March 29, 2018

ISSUED FOR USE
FILE: ENG.WARC03242-12
Via Email: catherine.macDonald@gov.yk.ca

Government of Yukon
Department of Community Services
Infrastructure Development Branch (C-13)
Box 2703
Whitehorse, YT Y1A 2C6

Attention: Ms. Catherine MacDonald, Project Manager

Subject: Geotechnical Evaluation – Underground Utility Upgrades – 3rd and 4th Avenues
Dawson City, YT

1.0 INTRODUCTION

1.1 General

Government of Yukon, Department of Community Services (YG-CS) retained Tetra Tech Canada Inc. (Tetra Tech) to complete a geotechnical evaluation for proposed upgrades to the sanitary and water underground utilities in Dawson City, YT. Ms. Catherine MacDonald authorized the work by way of signed Government Contract C00040319, dated September 18, 2017.

This report addresses the proposed upgrades to underground utilities on 3rd and 4th Avenues. The geotechnical evaluation for a proposed new outfall line on Church Street, and the report assessing the feasibility of bedrock excavation for the Craig Street sewer line are presented in separate letters.

This report complements two previous reports prepared by Tetra Tech for YG-CS under project number W14103567-21 and issued January 30, 2017, providing geotechnical evaluations for additional planned upgrades to underground utilities in Dawson City.

1.2 Scope of Services

Based on the proposal submitted to YG-CS on September 15, 2017, Tetra Tech's scope of services includes the following items:

- Project management, including establishing project documentation, project coordination and communication between Tetra Tech, YG-CS, and other consultants as required, and other miscellaneous administrative tasks;
- A review of available historical geotechnical information from the project site and surrounding areas;
- A geotechnical drilling program to characterize the subsurface conditions along the proposed utility routes on 3rd and 4th Avenues, as well as a borehole at 5th Avenue and Harper Street to augment the geotechnical data Tetra Tech collected in November 2016; and
- The preparation of a geotechnical report including:
  - A summary of the geotechnical conditions at the site, including borehole logs and laboratory test results;
  - A summary of permafrost conditions along the route;

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- A summary of the groundwater conditions in the area;
- Recommendations for safe trench excavation in potentially soft or frozen soil;
- Recommendations for material selection and compaction requirements for pipe bedding, trench backfill, road surface fill, and reconstruction of the surface of the Robert Service School playing field;
- Insulation requirements for the trench and buried pipes;
- Geotechnical input for the possible use of infiltration points for storm water management, including existing soil hydraulic conductivity (k) for rock pit design for the entire project area, which includes sections of 3rd, 4th, and 5th Avenues, as well as Craig Street;
- Discussion of the overall delineation of the permafrost and non-permafrost zones in the downtown area of Dawson City; and
- A summary of the geotechnical conditions encountered in the borehole at the intersection of Fifth Avenue and Harper Street, including borehole logs and any laboratory test results.

1.3 Project Location

The location of the proposed utility alignment is presented in Figure 1. The study area includes the path of the underground utilities along 3rd Avenue between Albert Street and King Street, and along 4th Avenue immediately north of Princess Street on the Robert Service School playing field.

2.0 GEOTECHNICAL SITE INVESTIGATION

The geotechnical site investigation was completed on October 5 and 6, 2017. Donjeck Drilling of Whitehorse, YT was retained by Tetra Tech to drill eight boreholes (BH17-01 to -08), as shown on Figure 1. BH17-01 to -04 were drilled to the target depth of 6.1 m below ground surface. BH17-05 to -08 were all terminated between 3.8 and 4.5 m below ground surface due to drill refusal on permafrost. Prior to drilling, underground utility locates were completed and the borehole locations were cleared for the presence of underground lines.

During drilling, the soil profile was logged by Tetra Tech's field representative, Mr. Taidhg Mulroy, EIT, and disturbed grab samples were collected and returned to Tetra Tech's Whitehorse laboratory for routine geotechnical index testing. Geotechnical index testing included moisture content and particle size analyses to verify soil classifications made during drilling, and to further characterize subsurface conditions including frost susceptibility and level of saturation. In addition, environmental samples for hydrocarbons, metals, and asbestos testing were collected based on location and depth recommendations from Associated Engineering (AE). Samples collected for hydrocarbons and metals testing are labelled ESA on the borehole logs. Samples collected for asbestos testing are labelled ASA on the borehole logs. Testing and reporting of test results for these samples was neither completed by Tetra Tech, nor are the results included in this report.

Upon completion of each borehole, the UTM coordinates were recorded with a handheld GPS and the boreholes were backfilled to grade with drill cuttings and compacted by the drill.

BH17-06 and -07 were drilled on the Robert Service School playing field. Prior to drilling, Tetra Tech coordinated with Mr. Mike Fraser to ensure the drilling schedule did not affect any school activities by completing the drilling after 16:00 in the afternoon. The sod under the borehole footprint was cut out of the ground before drilling each borehole, and replaced following drilling to minimize disturbance to the field.

3.0 SITE CONDITIONS

3.1 Surface Features

BH17-01 to -05 and -08 were drilled on the shoulders of existing gravel roads in Dawson City. BH17-06 and -07 were drilled on the grass-covered Robert Service School playing field. Topography followed the generally flat relief of downtown Dawson City.

3.2 Subsurface Conditions

The borehole logs and laboratory testing results are included in Appendix B. Please note that the borehole logs contain detailed information describing the geotechnical conditions, and should be read in preference to the generalized descriptions provided below.

The generalized soil profile along the proposed utility alignments is summarized in Table 1.

Table 1: Summary of Subsurface Soil Conditions

Soil Type	Strata Depth Range (m)							
	BH17-01	**BH17-02**	**BH17-03**	**BH17-04**	**BH17-05**	**BH17-06**	**BH17-07**	**BH17-08**
TOPSOIL/ROOT MAT	-	-	-	-	-	Surface to 0.2 m	Surface to 0.2 m	-
SAND (FILL)	Surface to 1.3 m	Surface to 1.2 m	Surface to 1.0 m	Surface to 1.9	Surface to 0.6 m	0.2 – 1.0	0.2 – 0.6	Surface to 1.2 m
ORGANICS	1.3 – 1.7	1.2 – 1.3	1.0 – 1.6	1.9 – 2.0	0.6 – 0.8	1.0 – 1.2	0.6 – 1.4	1.2 – 1.3
SILT	1.7 – 3.1	1.3 – 2.7	1.6 – 3.1	2.0 – 3.1	0.8 – 3.9	1.2 – 3.1	1.4 – 3.0	1.3 – 4.0
GRAVEL	3.1 – 6.1	2.7 – 3.1	3.1 – 6.1	3.1 – 6.1	3.9 – 4.0	3.1 – 4.5	3.0 – 3.8	-
END of BOREHOLE	6.1	6.1	6.1	6.1	4.0	4.5	3.8	4.0

3.3 Groundwater Conditions

Groundwater was encountered at 3.2, 3.3, and 2.9 m below ground surface in BH17-01, -02, and -03, respectively. Groundwater was not encountered in BH17-04 to -08. The groundwater encountered in these boreholes is believed to be pooled on top of permafrost, or possibly thawed permafrost, and is expected to be localized to the north extent of 3rd Avenue where it was encountered. The area is within the permafrost region of Dawson City and is likely not hydraulically connected to the fluctuating seasonal water levels of the Yukon River.

3.4 Permafrost

Permafrost or possible permafrost was encountered in all boreholes.

Due to the method of investigation (solid-stem auger drilling) the samples returned to surface were very disturbed and it was not possible to discern ice content in most of the samples. If excess ice is present in the silt, future settlement may occur if there is permafrost thaw in these areas.

A CRREL barrel on an auger drill rig (in the fine-grained soils overlying the gravel) or a sonic drill rig should be used for future drilling in Dawson City if determining the ice content of the permafrost is a priority for the drilling program.

3.5 Bedrock

Bedrock was not encountered in any of the boreholes.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Trench Excavation

Tetra Tech understands that the underground utility upgrades will be completed using conventional cut and cover trenching techniques with depths of installation between about 2.0 and 4.0 m below ground surface. At these depths the exposed subgrade is generally expected to consist of silt or the underlying gravel. If possible, Tetra Tech recommends that the trench be excavated within the footprint of the trench for the existing underground utilities. This will reduce disturbance to native ground, and confine the new underground utilities to areas where permafrost has been previously exposed.

Frozen soils will likely be encountered during trench excavation, particularly in areas where shallow permafrost was encountered during drilling. The frozen soil will likely begin rapidly thawing if exposed to ambient summer temperatures. Depending on the time of year when excavation takes place, seasonal frost may be present as well in the trench excavation.

Trenching should be carried out in accordance with applicable *Occupational Health and Safety Regulations.* Trenches deeper than 1.2 m must be sloped or shored according to Yukon *Workers' Compensation Health and Safety Board Regulations* prior to workers entering the trench. Unfrozen silt and organics may be soft and saturated, requiring a shallower slope than the Regulations stipulate.

Where the exposed subgrade is silt, the base of the excavation will be very sensitive to disturbance. Upon excavation, and if too soft to work safely, the base of the trench in these areas should be immediately covered with non-woven geotextile filter fabric and a 150 mm thick layer of 25 mm bedding stone (pipe bedding material) placed to protect the subgrade soil and provide a stable working surface during underground utility installation. The gradation for the 25 mm bedding stone is specified on Table 2 below.

Table 2: Bedding Stone Gradation Specifications

Particle Size (mm)	% Passing by Mass
25.0	100
20.0	70 – 100
12.5	55 – 100
10.0	30 – 80
5.00	0 – 40
2.00	0 – 10

Where underground utility upgrades will require excavation through the Robert Service School playing field, the sod and topsoil should be carefully excavated so as not to mix it with the underlying soils. The sod and topsoil should be blended and stockpiled separately from underlying soils. Buried wooden piles that supported the old school may be encountered during excavation through the playing field. If encountered, these piles should be removed from the excavation and disposed of.

4.2 Trench Backfilling

As discussed above, 25 mm bedding stone is proposed for use as pipe bedding. This type of material can be somewhat self-compacting; however, nominal compaction effort (rodding, small plate tamper, or similar) should be applied during placement to ensure the particles are well seated against one another and that no voids remain

adjacent to or below the pipe. All pipe bedding should be fully encapsulated in non-woven geotextile filter fabric to prevent internal erosion and migration of fine particles into the bedding stone from the surrounding soils.

Tetra Tech understands that standard practice in Dawson City is to backfill the remainder of the trench using the native and/or fill materials removed during excavation. This is considered acceptable provided the backfill is placed in relatively thin lifts (approximately 150 mm maximum thickness), moisture conditioned, and compacted to at least 95% Standard Proctor Maximum Dry Density (SPMDD) to within 1.0 depth from final grade. The final 1.0 m of trench backfill should be placed in maximum 150 mm thick lifts, moisture conditioned, and compacted to 98% SPMDD. Tetra Tech recommends that any saturated and/or highly organic soils encountered not be used as backfill, and should be removed from the site.

The road surface should be re-established with at least 300 mm of 20 mm crushed basecourse, placed in maximum 150 mm thick lifts, moisture conditioned, and compacted to at least 98% SPMDD. The recommended gradation for 20 mm crushed basecourse is provided in Table 3 below.

Table 3: Crushed Basecourse Gradation Specifications

Particle Size (mm)	% Passing by Mass
20.0	100
12.5	64 – 100
5.00	36 – 72
1.25	12 – 42
0.315	4 – 22
0.080	3 – 6

The 20 mm crushed basecourse described above will not be required through the Robert Service School playing field. Instead, the blended topsoil and sod should be spread over the backfilled excavation to re-establish a level field surface, and seeded with grass. The seeded topsoil surface should be watered as required to promote growth, and access should be restricted until the new grass has taken root and is growing.

4.3 Insulation Requirements

Based on the standard 75 mm thickness of factory insulation installed on the outside of pipes, additional insulation is not considered necessary to protect permafrost below the new underground utility lines.

However, some disturbance and localized thawing of permafrost should be anticipated during underground utility installation when frozen soil is exposed to ambient above-freezing temperatures. The impact of thawing permafrost can be reduced by staging construction activities to install the underground utilities in relatively short 20 to 30 m segments; thereby minimizing the amount of time that the frozen soils are exposed to thawing conditions between excavation and backfilling. Tetra Tech does not recommend insulating the excavation in permafrost areas.

Notwithstanding any measures taken to minimize impacts, some permafrost thaw and associated settlement should be anticipated beneath the underground utilities due to disturbance caused during installation as well as long-term climate change effects. Permafrost thaw below and adjacent to underground lines may create a loss of lateral support for the pipes, and the pipes must be designed to withstand full overburden pressure with no lateral support. Previous installations in Dawson City have sometimes included a corrugated metal pipe (CMP) jacket to provide additional strength. The City of Dawson should be consulted to determine whether or not these measures are applicable to the areas described in this report. Underground lines that are dependent on gradient to operate effectively should be installed at steeper than standard gradients, in accordance with standard practice in Dawson City, so that minimal settlement caused by permafrost thaw will not render the line inoperable. As previously noted, installing the new underground utilities within the existing trenches will minimize the amount of disturbance to virgin ground and will locate the new utilities in areas that have already undergone preliminary settlement from thawing permafrost.

4.4 Permafrost Delineation

Traditionally, the delineation of permafrost in Dawson City has been simplified as Church Street, with the permafrost zone extending to the north and the non-permafrost zone to the south. In reality the delineation is more subtle, with transition zones on either side of an S-shaped boundary. The presence of permafrost in Dawson City is dependent on numerous factors, including, but not limited to, surface cover and soil stratigraphy, historical soil disturbance, and groundwater conditions. Despite the boundary, unfrozen/thawed areas may be present beyond the transition zone on the permafrost side of the boundary, and locally frozen areas may be present on the non-permafrost side. A map of Dawson City showing the current assumed permafrost extents is shown on Figure 2.

4.5 Water Management

Based on Tetra Tech's experience working in Dawson City in the summer, groundwater should be expected in all the excavations, perched above the permafrost. Tetra Tech recommends that the contractor supply a water storage tank during excavation in this area. Using pumps, the trench excavation can be dewatered into the storage tank. The tank should be at least 10,000 L to afford adequate time for sediment to settle out, and may need to be decanted into a vac truck depending on the volume of water encountered. The truck can then discharge the sediment free water into the existing storm system, if permitted. Tetra Tech recommends this approach be taken for any water that is encountered during excavation for any of the underground utility upgrades around Dawson City, within either the permafrost or non-permafrost zones.

Tetra Tech understands that AE and YG-CS are considering the installation of a rock pit permanent infiltration point systems for storm water management, particularly on 5th Avenue between Church Street and Turner Street. If these systems were to be developed, the rock pits should be installed into the gravel and sand, generally encountered between 3 and 4 metres below ground surface. The hydraulic conductivity of the unfrozen gravel and sand is estimated to be approximately 5 x 10-3 m/s. However, Tetra Tech notes that the proposed location of the infiltration point system for storm water lies within the Dawson City potable water Wellhead Protection Area (WPA). The WPA was defined in Tetra Tech's October 2017 report titled *City of Dawson Aquifer and Wellhead Protection Plan* and defines the area of the City's drinking water supply well capture zone where a higher level of protection to the water source is recommended. The Dawson City WPA encompasses the whole of non-permafrost zone, and its approximate extent is shown on Figure 3. Given that the Aquifer and Wellhead Protection Plan identified stormwater as a high risk to the drinking water source due to microbiological contaminants (e.g. E.coli, coliforms), and other potential contaminants, discharging stormwater directly into the City's drinking water aquifer places the community water supply at risk of contamination. Therefore, Tetra Tech strongly advises against the installation of an infiltration point system at the proposed location, or anywhere within the Dawson City WPA. Furthermore, rock pit infiltration systems are not considered feasible in the permafrost zone.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon, Department of Community Services and its agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Government of Yukon, Department of Community Services, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech Canada Inc.'s Services Agreement. Tetra Tech's Limitations are provided in Appendix A of this report.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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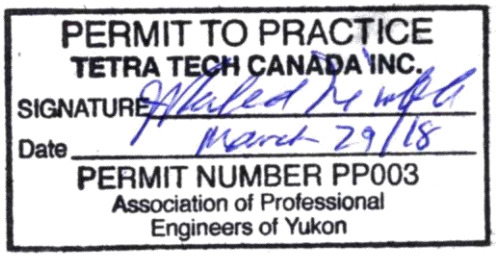

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/lb

FIGURES

Q:\Whitehorse\Data\0201drawings\Dawson City Area\ENG.WARC03242-12 2017 Underground Utility Upgrades Geotech Services\ENG.WARC03242-12 3rd & 4th Ave Fig.1-R0.dwg [FIGURE 1] March 27, 2018 - 3:12:21 pm (BY: BUCHAN, CAMERON)

LEGEND

- BOREHOLE LOCATION
- UNDERGROUND UTILITY UPGRADE AREA

0 150m

Scale: 1:3,000 @ 11"x17"

CLIENT

Yukon Government

TETRA TECH

GEOTECHNICAL EVALUATION
3rd AND 4th AVENUE UNDERGROUND UTILITY UPGRADES
DAWSON CITY, YUKON

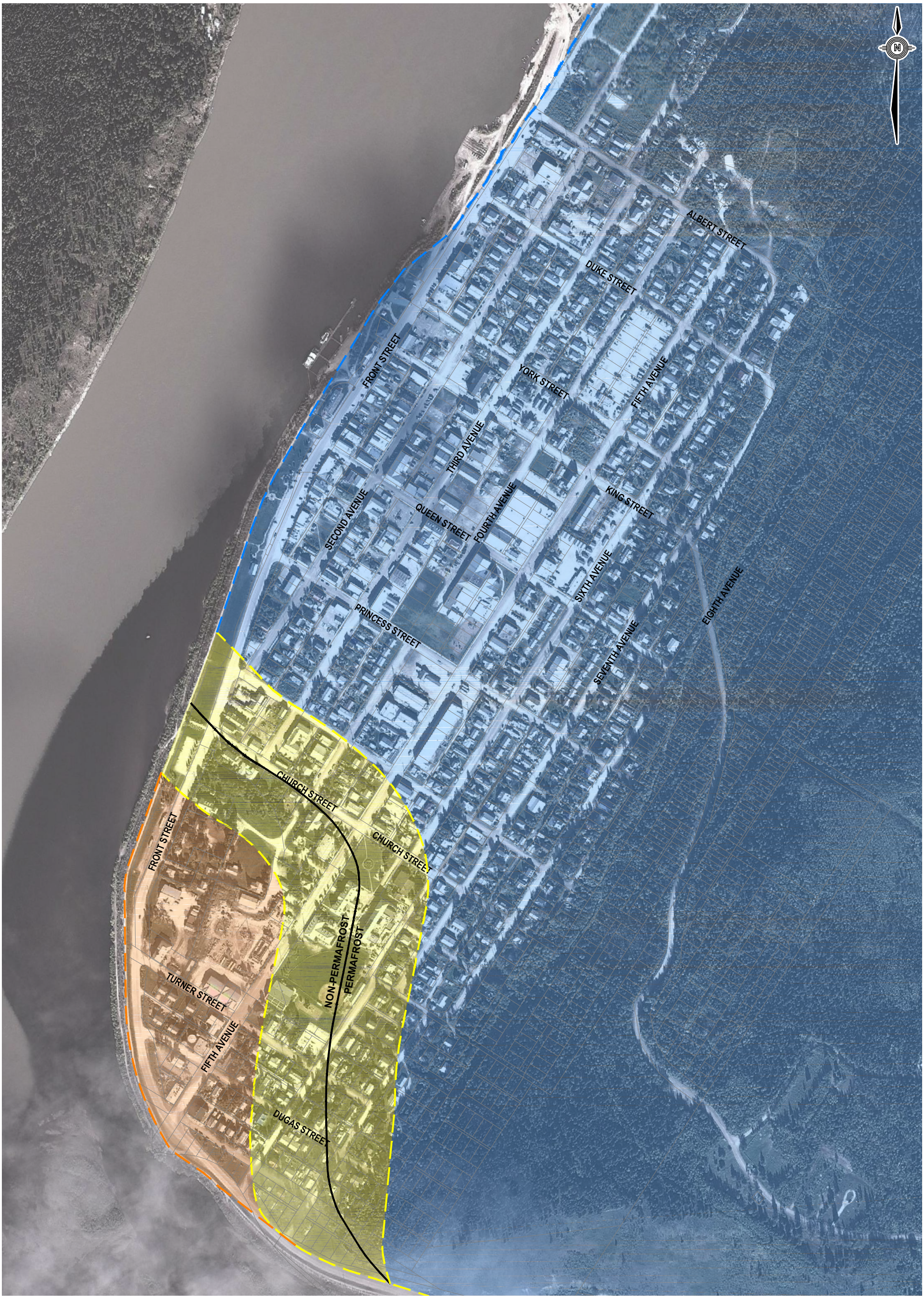
SITE PLAN SHOWING BOREHOLE LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENG.WARC03242-12	CB	TM	0

OFFICE	DATE
EBA-WHSE	October 27, 2017

Figure 1

Q:\Whitehorse\Data\0201drawings\Dawson City Area\ENG.WARC03242-12 2017 Underground Utility Upgrades Geotech Services\ENG.WARC03242-12 3rd & 4th Ave Fig.1-R0.dwg [FIGURE 2] March 29, 2018 - 10:16:04 am (BY: BUCHAN, CAMERON)



LEGEND

- PERMAFROST TRANSITION ZONE
- PERMAFROST ZONE
- NON-PERMAFROST ZONE

0 250m

Scale: 1:5,000 @ 11"x17"

CLIENT

Yukon Government

TETRA TECH

GEOTECHNICAL EVALUATION
3rd AND 4th AVENUE UNDERGROUND UTILITY UPGRADES
DAWSON CITY, YUKON

ASSUMED PERMAFROST DELINEATION - DAWSON CITY

PROJECT NO.	DWN	CKD	REV
ENG.WARC03242-12	CB	TM	0

OFFICE	DATE
EBA-WHSE	October 27, 2017

Figure 2

Q:\Vancouver\GIS\ENGINEERING\WARC\WARC03242-12\Maps\WARC03242-12_Figure03_WellHead.mxd modified 11/3/2017 by morgan.zondervan

LEGEND

- Water Supply Well
- Dawson City Wellhead Protection Area (DC-WPA)
- River Flow Direction

NOTES
Base data source: Imagery from mapservices.gov.yk (2003/2014)
Permafrost (EBA, 2017)

STATUS
ISSUED FOR REVIEW

Scale: 1:8,000
100 50 0 100
Metres

PROJECTION	DATUM
UTM Zone 7	NAD83

FILE NO.
WARC03242-12_Figure03_WellHead.mxd

CLIENT
Yukon Government

TETRA TECH

GEOTECHNICAL EVALUATION
3RD AND 4TH AVENUE UNDERGROUND UTILITY UPGRADES
DAWSON CITY, YUKON

Dawson City Wellhead Protection Area

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	TM	0

DATE	PROJECT NO.
November 3, 2017	ENG.WARC03242-12

Figure 3

APPENDIX A

TETRA TECH / YUKON GOVERNMENT LIMITITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B

BOREHOLE LOGS AND LABORATORY TEST RESULTS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE - GRAINED SOILS More than 50% retained on No. 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SM, SC Borderline classification requiring use of dual symbols Less than 5% pass 75 µm sieve More than 12% pass 75 µm sieve 5% to 12% pass 75 µm sieve	$C_U = D_{60} / D_{10}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below 'A' line or plasticity index less than 4 — Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = D_{60} / D_{10}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly-graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot above 'A' line and plasticity index less than 4 — Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS Liquid limit <50		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity	PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils Equation of 'A' line: PI = 0.73(LL-20) PLASTICITY INDEX LIQUID LIMIT CH 'A' line CL CI MH or OH CL-ML ML or OL	
	SILTS Liquid limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts		
	CLAYS Above "A" line on plasticity chart negligible organic content Liquid limit <30		CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays		
	CLAYS Liquid limit 30-50		CI	Inorganic clay of medium plasticity, silty clays		
	CLAYS Liquid limit >50		CH	Inorganic clay of high plasticity, fat clays		
	ORGANIC SILTS AND CLAYS Liquid limit <50		OL	Organic silts and organic silty clays of low plasticity		
	ORGANIC SILTS AND CLAYS Liquid limit >50		OH	Organic clays of medium to high plasticity		
HIGHLY ORGANIC SOILS			PT	Peat, muck and other highly organic soils		

* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	
	Nbn	No excess ice, well-bonded	
	Nbe	Excess ice, well-bonded	

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	
	ICE	Ice without soil inclusions (greater than 25 mm thick	

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND: Soil ☐ Ice ■

Borehole No: **BH17-01**

Government of Yukon

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 3rd and Albert St.	
Dawson City, YT	UTM: 576801 E; 7105348 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0								0
	Solid stem auger	SAND and GRAVEL (FILL) - some silt, well graded, sub-angular to sub-rounded gravel, moist, compact (est.), greyish brown	Unfrozen		SA01	11.5	●	
		ORGANICS (PEAT) - amorphous, damp, black						
		SAND (FILL) - some gravel, some silt, well graded, sub-angular to sub-rounded gravel, damp, grey, slight septic odour			ESA1			
1					SA02	8.6	●	
					ASA1			
		ORGANICS (PEAT) - fibrous and amorphous components, wet, dark brown			SA03	90	●	
		SILT - some clay, some sand, wet, firm (est.), medium plastic, greyish brown						
2			Possibly Frozen					
		- trace gravel below 2.3 m			SA04	28.2	●	
3 ▼ 5/10/17		GRAVEL and SAND - some cobbles, poorly graded, sub-rounded to rounded, wet, dense (est.), grey						▼ 5/10/17
					SA05	10.4	●	
4								
5					SA06	9.6	●	
6		END of BOREHOLE at 6.1 m (Target Depth)						
7								
8								
9								
10								

TETRA TECH

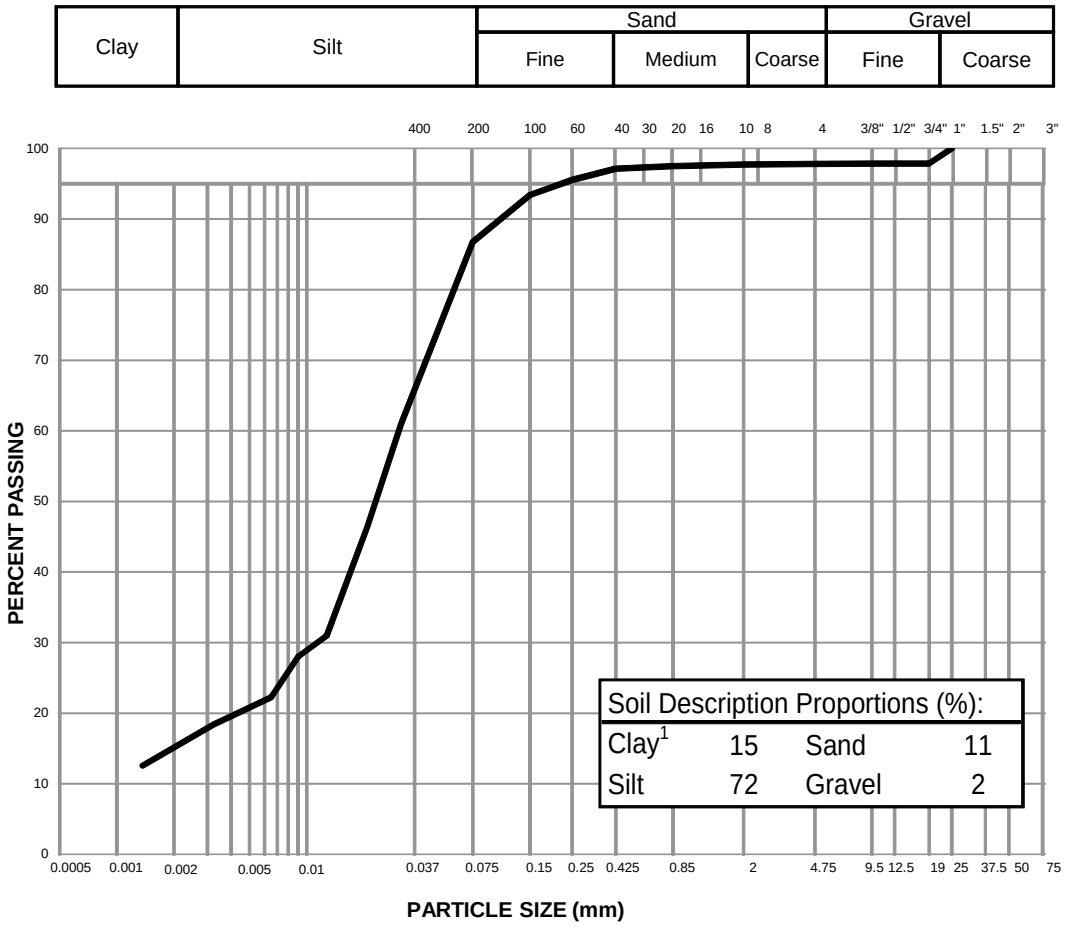
Contractor: Donjeck Drilling	Completion Depth: 6.1 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Dawson City Underground Utilities	Sample No.:	SA04
Project No.:	ENG.WARC03242-12	Material Type:	-
Site:	Dawson City, Yukon	Sample Loc.:	BH17-01
Client:	YG - Community Services	Sample Depth:	2.2 m
Client Rep.:	Catherine MacDonald	Sampling Method:	Grab
Date Tested:	October 21, 2017 By: AMT	Date sampled:	October 5, 2017
Soil Description[2]:	SILT - some clay, some sand, trace gravel	Sampled By:	TM
		USC Classification:	Cu: #N/A
Moisture Content:	28.2%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	
25	100
19	98
12.5	98
10	98
5	98
2	98
0.85	98
0.425	97
0.25	96
0.15	93
0.075	86.8
0.0314	60.9
0.0209	46.4
0.0127	31.0
0.0090	28.1
0.0065	22.2
0.0032	18.4
0.0014	12.6



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to EBA description protocols

Specification: _____

Remarks: _____

Reviewed By: _____ P.Eng.

TETRA TECH

Government of Yukon

Borehole No: **BH17-02**

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 3rd between Duke St. and Albert St.	
Dawson City, YT	UTM: 576762 E; 7105256 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0								0
	Solid stem auger	SAND and GRAVEL (FILL) - some silt, well graded, sub-angular to sub-rounded gravel, damp, compact (est.), brownish grey, debris inclusions (plywood, garbage)	Unfrozen		ASA2			1
					SA07	7.4	●	2
1								3
		ORGANICS (PEAT) - amorphous, moist, dark brown						4
		SILT - sandy, wet, stiff (est.), non-plastic, grey			SA08	27.8	●	5
2								6
			Possibly Frozen					7
					ESA2			8
		- some clay, trace sand, soft (est.), medium palstic, light brown below 2.7 m			SA09	32.4	●	9
3								10
5/10/17 ▼		GRAVEL and SAND - some cobbles, poorly graded, sub-rounded to rounded, wet, dense (est.), grey						5/10/17 ▼ 11
					SA10	10	●	12
4								13
								14
								15
5								16
					SA11	10.8	●	17
								18
								19
6								20
		END of BOREHOLE at 6.1 m (Target Depth)						21
								22
7								23
								24
								25
								26
8								27
								28
								29
								30
9								31
								32
10								

TETRA TECH

Contractor: Donjeck Drilling	Completion Depth: 6.1 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

Borehole No: **BH17-03**

Government of Yukon

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 3rd and Duke St.	
Dawson City, YT	UTM: 576704 E; 7105169 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		SAND and GRAVEL (FILL) - silty, well graded, sub-angular to sub-rounded gravel, moist, compact (est.), brownish grey, trace oragnic inclusions	Unfrozen		SA12	17.6		0
					ASA3			
1		ORGANICS (PEAT) - some silt, fibrous and amorphous matter, moist, dark brown			SA13	86.2		1
					ESA3			
		SILT - some sand, trace clay, wet, firm (est.), non-plastic, dark grey						2
2			Possibly Frozen		SA14	48.8		
								3
3	Solid stem auger	- trace gravel below 2.7 m						
5/10/17					ESA4			5/10/17
		GRAVEL and SAND - some cobbles, poorly graded, sub-rounded to rounded, wet, dense (est.), grey			SA15	19.8		4
4								
								5
5					SA16	15.4		
								6
6		END of BOREHOLE at 6.1 m (Target Depth)						
								7
7								
								8
8								
								9
9								
								10
10								

Contractor: Donjeck Drilling	Completion Depth: 6.1 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

TETRA TECH

Borehole No: **BH17-04**

Government of Yukon

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 3rd and York St.	
Dawson City, YT	UTM: 576660 E; 7105086 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0								0
1	Solid stem auger	SAND and GRAVEL (FILL) - silty, well graded, sub-angular to sub-rounded gravel, moist, compact (est.), greyish brown, trace debris inclusions - dark grey below 0.2 m	Unfrozen		SA17	12.5	●	3
					ASA4			4
2		ORGANICS (PEAT) - fibrous and amorphous matter, moist, dark brown						6
		SILT - trace clay, trace sand, wet, firm (est.), low plastic, grey	Permafrost - Nbe		SA18	34	●	7
		- some sand, stiff (est.), non-plastic, below 2.7 m			SA19	40.6	●	9
3		- trace gravel, trace sand below 3 m						10
		GRAVEL and SAND - some cobbles, poorly graded, sub-rounded to rounded, frozen, grey						11
4					SA20	7.6	●	13
5								16
					SA21	7.4	●	17
6								19
		END of BOREHOLE at 6.1 m (Target Depth)						20
7								22
								23
8								26
								27
9								29
								30
10								32

TETRA TECH

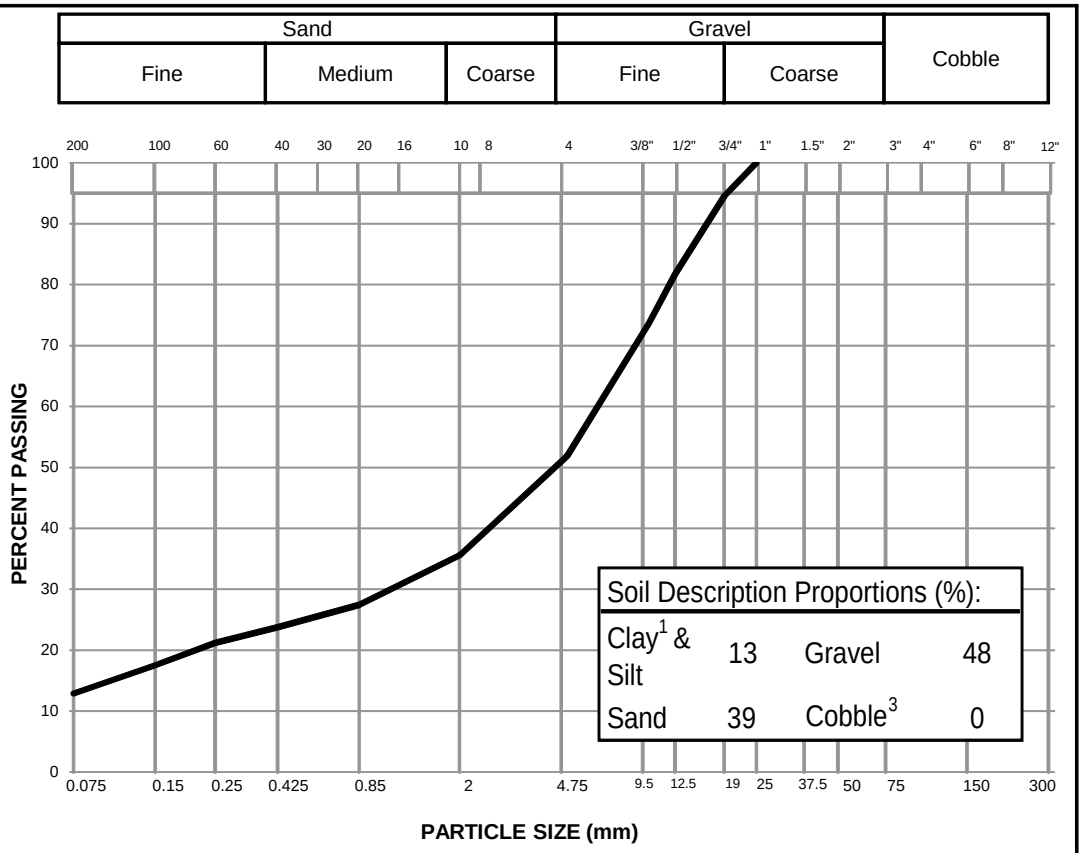
Contractor: Donjeck Drilling	Completion Depth: 6.1 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Dawson City Underground Utilities	Sample No.:	SA21
Project No.:	ENG.WARC03242-12	Material Type:	-
Site:	Dawson City, Yukon	Sample Loc.:	BH17-04
Client:	YG - Community Services	Sample Depth:	5.3 m
Client Rep.:	Catherine MacDonald	Sampling Method:	Grab
Date Tested:	October 21, 2017 By: AMT	Date sampled:	October 5, 2017
Soil Description[2]:	GRAVEL and SAND - some silt	Sampled By:	TM
		USC Classification:	Cu: 106.5
Moisture Content:	7.4%		Cc: 3.3

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	94
12.5	82
10	74
5	52
2	36
0.85	27
0.425	24
0.25	21
0.15	18
0.075	12.9



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

Reviewed By: _____ P.Eng.

TETRA TECH

Government of Yukon

Borehole No: **BH17-05**

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 3rd between York St. and King St.	
Dawson City, YT	UTM: 576601 E; 7105015 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0								0
	Solid stem auger	GRAVEL and SAND (FILL) - some silt, well graded, sub-angular to sub-rounded gravel, damp, compact (est.), brownish grey	Unfrozen		SA37	6.3	●	1
					ASA5			2
		ORGANICS (PEAT) - fibrous and amorphous matter, moist, dark brown						3
1		SILT - trace sand, trace clay, damp, firm (est.), non-plastic, dark grey, trace organic inclusions aboove 1.2 m						4
		- frozen below 1.1 m	Permafrost - Vx,Vr 10-15% ice		SA38	69.2	●	5
								6
2								7
					SA39	103.6	●	8
								9
3								10
		GRAVEL and SAND - cobbles, poorly graded, sub-rounded to rounded, frozen, grey						11
					SA40	14	●	12
4								13
		END of BOREHOLE at 4.0 m (Refusal on Permafrost)						14
								15
5								16
								17
								18
6								19
								20
								21
7								22
								23
								24
8								25
								26
								27
9								28
								29
								30
10								31
								32

TETRA TECH

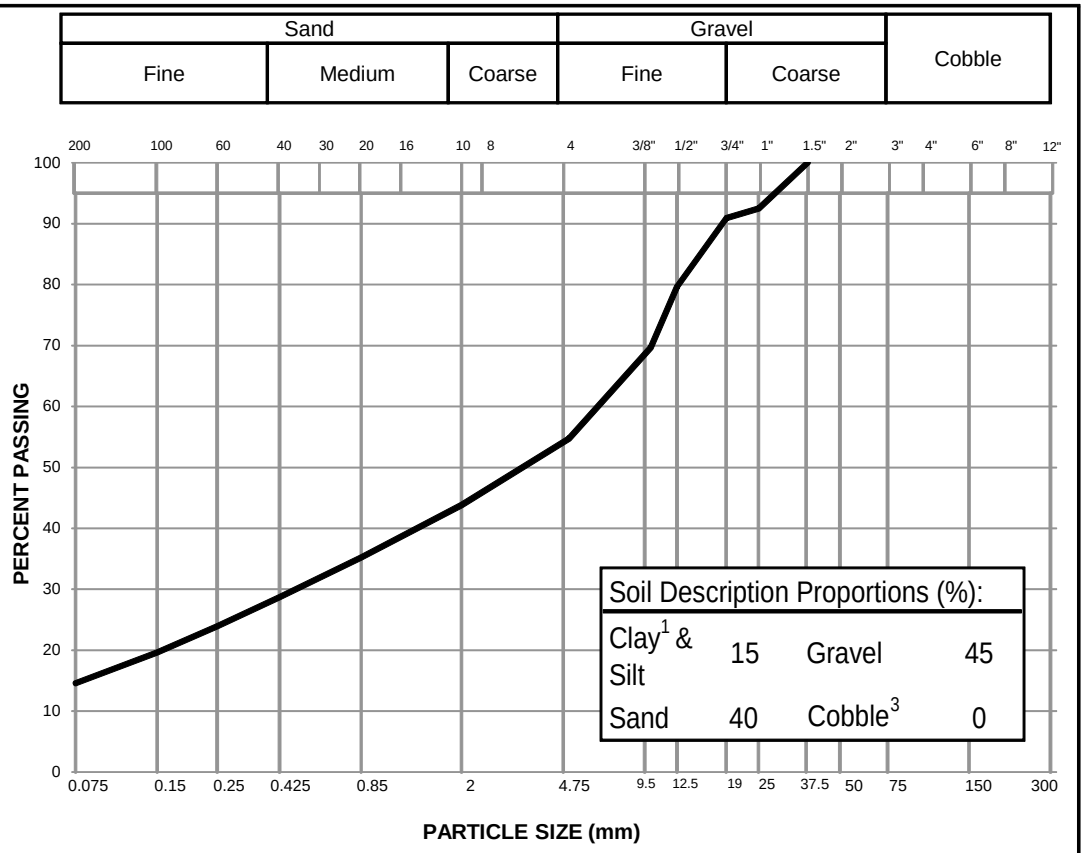
Contractor: Donjeck Drilling	Completion Depth: 4 m
Drilling Rig Type: Truck mounted CME75	Start Date: 6 October 2017
Logged By: TM	Completion Date: 6 October 2017
Reviewed By: JRT	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Dawson City Underground Utilities	Sample No.:	SA37
Project No.:	ENG.WARC03242-12	Material Type:	-
Site:	Dawson City, Yukon	Sample Loc.:	BH17-05
Client:	YG - Community Services	Sample Depth:	0.3 m
Client Rep.:	Catherine MacDonald	Sampling Method:	Grab
Date Tested:	October 21, 2017 By: AMT	Date sampled:	October 6, 2017
Soil Description[2]:	GRAVEL and SAND - some silt	Sampled By:	TM
		USC Classification:	Cu: 112.7
Moisture Content:	6.3%		Cc: 0.6

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	92
19	91
12.5	80
10	70
5	55
2	44
0.85	35
0.425	29
0.25	24
0.15	20
0.075	14.6



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

Reviewed By _____ P.Eng.

TETRA TECH

Government of Yukon

Borehole No: **BH17-06**

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: RSS field north end	
Dawson City, YT	UTM: 576504 E; 7104704 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Depth (ft)
0						Plastic Limit / Moisture Content / Liquid Limit (20, 40, 60, 80)	0
	Solid stem auger	TOPSOIL and GRASS ROOT MAT	Unfrozen				
		SAND (FILL) - gravelly, trace silt, poorly graded, sub-angular to sub-rounded gravel, damp, compact (est.), light brown			SA22	4.7	1
		- silty, well graded, moist, grey below 0.5 m			SA23	15.9	2
1					ASA6		3
		ORGANICS (PEAT) - fibrous and amorphous matter, moist, dark brown					
		SAND (POSSIBLE FILL) - gravelly, silty, well graded, sub-angular to sub-rounded gravel, moist, compact (est.), grey			SA24	19.7	4
		SILT - trace clay, frozen, blueish grey	Permafrost - Nbe				5
							6
2					SA25	31.8	7
							8
							9
			Permafrost - Vx,Vr 20-30% ice		SA26	94.3	10
3		GRAVEL and SAND - trace cobbles, poorly graded, sub-rounded to rounded, frozen, grey					11
							12
4					SA27	12.5	13
							14
		END of BOREHOLE at 4.5 m (Refusal on Permafrost)					15
5							16
							17
							18
							19
6							20
							21
							22
7							23
							24
							25
							26
8							27
							28
							29
9							30
							31
							32
10							

TETRA TECH

Contractor: Donjeck Drilling	Completion Depth: 4.5 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

Government of Yukon

Borehole No: **BH17-07**

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: RSS field south end	
Dawson City, YT	UTM: 576498 E; 7104658 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Depth (ft)
0						Plastic Limit / Moisture Content / Liquid Limit (20, 40, 60, 80)	0
0	Solid stem auger	TOPSOIL and GRASS ROOT MAT	Unfrozen				0
		SAND (FILL) - gravelly, trace silt, poorly graded, sub-angular to sub-rounded gravel, dry, compact (est.), brownish grey			ASA7		1
					SA28	4.6	2
		ORGANICS (PEAT) - fibrous and amorphous matter, damp, dark brown					3
1		- frozen below 1.1 m	Permafrost - Nbe		SA29	163.1	4
		SILT - trace clay, frozen, blueish grey					5
							6
2					SA30	39.7	7
							8
							9
3		GRAVEL and SAND - some cobbles, poorly graded, sub-rounded to rounded, frozen, grey					10
					SA31	15.6	11
							12
4		END of BOREHOLE at 3.8 m (Refusal on Permafrost)					13
							14
							15
5							16
							17
							18
6							19
							20
							21
7							22
							23
							24
8							25
							26
							27
9							28
							29
							30
10							31
							32

TETRA TECH

Contractor: Donjeck Drilling	Completion Depth: 3.8 m
Drilling Rig Type: Truck mounted CME75	Start Date: 5 October 2017
Logged By: TM	Completion Date: 5 October 2017
Reviewed By: JRT	Page 1 of 1

Government of Yukon

Borehole No: **BH17-08**

Project: Dawson City Underground Utility Upgrades	Project No: ENG.WARC03242-01
Location: 5th and Harper St.	
Dawson City, YT	UTM: 576491 E; 7104479 N; Z 7 NAD83

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0								0
0	Solid stem auger	SAND and GRAVEL (FILL) - trace silt, well graded, sub-angular to sub-rounded gravel, dry, compact (est.), brownish grey	Unfrozen		ASA8 SA32	4		1
		SILT and SAND (PROBABLE FILL) - some gravel, sub-angular to sub-rounded gravel, damp, firm, (est.), non-plastic, dark brownish grey						2
1					SA33	15.6		3
		ORGANICS (PEAT) - fibrous and amorphous matter, wet, dark brown			SA34	56.1		4
		SILT - trace clay, stiff (est.), low plastic, dark greyish brown, some organic inclusions above 1.5 m - frozen below 1.6 m	Permafrost - Nbe					5 6
2					SA35	45.6		7 8
		- trace gravel below 2.9 m Limited Recovery Below 3.0 m						9 10
3								11
					SA25	33.2		12
4		END of BORHOLE at 4.0 m (Refusal on Permafrost)						13 14
5								15 16 17
								18 19
6								20 21
								22 23
7								24 25
								26 27
8								28 29
								30 31
9								32
10								

TETRA TECH

Contractor: Donjeck Drilling	Completion Depth: 4 m
Drilling Rig Type: Truck mounted CME75	Start Date: 6 October 2017
Logged By: TM	Completion Date: 6 October 2017
Reviewed By: JRT	Page 1 of 1