

October 11, 2019

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ISSUED FOR USE  
FILE: 704-ENG.EARC03567-01  
Via Email: simon@3 pikas.com

**Attention:** Simon Lapointe

**Subject:** Geotechnical Evaluation – Lone Tree R-13A Residential Lot Development  
North Shore of Teslin Lake

## 1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) has been directed to provide geotechnical evaluation services for the above captioned project. Information presented in this report is based on in-house geotechnical data and observations made during a site reconnaissance performed on October 25, 2018, as well as a site-specific testpitting program completed on August 7, 2019.

## 2.0 GENERAL LOCATION AND SITE ACCESS

The study area is a sliver of land overlooking Teslin Lake located between the current Alaska Highway alignment and the Old Alaska Highway between Lone Tree Creek and Deadman Creek near Teslin, Yukon. The east portion of the study area is the Teslin Tlingit Council (TTC) R-13A land selection and the west end of the study area belongs to the Yukon Government (YG).

Along the south side, the site is accessed along the Old Alaska Highway which intersects the current highway alignment at the east and west ends of the study area. The north side of the site can also be accessed along the current Alaska Highway corridor.

## 3.0 TERRAIN AND SURFICIAL GEOLOGY

### 3.1 Terrain

Terrain features throughout the study area were observed during the October 25, 2018 site reconnaissance and again during the August 7, 2019 testpitting program. The most significant terrain issue for development is the fact that the site is located along a long slope that begins at lake elevation and extends north, well beyond the current Alaska Highway corridor. The slopes are somewhat variable in steepness but in general they are between 10% and 15%. This may make residential development challenging when siting structures and on-site sewage disposal systems. Observations included:

- Slopes throughout the TTC end of the study area tend to be steeper than the slopes observed throughout the YG portion of the study area where gently rolling terrain was noted and minimal slopes exceeding 10% were observed.
- From the Old Alaska Highway down to the lake, there are slopes steeper than 20% and this could complicate the construction of direct road or trail access to the lake. The steeper slopes down to the lake will also be more prone to erosion if surface water across the TTC and YG sites is not controlled.

## 3.2 Surficial Geology

Two surficial geology maps were reviewed to assess geotechnical conditions throughout the study area, including:

- Geological Survey of Canada - Map Number 1891A – Surficial Geology – Teslin; and
- Soils and Surficial Geology – Southern Lakes Project (1980 to 1982) – Map Sheet 105 C SW prepared by Morison, McKenna and Davies.

Details from the two map sheets are summarized as:

- Soil deposition in this area is from the Morley Bay Soil Association Complex.
- Soils throughout include morainal (till) and lacustrine sediments.
- The morainal soils have cobbles and boulders throughout.
- Both the morainal till and lacustrine sediments are described as loamy (which is encouraging when determining potential for on-site sewage system feasibility).
- The till soils can be either lodgement till (sediments deposited below the glacial ice) and ablation till (sediments moved along the surface of the glacier). This information is considered important when assessing on-site sewage disposal system feasibility as the lodgement tills tend to be much denser than the ablation tills.

The site reconnaissance and the recent testpitting program confirmed the presence of both morainal and lacustrine soils. As well, a thin veneer of glaciofluvial gravel was noted in some of the testpits excavated. Exposures along the up-gradient side of both the Old Alaska Highway and the current highway alignment show areas with fine grained sediments only (lacustrine) and areas with gravel, cobbles and boulders in a silt matrix (morainal). Development throughout the TTC end will encounter these soils while the west end of the Yukon section may transition into the Deadman Creek alluvial gravels.

## 4.0 SITE DRAINAGE

The entire study area is located along a south facing slope that extends well north of the current Alaska Highway corridor. Up-slope there is probably exposed bedrock and scree. Runoff from this slope is channeled through culverts on the current highway alignment and down through the study area. Conceptual design (3 Pika Option 2) has taken this into consideration as green spaces have been identified for the portions of the site downgradient of the two culverts noted on the Alaska Highway.

During the October 2018 site reconnaissance, low-lying areas were noted along the Old Alaska Highway alignment. At approximately 2.2 km in from the east end of the development area, there is an embankment failure (a 1 m diameter sinkhole) over a culvert. Significant flow was noted out the down gradient end of the culvert. This was the only culvert location noted during the site reconnaissance but there are likely others along the current Alaska Highway alignment.

At approximately 2.4 km in from the east end, a major slide area was noted (slightly west of the S-209B site). This slide may have been the result of poor control of surface water, or perhaps a seepage zone under the Old Alaska Highway embankment. The damage was extensive and slope stabilization may be required if lots throughout the study area are accessed along the Old Alaska Highway.

The lacustrine and morainal till soils found throughout the study area are very prone to erosion. Therefore, surface water control is important and if culverts are installed or reconstructed across the Old Alaska Highway, the outfall ends must be constructed with velocity dissipaters to minimize potential for erosion along the slope down to Teslin Lake. On individual lots, it is acknowledged that clearing will be required along driveways, throughout the footprints of all structures and throughout the on-site sewage disposal system areas. However, for the remainder of the individual lots, tree and ground cover should be maintained to help control surface water flow.

## 5.0 TESTPITTING PROGRAM

The testpitting program was completed on August 7, 2019. Six testpits were excavated to a termination depth of 3.0 m using a Kubota KXD57-4 tracked excavator sub-contracted from Deadman Creek Enterprises of Teslin, Yukon. Two testpits were excavated within the YG portion of the development area and four testpits were excavated throughout the TTC portion.

Representative samples were collected throughout the depth of each of the testpits, geotechnical conditions were recorded, percolation testing was performed in TP03 and TP05 and UTM coordinates were recorded using a Garmin hand held GPS unit for report purposes and future reference.

In Appendix B, Figure 1 presents the location of the testpits excavated. As well, testpit logs detailing the geotechnical conditions encountered are presented along with accompanying laboratory test result report forms.

## 6.0 GEOTECHNICAL CONDITIONS

Conditions encountered at each testpit location are summarized below:

- TP01 was excavated in the west half of the YG portion of the study area. Below the moss ground cover and organics, sand and silt till was encountered and extended to the 3.0 m testpit termination depth. Boulders up to 1.0 m in size were noted. No bedrock or groundwater was encountered.
- TP02 was excavated at the east end of the YG portion of the study area. At this location, a thin veneer of gravel from the construction of the Old Alaska highway was encountered over the organic root mat. Below the organic root mat, the sand and silt till. Cobbles, but no boulders, were observed at this location. No bedrock or groundwater was encountered.
- TP03 was excavated above an old borrow area exposure located along the Old Alaska Highway. At this location, heavy moss cover and organic root mat was noted over a thin veneer of glaciofluvial gravel. At 0.3 m, silty sand till was encountered. Cobbles, but no boulders, were observed at this location. No bedrock or groundwater was encountered. A percolation test was performed at a depth of 0.3 m to 0.6 m to assess feasibility to install onsite sewage disposal systems. A percolation rate of 8 minutes/25 mm was measured, confirming good potential for on-site sewage disposal system installation.
- TP04 was excavated within an old borrow area at the east end of the TTC section. All surficial gravel had been removed, exposing sand and silt till with cobbles throughout. Consistent conditions extended to the termination depth of 3.0 m. No groundwater or bedrock was encountered.

- Referencing Concept Option 2, TP05 was drilled along the proposed service road that will access proposed lots 11 to 17. This area was quite flat and geotechnical conditions included moss ground cover and organic root mat over surficial silt soils to a depth of 0.3 m. Between 0.3 m and 0.5 m, glaciofluvial sand and gravel was encountered. Within this soil unit, a percolation test was performed, and a 45 second/25 mm percolation rate was measured, confirming potential for on-site sewage disposal system installation (a sand filter will be necessary). Below the sand and gravel and extending to the 3.0 m termination depth, sand and silt till was encountered. No bedrock or groundwater was noted.
- At the west end of the TTC site, driveway access to lots 1 to 3 is proposed. TP06 was excavated along the proposed driveway. The surficial geology mapping used for this evaluation mentions the presence of glaciolacustrine soils throughout this area and it was encountered at this location below the organic root mat and surficial silts noted during testpit excavation. This fine grained, frost susceptible soil unit extended to the termination depth of 3.0 m.

As mentioned above, the testpit locations presented on Figure 1 and the detailed testpit logs are presented in Appendix B of this report. The laboratory test result report forms are also presented in Appendix B. Please note that the testpit logs and laboratory results contain detailed information describing the geotechnical conditions at the site and should be read in preference to the generalized description provided above.

## 7.0 RECOMMENDATIONS

### 7.1 Roadways

Referencing Concept Option 2, lots 1 to 3 and 11 to 17 will be accessed off the Alaska Highway while lots 4 to 10 will be accessed off the Old Alaska Highway where existing roadway structure can be utilized.

Observations made during the October 2018 site reconnaissance confirmed that the Old Alaska Highway was constructed over till subgrade soils and based on the old granular borrow areas noted during site work, the surficial granular soils were likely used as a sub-base course over the till subgrade. Although the Old Alaska Highway site access route will require minor clearing, grubbing, regrading and compaction, along with ditching and the installation of culverts at key locations, it is considered acceptable as an access road and driveway alignment. If the actual Old Alaska Highway surface is used, all that would be required after regrading of the existing surface is the construction of a 0.15 m thick lift of 20 mm crushed basecourse aggregate.

The new service road constructed to provide access to lots 11 to 17 will be constructed on a sand and silt till subgrade. Minimum granular structure over a properly prepared subgrade surface should include 0.3 m of 80 mm sub-base gravel and 0.15 m of 20 mm crushed basecourse gravel.

The driveway accessing lots 1 to 3 will be constructed on both a sand and silt till subgrade (west end) and transitioning into a fine-grained lacustrine silt subgrade (towards the east end of the driveway). Proper subgrade preparation will be very important over the lacustrine silt section. Moisture conditioning (drying out) the subgrade silts to at least 3% below optimum moisture will be necessary to ensure a stable subgrade surface on which to place and compact sub-base (0.2 m will be sufficient) and basecourse gravel (0.1 m recommended). If subgrade stability is difficult to achieve, additional sub-base structure may be required.

The access road from the Alaska Highway down to the Old Alaska Highway at the west end of the TTC end will likely be constructed on a sand and silt till subgrade. Over a properly prepared sub-grade, 0.3 m of 200 mm sub-base gravel and 0.15 m of 20 mm crushed basecourse gravel is recommended for granular structure.

It is assumed that all roadways will be constructed to a local, rural road standard with 3.0 m driving lanes and 2:1 (H:V) sideslopes along both cut and fill sections. The subgrade soils throughout the development area will support this geometric design.

Imported granular materials should meet the gradation specifications presented in Table 1. If a coarser sub-base gravel is proposed for use, a sample should be submitted for sieve analysis testing and an opinion regarding acceptability for sub-base construction can be given.

**Table 1: Recommended Granular Material Specifications**

200 mm Pit Run Sub-Base Gravel (Gran E)		20 mm Basecourse Gravel (Gran A)	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
200.000	100		
80.000	75 - 100	-	-
25.000	55-100	20.000	100
12.500	42-84	12.500	64-100
5.000	26-65	5.000	36-72
1.250	11-47	1.250	12-42
0.315	3-30	0.315	4-22
0.080	0-8	0.080	3-6

All imported gravel is to be placed in lifts no thicker than 200 mm, moisture conditioned, and compacted to at least 98% of Standard Proctor Maximum Dry Density (as per ASTM D698).

### 7.1.1 Borrow Sources

As part of the October 25, 2018 site reconnaissance, visits were made to potential granular borrow areas including the YG Deadman Creek pit which can likely provide pit run sub-base and perhaps 20 mm crushed BST aggregate (pending permission from YG Highways and Public Works).

There are also privately owned borrow sources within the Deadman Creek alluvial fan area beyond the west end of the study area (believed to be owned by the Hassard family). Materials from this area are very good quality.

Also noted during reconnaissance is the bedrock outcrop behind the small pit at Lone Tree Creek along the north side of the Alaska Highway. Tenure of this area is unclear but perhaps this area can be considered for the supply of rip rap or armour where angular blast rock is required around culverts or downstream of culvert outlets for velocity dissipation.

## 7.2 Foundations

The morainal till or lacustrine soils are considered acceptable for conventional shallow foundations (including strip and spread footings at depth or thickened monolithic slab-on-grade foundation systems). However, builders must be aware that the foundation soils are frost susceptible and this will necessitate the use of perimeter insulation to minimize potential for frost heave of foundation elements. The thickness and extent of perimeter insulation will be site specific and dependent upon the amount of protective soil cover about the footings. Typically, footings founded at a depth of 1.2 m will require 0.1 m of rigid, moisture resistant and backfillable insulation extending 1.2 m out from the perimeter of the structure to minimize potential for frost heave.

### **7.2.1 Preserved Wood Foundation Recommendations**

If the use of preserved wood foundations (PWF) is preferred, a granular drainage layer will be required beneath all footings as well as basement or crawlspace slabs, in accordance with CAN-CSA S406. This applicable since foundation excavation will likely expose frost susceptible soils that are not considered to be free draining.

The granular drainage layer should be constructed using a clean crushed stone or screened drain rock material of maximum particle size 40 mm and having less than 10% sand (passing the 5 mm sieve). This layer shall be at least 0.15 m thick and shall extend a minimum of 0.3 m beyond the footing perimeter. The granular drainage layer shall drain to a sump which, in turn, shall drain to a point of final disposal beyond the building's footprint.

In accordance with CAN-CSA S406, the use of perimeter drainage tile or pipe is not recommended with PWF.

All backfill material placed within 0.6 m of the foundation walls shall be free of deleterious debris, frozen materials, and boulders larger than 0.15 m in diameter.

### **7.2.2 Concrete Foundation Recommendations**

If the use of concrete foundations is desired, the drainage tile and pipe, granular drainage layers, drainage disposal and surface drainage specifications as per NBC 2005, Section 9.14 "Drainage" must be followed.

Full depth concrete foundations with concrete footings are required to have perimeter drainage tile which terminates in a sump pit. A sump pit is to be installed to assist in the removal of water from the foundation area (should water accumulation in the sump pit warrant it).

### **7.2.3 Foundations on Free Draining Soils**

The prescriptive measures described above may not apply if adequate thicknesses of free draining soil exists below foundation elements. If underlying soils meet the conditions of "free draining" soils (as verified by geotechnical engineering staff capable of soil classification), the drainage layer and sump may be omitted. Since the current testpitting program did note near surface granular soils in some of the testpits, there is potential.

### **7.2.4 Control of Surface Water and Site Grading Around Foundations**

To minimize potential for seepage into crawl spaces and damage due to frost heave, it is very important to control roof runoff and surface water that may travel along the slope up-gradient of all structures. The proper installation of rain gutters and downspouts is critical and the construction of swales above the structures to deflect surface water flow (rain or snow melt) should be considered.

## **7.3 On Site Sewage Disposal Systems**

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The current testpitting program has established fair to good potential for the design and construction of approved on-site sewage disposal systems for the subject site.

Percolation rates were measured as 8 minutes/25 mm in TP03 (till soils) and 45 second/25 mm in the granular soil veneer in TP05 between 0.3 m and 0.5 m. As long as the absorption systems aren't constructed deep into the till soils, identifying an accepting soil zone should not be problematic.

The one area of concern will be systems for lots 1, 2 and 3 since line-grained lacustrine soils were encountered in TP06. For these three lots, systems may have to be installed down gradient where there should be till soils.

Slopes will be an issue on all lots. The Environmental Health Guidelines specify that on lots with slopes steeper than 10%, absorption field systems are not allowed. Since most of the study area has slopes of between 10% and 15%, wide absorption trench systems or chamber systems constructed parallel to the contours are better candidates for system construction.

Again, although this site evaluation has established potential for on-site sewage disposal system construction throughout this study area, each lot will require a site specific testpitting and percolation test program to be included in the Environmental Health Application to Install.

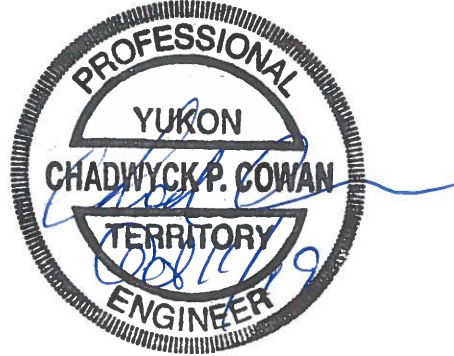
## 8.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of 3 Pikas (client) and the Teslin Tlingit Council (end client) and their 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 3 Pikas (client) and the Teslin Tlingit Council (end client), 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 document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

## 9.0 CLOSURE

We trust this document 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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## APPENDIX A

### TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

# LIMITATIONS ON USE OF THIS DOCUMENT

## GEOTECHNICAL

### 1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

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### 1.2 ALTERNATIVE DOCUMENT FORMAT

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

### SITE PLAN SHOWING TESTPIT LOCATIONS; TESTPIT LOGS AND ACCOMPANYING LABORATORY TEST RESULT REPORT FORMS



**LEGEND**  
 ☒ - TESTPIT LOCATION

0 500m  
 Scale: 1:12,500 @ 11"x17"

CLIENT

3 PIKAS



LONE TREE AREA LOT DEVELOPMENT  
 TESLIN, YUKON

SITE PLAN SHOWING TESTPIT LOCATIONS

PROJECT NO. ENG.WARC03567-01	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE September 11, 2019		

Figure 1

# 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.

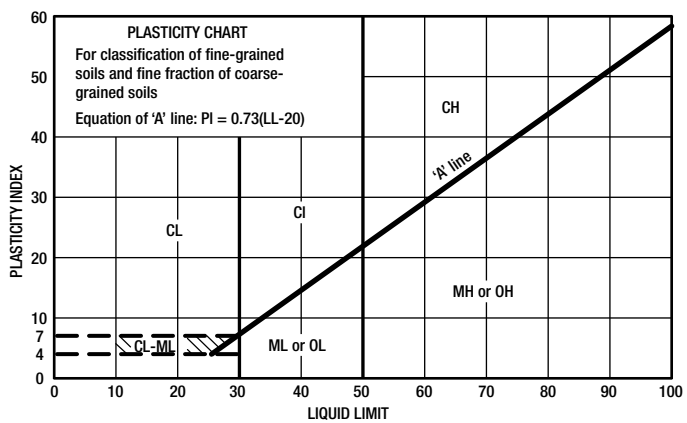
**Calcareous** - containing appreciable quantities of calcium carbonate.;

**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			
<b>COARSE - GRAINED SOILS</b> More than 50% retained on No. 75 µm sieve*	<b>GRAVELS</b> 50% or more of coarse fraction retained on No. 4 sieve	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	$C_u = D_{60} / D_{10}$ 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		
		<b>GRAVELS WITH FINES</b>	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	
		<b>SANDS</b> More than 50% of coarse fraction passes No. 4 sieve	<b>CLEAN SANDS</b>		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	
	<b>SANDS WITH FINES</b>		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	



\* 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				VISIBLE ICE LESS THAN 50% BY VOLUME			
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION		GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable		V	Vx	Individual ice crystals or inclusions	
	Nbn	No excess ice, well-bonded			Vc	Ice coatings on particles	
	Nbe	Excess ice, well-bonded			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:**
- Dual symbols are used to indicate borderline or mixed ice classifications.
  - Visual estimates of ice contents indicated on borehole logs ± 5%
  - 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 KEYSHEET

## Water Level Measurement



Measured in standpipe, piezometer or well



Inferred

## Sample Types



A-Casing



Core



Disturbed, Bag, Grab



HQ Core



Jar



Jar and Bag



75 mm SPT



No Recovery



Split Spoon/SPT



Tube



CRREL Core

## Backfill Materials



Asphalt



Bentonite



Cement/Grout



Drill Cuttings



Grout



Gravel



Sand



Slough



Topsoil Backfill

## Lithology - Graphical Legend<sup>1</sup>



Asphalt



Bedrock



Cobbles/Boulders



Clay



Coal



Concrete



Fill



Gravel



Limestone



Mudstone



Organics



Peat



Sand



Sandstone



Shale



Silt



Siltstone



Conglomerate



Topsoil



Till

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

# 3 Pikas

## Borehole No: TP01

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Teslin, Yukon

UTM: 609492 E; 6687845 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		MOSS AND TEA GROUND COVER OVER ORGANIC MAT - (100 mm thick) SAND AND SILT (TILL) - trace to some gravel, trace clay, cobbles and boulder to 1.0 m diameter, damp, compact, greyish brown	Unfrozen			20	40	80	0
1	Excavated	- dense			9.1				1
2					8.7				2
3					9				3
3		END OF TESTPIT (3.0 metres)							10
4									13
5									16



**TETRA TECH**

Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

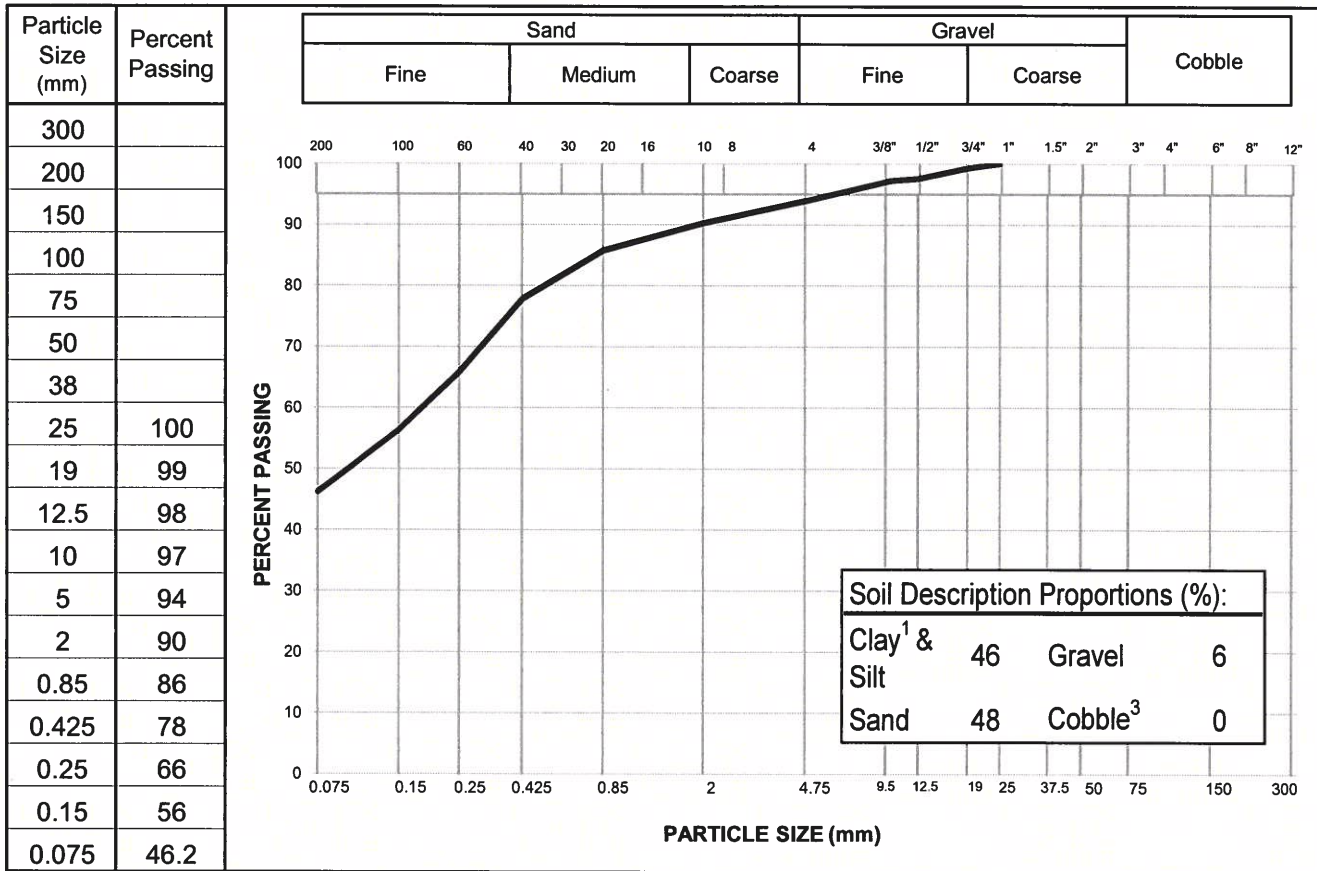
Reviewed By: CC

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# PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Lone Tree Area Lot Development	Sample No.:	SA02
Project No.:	ENG.WARC03567-01	Material Type:	-
Site:	Teslin Lake, Yukon	Sample Loc.:	TP01
Client:	3 Pikas	Sample Depth:	1.5 m
Client Rep.:	Simon Lapointe	Sampling Method:	Grab
Date Tested:	August 8, 2019	By:	SY
Date Tested:	August 8, 2019	Date Sampled:	August 7, 2019
Soil Description <sup>2</sup> :	SAND and SILT - trace of gravel	Sampled By:	MCP
		USC Classification:	Cu: #N/A Cc: #N/A
Moisture Content:	8.7%		



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

Specification: \_\_\_\_\_  
 Remarks: \_\_\_\_\_

Reviewed By: C.E.T.

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# 3 Pikas

## Borehole No: TP02

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Ground Elev: 714 m

Teslin, Yukon

UTM: 610078 E; 6686930 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Elevation (m)
0						20	40	80	714
0 - 0.1	Excavated	THIN VENEER OF GRAVEL (FILL) FROM OLD ALASKA HIGHWAY CONSTRUCTION - sandy, some silt, damp, brown, (100 mm thick)	Unfrozen						
0.1 - 0.2		ORGANICS - damp, black, (100 mm thick)							
0.2 - 3.0		SAND AND SILT (TILL) - trace to some gravel, trace clay, occasional cobbles, damp, compact to dense with depth, brownish grey			7.7				
1.0									713
2.0									712
3.0		END OF TESTPIT (3.0 metres)							711
4.0									710
5.0									709



Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

Reviewed By: CC

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# 3 Pikas

# Borehole No: TP03

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Teslin, Yukon

UTM: 610862 E; 6686106 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
0 - 0.15	Excavated	HEAVY MOSS GROUND COVER AND ORGANIC ROOT MAT - (150 mm thick)	Unfrozen						
0.15 - 0.3	Excavated	GRAVEL AND SAND - some silt, dry, compact, brown, subangular							
0.3 - 3.0	Excavated	SAND (TILL) - silty, some clay, some gravel, occasional cobble, damp, compact to dense, brownish grey - Percolation test performed from 0.3 - 0.6 m. percolation rate measured as 8 min./25 mm based on two repetitions			6	●			1
4.1	Excavated			7.9	●			5	
8.1	Excavated			7.9	●			9	
3.0		END OF TESTPIT (3.0 metres)							10



**TETRA TECH**

Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

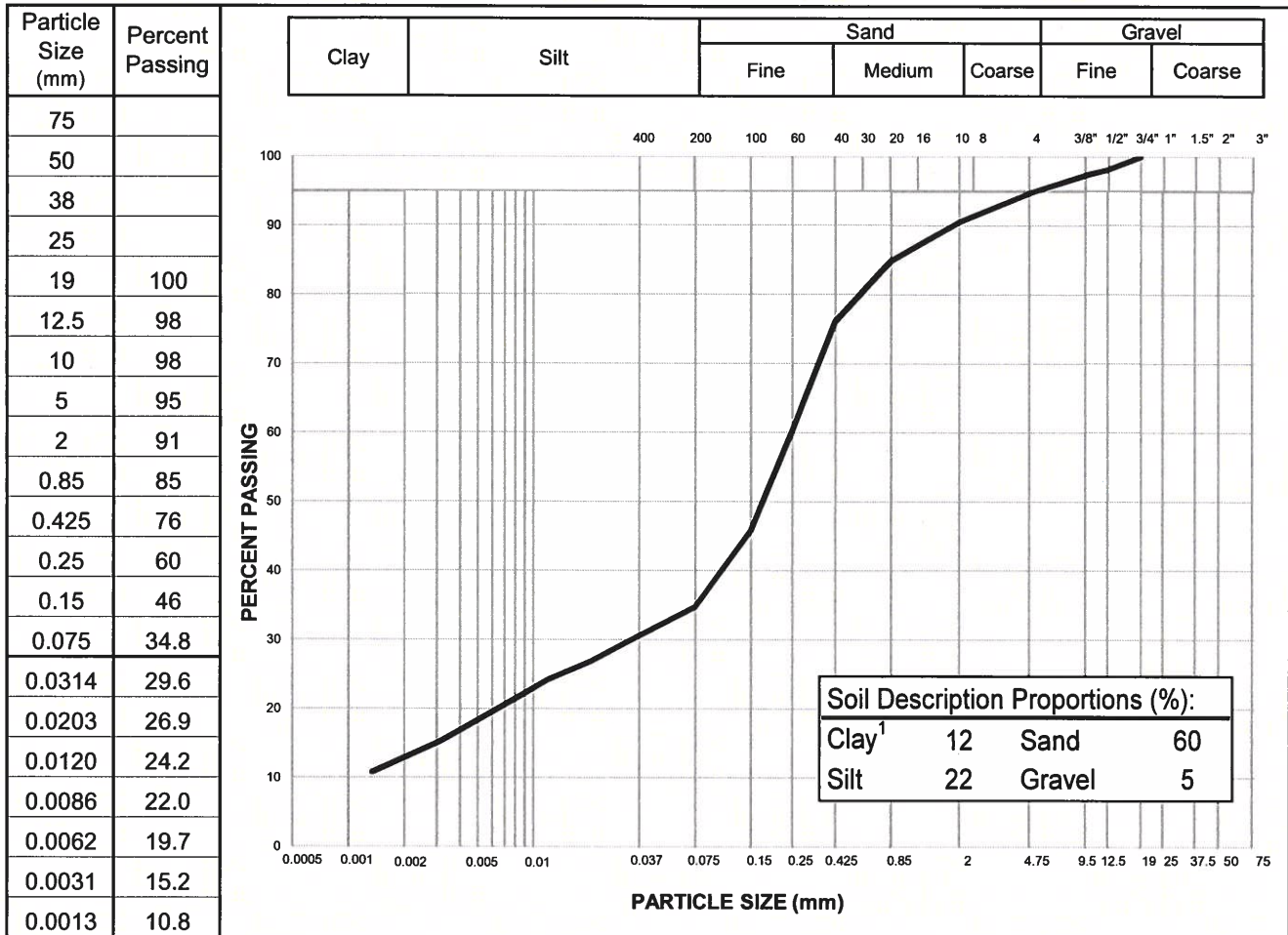
Reviewed By: CC

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# PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Lone Tree Area Lot Development	Sample No.:	SA01
Project No.:	ENG.WARC03567-01	Material Type:	-
Site:	Teslin Lake, Yukon	Sample Loc.:	TP03
Client:	3 Pikas	Sample Depth:	0.5 m
Client Rep.:	Simon Lapointe	Sampling Method:	Grab
Date Tested:	August 14, 2019	By:	AT
Date Tested:	August 14, 2019	Date Sampled:	August 7, 2019
Soil Description <sup>2</sup> :	SAND - silty, some clay, trace of gravel	Sampled By:	MCP
Moisture Content:	6.0%	USC Classification:	Cu: #N/A Cc: #N/A



Notes: <sup>1</sup> The upper clay size of 2 um, per the Canadian Foundation Engineering Manual  
<sup>2</sup> The description is visually based & subject to Tetra Tech description protocols

Specification: \_\_\_\_\_

Remarks: \_\_\_\_\_

Reviewed By: C.E.T.

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# 3 Pikas

# Borehole No: TP04

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Teslin, Yukon

UTM: 611524 E; 6685018 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	60	0
0	Excavated	SAND AND SILT (TILL) - trace to some gravel, trace clay, cobbles throughout, damp, compact to dense, dark grey	Unfrozen		8.2				0
1									1
2									2
3									3
4									4
5									5
6									6
7									7
8									8
9									9
10									10
11									11
12									12
13									13
14									14
15									15
16									16

END OF TESTPIT (3.0 metres)  
 Note: Old borrow pit - all surficial gravel removed



**TETRA TECH**

Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

Reviewed By: CC

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# 3 Pikas

# Borehole No: TP05

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Teslin, Yukon

UTM: 611368 E; 6685522 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
0 - 0.1		MOSS GROUND COVER AND ORGANIC ROOT MAT - (100 mm thick)	Unfrozen						
0.1 - 0.2		SILT - some sand, damp, light brown, (200 mm thick)							
0.2 - 0.3		SAND AND GRAVEL - trace silt, damp, compact, brown, (200 mm thick) - Shallow perflation test in gravel at surface, percolation rate of 45 sec./25 mm measured			1.9				
0.3 - 3.0	Excavated	SAND AND SILT (TILL) - some gravel, cobbles throughout, damp, dense  - very dense  - sandier			4.4				
3.0		END OF TESTPIT (3.0 metres)			5.4				10



Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

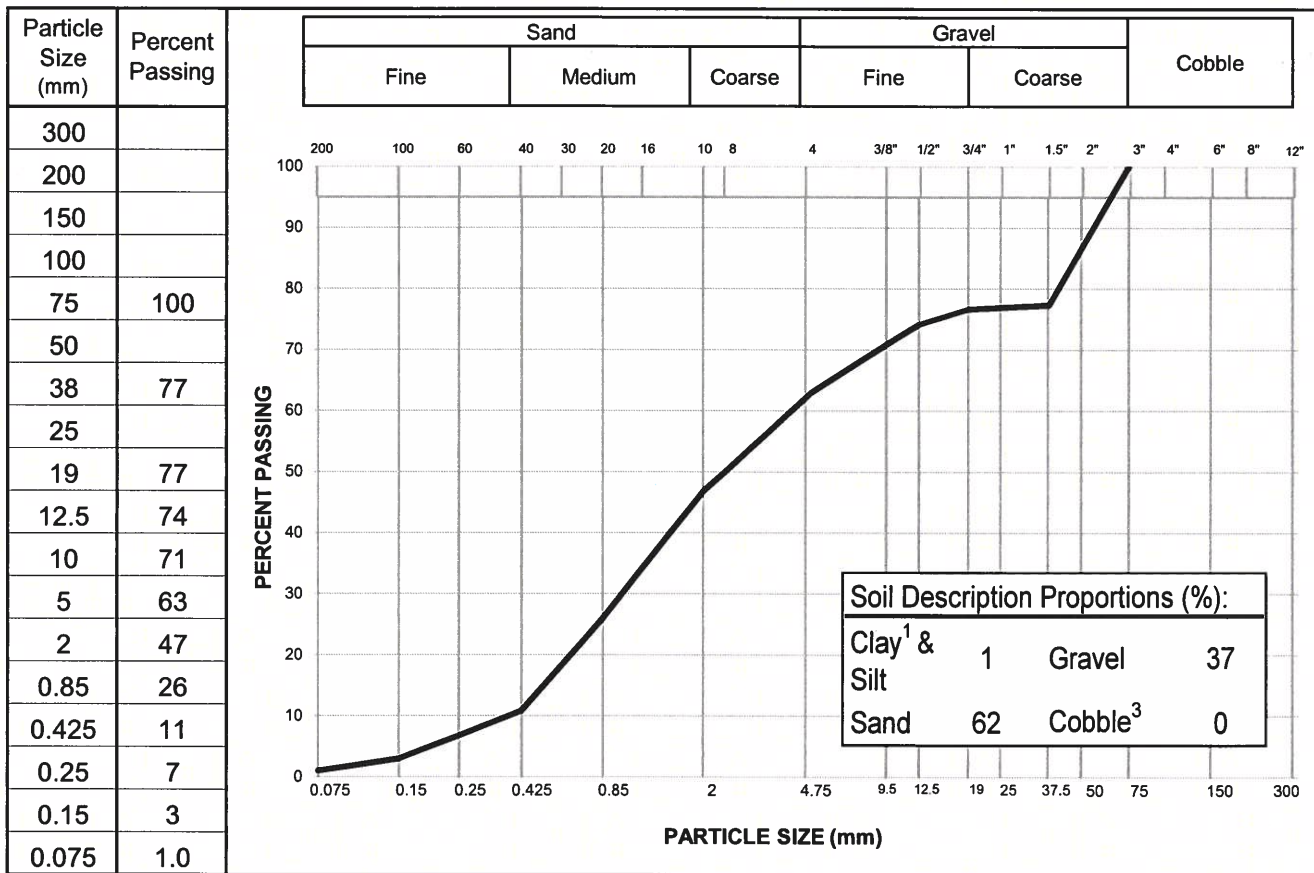
Reviewed By: CC

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# PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Lone Tree Area Lot Development	Sample No.: SA01
Project No.: ENG.WARC03567-01	Material Type: -
Site: Teslin Lake, Yukon	Sample Loc.: TP05
Client: 3 Pikas	Sample Depth: 0.3 m
Client Rep.: Simon Lapointe	Sampling Method: Grab
Date Tested: August 8, 2019      By: SY	Date Sampled: August 7, 2019
Soil Description <sup>2</sup> : SAND and GRAVEL - trace of silt	Sampled By: MCP
Moisture Content: 1.9%	USC Classification:      Cu: 11.5 Cc: 0.7



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

Specification: \_\_\_\_\_  
 Remarks: \_\_\_\_\_  
 \_\_\_\_\_

Reviewed By: C.E.T.

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# 3 Pikas

## Borehole No: TP06

Project: Lone Tree Site Development

Project No: ENG.WARC03567-01

Location: TTC R-13A

Teslin, Yukon

UTM: 661209 E; 6687312 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
0 to 0.1		ORGANIC ROOT MAT - damp, black, (100 mm thick)	Unfrozen						
0.1 to 1.0		SILT - some clay, trace sand, rootlets throughout, moist, greyish brown			16.8				1
1.0 to 3.0	Excavated	SILT (GLACIOLACUSTRINE) - some clay, moist to wet with depth, firm, grey, horizontal parallel laminae throughout			22.2				2
3.0		END OF TESTPIT (3.0 metres)			28.5				3



**TETRA TECH**

Contractor: Deadman Creek Enterprises

Completion Depth: 3 m

Drilling Rig Type: Track mounted excavator

Start Date: 2019 August 7

Logged By: MCP

Completion Date: 2019 August 7

Reviewed By: CC

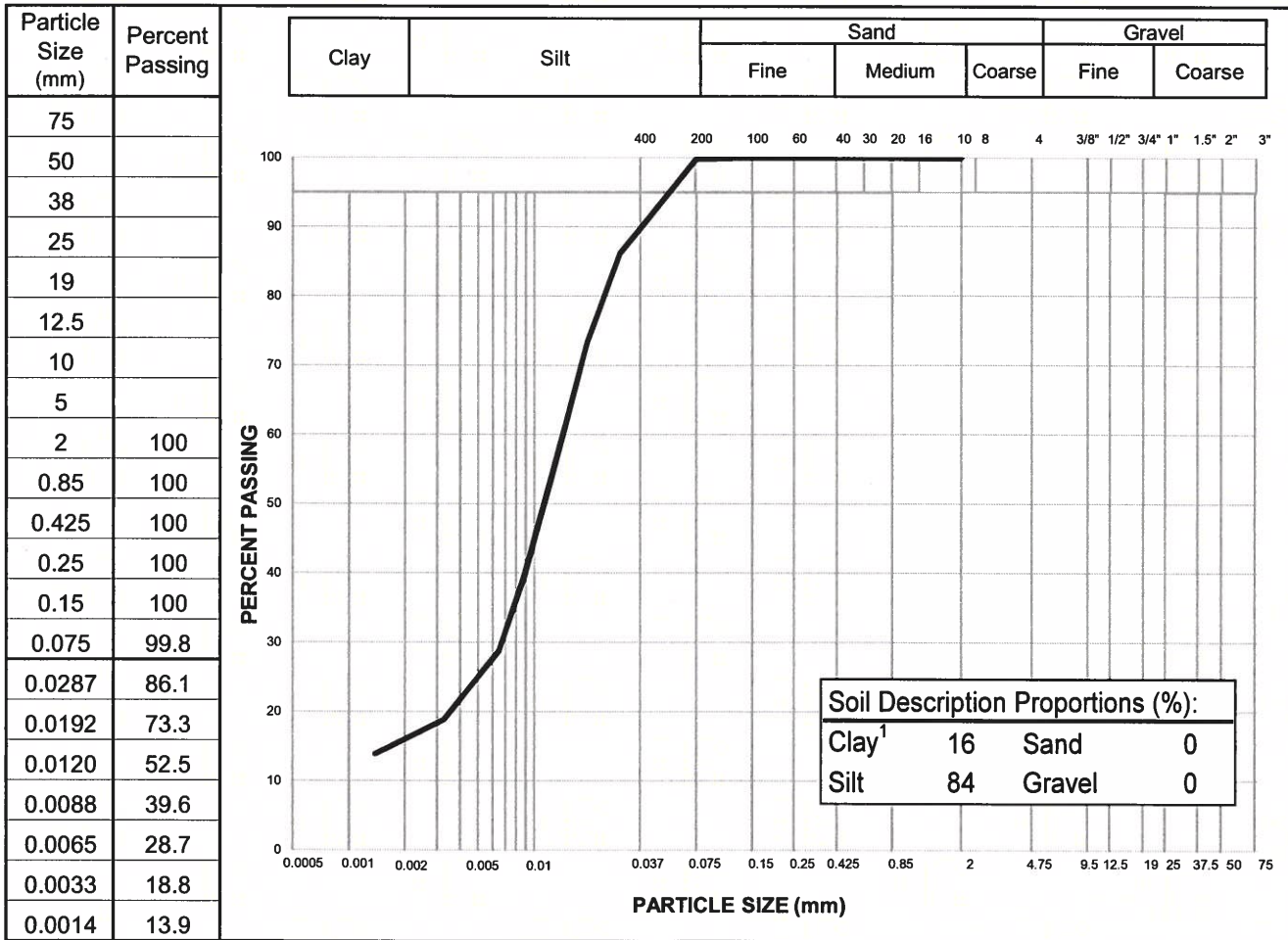
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# PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Lone Tree Area Lot Development	Sample No.: SA02
Project No.: ENG.WARC03567-01	Material Type: -
Site: Teslin Lake, Yukon	Sample Loc.: TP06
Client: 3 Pikas	Sample Depth: 1.5 m
Client Rep.: Simon Lapointe	Sampling Method: Grab
Date Tested: August 14, 2019	By: AT
Soil Description <sup>2</sup> : SILT - some clay	Date Sampled: August 7, 2019
	Sampled By: MCP
	USC Classification: Cu: #N/A
	Cc: #N/A

Moisture Content: 22.2%



Notes: <sup>1</sup> The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

<sup>2</sup> The description is visually based & subject to Tetra Tech description protocols

Specification: \_\_\_\_\_

Remarks: \_\_\_\_\_

Reviewed By: C.E.T.

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