



APPENDIX
Geotechnical Report

B

February 7, 2022

ISL Engineering and Land Services
203 – 100 Main Street
Whitehorse, YT Y1A 2A8

ISSUED FOR REVIEW
FILE: 704-ENG.WARC04159-01
Via Email: THeal@islengineering.com

Attention: Tyler Heal, M.Eng., P.Eng. Structural Engineer – Whitehorse Manager

Subject: Desktop Level Geotechnical Evaluation – New Rink and Sand Shed
5 Mile Reserve – Atlin, British Columbia

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by ISL Engineering & Land Services Ltd. (ISL) to complete a geotechnical evaluation and provide recommendations for the design and construction of new foundations to support a new rink structure and sand shed in the 5 Mile Reserve located along the Warm Bay Road south of the Atlin townsite.

Authorization to proceed was in the form of a signed sub-consultant agreement dated January 16, 2022.

2.0 EXISTING GEOTECHNICAL INFORMATION

EBA/Tetra Tech has completed numerous geotechnical and environmental projects throughout the 5 Mile Reserve.

Pertinent to the two sites being evaluated are:

- In 1996, two testpits were excavated the truck garage site close to the intersection of Taxgoon Road and Warm Bay Road (EBA Project Number 0201-96-12295). This is the site where the sand shed is proposed.
- In 1994, numerous testpits and boreholes were advanced along Taxgoon Road as part of the Sanitary Sewer Collection and Disposal project (EBA Project Number 0201-11639). A testpit and a borehole were advanced on opposite sides of Taxgoon Road at the entrance to the site where the new rink is proposed.

Attached to this document are:

- A General Location Google Image showing the location of the two subject sites;
- A Site Plan showing the locations of the two testholes on Taxgoon Road in front of the site of the new rink along with the two testhole logs; and,
- A site plan showing the locations of the testpits at the truck garage site along with testpit logs and accompanying laboratory test result report forms.

3.0 GEOTECHNICAL CONDITIONS

The soil conditions throughout the 5 Mile Reserve are quite consistent. Most importantly, the two subject sites are underlain with silt and sand till with varying gravel, cobble and boulder content. All projects completed throughout the 5 Mile Reserve has also noted that the till soils become denser with depth as they transition from the weathered near surface ablation tills to the underlying basal tills.

3.1 Groundwater and Bedrock

Along Taxgoon Road in front of the rink site, soils became saturated below 7.6 m in December 1994 and the borehole logs suggested that groundwater may be at or close to that elevation. Even accounting for seasonal fluctuations, ground water should not be a concern for either site.

Bedrock has not been encountered (or expected) on any of the 5 Mile Reserve sites investigated by this office.

As mentioned above, detailed testhole logs and accompanying laboratory test result report forms (when available) are attached.

4.0 RECOMMENDATIONS

4.1 General

Key to both the new rink and the sand shed sites is that the foundations will be constructed over frost susceptible soils. Lab data for Taxgoon Road in front of the new rink site suggested fines content of the till soils is more than 30% and data for the truck garage site where the sand shed will be constructed has up to 45% fines in the till soils. Minimizing potential for frost heave will be important for both structures.

4.2 Sub-Excavation and Backfill

4.2.1 Site Preparation For The New Rink Slab & The Sand Shed Slab

Rink structure options mentioned in previous correspondence includes a Sprung structure (similar to the Whitehorse Broomball facility) or a mass timber structure that would cover the rink surface. It is understood that the ice surface will be constructed as a raft slab and the structure over the ice surface would be supported by a spread footing and pedestal foundation.

For the rink slab, it is recommended that the footprint (plus 1m out on all sides) be sub-cut to 0.8 m below the current ground elevations. The excavation should be completed using a clean out bucket to minimize disturbance and the excavated surface should be recompact to ensure a stable subgrade surface on which to construct the engineered fill. The recommended engineered fill thickness will be 1.0 m (ensuring positive drainage away from the ice surface slab. If the soils at the base of the excavation appear unstable, a medium weight geotextile should be placed across the surface of the unstable area (1m overlap is recommended), followed by a 300 mm thick lift of coarse clear stone to bridge the soft subgrade and provide a stable surface on which to construct the remaining engineered fill. The upper surface of the coarse clear stone should also be covered with geotextile so that no fines are lost from the gravel placed above.

The sand shed will be constructed on a thickened monolithic slab-on-grade. Since there is potential for heavy truck and equipment travel across the floor slab, site preparation for the sand shed should follow the same sub-cut recommendations as the ice surface raft slab.

The engineered fill for both structures should be placed in 200 mm lifts, moisture conditioned and compacted to at least 98% SPMDD. The final lift (in contact with the concrete foundation elements) should be a 150 mm thick lift of 25 mm crushed basecourse aggregate.

Imported granular materials should meet the gradation limits for 80 mm pit run gravel and 25 mm basecourse gravel presented in Table 1, below.

During construction, the excavation must be protected from the inflow of surface water and snow and kept free of seasonal frost.

Table 1: Recommended Gradation for Granular Fill Materials

Non-Frost Susceptible 80 mm Pit Run Gravel		25 mm Crushed Basecourse Gravel	
Particle Size (mm)	% Passing (by weight)	Particle Size (mm)	% Passing (by weight)
80.000	100	25.000	100
20.000	55 – 100	20.000	80 - 100
12.500	42 – 84	10.000	50 – 85
5.000	26 – 65	5.000	35 – 70
1.250	11 – 47	2.500	25 – 50
0.315	3 – 30	1.250	15 - 35
0.080	0 – 6	0.315	5 – 20
		0.080	0 – 5

The 25 mm Crushed Basecourse Gradation Limits presented in Table 1 are based BC MoTI – Table 202-C – 25 mm WGB specs.

4.3 Foundation Design

4.3.1 General

The structure over the rink slab will be constructed on spread footings and pedestals. It is assumed that the spread footings will meet the NBCC 2015 minimum requirements for spread footing sizes (approximately 1.0 m x 1.0 m) and bearing resistance calculations are based on a footing depth of 1.2 m.

For the sand shed’s thickened monolithic slab-on-grade, the perimeter thickening is assumed to be 0.3 m thick and 0.4 m wide.

4.3.2 Limit States Bearing Resistances

The 2015 edition of the National Building Code of Canada (NBCC 2015) stipulates that foundation design must be carried out using Limit State Design (LSD) methods. Under LSD, a minimum of two loading cases must be considered by geotechnical and structural designers, including the Ultimate Limit State (ULS) and the Serviceability Limit State (SLS). The ULS and SLS bearing resistances are calculated differently. The ULS bearing resistance is the maximum pressure that can be applied to the soil without causing bearing failure. The SLS bearing pressure is the maximum allowable pressure required to limit the settlement to a tolerable amount. Both the ULS and SLS

bearing resistances are highly dependent on soil properties and footing geometry, including the footing size, shape, and burial depth.

Resistance factors are applied to the calculated (unfactored) resistances to determine the maximum allowable factored design load. Geotechnical resistance factors for design of shallow foundations against vertical bearing failure (ULS), horizontal displacement (sliding under lateral loading), and overturning, per the NBCC 2015, are provided in Table 2.

Table 2: Geotechnical Resistance Factors - Shallow Foundations

Item	Resistance Factor
Vertical Bearing Resistance (ULS)	0.5
Sliding (ULS)	0.8
Overturning (ULS)	0.5

Based on the data collected at or near the subject sites, it is recommended the foundations supporting both the rink structure and the sand shed be designed based on the unfactored ULS and SLS bearing resistance presented below:

- For the spread footing foundation system supporting the structure over the rink slab, which will be founded at a depth of 1.2 m below grade, use 600 kPa for the ULS bearing resistance and 250 kPa for the SLS bearing resistances.
- For the sand shed thickened monolithic slab-on-grade, bearing resistances of 300 kPa for ULS and 500 kPa for SLS can be used for design.
- A Subgrade Modulus value was also calculated based on the site preparation and 4.5 MPa/m can be used for slab design.

4.3.3 Seismic Site Classification

NBCC 2015 requires that a seismic site classification be established for seismic design of new or existing structures. Design is generally based on the soil properties within the top 30 m when determining site stiffness. For the 5 Mile Reserve, a Site Classification D, per Table 4.1.8.4.A in NBCC 2015 is considered appropriate.

4.4 Frost Protection

For frost heave to occur, there must be sub-zero temperatures, frost susceptible soils (which the tills at 5Mile Reserve are) and excess moisture in the soils underlying the foundation. To mitigate potential for frost related movement, one of these conditions must be eliminated. For northern communities where sub-zero temperatures can last six months of the year, the most effective solutions are to ensure the soils beneath the foundation elements don't become saturated and are protected with adequate soil cover or additional insulation. For the rink and sand shed structures, consider the following insulation recommendations.

- For the structure over the ice surface of the new rink, the spread footings founded at 1.2 m should be protected with 100 mm of moisture resistant, backfillable rigid insulation that extends 1.2 m out from each of the pedestals. The insulation can be placed across the top of the spread footings and should be placed on a slight angle so that surface water is shed away from the spread footings and pedestals.

- For the ice surface slab, 100 mm of insulation should be placed under the slab and near the top of the engineered fill. The ideal elevation would be under the 25 mm crushed basecourse. This insulation should extend 1.2 m out beyond the slab to not only slow down seasonal frost penetration, but to also ensure that any surface water is shed away from the engineered fill.
- The sand shed will be an unheated structure with a shallow foundation system so it would be ideal if it was protected with the same amount of insulation as recommended for the ice surface slab.

4.5 Site Grading

Positive drainage away from foundations is always important. Both the new rink site and the sand shed site are fairly flat so it is important to ensure that site grading directs surface water away from all foundation elements.

4.6 Concrete

It is recommended that F-2 exposure class concrete be specified for the spread footings supporting the roof structure over the ice surface slab. For F-2 concrete, a minimum 28-day compressive strength of 25 MPa is recommended, and all concrete placed should have 4% to 7% entrained air.

For the pedestals, 30 MPa concrete is recommended and since it will be exposed to numerous freeze thaw cycles, it is suggested that 5% to 7% entrained air be targeted.

N-CF exposure class concrete is often specified for ice surface slabs. This exposure class implies natural air only, allowing for a steel troweled surface. For arenas with ice plants, the slab is dry and frozen before flooding begins and after the season is over, the ice is typically removed as the slab begins to thaw. What this implies is that there is only one freeze thaw cycle per year and the concrete is not allowed to become saturated. For outdoor rinks, there is potential for numerous freeze thaw cycles and unless it is completely enclosed, exposure to wet weather may result in portions of the slab becoming wet or even saturated in the shoulder season just before flooding starts. Under these conditions, a steel troweled slab surface may not hold up as well in the long term and if damage occurs, surface repairs are difficult and not very attractive. To ensure additional long-term durability, it may be preferable to specify a F-1 exposure class (subject to freeze thaw in a saturated condition) and tighten up the entrained air requirement to between 4% and 6%) so that a sufficiently smooth finish can be achieved (for basketball and other summer activities). Additional conversation with TRTFN is suggested to ensure that the objectives are clear in advance of tendering the project.

For the thickened monolithic slab-on-grade at the sand shed site, there is potential for the sand to have chlorides mixed in with the sand (this keeps the pile live during cold weather). The slab will be exposed to freezing and thawing and since there is potential for chloride attack, a C-1 exposure class should be considered. 35 MPa concrete with 5% to 8% entrained air should ensure long term durability.

4.7 Construction Inspection and Quality Control Testing

We recommend that Tetra Tech be retained to provide the following inspection and quality control testing services during construction of both the rink and sand shed structures:

- Excavation inspection(s) to confirm that the conditions encountered at the base of all excavations (ice surface sub-cut and spread footing excavations at the rink site and the sub-cut at the sand shed site) are as anticipated and to confirm proper base preparation.

- Compaction testing of engineered fill placed beneath the concrete foundation elements prior to pouring concrete as well as backfill after the foundation elements have reached adequate strength.
- Concrete testing of concrete placed on both sites, including on-site air and slump testing and casting of test cylinders for compressive strength testing in Tetra Tech's Whitehorse laboratory.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of ISL Engineering & Land Services 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 ISL Engineering & Land Services, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix.

ATTACHMENTS

General Location Google Image Showing Location of the New Rink Site and the Sand Shed Site

Site Plan and Testhole Logs Along Taxgoon Road in Front of The New Rink Site

Site Plan, Testpit Logs and Accompanying Lab Data for the Truck Garage Site Where the Sand Shed Will Be Constructed

5 Mile Reserve - General Location Map

Location of New Rink Site and Sand Shed Site
Client: ISL Engineering and Land Services
Project Number: ENG.WARC04159-01

Legend



Google Earth

Image © 2022 Maxar Technologies



2000 ft

Scale: 1:1,250 @ 8.5"x11"
0 50m



PROJECT NO.	ENG.WARC04159-01
DWN	CB
MCP	CKD
REV	0
DATE	February 4, 2022
OFFICE	EBA-WHSE

Figure 1

ISL Engineering and Land Services

- LEGEND
- ◆ - BOREHOLE LOCATION
 - ⊕ - TESTPIT LOCATION

CLIENT

5 MILE RESERVE ARENA
ATLIN, BRITISH COLUMBIA

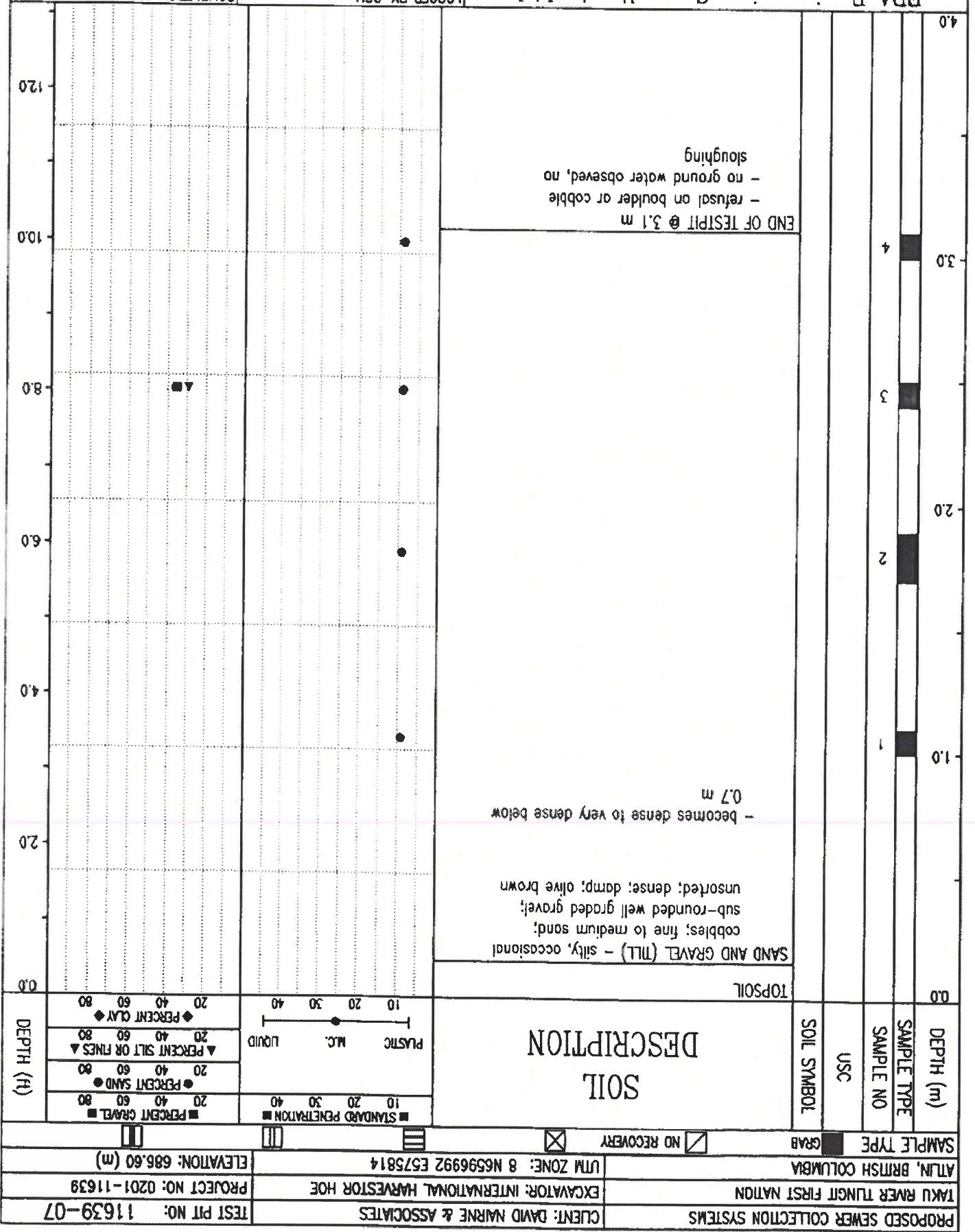
SITE PLAN SHOWING TESTHOLE LOCATIONS FROM 1994
GEOTECHNICAL EVALUATION ALONG TAXGOON ROAD



EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: CRH
REVIEWED BY: CRH
Fig. No.:

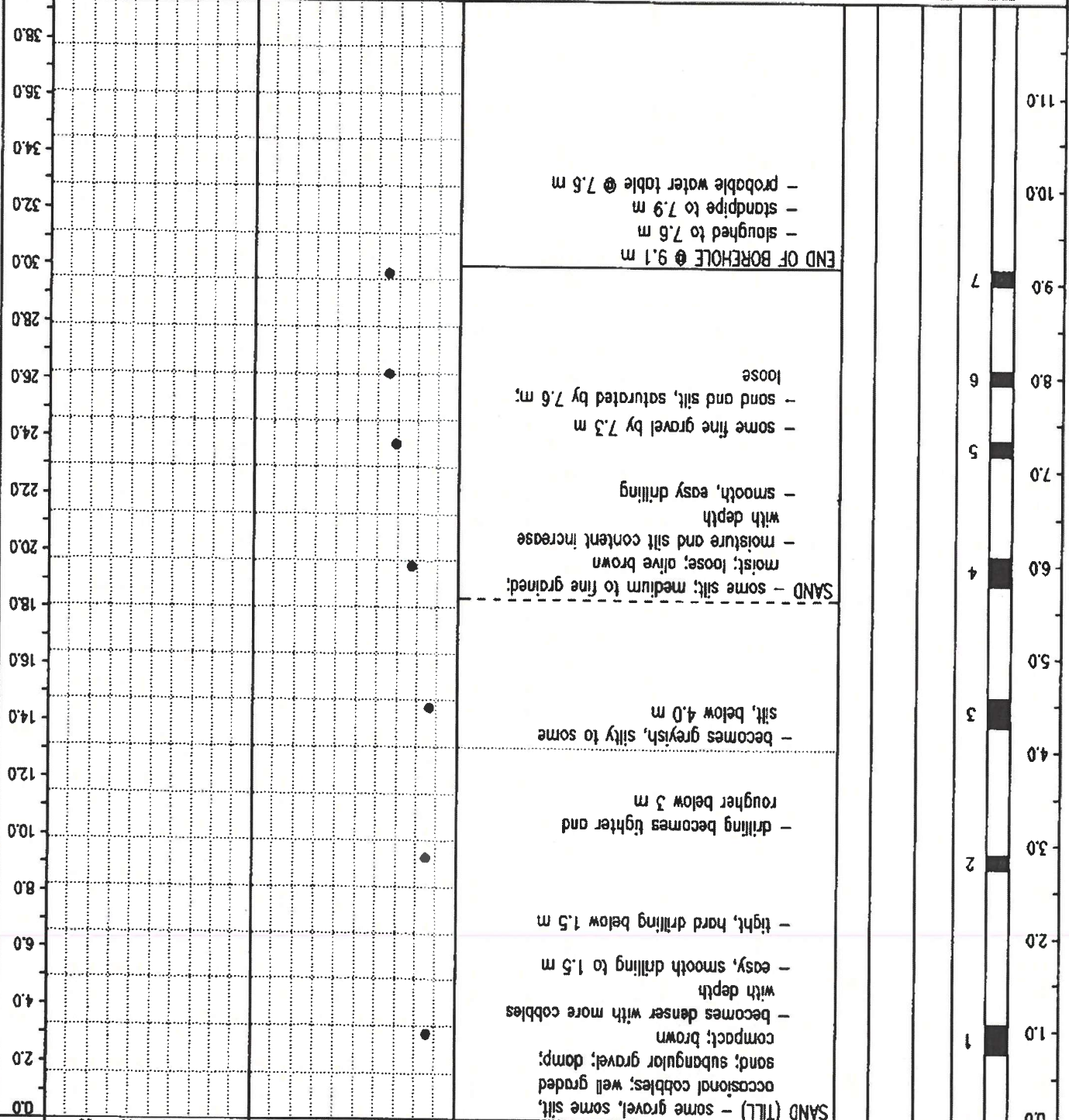
COMPLETION DEPTH: 3.1 m
COMPLETE: 21/10/94
Page 1 of 1



PROPOSED SEWER COLLECTION SYSTEMS
CLIENT: DAVID NARNE & ASSOCIATES
TEST PIT NO: 11639-07
TAKU RIVER TUNGST FIRST NATION
EXCAVATOR: INTERNATIONAL HARVESTER HOE
ATLUN, BRITISH COLUMBIA
UTM ZONE: 8 N6596992 E575814
ELEVATION: 686.60 (m)
PROJECT NO: 0201-11639
SAMPLE TYPE: GRAB
NO RECOVERY

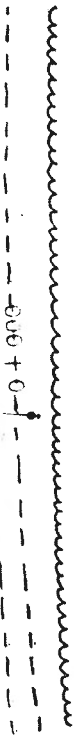
EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: CRH
REVIEWED BY: CRH
COMPLETE: 12/12/94
Page 1 of 1



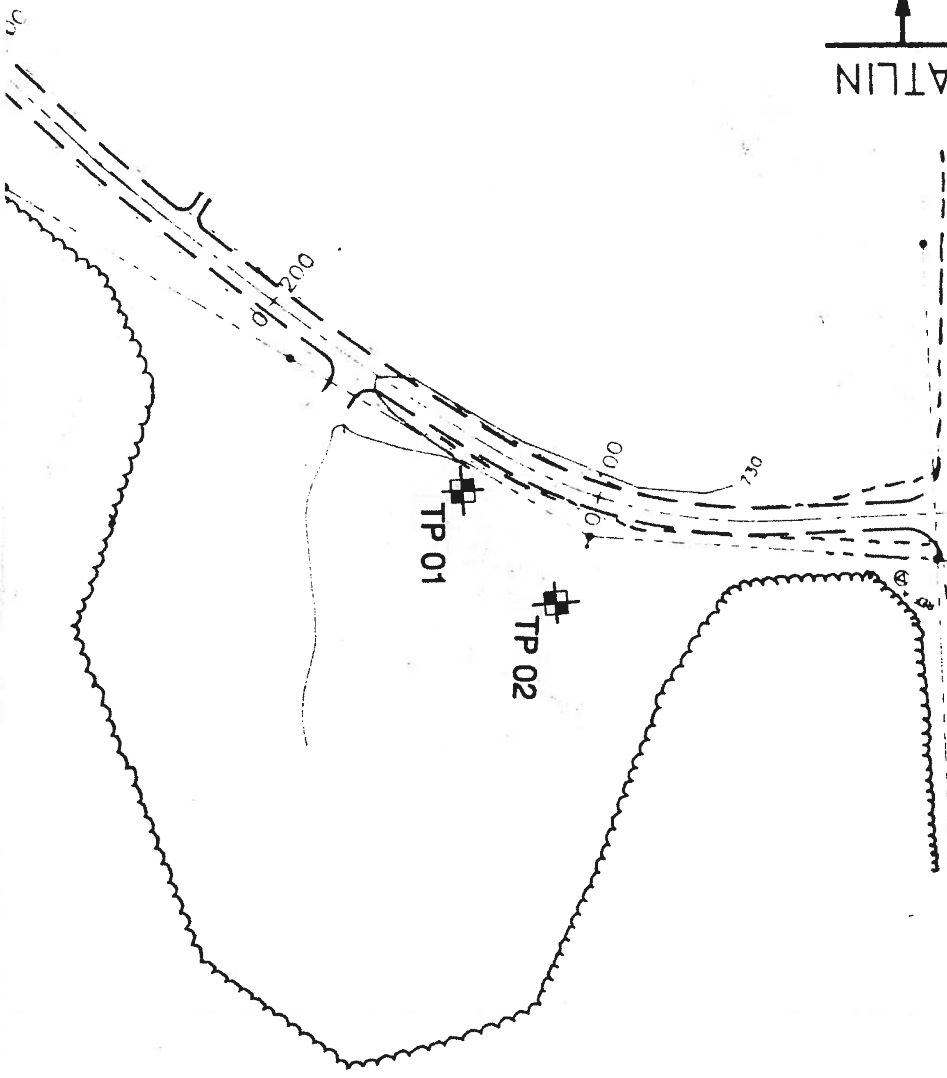
PROPOSED SEWER COLLECTION SYSTEMS	CLIENT: DAVID NARNE & ASSOCIATES	BOREHOLE NO: 11639-BH16
TAKU RIVER TUNGT FIRST NATION	DRILL: CME-75 C/W SOLID SHAFT	PROJECT NO: 0201-11639
ATL'N, BRITISH COLUMBIA	UTM ZONE: 8 N6597010 E575730	ELEVATION: 685.60 (m)
SAMPLE TYPE	<input checked="" type="checkbox"/> STANDARD PEN. <input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE BARREL <input checked="" type="checkbox"/> CORE
SAMPLE TYPE	GRAB	
SPT(N)		
USC		
SOIL SYMBOL		
DEPTH (m)		
SAMPLE TYPE		
SAMPLE NO		

↑ ↑
TO ATLIN



WARM BAY ROAD

ATLIN LAKE



TP 01

TP 02

←
NORTH

FIVE MILE RESERVE

EBA Engineering Consultants Ltd.

PROJECT
NEW TRUCK GARAGE ATLIN, B.C.

CLIENT
TAKU RIVER TLINGITS FIRST NATION

TITLE
SITE PLAN SHOWING TESTPIT LOCATIONS

DATE
20/06/96

DWN
JLD

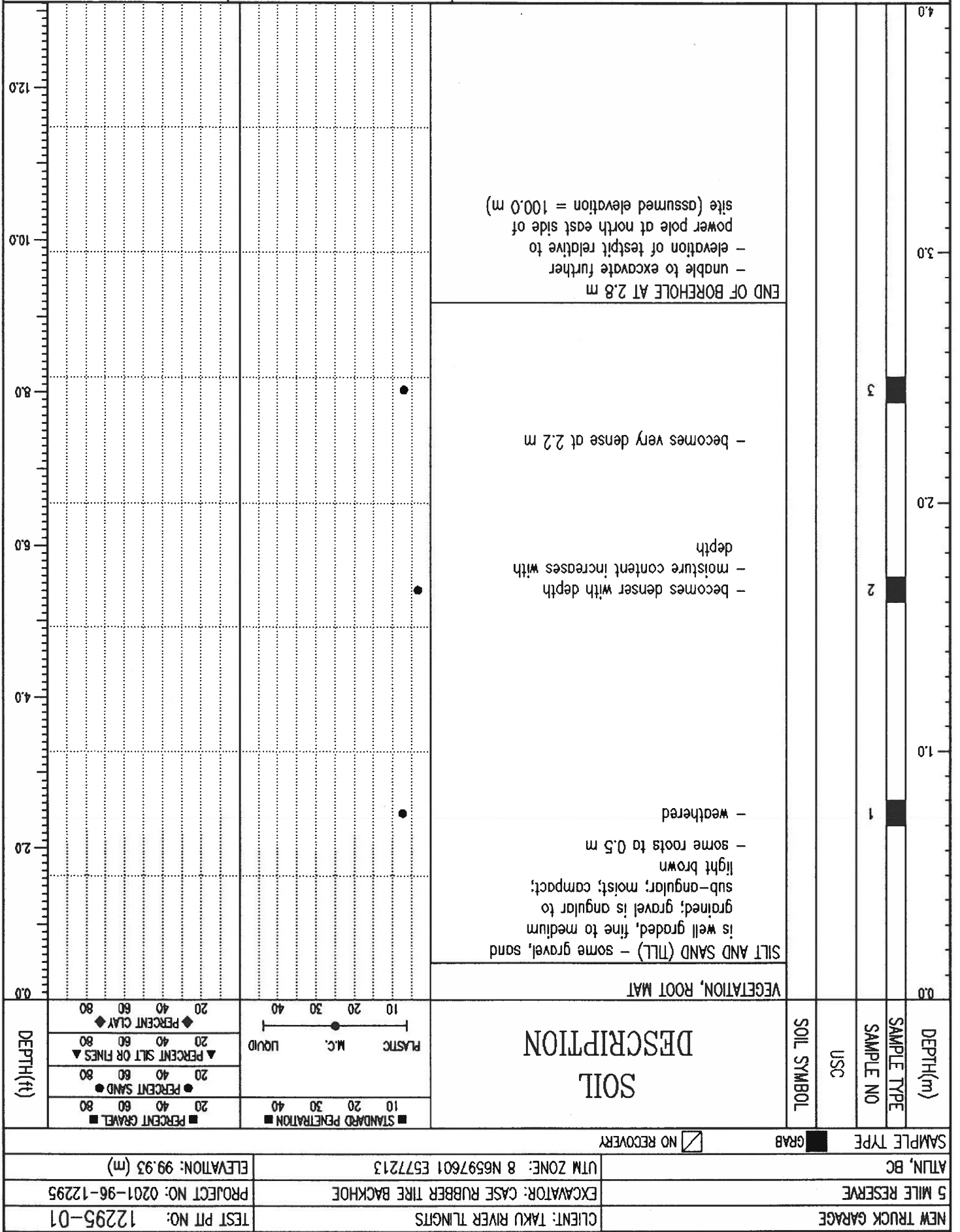
CHKD

DWG NO.
0201-96-12295

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: JLD
REVIEWED BY: JLD
Fig. No.:

COMPLETION DEPTH: 2.8 m
COMPLETE: 96/06/05



NEW TRUCK GARAGE	CLIENT: TAKU RIVER TUNGITS	TEST PIT NO: 12295-01
5 MILE RESERVE	EXCAVATOR: CASE RUBBER TIRE BACKHOE	PROJECT NO: 0201-96-12295
ATLIN, BC	UTM ZONE: 8 N6597601 E577213	ELEVATION: 99.93 (m)
SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> NO RECOVERY

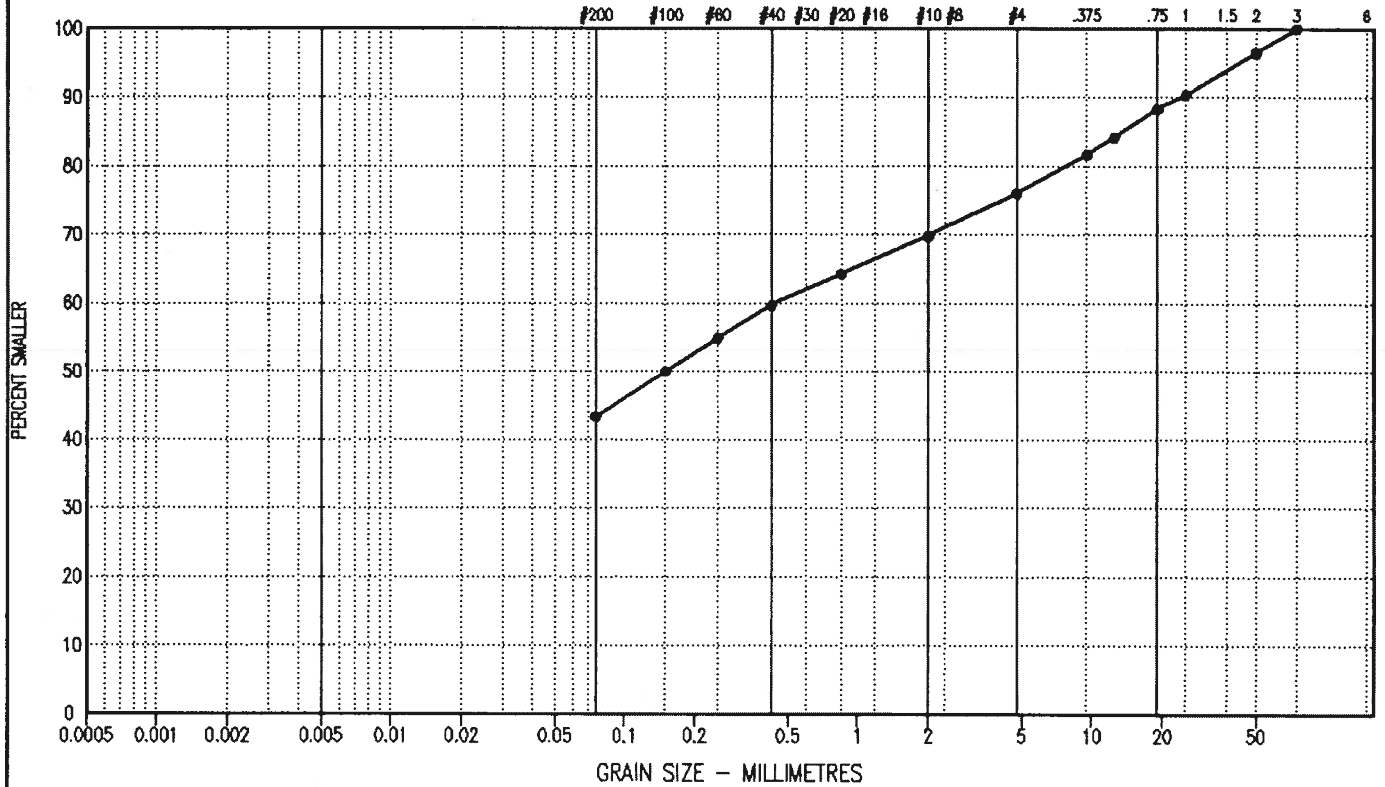
SOIL DESCRIPTION

STANDARD PENETRATION
 PERCENT GRAVEL
 PERCENT SAND
 PERCENT SILT OR FINES
 PERCENT CLAY
 PLASTIC M.C.
 LIQUID

PARTICLE SIZE - ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE

U.S. STANDARD SIEVE SIZES



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●—●	12295-01	2.40 - 2.50	43.2	32.8	24.0	26.3	0.3	SM

Project: 0201-96-12295

Date Tested: 96/06/10

BY: JLD

Tested in accordance with ASTM D422 unless otherwise noted.

Data presented herein is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA

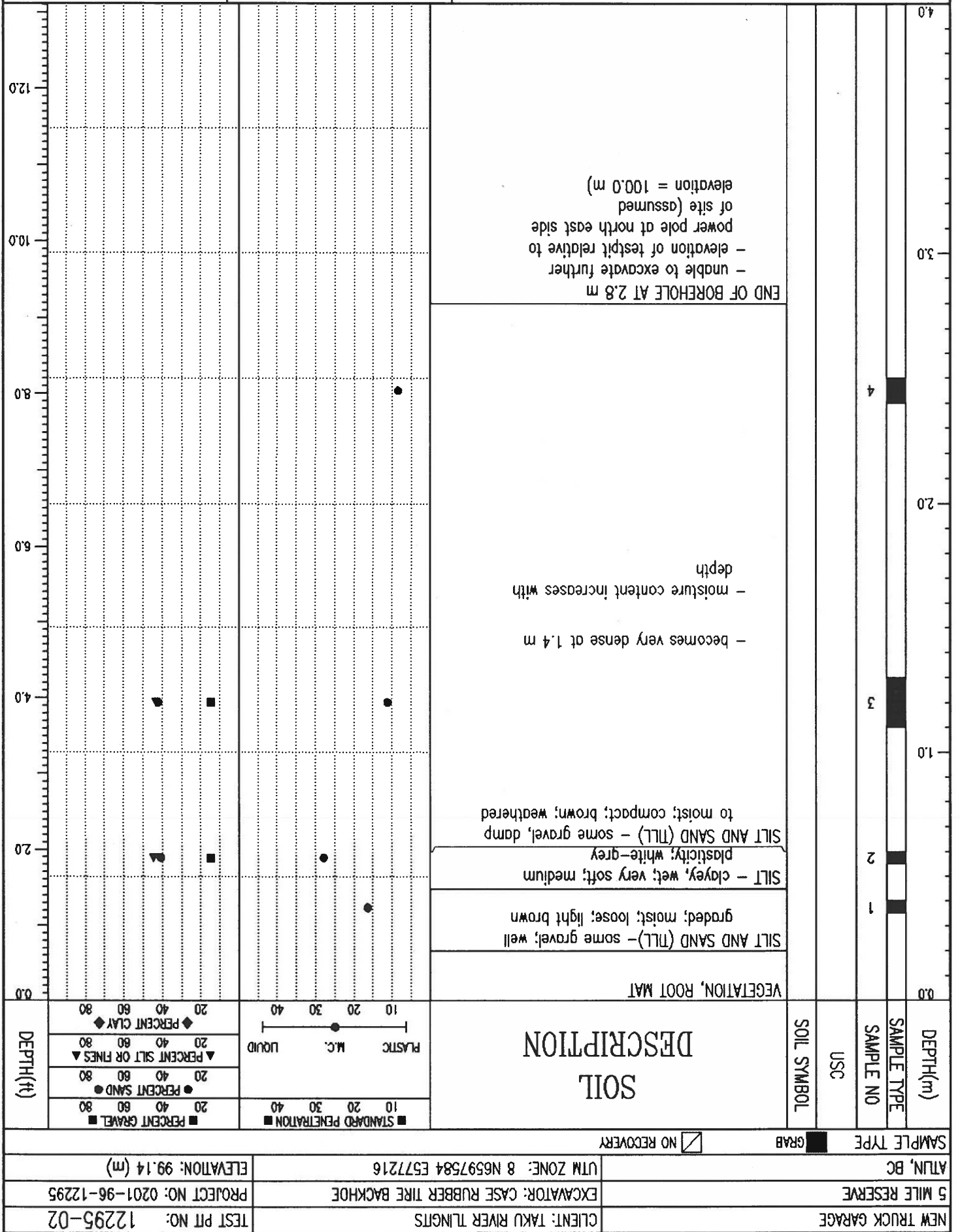
The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.



EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: JLD
REVIEWED BY: JLD
Fig. No:

COMPLETION DEPTH: 2.8 m
COMPLETE: 96/06/05

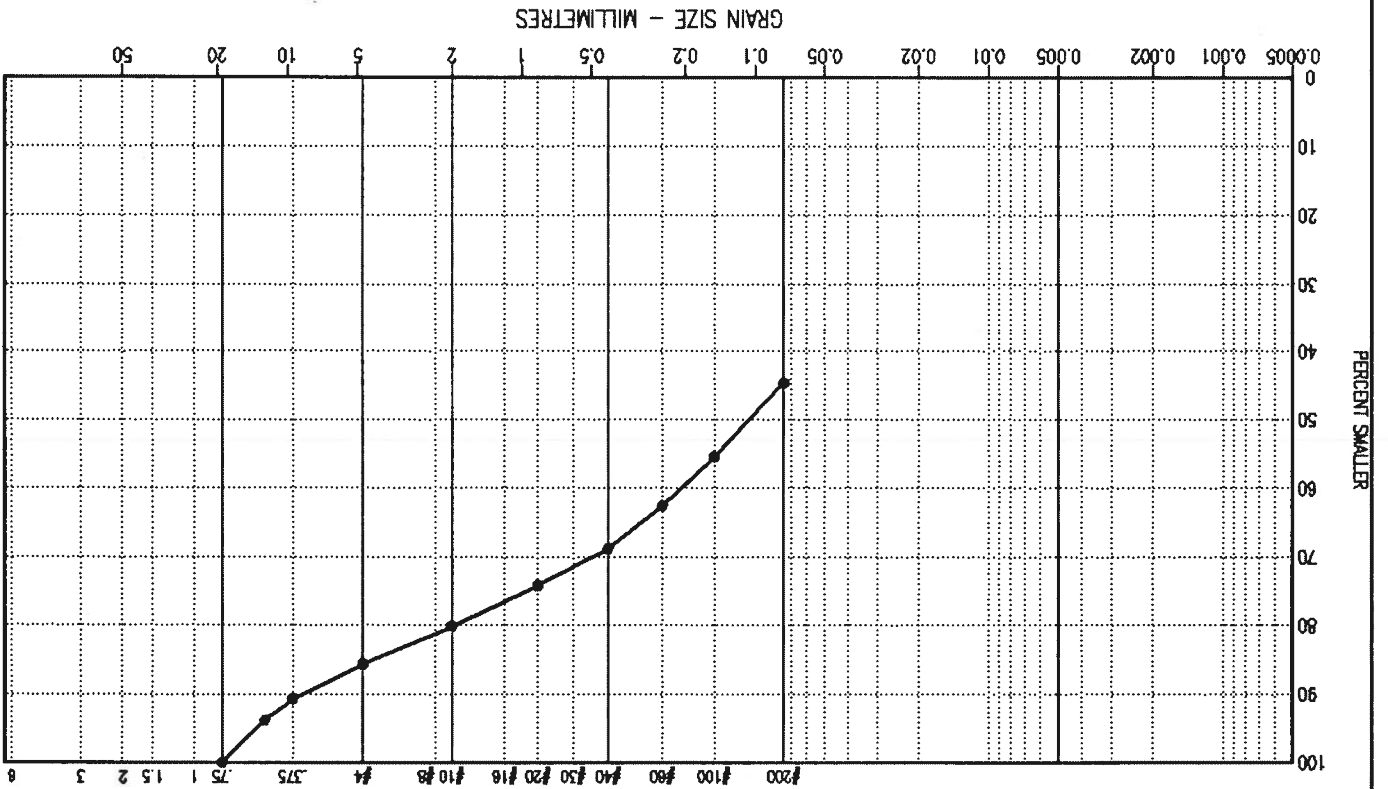


DEPTH (ft)	STANDARD PENETRATION		PERCENT GRAVEL		PERCENT SAND		PERCENT SILT OR FINES		PERCENT CLAY	
	10	20	20	40	20	40	20	40	20	40
0.0 - 0.5	10	20	20	40	20	40	20	40	20	40
0.5 - 1.0	10	20	20	40	20	40	20	40	20	40
1.0 - 1.5	10	20	20	40	20	40	20	40	20	40
1.5 - 2.0	10	20	20	40	20	40	20	40	20	40
2.0 - 2.8	10	20	20	40	20	40	20	40	20	40

PARTICLE SIZE - ANALYSIS OF SOILS

CLAY	SILT	SAND	GRAVEL
		FINE	FINE
		MEDIUM	COARSE
		COARSE	COARSE

U.S. STANDARD SIEVE SIZES



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
12295-TP02	0.35 - 0.40	44.6	40.9	14.5	12.7	0.7	SM	

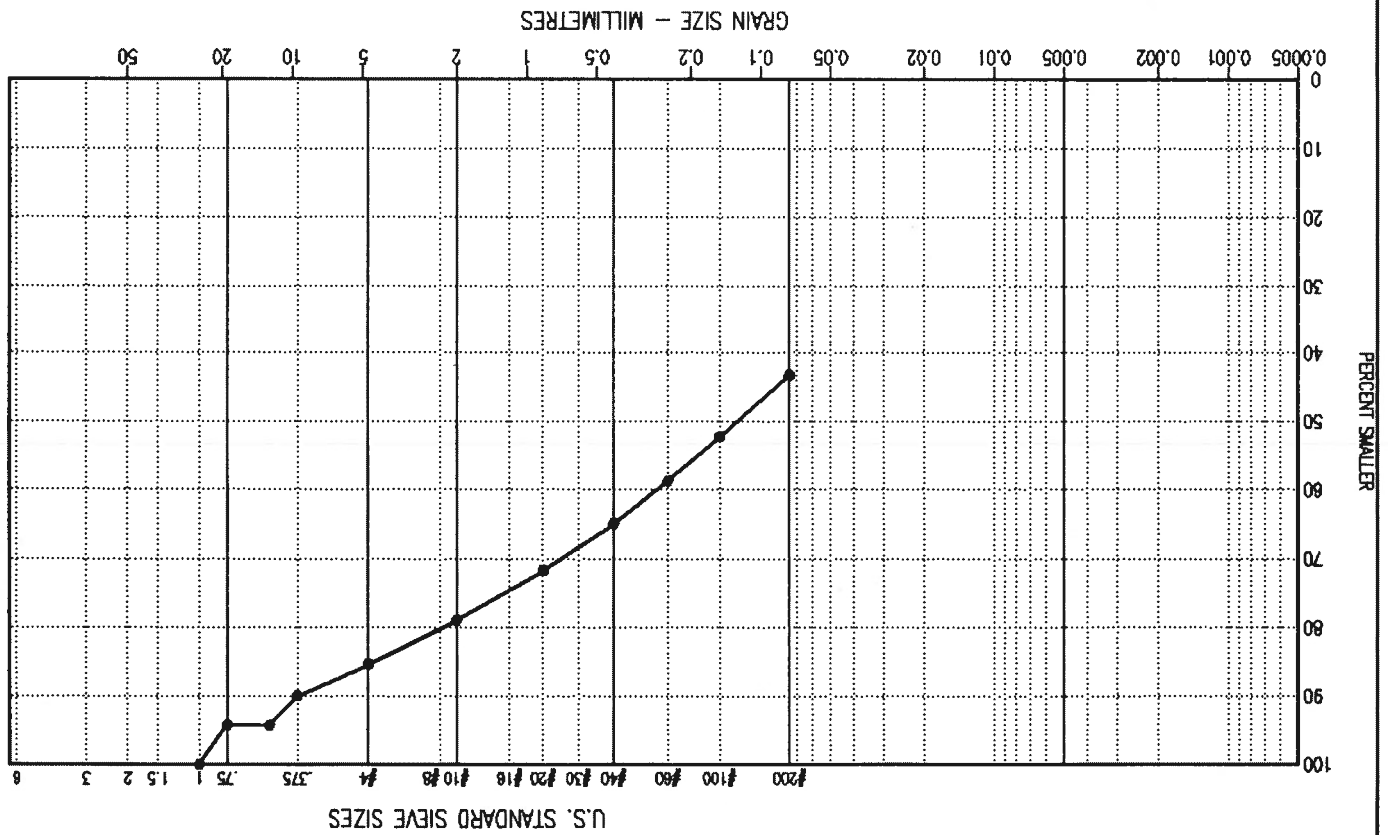
Project: 0201-12295 Date Tested: 96/05/12 BY: JLD

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.



PARTICLE SIZE - ANALYSIS OF SOILS

CLAY	SILT	SAND	GRAVEL
		FINE	FINE
		MEDIUM	COARSE
		COARSE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			GRAVEL %	SAND %	CLAY & SILT %			
●—●	12295-TP02	1.10 - 1.30	14.8	42.0	43.2	16.5	0.5	SM

Project: 0201-12295
 Date Tested: 96/06/12
 BY: JLD

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of, specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.



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.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

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.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

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.