

September 28, 2020

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

ISSUED FOR USE
FILE: 704-ENG.WARC03386-71
Via Email: kevin.fisher@gov.yk.ca

Attention: Mr Kevin Fisher, Program Manager

Subject: Lots 3 – 7; Blk. 11 and Lots 27 – 30; Blk12 Lot Development
Along 1st Avenue in Mayo, 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 complete a geotechnical evaluation of the two parcels captioned above. For the Blk 11 development, the intent is to create double lots for lots 4 & 5 and lots 6 & 7, while lot 3 will remain a single lot. For Blk 12 development, double lots will be created for lots 27 & 28 and lots 29 & 30.

The purpose of this evaluation is to assess feasibility of residential development in the 1st Avenue area between Laurier Street and Montreal Street and to establish possible foundation systems considered most applicable for supporting residential structures:

2.0 TESTPITTING PROGRAM

On August 12, 2020, a testpitting program was completed. Two testpits were excavated on Blk 11 and a single testpit was excavated on Blk 12. All testpits were excavated with a tracked excavator provided by the Village of Mayo. The testpits were excavated in advance of Tetra Tech mobilizing to site to observe the soil conditions in each testpit. After detailed testpit logs had been created and site conditions had been documented, Village of Mayo staff were informed that they could backfill the testpits to ensure safe site conditions.

3.0 SITE CONDITIONS

3.1 Surficial Geology and Terrain

The surficial geology of the Mayo area is quite complex. The area has been affected by a combination of valley glaciation and fluvial action related to the Mayo and Stewart River channels. Glacial sediments have been found to extend to depths in excess of two hundred metres (as determined by water well drilling throughout the Village of Mayo).

Near the surface, glacial melt water deposited glaciolacustrine silt and clay in temporary pro-glacial lakes. Fluvial deposition of coarse granular outwash deposits is also common. Adjacent to the Mayo and Stewart River channels, soil deposition is further complicated by the erosion of glacial sediments and deposition of river gravels throughout post-glacial river floodplains (*which is evident throughout the Blk 11 and 12 sites*).

This section of 1st Avenue is located in a slight depression. This is significant because a culvert collects surface water flow on the south side of 1st Avenue and releases it onto the Blk 11 site. The Mayo area has received higher than normal snow for the last two years and this summer has been quite wet so water flowing across 1st Avenue onto Blk 11 has likely contributed to wet surficial soils.

The lots comprising Blk 11 are grass and tree covered. The heavy grass and a mix of willow, birch and spruce are typically indicative of poorly drained soil conditions. The testpit location on Blk 12 has grass ground cover but was cleared of trees.

3.2 Soil Conditions

TP01 and TP02 were excavated on Blk 11 and TP03 was excavated on Blk 12. The soil stratigraphy noted was relatively consistent with organics and silty surficial soils observed overlying granular soil, which was encountered at depths of between 3.5 to 4.0 m. The testpits were relatively shallow (around 4.0 m when excavated), but it is known that the area is underlain by fine grained glaciolacustrine soils.

3.3 Bedrock

No bedrock was encountered during the completion of the current or historic geotechnical evaluations completed within the Mayo town site. The only indicator of the depth to bedrock was at the community water well site (which was developed just above the bedrock surface at approximately 240 m)

3.4 Groundwater

The presence and depth to groundwater is quite random. The presence of groundwater seems to be related to water level fluctuations in areas close to the Mayo and Stewart Rivers. Case in point, groundwater was noted in all three testpits when excavated (in advance of mobilizing to site) but water levels had dropped in the Stewart River and when the conditions in the testpits were observed, no groundwater was observed - but the underlying gravels were oxidized and mottled, confirming that groundwater levels do fluctuate throughout the study area.

3.5 Permafrost

No permafrost was encountered during the current testpitting program. However, on uncleared sites, (especially if there is a significantly thick organic root mat), there is always potential.

The bigger threat to long term serviceability of foundations is the potential for pockets of ice rich permafrost at depth in the glaciolacustrine soils that exist below the near surface granular soils.

4.0 DEVELOPMENT FEASIBILITY AND FOUNDATION CONSTRUCTION

Anecdotal information from the Village of Mayo – Public Works staff has been very helpful during the completion of this geotechnical evaluation. Conversation while on site has established:

- There used to be a small pond on the Blk 11 site. The near surface fine grained soils were wet and soft; but there were no signs of surface water.
- The permafrost degradation problems throughout the NNDFN subdivision to the east is well documented. The damage to deep utilities infrastructure and foundations has been extensive but when the Village staff was asked if any damage to the deep utilities had been noted during recent camera work, it was confirmed that everything was still functioning properly along this section of 1st Avenue. This means that it is likely that no near surface permafrost exists beneath the 1st Avenue corridor in the block where the Blk 11 and Blk 12 sites are located.
- There was also recollection that a portion of Blk 11 was used as a dump site (an oil drum and some debris was noted at the TP02 location).
- The residential structure located directly west of Lot 7 has on-going issues with frost heave because decks and fencing has been constructed over the frost susceptible fine-grained surficial soils.
- As well, it was mentioned that the 2nd house in from the Laurier Street intersection (owned by Yukon Housing) is condemned due to the presence of radon gas. When talking to the owner of the house beside Lot 7, testing for radon gas is on the to-do list but hasn't been completed as of August 12, 2020.

To summarize:

- The site is located in a slight depression and surface water is being directed onto the Blk 11 site;
- Soil conditions include wet, soft, very frost susceptible fine-grained soils overlying granular soils;
- No permafrost was encountered in the testpits excavated on Blk 11 and Blk 12;
- No damage to the existing deep utilities has been noted (based on recent camera work);
- Radon gas may be an issue; and,
- An environmental site assessment (Level 1 ESA to attempt to verify the possibility that there was a dump site) would probably be a good idea.

4.1 Preferred Foundation Systems

Three foundation systems have been discussed with geotechnical colleagues in the Whitehorse office. The options considered include:

- Subexcavation to expose the underlying gravel layer and engineered fill construction to bring the site back up to design elevations. This option is preferred since foundations would be supported by a non-frost susceptible granular fill. Dependent upon water levels in the Stewart River, there may be groundwater at the base of an excavation founded in the underlying gravel. This would necessitate the use of coarse clear stone as a first lift to get out of the water.
- Partial subexcavation, placement of a medium weight, non-woven geotextile on a soft subgrade surface and engineered fill construction to bring the site up to design elevations. The soft, fine grained soils noted during the testpitting program could be problematic unless this work could be done well in advance of residential

construction. The fill may act as a preload so the fill would have to be monitored to establish when initial dynamic settlement had ended. The lots on Blk 11 are low lying so additional fill for site grading would likely be required. If good quality granular fill is used and the end result is a 2.0 m engineered fill, this option may be more cost effective but additional perimeter insulation may be required to protect the foundation from seasonal frost related movements.

- The installation of helical piles to support the residential structures was also considered but is considered risky. The risks with this approach would be long term, differential foundation movement if ice rich permafrost exists in the glaciolacustrine soils beneath the gravels encountered during the current testpitting program. As well, pile depths would have to be established by additional site specific work since the thickness of the gravel unit is considered to be variable (based on historical data for the Village of Mayo) and there could be a range in soil consistency due to fluctuating groundwater elevations.

It is understood the preferred option of subexcavation to the granular soil interface and the construction of an engineered fill is considered cost prohibitive. In the last two years, Tetra Tech has completed similar projects in Mayo and the costs ranged from approximately \$25,000 (subexcavation and engineered fill was limited to the building footprint only) to \$50,000 (subexcavation and engineered fill construction included an entire single lot in downtown Mayo).

Once the lots are sold, it is recommended that site specific geotechnical input be provided to the owner(s) so that the objectives of the development vision can be met.

5.0 LIMITATIONS OF REPORT

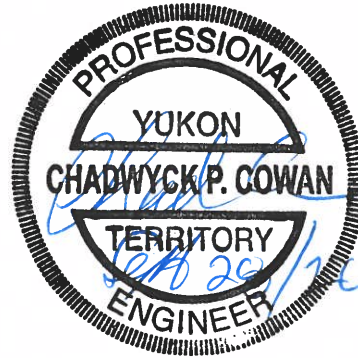
This report and its contents are intended for the sole use of the Government of Yukon and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report 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.

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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Date	<u><i>SEP 28/20</i></u>
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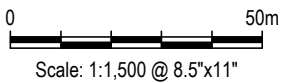
ATTACHMENTS

Site Plan Showing Testpit Locations
Testpit Logs

Q:\Whitehorse\Data\0201\drawings\Mayo\ENG.WARC03386-71 Block 11 & 12 Site Development\ENG.WARC03386-71 Fig.1-R0.dwg [FIGURE 1] September 23, 2020 - 7:08:54 pm (BY: BUCHAN, CAMERON)



LEGEND
 - TESTPIT LOCATION



CLIENT



**BLOCK 11 & 12 SITE DEVELOPMENT
MAYO, YUKON**

SITE PLAN SHOWING TESTPIT LOCATIONS

PROJECT NO. ENG.WARC03386-71	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE September 23, 2020		

Figure 1

YTG - Community Services

Testpit No: TP01

Project: Block 11 & 12 Lot Development

Project No: ENG.WARC03386-71

Location: 1 Avenue

Mayo, Yukon

UTM: 455750 E; 7051778 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Depth (ft)
0	Excavated	ORGANICS - wet, black, (300 mm thick)	Unfrozen		0
		SILT - some clay, wet, soft, grey, some brown mottling, organic inclusions throughout			1
1					2
2					3
3				4	
4				5	
				6	
				7	
				8	
				9	
				10	
				11	
				12	
				13	
				14	
				15	
5				16	

GRAVEL - sandy, some silt, moist to wet, compact, mottled brown and rusty brown, rounded gravel

END OF TESTPIT (3.8 metres)
 Note: Excavation contractor confirmed that groundwater was visible at time of excavation - dependant upon water levels in the Stewart River.



Contractor: Village of Mayo

Completion Depth: 3.8 m

Drilling Rig Type: Tracked Excavator

Start Date: 2020 August 12

Logged By: MCP

Completion Date: 2020 August 12

Reviewed By: CPC

Page 1 of 1

YTG - Community Services

Testpit No: TP02

Project: Block 11 & 12 Lot Development

Project No: ENG.WARC03386-71

Location: 1 Avenue

Mayo, Yukon

UTM: 455775 E; 7051778 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Depth (ft)
0	Excavated	SILT AND ORGANICS - wet, black and grey	Unfrozen		0
1		SILT - some clay, wet, soft, grey, some brown mottling			1
2		- 100 mm thick sand lens - wet, brown, fine to medium sand			2
3		GRAVEL - sandy, some silt, moist to wet, compact, mottled brown and rust brown, rounded gravel			3
4		END OF TESTPIT (4.2 metres) Notes: An oil drum and other debris noted at this location. Water in testpit when excavated.			4
5					5



Contractor: Village of Mayo

Completion Depth: 4.2 m

Drilling Rig Type: Tracked Excavator

Start Date: 2020 August 12

Logged By: MCP

Completion Date: 2020 August 12

Reviewed By: CPC

Page 1 of 1

YTG - Community Services

Testpit No: TP03

Project: Block 11 & 12 Lot Development

Project No: ENG.WARC03386-71

Location: 1 Avenue

Mayo, Yukon

UTM: 455797 E; 7051730 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Depth (ft)
0	Excavated	SILT AND ORGANICS - wet, black and grey	Unfrozen		0
1					1
2		SILT - some clay, wet, soft, grey, some brown mottling			2
3		GRAVEL - sandy, some silt, moist to wet, compact (est.), mottled brown and rusty brown, rounded gravel			3
4		END OF TESTPIT (3.5 metres) Note: Water in testpit when excavated.			4
5					5



Contractor: Village of Mayo

Completion Depth: 3.5 m

Drilling Rig Type: Tracked Excavator

Start Date: 2020 August 12

Logged By: MCP

Completion Date: 2020 August 12

Reviewed By: CPC

Page 1 of 1

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

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 use of TETRA TECH's Client, its officers, employees, agents, representatives, successors and assigns (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. Any changes to the conclusions, opinions, and recommendations presented in TETRA TECH's Professional Document must be authorized by TETRA TECH.

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.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems, as per agreed project deliverable formats. TETRA TECH makes no representation about the compatibility of these files with the Client's 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.

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

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.

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, and subject to the standard of care herein, 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, except where TETRA TECH has subcontracted for such information.

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 report, 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 make, 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 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the Client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

1.8 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.

1.9 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.