOLS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

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

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

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

SOIL TESTS

w	water content
PL	plastic limit
LL	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)
Y	unit weight

Note: [1] Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

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.) drive open sampler for a distance of 300 mm (12 in.).

Piezo-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; 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

NON-COHESIVE (COHESIONLESS) SOILS

Compactness

Term	SPT 'N' (blows/0.3m)*
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 D 1586, uncorrected for overburden pressure effects or energy transfer.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

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

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' (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 D 1586, uncorrected for overburden pressure effects or energy transfer.

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.

$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

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 ($\sigma' = \sigma - \mu$)
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
μ	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
$_p$	plastic limit
I_p	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 = (emax - e) / (emax - emin) (formerly relative density)

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

(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	comression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
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

T_p, T_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:

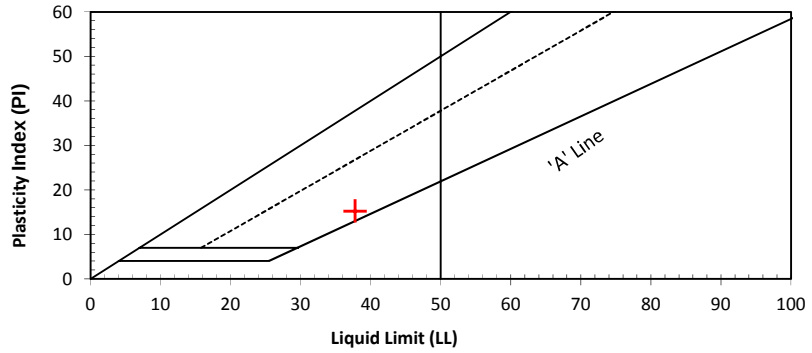
1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{D^2_{30}}{D_{10} \times D_{60}}$	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 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 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
			Gravels 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	Group Name
				Dilatancy	Dry Strength	Thread Diameter	Toughness (of 3 mm Thread)			
INORGANIC Organic Content <30% by mass)	FINE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	SILTS (PI and LL plot below A-Line on Plasticity Chart)	Liquid Limit <50	Rapid	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	3 mm to 6 mm	None to Low	<5%	ML	CLAYEY SILT
				Slow to Very Slow	Low to Medium	3 mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit >50	Slow to Very Slow	Low to Medium	3 mm to 6 mm	Low to Medium	<5%	MH	CLAYEY SILT
				None	Medium to High	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)	Liquid Limit <35	None	Low to Medium	~3 mm	Low to Medium	0% to 30%	CL	SILTY CLAY
			Liquid Limit 35 to 50	None	Medium to High	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit >50	None	High	<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%		PEAT

PLASTICITY CHART



Dual Symbol - A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used when the soil has between 5 and 12% fines (i.e. between "clean" sand and "dirty" sand) or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol - A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

BOREHOLE NO: **BH-01**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/17/2020 - 09/17/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core

DEPTH (m)	WET UNIT WEIGHT (kN/m³) 17 18 19 20 21 / WATER CONTENT and LIMITS (%) PLASTIC M.C. LIQUID 20 40 60 80	COMPRESSIVE STRENGTH (kPa) ▲ Pocket Pen ◆ Remoulded □ Intact 100 200 300 400 / STANDARD PENETRATION (N) ■ 20 40 60 80	SAMPLE STATE	SAMPLE TYPE and NUMBER	SPT (N)	USC	GROUNDWATER CONDITIONS	ELEVATION - m DEPTH - m	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0								0.0		GRAVEL some silt, some sand, dry, brown, fine to medium, crushed	
1											-1
2				AS-01							-2
3				AS-02							-3
4				AS-03				-4.0			-4
								4.0		BEDROCK	
5											-5
6								-6.0			-6
								6.0		END OF BOREHOLE	
7											-7
8											-8
9											-9
10											-10
11											-11

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REMARK:
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COMPILED BY: MW
REVIEWED BY: Kiran Chandra Prakash
REPORT DATE: 12/07/2020

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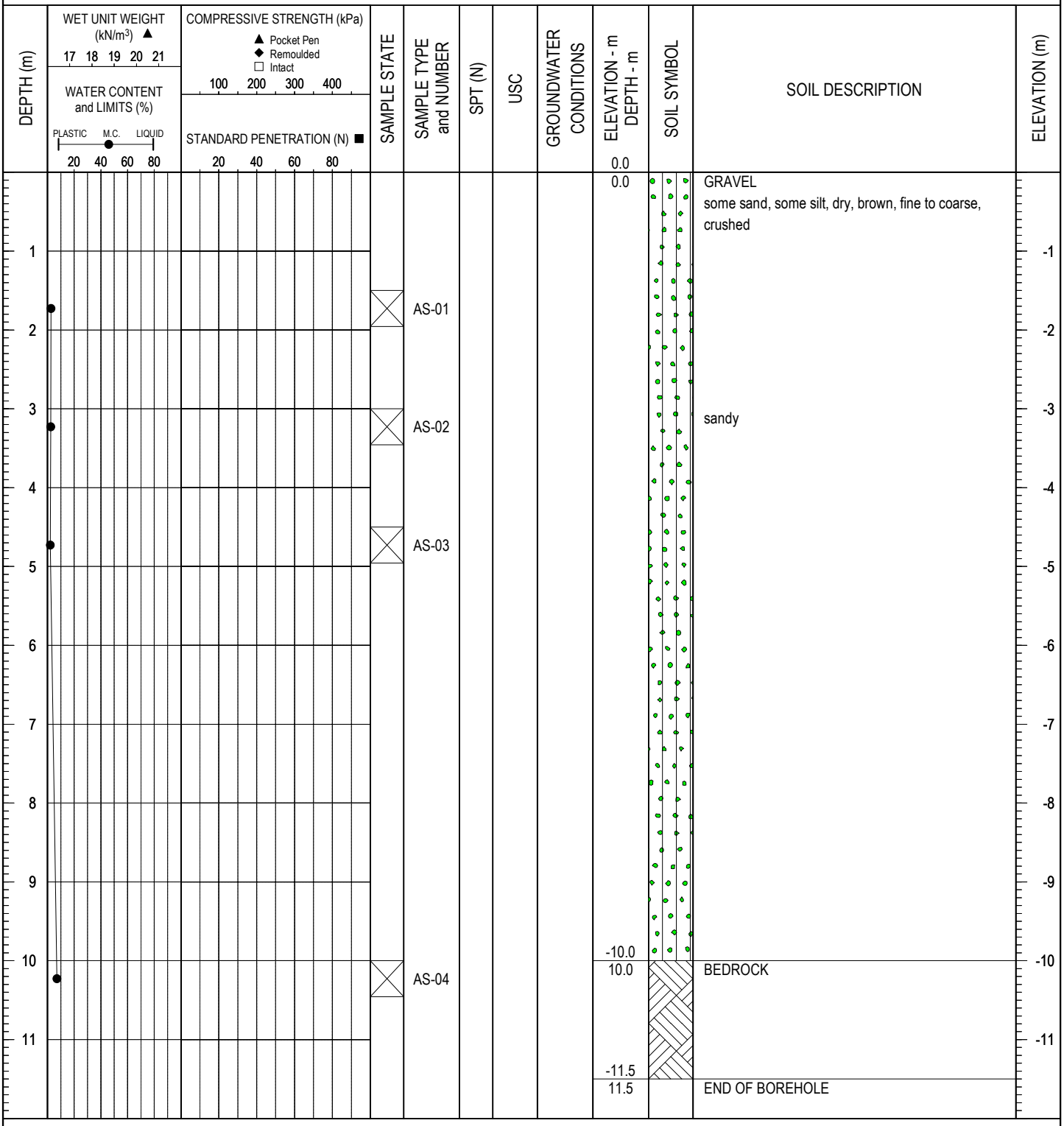
BOREHOLE NO: **BH-02**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/17/2020 - 09/17/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core



REMARK:
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BOREHOLE NO: **BH-03**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/17/2020 - 09/17/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core

WET UNIT WEIGHT (kN/m³) ▲ 17 18 19 20 21
WATER CONTENT and LIMITS (%) PLASTIC M.C. LIQUID 20 40 60 80
COMPRESSIVE STRENGTH (kPa) ▲ Pocket Pen ◆ Remoulded □ Intact 100 200 300 400
STANDARD PENETRATION (N) ■ 20 40 60 80

DEPTH (m)	SAMPLE STATE	SAMPLE TYPE and NUMBER	SPT (N)	USC	GROUNDWATER CONDITIONS	ELEVATION - m DEPTH - m	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0						0.0		SANDY GRAVEL some silt, dry, brown, fine to coarse, crushed	
1									-1
2		AS-01							-2
3		AS-02				-3.0 3.0		GRAVELLY SAND some silt, trace clay, dry, brown, fine to coarse Sand 52.1%, Gravel 32%, Silt 9.3%, Clay 6.5%	-3
4									-4
5		AS-03				-4.5 4.5		BEDROCK	-5
6									-6
7						-6.5 6.5		END OF BOREHOLE	-7
8									-8
9									-9
10									-10
11									-11

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REPORT DATE: 12/07/2020

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BOREHOLE NO: **BH-04**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/17/2020 - 09/17/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core

WET UNIT WEIGHT (kN/m³) ▲ 17 18 19 20 21
WATER CONTENT and LIMITS (%) PLASTIC M.C. LIQUID 20 40 60 80
COMPRESSIVE STRENGTH (kPa) ▲ Pocket Pen ◆ Remoulded □ Intact 100 200 300 400
STANDARD PENETRATION (N) ■ 20 40 60 80

DEPTH (m)	SAMPLE STATE	SAMPLE TYPE and NUMBER	SPT (N)	USC	GROUNDWATER CONDITIONS	ELEVATION - m DEPTH - m	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
						0.0			
1						0.0		SANDY GRAVEL some silt, dry, brown, fine to coarse, crushed	-1
2		AS-01							-2
3		AS-02						light brown	-3
4		AS-03				-4.0 4.0		BEDROCK	-4
5									-5
6						-6.0 6.0		END OF BOREHOLE	-6
7									-7
8									-8
9									-9
10									-10
11									-11

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BOREHOLE NO: **BH-05**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/18/2020 - 09/18/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core

WET UNIT WEIGHT (kN/m³) ▲ 17 18 19 20 21
WATER CONTENT and LIMITS (%) PLASTIC M.C. LIQUID 20 40 60 80
COMPRESSIVE STRENGTH (kPa) ▲ Pocket Pen ◆ Remoulded □ Intact 100 200 300 400
STANDARD PENETRATION (N) ■ 20 40 60 80

DEPTH (m)	SAMPLE STATE	SAMPLE TYPE and NUMBER	SPT (N)	USC	GROUNDWATER CONDITIONS	ELEVATION - m DEPTH - m	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0						0.0			
						0.0		SANDY GRAVEL some silt, dry, grey, fine to coarse, crushed	
1									-1
2		AS-01							-2
						-3.0			
3						3.0		GRAVELLEY SAND some silt, some clay, dry, brown	-3
4									-4
5		AS-03						some gravel	-5
6								Sand 60.9%, Gravel 17.3%, Silt 11.7%, Clay 10%	-6
						-6.5			
						6.5		BEDROCK	
7									-7
8									-8
						-8.5			
						8.5		END OF BOREHOLE	
9									-9
10									-10
11									-11

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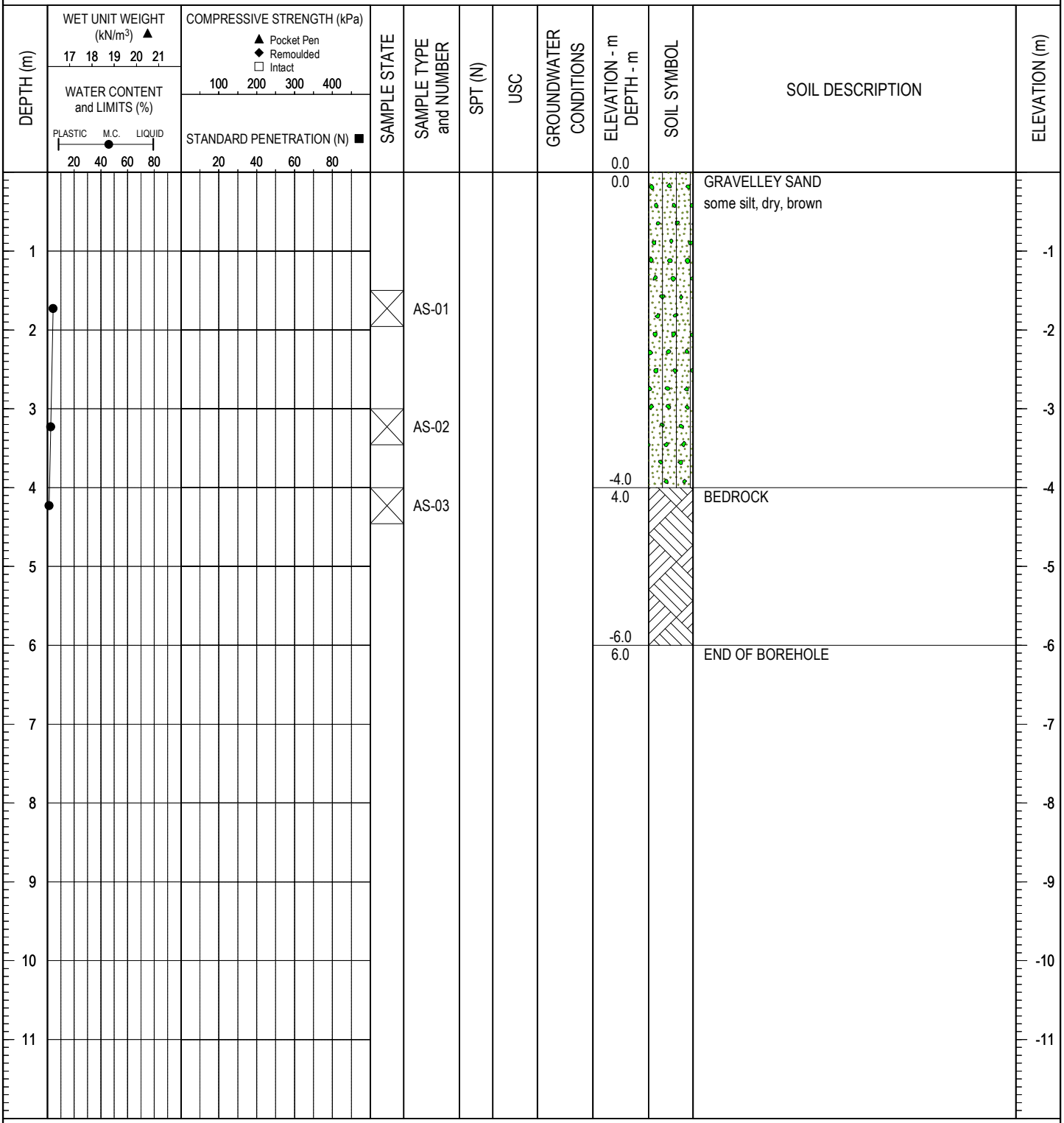
BOREHOLE NO: **BH-06**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/18/2020 - 09/18/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core



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REPORT DATE: 12/07/2020

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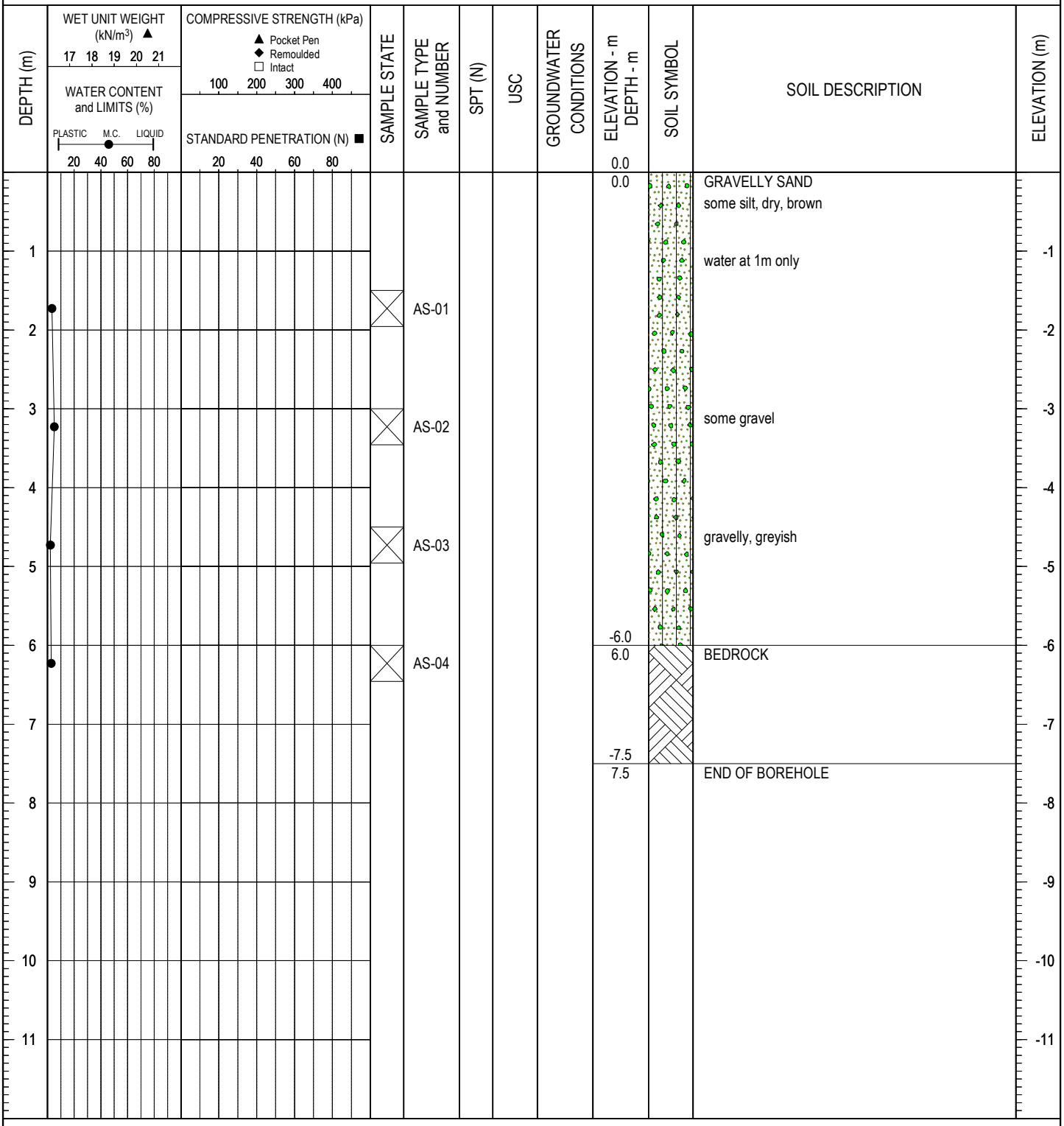
BOREHOLE NO: **BH-07**
PROJECT NO: IGLOOLIK
ELEVATION: m

N E
MTM ZONE:

DATES: 09/18/2020 - 09/18/2020

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core



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REPORT DATE: 12/07/2020

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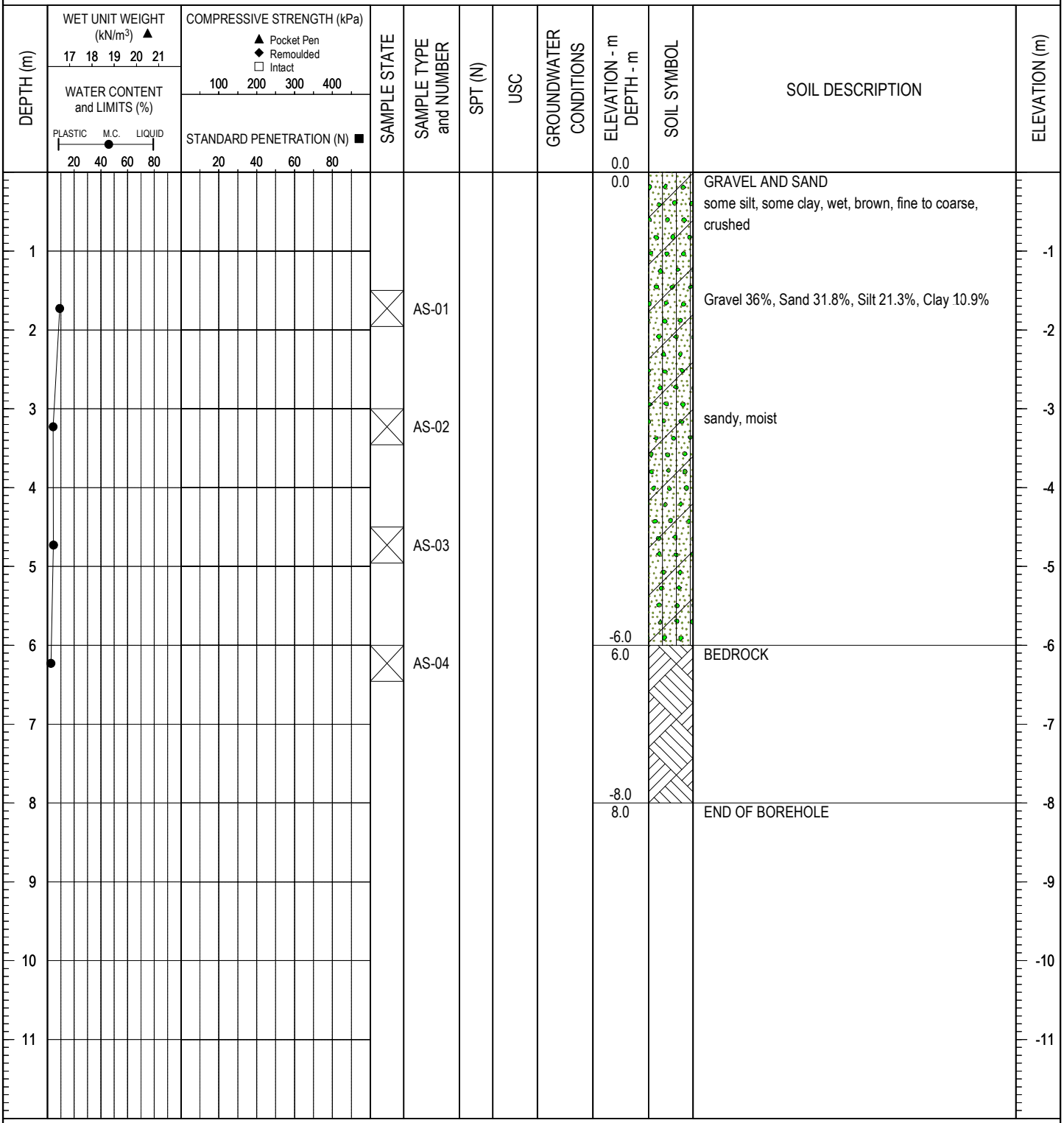
BOREHOLE NO: BH-08
PROJECT NO: IGLOOLIK
ELEVATION: m

DATES: 09/18/2020 - 09/18/2020
N E
MTM ZONE:

SAMPLE STATE: Remoulded | Intact | Core | Lost (no recovery)

SAMPLE TYPE: AS: Auger Sample | ST: Shelby Tube | SS: Split Spoon | MA: Manual Sample | DC: Diamond Rock Core



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REPORT DATE: 12/07/2020

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Appendix 3 Geotechnical Laboratory Results

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Moisture Content

In Accordance With ASTM D2217

CCIL Canadian Council of Independent Laboratories

Client:	Qulliq Energy Corporation
Project:	Geotechnical Evaluation
Project Location:	Igloolik - Option 1
Sample Source:	Boreholes (Geo)
Reviewed:	Connor C

Date:	14-Oct-20
Project No.:	P-0023273
Sample No.:	1857
Technician:	MW

Test Hole No.:		1	1	1	2	2
Sample No.:		IG OP-01	IG OP-01	IG OP-01	IG OP-01	IG OP-01
Depth:		1.8m	3m	4m	1.5m	3m
Container No.:	g	103	89	46	68	18
Tare of Container:	g	5.4	5.4	5.4	5.4	5.4
Wt. of Wet Sample + Tare:	g	425.6	432.7	466.8	508.8	467.7
Wt. of Dry Sample + Tare:	g	417.1	419.9	460.7	495.7	456.4
Wt. of Water:	g	8.5	12.8	6.1	13.1	11.3
Wt. of Dry Soil:	g	411.7	414.5	455.3	490.3	451.0
Moisture Content:	%	**2.1%**	**3.1%**	**1.3%**	**2.7%**	**2.5%**

Test Hole No.:		2	3	3	3	4
Sample No.:		IG OP-01	IG OP-01	IG OP-01	IG OP-01	IG OP-01
Depth:		4.5m	1.5m	3m	4.5m	1.5m
Container No.:	g	41	36	67	83	24
Tare of Container:	g	5.4	5.4	5.4	5.4	5.4
Wt. of Wet Sample + Tare:	g	519.6	490.9	475.2	468.6	447.3
Wt. of Dry Sample + Tare:	g	509.2	475.4	462.7	453	435.6
Wt. of Water:	g	10.4	15.5	12.5	15.6	11.7
Wt. of Dry Soil:	g	503.8	470.0	457.3	447.6	430.2
Moisture Content:	%	**2.1%**	**3.3%**	**2.7%**	**3.5%**	**2.7%**

Test Hole No.:		4	4	4	5	5
Sample No.:		IG OP-01	IG OP-01	IG OP-01	IG OP-01	IG OP-01
Depth:		3m	4.5m	10m	1.5m	3m
Container No.:	g	49	80	33	90	55
Tare of Container:	g	5.4	5.4	5.4	5.4	5.4
Wt. of Wet Sample + Tare:	g	433.4	404.4	379.5	444.6	473.7
Wt. of Dry Sample + Tare:	g	428.1	398.8	354.6	429.1	460.6
Wt. of Water:	g	5.3	5.6	24.9	15.5	13.1
Wt. of Dry Soil:	g	422.7	393.4	349.2	423.7	455.2
Moisture Content:	%	**1.3%**	**1.4%**	**7.1%**	**3.7%**	**2.9%**

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Moisture Content

In Accordance With ASTM D2217

CCIL Canadian Council of Independent Laboratories

Client:	Qulliq Energy Corporation
Project:	Geotechnical Evaluation
Project Location:	Igloolik - Option 1
Sample Source:	Boreholes (Geo)
Reviewed:	Connor C

Date:	14-Oct-20
Project No.:	P-0023273
Sample No.:	1857
Technician:	MW

Test Hole No.:		5	5	6	6	6
Sample No.:		IG OP-01	IG OP-01	IG OP-01	IG OP-01	IG OP-01
Depth:		6m	6.5m	1.5m	3m	4.5m
Container No.:	g	37	91	111	93	101
Tare of Container:	g	5.4	5.4	5.4	5.4	5.4
Wt. of Wet Sample + Tare:	g	427.4	430.1	449.4	505.6	457.9
Wt. of Dry Sample + Tare:	g	409.6	420	431.7	494	452.4
Wt. of Water:	g	17.8	10.1	17.7	11.6	5.5
Wt. of Dry Soil:	g	404.2	414.6	426.3	488.6	447.0
Moisture Content:	%	**4.4%**	**2.4%**	**4.2%**	**2.4%**	**1.2%**

Test Hole No.:		7	7	7	7	8
Sample No.:		IG OP-01	IG OP-01	IG OP-01	IG OP-01	IG OP-01
Depth:		1.5m	3m	4.5m	6m	1.5m
Container No.:	g	52	770	64	31	8
Tare of Container:	g	5.4	5.4	5.4	5.4	5.4
Wt. of Wet Sample + Tare:	g	479.1	472	489.8	519	496.8
Wt. of Dry Sample + Tare:	g	463.4	449.3	479.6	504.4	455.6
Wt. of Water:	g	15.7	22.7	10.2	14.6	41.2
Wt. of Dry Soil:	g	458.0	443.9	474.2	499.0	450.2
Moisture Content:	%	**3.4%**	**5.1%**	**2.2%**	**2.9%**	**9.2%**

Test Hole No.:		8	8	8		
Sample No.:		IG OP-01	IG OP-01	IG OP-01		
Depth:		3m	4.5m	6m		
Container No.:	g	104	88	4		
Tare of Container:	g	5.4	5.4	5.4		
Wt. of Wet Sample + Tare:	g	449.3	462.2	498.6		
Wt. of Dry Sample + Tare:	g	431	442.4	485.9		
Wt. of Water:	g	18.3	19.8	12.7		
Wt. of Dry Soil:	g	425.6	437.0	480.5		
Moisture Content:	%	**4.3%**	**4.5%**	**2.6%**		

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GRAIN SIZE ANALYSIS AND HYDROMETER TEST REPORT

ASTM D422 − 63

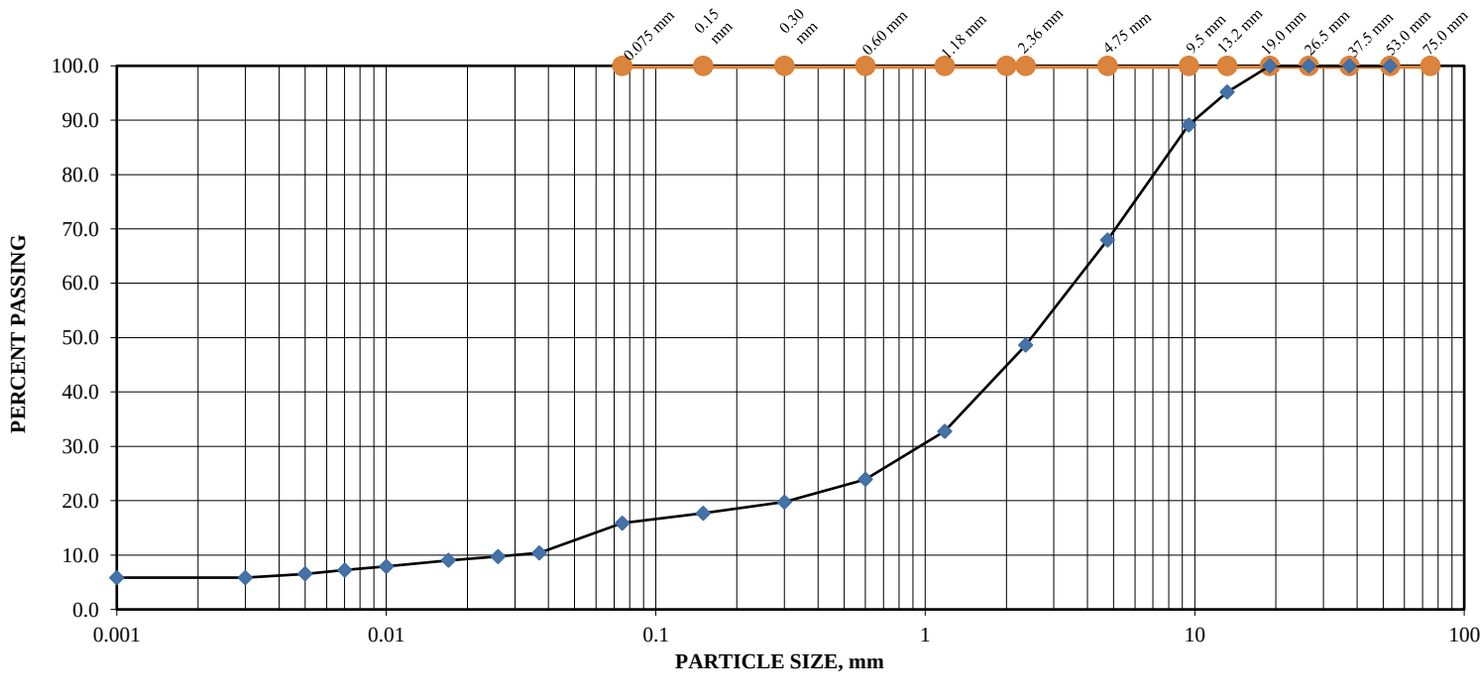
PROJECT NO:	P-0023273	**GRAIN SIZE ANALYSIS**		SAMPLE ID:	1857
CLIENT NAME:	Qulliq Energy Corporation				
PROJECT NAME:	Geotechnical Evaluation	SIEVE SIZE mm	% PASSING	JOB NO.:	N/A
PROJECT LOCATION:	Igloolik - Option 1			SAMPLER:	Sharath
SAMPLING LOCATION:	BH 3	53	100.0	TESTER:	Camille
SAMPLING METHOD:	Grab Sample	37.5	100.0	**HYDROMETER ANALYSIS**	
SAMPLE NUMBER:	IG OP-01	26.5	100.0		
SAMPLING DEPTH, m:	3.0m	19	100.0	DIAMETER mm	% PASSING
SAMPLING DATE:	14-Oct-20	13.2	95.2		
GRAIN SIZE PROPORTIONS, %		9.5	89.1	0.037	10.4
		4.75	68.0	0.026	9.7
% GRAVEL (> 4.75 mm):	32.0	2.4	48.6	0.017	9.0
% SAND (75 µm to 4.75 mm):	52.1	1.18	32.8	0.01	7.9
% Silt (5 µm to 75 µm):	9.3	0.60	23.9	0.007	7.3
% Clay (<5 µm):	6.5	0.30	19.8	0.005	6.5
DELIVERED MOISTURE CONTENT:	2.7%	0.15	17.7	0.003	5.8
		0.075	15.9	0.001	5.8

PARTICLE SIZE DISTRIBUTION,

CLAY	SILT	VERY FINE SAND	FINE	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487-17

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



Reviewed by: Connor Carlson

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Edmonton, Alberta
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GRAIN SIZE ANALYSIS AND HYDROMETER TEST REPORT

ASTM D422 − 63

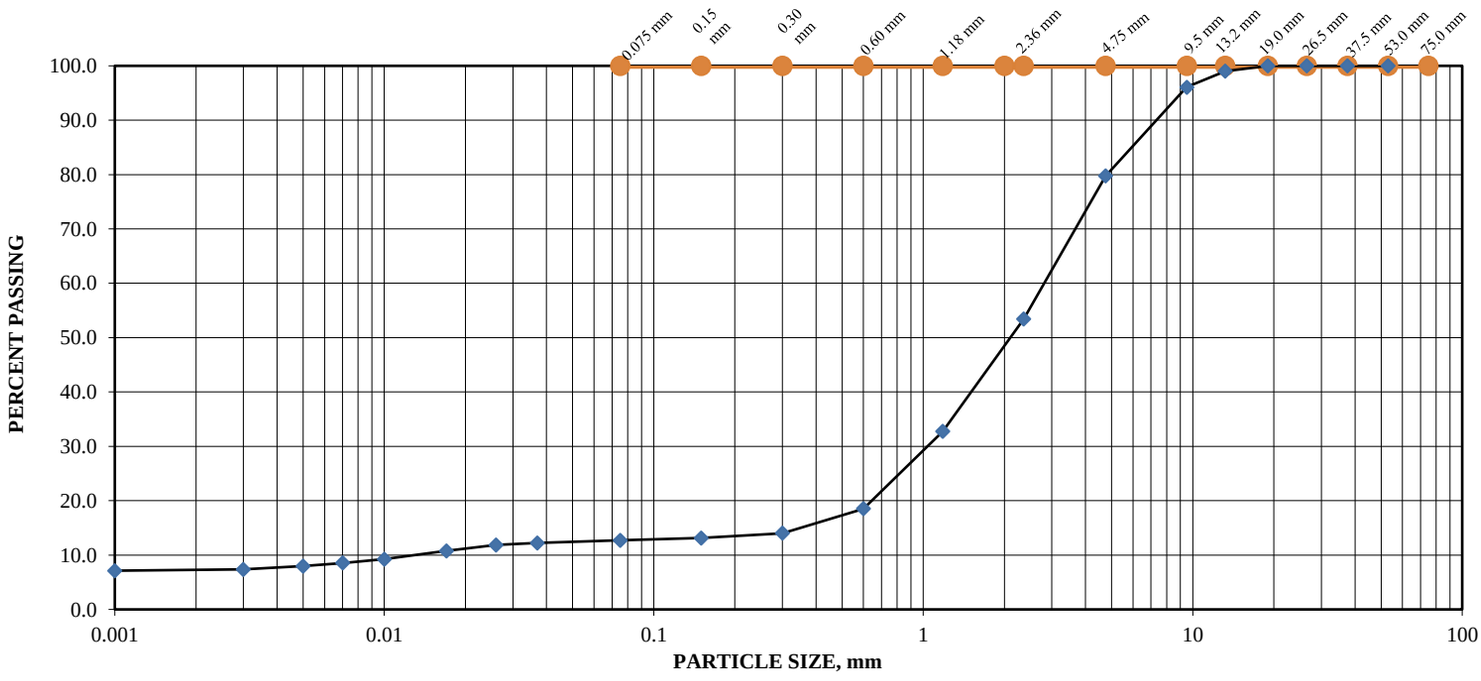
PROJECT NO:	P-0023273	**GRAIN SIZE ANALYSIS**		SAMPLE ID:	1857
CLIENT NAME:	Qulliq Energy Corporation				
PROJECT NAME:	Geotechnical Evaluation	SIEVE SIZE mm	% PASSING	JOB NO.:	N/A
PROJECT LOCATION:	Igloolik - Option 1			SAMPLER:	Sharath
SAMPLING LOCATION:	BH 4	53	100.0	TESTER:	Camille
SAMPLING METHOD:	Grab Sample	37.5	100.0	**HYDROMETER ANALYSIS**	
SAMPLE NUMBER:	IG OP-01	26.5	100.0		
SAMPLING DEPTH, m:	10.0m	19	100.0	DIAMETER mm	% PASSING
SAMPLING DATE:	14-Oct-20	13.2	99.0		
GRAIN SIZE PROPORTIONS, %		9.5	96.1	0.037	12.2
		4.75	79.7	0.026	11.9
% GRAVEL (> 4.75 mm):	20.3	2.4	53.4	0.017	10.8
% SAND (75 µm to 4.75 mm):	67.0	1.18	32.7	0.01	9.2
% Silt (5 µm to 75 µm):	4.8	0.60	18.5	0.007	8.5
% Clay (<5 µm):	7.9	0.30	14.0	0.005	7.9
DELIVERED MOISTURE CONTENT:	7.1%	0.15	13.1	0.003	7.4
		0.075	12.7	0.001	7.1

PARTICLE SIZE DISTRIBUTION,

CLAY	SILT	VERY FINE SAND	FINE	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487-17

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



Reviewed by: Connor Carlson

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GRAIN SIZE ANALYSIS AND HYDROMETER TEST REPORT

ASTM D422 − 63

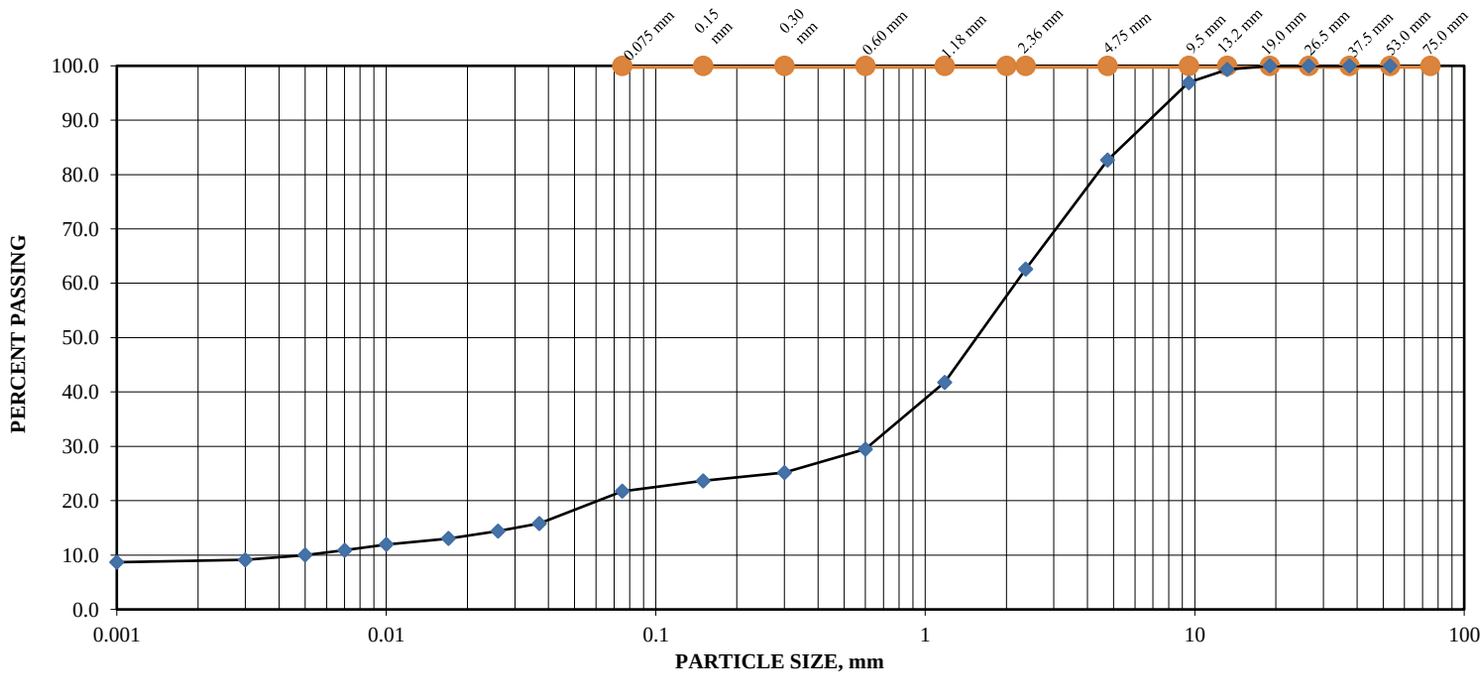
PROJECT NO:	P-0023273	**GRAIN SIZE ANALYSIS**		SAMPLE ID:	1857
CLIENT NAME:	Qulliq Energy Corporation				
PROJECT NAME:	Geotechnical Evaluation	SIEVE SIZE mm	% PASSING	JOB NO.:	N/A
PROJECT LOCATION:	Igloolik - Option 1			SAMPLER:	Sharath
SAMPLING LOCATION:	BH 5	53	100.0	TESTER:	Camille
SAMPLING METHOD:	Grab Sample	37.5	100.0	**HYDROMETER ANALYSIS**	
SAMPLE NUMBER:	IG OP-01	26.5	100.0		
SAMPLING DEPTH, m:	6.0m	19	100.0	DIAMETER mm	% PASSING
SAMPLING DATE:	14-Oct-20	13.2	99.3		
GRAIN SIZE PROPORTIONS, %		9.5	96.9	0.037	15.8
		4.75	82.7	0.026	14.4
% GRAVEL (> 4.75 mm):	17.3	2.4	62.6	0.017	13.1
% SAND (75 µm to 4.75 mm):	60.9	1.18	41.8	0.01	11.9
% Silt (5 µm to 75 µm):	11.7	0.60	29.5	0.007	10.9
% Clay (<5 µm):	10.0	0.30	25.2	0.005	10.0
DELIVERED MOISTURE CONTENT:	4.4%	0.15	23.7	0.003	9.1
		0.075	21.7	0.001	8.7

PARTICLE SIZE DISTRIBUTION,

CLAY	SILT	VERY FINE SAND	FINE	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487-17

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



Reviewed by: Connor Carlson

Rev:May 5,2018

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Canada, T5M 2Z5
Ph: 780-481-1416

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GRAIN SIZE ANALYSIS AND HYDROMETER TEST REPORT

ASTM D422 − 63

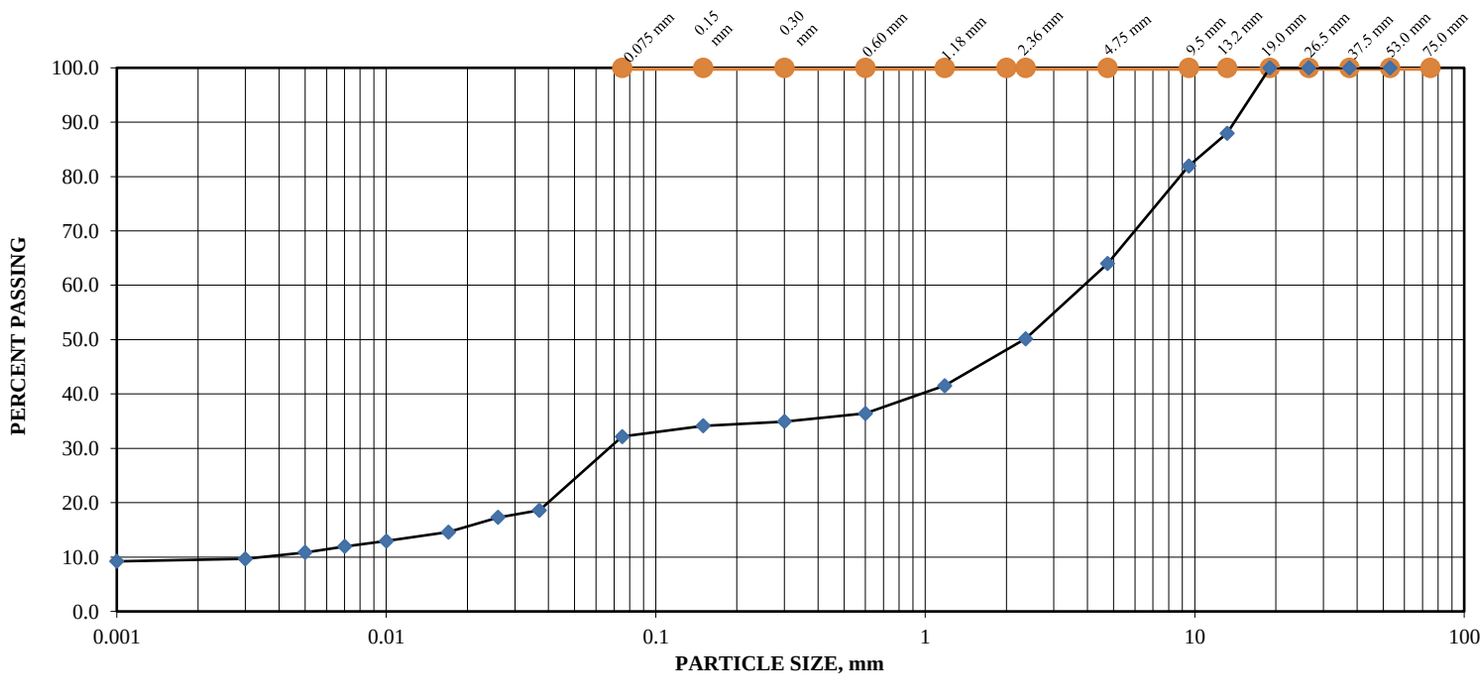
PROJECT NO:	P-0023273	**GRAIN SIZE ANALYSIS**		SAMPLE ID:	1857
CLIENT NAME:	Qulliq Energy Corporation				
PROJECT NAME:	Geotechnical Evaluation	SIEVE SIZE mm	% PASSING	JOB NO.:	N/A
PROJECT LOCATION:	Igloolik - Option 1			SAMPLER:	Sharath
SAMPLING LOCATION:	BH 8	53	100.0	TESTER:	Camille
SAMPLING METHOD:	Grab Sample	37.5	100.0	**HYDROMETER ANALYSIS**	
SAMPLE NUMBER:	IG OP-01	26.5	100.0		
SAMPLING DEPTH, m:	1.5m	19	100.0	DIAMETER mm	% PASSING
SAMPLING DATE:	14-Oct-20	13.2	88.0		
GRAIN SIZE PROPORTIONS, %		9.5	81.9	0.037	18.6
		4.75	64.0	0.026	17.3
% GRAVEL (> 4.75 mm):	36.0	2.4	50.2	0.017	14.6
% SAND (75 µm to 4.75 mm):	31.8	1.18	41.5	0.01	12.9
% Silt (5 µm to 75 µm):	21.3	0.60	36.4	0.007	12.0
% Clay (<5 µm):	10.9	0.30	34.9	0.005	10.9
DELIVERED MOISTURE CONTENT:	9.2%	0.15	34.1	0.003	9.6
		0.075	32.2	0.001	9.2

PARTICLE SIZE DISTRIBUTION,

CLAY	SILT	VERY FINE SAND	FIN E	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487-17

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



Reviewed by: Connor Carlson

Rev:May 5,2018

Appendix 4 Chemical Analyses Results

AGAT Laboratories

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CANADA T6B 3P9
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FAX (780)462-2490
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CLIENT NAME: ENGLOBE CORP
16114 114 AVE N.W.
EDMONTON , AB T5M 2Z5
780-481-1416
ATTENTION TO: Kiran Prakash
PROJECT: P-0023273-Igloolik
AGAT WORK ORDER: 20E664194
SOIL ANALYSIS REVIEWED BY: Qiuhong Dong, Lab Technician A
TRACE ORGANICS REVIEWED BY: Jarrod Roberts, Operations Manager
DATE REPORTED: Oct 23, 2020
PAGES (INCLUDING COVER): 11
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (780) 395-2525

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
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- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
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Certificate of Analysis

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

CLIENT NAME: ENGLOBE CORP

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

CCME / Tier 1 Metals (Soil)

DATE RECEIVED: 2020-10-14

DATE REPORTED: 2020-10-16

		SAMPLE DESCRIPTION:		BH20-01 1.5m	BH20-05 1.5m	BH20-07 1.5m	BH20-02 3.0m
		SAMPLE TYPE:		Soil	Soil	Soil	Soil
		DATE SAMPLED:		2020-10-13	2020-10-13	2020-10-13	2020-10-13
Parameter	Unit	G / S	RDL	1562930	1562933	1562934	1562935
Antimony	mg/kg	20	0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	mg/kg	17	0.5	4.1	1.9	1.8	1.8
Barium	mg/kg	750	0.5	35.0	18.6	7.6	6.6
Beryllium	mg/kg	5	0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	mg/kg	1.4	0.5	<0.5	<0.5	<0.5	<0.5
Chromium	mg/kg	64	0.5	7.2	9.4	7.4	8.8
Cobalt	mg/kg	20	0.5	2.8	1.7	1.4	1.2
Copper	mg/kg	63	0.5	13.3	4.2	3.9	3.8
Lead	mg/kg	70	0.5	5.0	2.7	4.2	2.9
Molybdenum	mg/kg	4	0.5	1.2	0.9	0.9	0.9
Nickel	mg/kg	45	0.5	7.8	4.7	4.3	4.1
Selenium	mg/kg	1	0.5	<0.5	<0.5	<0.5	<0.5
Silver	mg/kg	20	0.5	<0.5	0.8	<0.5	<0.5
Thallium	mg/kg	1	0.5	<0.5	<0.5	<0.5	<0.5
Tin	mg/kg	5	0.5	1.2	0.5	4.6	<0.5
Uranium	mg/kg	23	0.5	<0.5	<0.5	<0.5	<0.5
Vanadium	mg/kg	130	0.5	11.1	13.1	7.3	10.6
Zinc	mg/kg	250	1	6	4	4	3

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Alberta Tier 1 - Soil - Agricultural - Fine
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

1562930-1562935 Results are based on the dry weight of the sample.

Analysis performed at AGAT Edmonton (unless marked by *)

Certified By: Qiuhong Dong

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CANADA T6B 3P9
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Certificate of Analysis

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

CLIENT NAME: ENGLOBE CORP

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

Soil Analysis - Salinity (pH Calcium Chloride)

DATE RECEIVED: 2020-10-14

DATE REPORTED: 2020-10-19

		SAMPLE DESCRIPTION:		BH20-07 1.5m	BH20-02 3.0m
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2020-10-13	2020-10-13
Parameter	Unit	G / S	RDL	1562934	1562935
pH (CaCl2 Extraction)	pH Units		N/A	8.40	8.63
Electrical Conductivity (Sat. Paste)	dS/m		0.05	3.31	4.21
Sodium Adsorption Ratio	N/A		0.34	4.52	5.56
Saturation Percentage	%		1	23	25
Chloride, Soluble	mg/L		5	780	1110
Calcium, Soluble	mg/L		1	71	70
Potassium, Soluble	mg/L		2	29	48
Magnesium, Soluble	mg/L		1	126	158
Sodium, Soluble	mg/L		2	274	367
Sulfate, Soluble	mg/L		4	191	153
Theoretical Gypsum Requirement	tonnes/ha		0.01	<0.01	<0.01
Calcium, Soluble (meq/L)	meq/L		0.05	3.54	3.49
Calcium, Soluble (mg/kg)	mg/kg		1	16	18
Chloride, Soluble (meq/L)	meq/L		0.06	22.0	31.3
Chloride, Soluble (mg/kg)	mg/kg		2	179	278
Magnesium, Soluble (meq/L)	meq/L		0.08	10.4	13.0
Magnesium, Soluble (mg/kg)	mg/kg		1	29	40
Potassium, Soluble (meq/L)	meq/L		0.05	0.74	1.23
Potassium, Soluble (mg/kg)	mg/kg		2	7	12
Sodium, Soluble (meq/L)	meq/L		0.09	11.9	16.0
Sodium, Soluble (mg/kg)	mg/kg		2	63	92
Sulfur (as Sulfate), Soluble (meq/L)	meq/L		0.04	3.98	3.19
Sulfur (as Sulfate), Soluble (mg/kg)	mg/kg		2	44	38

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1562934-1562935 If sodium results in mg/L are less than detection, SAR is non-calculable and is reported as 0.
Sodium Adsorption Ratio is a calculated parameter. The calculated value is the ratio of the sodium concentration in mmol/L over the square rooted sum of the calcium and magnesium concentrations in mmol/L.
Theoretical Gypsum Requirement is a calculated parameter. The calculation is from “A Comparison of Methods for Gypsum Requirement of Brine-Contaminated Soils”, Canadian Journal of Soil Science, 1998.

Analysis performed at AGAT Edmonton (unless marked by *)

Certified By: Qiuhong Dong

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EDMONTON, ALBERTA
CANADA T6B 3P9
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Certificate of Analysis

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

CLIENT NAME: ENGLOBE CORP

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

Petroleum Hydrocarbons (BTEX/F1-F4) in Soil (CWS) (Methanol Field Stabilized)

DATE RECEIVED: 2020-10-14

DATE REPORTED: 2020-10-20

		SAMPLE DESCRIPTION:		BH20-01 1.5m	BH20-05 1.5m	BH20-07 1.5m	BH20-02 3.0m
		SAMPLE TYPE:		Soil	Soil	Soil	Soil
		DATE SAMPLED:		2020-10-13	2020-10-13	2020-10-13	2020-10-13
Parameter	**Unit**	**G / S**	**RDL**	**1562930**	**1562933**	**1562934**	**1562935**
Benzene	mg/kg		0.005	<0.005	<0.005	<0.005	<0.005
Toluene	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	mg/kg		0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05
C6 - C10 (F1)	mg/kg		10	<10	<10	<10	<10
C6 - C10 (F1 minus BTEX)	mg/kg		10	<10	<10	<10	<10
C10 - C16 (F2)	mg/kg		10	<10	<10	<10	<10
C16 - C34 (F3)	mg/kg		10	520	640	400	160
C34 - C50 (F4)	mg/kg		10	220	330	210	80
Gravimetric Heavy Hydrocarbons	mg/kg		1000	N/A	N/A	N/A	N/A
Moisture Content	%		1	2	7	4	4
Surrogate	**Unit**	**Acceptable Limits**					
Toluene-d8 (BTEX)	%	60-140		103	104	104	104
Ethylbenzene-d10 (BTEX)	%	60-140		114	86	115	98
o-Terphenyl (F2-F4)	%	60-140		69	69	70	69

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Certificate of Analysis

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

CLIENT NAME: ENGLOBE CORP

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

Petroleum Hydrocarbons (BTEX/F1-F4) in Soil (CWS) (Methanol Field Stabilized)

DATE RECEIVED: 2020-10-14

DATE REPORTED: 2020-10-20

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1562930-1562935 Results are based on the dry weight of the sample.
The C6-C10 (F1) fraction is calculated using toluene response factor.
The C10 - C16 (F2), C16 - C34 (F3), and C34 - C50 (F4) fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons (F4g) are not included in and cannot be added to the Total C6-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
Total C6 - C50 results are corrected for BTEX and PAH contributions (if requested).
Quality control data is available upon request.
Assistance in the interpretation of data is available upon request.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
The chromatogram returned to baseline by the retention time of nC50.
Extraction and holding times were met for this sample.
C6 –C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylenes + o-Xylene.

Analysis performed at AGAT Edmonton (unless marked by *)

Certified By:

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Quality Assurance

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

Soil Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
CCME / Tier 1 Metals (Soil)															
Antimony	290	1562934	<0.5	<0.5	NA	< 0.5	83%	70%	130%	97%	80%	120%	100%	70%	130%
Arsenic	290	1562934	1.8	1.4	NA	< 0.5	98%	80%	120%	90%	80%	120%	95%	80%	120%
Barium	290	1562934	7.6	7.5	1.7%	< 0.5	102%	70%	130%	104%	80%	120%	115%	70%	130%
Beryllium	290	1562934	<0.5	<0.5	NA	< 0.5	100%	70%	130%	94%	80%	120%	124%	70%	130%
Cadmium	290	1562934	<0.5	<0.5	NA	< 0.5	97%	70%	130%	102%	80%	120%	99%	70%	130%
Chromium	290	1562934	7.4	7.2	3.4%	< 0.5	103%	70%	130%	116%	80%	120%	113%	70%	130%
Cobalt	290	1562934	1.4	1.3	NA	< 0.5	100%	70%	130%	114%	80%	120%	114%	70%	130%
Copper	290	1562934	3.9	3.5	9.4%	< 0.5	112%	70%	130%	116%	80%	120%	104%	70%	130%
Lead	290	1562934	2.8	2.9	3.5%	< 0.5	99%	70%	130%	104%	80%	120%	101%	70%	130%
Molybdenum	290	1562934	0.9	0.9	NA	< 0.5	98%	70%	130%	101%	80%	120%	110%	70%	130%
Nickel	290	1562934	4.3	3.8	14.0%	< 0.5	113%	70%	130%	111%	80%	120%	112%	70%	130%
Selenium	290	1562934	<0.5	<0.5	NA	< 0.5	96%	70%	130%	101%	80%	120%	103%	70%	130%
Silver	290	1562934	<0.5	<0.5	NA	< 0.5	99%	70%	130%	99%	80%	120%	93%	70%	130%
Thallium	290	1562934	<0.5	<0.5	NA	< 0.5	97%	70%	130%	102%	80%	120%	111%	70%	130%
Uranium	290	1562934	<0.5	<0.5	NA	< 0.5	98%	70%	130%	104%	80%	120%	119%	70%	130%
Vanadium	290	1562934	4.6	5.3	13.5%	< 0.5	114%	70%	130%	117%	80%	120%	109%	70%	130%
Zinc	290	1562934	4	3	NA	< 1	117%	70%	130%	104%	80%	120%	92%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.
With multi element runs, a maximum of 10% for each QC parameter may fail to an absolute maximum of 10%

Soil Analysis - Salinity (pH Calcium Chloride)															
pH (CaCl2 Extraction)	289	1560154	6.04	6.02	0.3%	N/A	99%	90%	110%						
Electrical Conductivity (Sat. Paste)	292	1560154	0.20	0.22	NA	< 0.05	105%	80%	120%						
Saturation Percentage	292	1560154	50	48	4.1%	< 1	90%	80%	120%						
Chloride, Soluble	129	1560154	12	12	NA	< 5	96%	70%	130%	97%	80%	120%	89%	70%	130%
Calcium, Soluble	292	1560154	13	13	0.5%	< 1	94%	70%	130%	98%	80%	120%	108%	70%	130%
Potassium, Soluble	292	1560154	2	2	NA	< 2	90%	70%	130%	91%	80%	120%	100%	70%	130%
Magnesium, Soluble	292	1560154	3	3	NA	< 1	92%	70%	130%	88%	80%	120%	98%	70%	130%
Sodium, Soluble	292	1560154	30	30	0.2%	< 2	95%	70%	130%	93%	80%	120%	103%	70%	130%
Sulfate, Soluble	292	1560154	23	23	0.9%	< 2	96%	70%	130%	99%	80%	120%	102%	70%	130%

Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated
If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.

Certified By: Qiuhong Dong

AGAT Laboratories

6310 ROPER ROAD
EDMONTON, ALBERTA
CANADA T6B 3P9
TEL (780)395-2525
FAX (780)462-2490
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

Trace Organics Analysis

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Petroleum Hydrocarbons (BTEX/F1-F4) in Soil (CWS) (Methanol Field Stabilized)															
Benzene	2435	1562512	<0.005	<0.005	NA	< 0.005	87%	60%	140%	76%	60%	140%	105%	60%	140%
Toluene	2435	1562512	<0.05	<0.05	NA	< 0.05	97%	60%	140%	82%	60%	140%	113%	60%	140%
Ethylbenzene	2435	1562512	<0.01	<0.01	NA	< 0.01	103%	60%	140%	76%	60%	140%	107%	60%	140%
C6 - C10 (F1)	2435	1562512	<10	<10	NA	< 10	90%	60%	140%	76%	60%	140%	94%	60%	140%
C10 - C16 (F2)	1076	1562512	<10	<10	NA	< 10	90%	60%	140%	70%	60%	140%	73%	60%	140%
C16 - C34 (F3)	1076	1562512	140	190	30.3%	< 10	93%	60%	140%	79%	60%	140%	77%	60%	140%
C34 - C50 (F4)	1076	1562512	30	30	NA	< 10	93%	60%	140%	79%	60%	140%	82%	60%	140%
Moisture Content	1076	1562512	16	16	0.0%	< 1									

Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.
The sample spikes and dups are not from the same sample ID.

Certified By:

AGAT Laboratories

6310 ROPER ROAD
EDMONTON, ALBERTA
CANADA T6B 3P9
TEL (780)395-2525
FAX (780)462-2490
http://www.agatlabs.com

Method Summary

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Arsenic	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Barium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Beryllium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Cadmium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Chromium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP/MS
Cobalt	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Copper	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Lead	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Molybdenum	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Nickel	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Selenium	INORG-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Silver	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Thallium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Tin	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Uranium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Vanadium	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
Zinc	INOR-171-6006, INOR-171-6202	EPA SW 846-3050; SM 3125 B	ICP-MS
pH (CaCl2 Extraction)	INOR-171-6207	SHEPPARD 2007; HENDERSHOT 2008	PH METER
Electrical Conductivity (Sat. Paste)	INOR-171-6208	SHEPPARD 2007; MILLER 2007	CONDUCTIVITY METER
Sodium Adsorption Ratio	INOR-171-6201 & INOR-171-6002	McKeague 3.26	CALCULATION
Saturation Percentage	INOR-171-6002	MILLER 2007; SHEPPARD 2007	GRAVIMETRIC
Chloride, Soluble	INOR-171-6212	CARTER & GREGORICH 2007, SM 3120B	COLORIMETER
Calcium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Potassium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Magnesium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Sodium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Sulfate, Soluble	SOIL 0110; SOIL 0120; INST 0140	SHEPPARD 2007; EATON 2005	ICP/OES

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6310 ROPER ROAD
EDMONTON, ALBERTA
CANADA T6B 3P9
TEL (780)395-2525
FAX (780)462-2490
http://www.agatlabs.com

Method Summary

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 20E664194

PROJECT: P-0023273-Igloolik

ATTENTION TO: Kiran Prakash

SAMPLING SITE:

SAMPLED BY:SM

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Theoretical Gypsum Requirement	INOR-171-6201 & INOR-171-6002	USDA HDBK 60, 22D	CALCULATION
Trace Organics Analysis			
Benzene	ORG-170-5110/5140/5430/5440	EPA SW-846 8260	GC/MS
Toluene	ORG-170-5110/5140/5430/5440	EPA SW-846 8260	GC/MS
Ethylbenzene	ORG-170-5110/5140/5430/5440	EPA SW-846 8260	GC/MS
Xylenes	ORG-170-5110/5140/5430/5440	EPA SW-846 8260	GC/MS
C6 - C10 (F1)	ORG-170-5110/5140/5430/5440	CCME Tier 1 Method	GC/FID
C6 - C10 (F1 minus BTEX)	ORG-170-5110/5140/5430/5440	CCME Tier 1 Method	GC/FID
C10 - C16 (F2)	ORG-170-5120/5300	CCME Tier 1 Method	GC/FID
C16 - C34 (F3)	ORG-170-5120/5300	CCME Tier 1 Method	GC/FID
C34 - C50 (F4)	ORG-170-5120/5300	CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	ORG-170-5120/5300	CCME Tier 1 Method	GC/FID
Moisture Content	LAB-175-4002	CCME Tier 1 Method	GRAVIMETRIC
Toluene-d8 (BTEX)	ORG-170-5110/5140/5430/5440	EPA SW-846 8260-S	GC/MS
Ethylbenzene-d10 (BTEX)	ORG-170-5110/5140/5430/5440	EPA SW-846 8260-S	GC/MS
o-Terphenyl (F2-F4)	ORG-170-5120/5300	CCME Tier 1 Method	GC/FID

AGAT Laboratories

2910 12 Street NE
Calgary, Alberta T2E 7P7
P: 403-735-2005 • F: 403-735-2771
webearth.agatlabs.com

Laboratory Use Only
Arrival Temperature: 15-6
AGAT Job Number: 20E664194
Date and Time: [illegible] OCT 14 17:21

Chain of Custody Record

Emergency Support Services Hotline 1-855-AGAT 245 (1-855-242-8245)

Report Information
Company: Englobe Corp.
Contact: KIRAN PRAKASH
Address: 16 111 - 116 Ave NW
Phone: 7803965308 Fax:
LSD:
Client Project #: P-00 23273 - Iglookt
Sampled By: SM

Report Information
1. Name: KIRAN PRAKASH.
Email:
2. Name:
Email:
3. Name:
Email:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 Business Days
Rush TAT ☐ <24 Hours (200%) ☐ Two Day / Next Day (100%) ☐ Three Day (50%) ☐ Four Day (25%)
Date Required:

Report Format
~~☑~~ Single sample per page
☐ Multiple samples per page
☐ Export

Invoice To Same Yes ☒ / No ☐
Company:
Contact:
Address:
Phone: Fax:
PO/AFE#:
AGAT ID/Quote #:

Requirements *(Selection may impact detection limits)*
☐ CCME ☐ Agricultural ☐ Industrial ☐ Residential/Park ☐ Commercial ☐ FWAL
☐ AB Tier 1 ☐ Agricultural ☐ Industrial ☐ Residential/Park ☐ Commercial ☐ Natural Area
☐ Alberta Surface Water ☐ Chronic ☐ Acute ☐ SK Notice of Site Condition ☐ Drinking Water ☐ Other: Nunavut
Is this part of the Alberta SRP program? ☐ YES ☐ NO (If yes, please fill below)
Application Number:
Grant Amount:
Well/Facility/Location ID:
UWI:

LABORATORY USE (LAB ID #)	SAMPLE IDENTIFICATION	DEPTH	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS (FILTERED, PRESERVED, HAZARDOUS*) *ADDITIONAL FEE	# OF CONTAINERS VIALS / JARS	BAGS	BOTTLES
1	1562930 BH 20-01	1.5M	13 Oct	SOIL		2		2
2	2933 BH 20-05	1.5M	13 Oct	SOIL		2		2
3	2934 BH 20-07	1.5M	13 Oct	SOIL		2		2
4	2935 BH 20-02	3.0M	13 Oct	SOIL		2		2
5								
6								
7								
8								
9								
10								

Detailed Salinity: ☐ AB ☐ SK ☐ BC ☐ D50	☐ CCME/AB : BTEX/F1-F4 ☐ CCME/AB : BTEX /F1-F2	☐ BC: BTEX/VPH/EPH ☐ BC: LEPH/HEPH	SK: BTEX/TVH/C11-C22, C23-C60	Soil Metals: ☐ HWS-B ☐ SP-B ☐ Hg ☐ Cr6+	Water Metals: ☐ Dissolved ☐ Total ☐ Hg ☐ Cr6+	Routine Water Chemistry	Landfill: ☐ AB Class 2 ☐ BC ☐ SK	Coliforms: ☐ Total ☐ Fecal ☐ E.coli	Particle Size: ☐ Sieve (75µm) ☐ Texture						HOLD FOR 30 DAYS NO ANALYSIS (Additional Fee)	HOLD FOR 30 DAYS AFTER ANALYSIS (Additional Fee)
										METALS - Standard	Salinity	Hydro - Textures				
										✓	✓	✓				
										✓	✓	✓				
										X	X	X				
										X	X	X				

Samples Relinquished By (Print Name and Sign)	Date/Time	Samples Received By (Print Name and Sign)	Date/Time
KIRAN	14 Oct 2020.	[illegible]	
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Page 1 of 1

Nº: AB 146044

AGAT Laboratories

SAMPLE INTEGRITY RECEIPT FORM

RECEIVING BASICS - Shipping

Company/Consultant: Englobe

Courier: D/O - CB   Prepaid   Collect

Waybill#: —

Branch: **EDM** (circled) GP FN FM RD VAN LYD FSJ EST SASK Other:___

If multiple sites were submitted at once: Yes **No** (circled)

Custody Seal Intact: Yes No **NA** (circled)

TAT: <24hr 24-48hr 48-72hr **Reg** (circled) Other________

Cooler Quantity: 1

TIME SENSITIVE ISSUES - Shipping

ALREADY EXCEEDED HOLD TIME? Yes **No** (circled)

Inorganic Tests (Please Circle): Mibi , BOD , Nitrate/Nitrite , Turbidity , Color , Microtox , Ortho PO4 , Tedlar Bag , Residual Chlorine , Chlorophyll* , Chloroamines*

—

Earliest Expiry:______________

Hydrocarbons: Earliest Expiry TC

SAMPLE INTEGRITY - Shipping

Hazardous Samples: YES **NO** (circled) Precaution Taken:______________

Legal Samples: Yes **No** (circled)

International Samples: Yes **No** (circled)

Tape Sealed: Yes **No** (circled)

Coolant Used: Icepack Bagged Ice Free Ice Free Water **None** (circled)

Temperature (Bottles/Jars only) N/A if only Soil Bags Received

FROZEN (Please Circle if samples received Frozen)

1 (Bottle/**Jar**) 15.7 + 15.4 + 15.2 = 15.4 °C   2 (Bottle/Jar)___+___+___=____°C

3 (Bottle/Jar)___+___+___=____°C   4 (Bottle/Jar)___+___+___=____°C

5 (Bottle/Jar)___+___+___=____°C   6 (Bottle/Jar)___+___+___=____°C

7 (Bottle/Jar)___+___+___=____°C   8 (Bottle/Jar)___+___+___=____°C

9 (Bottle/Jar)___+___+___=____°C   10 (Bottle/Jar)___+___+___=____°C

(If more than 10 coolers are received use another sheet of paper and attach)

LOGISTICS USE ONLY

Workorder No: 20E664194

Samples Damaged: Yes **No** (circled) If YES why?

No Bubble Wrap   Frozen   Courier

Other: ______________

Account Project Manager: Mary Grace Unera have they been notified of the above issues: Yes No

Whom spoken to: Mary Grace   Date/Time: 15 Oct 20

CPM Initial_____

General Comments: ___ **JARS** were packed with ______ **VIALS**

samples mostly rocky

Vials 2930CD, 2933D, + 2934D have weights rubbed off

Vials 2930D + 2934D are below 10mL line

* Subcontracted Analysis (See CPM)

Date issued: March 11, 2020

Appendix 5 Seismic Hazard Calculations

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 69.369N 81.811W **User File Reference:** Igloolik 2021-01-15 17:31 UT

Requested by: Englobe

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.048	0.030	0.021	0.009
Sa (0.1)	0.068	0.045	0.032	0.015
Sa (0.2)	0.071	0.050	0.037	0.018
Sa (0.3)	0.065	0.048	0.036	0.018
Sa (0.5)	0.061	0.045	0.034	0.016
Sa (1.0)	0.043	0.031	0.023	0.010
Sa (2.0)	0.024	0.017	0.012	0.004
Sa (5.0)	0.006	0.004	0.003	0.001
Sa (10.0)	0.003	0.002	0.001	0.001
PGA (g)	0.040	0.027	0.019	0.009
PGV (m/s)	0.052	0.036	0.026	0.010

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information