

December 5, 2018

Government of Yukon  
Department of Community Services  
Rural Land Development - Land Development Branch  
Box 2703  
Whitehorse, YT Y1A 2C6

ISSUED FOR REVIEW  
FILE: ENG.WARC03386-21  
Via Email: kevin.fisher@gov.yk.ca

**Attention:** Mr. Kevin Fisher, Program Manager

**Subject:** CR1 Country Residential Site Development Suitability  
Watson Lake, Yukon

## 1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Kevin Fisher, Program Manager for the Government of Yukon (YG), Community Services, Rural Land Development, Land Development Branch to provide a geotechnical overview of the proposed Industrial Subdivision Expansion in Watson Lake, Yukon.

To meet the objectives of this project, the following tasks have been completed:

- An in-house project file search did not reveal any testhole data specific to the CR1 subject site. However, information presented on the Yukon Geological Survey Map File 2005-7 – Watson Lake Area suggests that the surficial soil deposition in this area is similar to areas to the west where Watson Lake testholes have encountered silt and sand till soils. This map sheet also indicates the presence of some interesting surficial features including a scarp defining the central portion of the east side of the study area (along the Old Alaska Highway) and a steep-sided melt water channel crossing the site approximately 3/4 of the way up from the north end. Air photo delineation of these two features was also performed using 1:40,000 scale air photos A26827-36 and -37 flown in September, 1985 and 1:20,000 scale air photos A28124-98 and -99 flown on August 27, 1994.
- A site reconnaissance was completed on October 18, 2018 to assess current conditions throughout the study area.
- Based on the conditions noted in the existing reports and the current site reconnaissance, a summary of terrain and soil conditions is presented.
- Potential for country residential development, including roadway construction, conventional foundation construction and issues associated with on-site sewage disposal system design and construction is discussed.

## **2.0 SITE CONDITIONS**

### **2.1 Location and Current Land Use**

The CR1 site is a large 131 ha parcel located at the east end of the Watson Lake townsite. It is located directly across the Alaska Highway from the weigh scales and is bordered on the east side by the Old Alaska Highway. The south boundary is along the crest overlooking the Liard River Valley.

The site is undeveloped; however, the fire break encroaches onto the subject site and current land use includes a recreational trail network including the Lucy Allen Loop which dissects the site and intersects the Birds Eye Trail which runs south to a view point overlooking the Liard River Valley. Both trails were used during the site reconnaissance to assess terrain and to confirm surficial soil conditions.

### **2.2 Terrain Conditions**

In general, slopes throughout the site have a northern exposure and are gentle (less than 15%). There is a height of land near the south end of the site and beyond that, the slopes are south facing and moderately steep as they extend down to the crest overlooking the Liard River Valley. The sides that define the melt water channel mentioned above are steep as is the exposure along the scarp that defines the east side of the central portion of the site.

### **2.3 Vegetation**

Vegetation throughout the area consists of mature white spruce mixed with lodgepole pine and poplars. Areas with birch and willows dispersed throughout the spruce tree cover were also noted during the site reconnaissance (likely areas that are not as well drained).

### **2.4 Soil Conditions**

The presence of silt and sand till soils, as presented on the Yukon Geological Survey Map File 2005-7 - Watson Lake Area, was confirmed during the October 18, 2018 site reconnaissance. In general, the site is covered with a morainal blanket comprising a heterogeneous mixture of sand, gravel and silt with cobbles and boulders transported by glacial ice without any modification. In general, the morainal till soils are compact near the surface and become dense with depth.

During the site reconnaissance, numerous surface boulders were noted. Many of them were very large (greater than 1 m in size).

Bedrock was noted along the crest overlooking the Liard River Valley. As well, due to the variability in the thickness of the till blanket covering the site, soil cover over bedrock along the height of land slightly south of the melt water channel may be minimal.

No evidence of seepage zones and groundwater was noted during the site reconnaissance.

## 2.5 Site Grades and Drainage

In general, the study area is well drained due to the positive drainage along the smooth, even slope extending up from the Alaska Highway. Beyond the height of land and extending south towards the crest overlooking the Liard River Valley, there was evidence of areas that were not as well drained (based on the presence of birch and willows).

## 3.0 DEVELOPMENT POTENTIAL AND RECOMMENDATIONS

The development potential for this site is considered fair to good. Future development issues related to this site will include:

- Development beyond the meltwater channel may be problematic. It is suggested that this terrain feature become the southern limit of this proposed development.
- Country residential development may be complicated due to the slopes encountered throughout the site. For terrain mapping purposes, 15% is still considered to be gentle but in reality, slopes between 10% and 15% make lot access along roadways and driveways difficult in northern communities that experience winter conditions and significant snow fall. Environmental Health Guidelines do not allow the installation of a septic system absorption fields on slopes greater than 15%, but there again, experience suggests that construction on slopes greater than 10% are difficult and likely more expensive.
- The presence of large surface boulders presents a challenge during roadway and foundation construction. If left upon a subgrade surface, there is potential that they will work their way up through the imported sub-base and basecourse gravels, causing damage to the driving surface. If left on the bearing surface supporting concrete foundations, the point pressure onto the boulder could cause the footing concrete to crack.
- Some poorly drained areas were noted during site reconnaissance. If the underlying tills soils are wet to saturated, absorption field design will be negatively impacted and subgrade stability during roadway construction may be difficult to achieve.

### 3.1 Minimum Lot Size

For country residential site development projects completed throughout the Yukon and northern British Columbia by Tetra Tech, a minimum lot size of 1 ha has been recommended. With the development constraints that exist for this project, a minimum lot size of 1 ha seems appropriate so that each lot has good potential for locating a residential structure and an on-site sewage disposal system, as well as a residential water supply well if desired.

### 3.2 Roadway Construction

The geotechnical conditions are likely to be fairly consistent throughout the entire study area with roadway construction on a till subgrade. The following recommendations for roadway construction apply.

The slopes throughout the study area are fairly smooth with very little micro terrain. Major cuts and fills are not anticipated. Therefore, once the roadway corridors are cleared, grubbed and stripped, the large surface boulders mentioned above will have to be dealt with so that design grades can be achieved.

The till soils are a good subgrade soil if they are not allowed to become wet or saturated. If they become saturated, the soil strength decreases significantly and the potential for frost heave damage increases significantly. Therefore, it is important that proper ditch lines be constructed, and culvert locations ensure drainage away from the roadway embankment.

It is anticipated that access roads will either be a gravel or BST surfaced roadway so the recommended structure over the till subgrade surface should be 150 mm of Gran A (20 mm crushed basecourse gravel) over 300 mm of Gran D (80 mm pit run sub-base gravel). Imported gravel should meet the gradation specifications presented in Table 1.

**Table 1: Recommended Granular Material Specifications**

80 mm Pit Run Gravel		20 mm Crushed Basecourse Gravel	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
80.000	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).

### 3.2.1 Borrow Sources

It is anticipated that imported gravel used on this project will come from a Government of Yukon gravel source. If unavailable at the time of construction, there are local contractors who can supply.

### 3.3 Foundations

Till soils, in an unsaturated state, are considered appropriate for supporting conventional shallow foundation systems including strip & spread footing and thickened monolithic slab-on-grade construction. Helical pile foundations are gaining popularity throughout the Yukon but the presence of cobbles and boulders within the till matrix will limit potential for this foundation option.

Tetra Tech can provide bearing resistances (ULS and SLS) and appropriate seismic site classification for structures built in this area.

#### 3.3.1 Frost Penetration & Seasonal Frost Heave Potential

As mentioned above, the surficial silt and the till soils underlying the subject site are considered frost-susceptible. Seasonal frost depths in the Watson Lake area exceed 4.5 m in areas cleared of snow; therefore, the potential for frost heave damage to foundations is a definite concern.

#### 3.3.2 Foundation Insulation Recommendations

Current local codes typically dictate the use of insulation around all foundations. However, the minimum insulation thickness and distance out from the foundation elements are often considered to be insufficient when dealing with frost susceptible soils. Tetra Tech always recommends insulating foundations constructed on frost susceptible soils to mitigate potential for seasonal frost-heave damage and it should be noted that Tetra Tech recommendations for insulation thickness and distance out from the perimeter foundation system are not generic. The frost susceptibility of soils supporting building foundations must be considered along with footing burial depth and the amount of protective soil cover over the footings. Tetra Tech or qualified geotechnical personnel should be contacted to provide site specific insulation recommendations.

## 4.0 ON-SITE SEWAGE DISPOSAL SYSTEM POTENTIAL

The silt till soils are not ideal for on-site sewage disposal system design and construction. However, solutions for on-site sewage treatment and disposal can likely be developed. That being said, the following should be considered:

- The underlying till soils become very dense with depth (percolation rates in till soils at 2.0 m can be greater than 45 minutes/25mm). Therefore, shallow soil absorption systems should be considered to take advantage of quicker near surface percolation rates in the weathered till soils.
- Minimum lot size should ensure sufficient space to establish a back-up absorption field in case the original field fails.
- Absorption field, shallow absorption trench, and chamber systems are all considered appropriate for the subject site.
- All systems must be designed and installed in accordance with the Yukon Government's Environmental Health Guidelines. This includes site specific permitting, percolation testing, design and construction, as well as the as-built documentation to support approval.

## 5.0 RECOMMENDATIONS FOR ADDITIONAL GEOTECHNICAL WORK

Potential for development from a geotechnical aspect has been established but this project would benefit from a final design stage geotechnical evaluation that would include a series of testpits along roadways and additional testpits on lots to establish on-site sewage disposal system solutions. Ideally, this work would be completed after the roadways have been cleared of trees.

## 6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon and their agents. Tetra Tech Canada Inc. (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, 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. Tetra Tech's General Conditions are provided in Appendix A of this report.

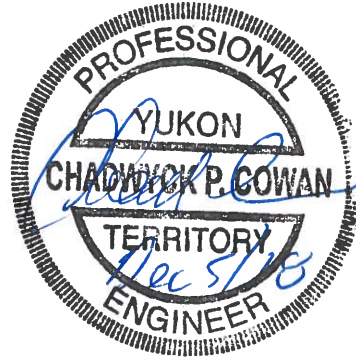
## 7.0 CLOSURE

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

Respectively Submitted,  
Tetra Tech Canada Inc.


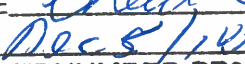


Myles Plaunt, CET  
Senior Engineering Technologist, Arctic Region  
Direct Line: 867.668.9217  
Myles.Plaunt@tetrattech.com



Chad Cowan, P.Eng.  
Geotechnical Manager – Yukon, Arctic Region  
Direct Line: 867.668.9214  
Chad.Cowan@tetrattech.com

Attachments: Site Plan, Testpit Logs and Laboratory Test Result Report Forms From 1994 Report  
Appendix A: Tetra Tech's Limitations on the Use of This Document

<b>PERMIT TO PRACTICE TETRA TECH CANADA INC.</b>	
SIGNATURE	
Date	
<b>PERMIT NUMBER PP003</b> Association of Professional Engineers of Yukon	

# ATTACHMENT

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Scan of 1:20,000 scale Air Photo A28124-98 (August 27, 1994)



A28124- 98

1: 20000

27/08/94

# APPENDIX A

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

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# LIMITATIONS ON USE OF THIS DOCUMENT

## GEOTECHNICAL – YUKON GOVERNMENT

### 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 (**Yukon Government**) 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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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.