TETRA TECH EBA

August 14, 2014

ISSUED FOR USE
FILE: W14103422-01
Via Email: zubair.qureshi@gov.yk.ca

Government of Yukon
Highways and Public Works
Property Management Division
2nd Floor, 9010 Quartz Road
PO Box 2703
Whitehorse, YT Y1A 2C6

**Attention:** Zubair Qureshi, Project Manager

**Subject:** Geotechnical Evaluation
St. Elias Adult Group Home, Whitehorse, YT

# 1.0 INTRODUCTION

Tetra Tech EBA Inc. (EBA) was retained by the Government of Yukon (YG) to complete a geotechnical testpitting program and provide geotechnical recommendations for the design and construction of foundations for the proposed new St. Elias Adult Group Home. Authorization to proceed was provided by Mr. Zubair Qureshi of YG by way of a signed contract, received by EBA on June 26, 2014. An increase in the project scope to include environmental testing for potential contaminated soil at the site was approved by way of a signed change order by Mr. Philip Christensen of YG, received by EBA on July 18, 2014.

## 1.1 Project Background

We understand that YG is contemplating construction of a new adult group home facility on three currently vacant lots in the southwest part of downtown Whitehorse, YT. Based on discussion with YG and potential site plans provided with YG's Service Request, we understand that the building location(s) have not been finalized but that the project will consist of one or more one to two-storey residential buildings.

## 1.2 Project Location

The property identified for the proposed St. Elias Adult Group Home is located approximately at the 6 Avenue right-of-way between Jeckell and Hoge Streets in Whitehorse, YT, on Lots 5, 6 and 7, Block N, Plan 53251 CLSR YT, and potentially within the 6 Avenue and Hoge Street right-of-ways.

The project site can be found on NTS Mapsheet 105-D/11 at approximate UTM coordinates of 6,730,780 N and 496,970 E in Zone 8V.

# 2.0 TESTPITTING PROGRAM

Arctic Backhoe Services Ltd. of Whitehorse was retained to complete a testpitting program at the site to describe the soil profile and to collect disturbed soil samples for geotechnical and environmental testing. A total of three testpits, W14103422-TP01 though -TP03 (herein referred to as TP01 through TP03), were excavated at the site using a Cat 420E backhoe. Testpit locations are shown on the attached Figure 1. Each testpit was excavated to the maximum reach of the backhoe, about 4 m below ground surface.



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The testpits were logged in the field by an experienced geotechnical engineer and representative disturbed samples were collected and returned to our Whitehorse laboratory for routine moisture content testing, with particle size testing carried out on selected samples.

Environmental field screening was also conducted using a photoionization detector (PID) and representative disturbed samples were collected and submitted to ALS Ltd. (ALS) in Whitehorse for hydrocarbon, heavy metals and glycols testing in ALS's Vancouver laboratory.

Upon completion, each testpit was backfilled using the excavated soil.

# 3.0 SITE CONDITIONS

## 3.1 Soil Stratigraphy

The results of our testpitting program are summarized below on Table 1 and in the testpit logs, attached in Appendix B. Please note that the attached testpit logs contain detailed information describing the geotechnical conditions at the site, and should be used in preference to the generalized descriptions provided below.

The soil profile observed in the testpits was generally consistent between each of the three testpit locations. A thin layer of organics (topsoil) was encountered at ground surface overlying a silt and sand layer of variable thickness that extends to 0.7 to 2 m depth. Below the silt and sand, a sand and gravel layer was encountered, also of variable thickness and ranging from sandy gravel at TP03 to sand and gravel at TP01. Moderately plastic clayey silt was encountered below the sand and gravel layer at 2 to 3 m depth. Each testpit was terminated within the silt.

In general, it is difficult to reliably assess the consistency of in situ soils during testpitting, particularly for granular soils. However, minimal sloughing of the testpit sidewalls was observed during excavation, suggesting that the near surface granular soils are nominally compact. Based on field estimates, the clayey silt is considered to be of "stiff" consistency.

**Table 1: Summary of Soil Stratigraphy.**

| Soil Type | Depth of Soil Unit (m) | | |
|---|---|---|---|
| | TP01 | TP02 | TP03 |
| ORGANICS | 0 – 0.2 | 0 – 0.3 | 0 – 0.2 |
| SILT and SAND | 0.2 – 2.0 | 0.3 – 0.7 | 0.2 – 2.0 |
| SAND and GRAVEL | 2.0 – 2.5 | 0.7 – 2.2 | 2.0 – 3.0 |
| Clayey SILT | 2.5 – 4.2 | 2.2 – 4.0 | 3.0 – 4.2 |
| End of Testpit | 4.2 | 4.0 | 4.2 |

Based on the results of particle size testing conducted on recovered samples, all of the soils encountered are considered to be frost susceptible with the exception of the sand and gravel layer, which appears to have a negligible fines content (<5% passing the #200 sieve).

## 3.2 Groundwater Conditions

No seepage of groundwater was observed in any of the testpits during excavation. However, wet soil was encountered at about 2 m depth in TP02, near the base of the gravel and sand layer. The underlying silt was observed to be moist, but relatively dry compared to the overlying gravel and sand. This is likely indicative of a perched groundwater table lying above the relatively impermeable silt layer at depth.

## 3.3 Results of Environmental Testing

YG advised that the site has been used historically as a rail yard, and that there is potential for contamination due to hydrocarbons and/or heavy metals. As such, an environmental testing program was completed using samples collected during the testpitting program.

As noted above, a PID was used in the field as a preliminary check of hydrocarbon contamination of recovered soil samples. The PID measures the ionizable components of organic vapours and provides a semi-qualitative indication of hydrocarbons present in the soil. Samples for headspace vapour screening were placed in plastic bags, sealed and allowed to volatilize. Vapour concentrations were then measured in parts per million (ppm). No indications of hydrocarbon contamination were detected through field screening in any of the samples collected.

Representative disturbed soil samples were also forwarded to ALS's Vancouver laboratory and tested for the following parameters: hydrocarbons (including: light extractable hydrocarbons, heavy extractable hydrocarbons, volatile hydrocarbon, polycyclic aromatic hydrocarbons and volatile organic compounds), metals and glycols. Three samples were collected from three discrete testpits. Samples were taken from depths of 1.0 to 1.1 m in TP01, 1.5 to 1.6 m in TP02 and 1.4 to 1.5 m in TP03.

The analytical results for soil analyses that are discussed in this report are compared with applicable numerical and matrix standards that are established in the *Yukon Environment Act, Contaminated Sites Regulations 2002/171* as well as sampling and analytical methods and standards described in Protocols 1, 2, 3, 5, 7 and 9. The standards that apply to the subject property are discussed below.

The site is in use as a residential site, and in the future is expected to continue in and be expanded in this function. Therefore, the CSR residential land use generic and matrix numerical soil standards have been compared with the soil analytical results. Generic numerical soil standards are listed in YCSR Schedules 1 and matrix-based numerical soil standards are listed in YCSR Schedule 2. By default, for the matrix numerical standards, the following site-specific exposure factors are considered to apply to all residential, commercial and industrial sites:

- Human Health Protection – Intake of contaminated soils; and
- Environmental Protection – Toxicity to soil invertebrates and plants.

Matrix numerical soil standards for groundwater quality protection depend on groundwater use and site-specific factors that consider contaminant migration routes and potential routes for human or environmental exposure to contaminants in groundwater. For the property, the following site-specific factors are considered to apply:

- Environmental Protection – Groundwater flow to surface water used by freshwater aquatic life.

Soil samples collected contained concentrations of all analyzed parameters that were less than the applicable CSR standards for residential land use.

Results of the environmental laboratory testing are provided in Appendix C.

# 4.0 RECOMMENDATIONS

Based on discussion with YG, we understand that the preferred foundation system is a structural slab-on-grade with integrated thickened spread and strip footings. As such, recommendations for the design and construction of the preferred foundation system are provided below.

## 4.1 Site Preparation

Because frost susceptible soils are present within the depth of seasonal frost penetration, installation of perimeter insulation and/or subexcavation and replacement of frost susceptible soil with non-frost susceptible granular fill will be required. As such, site preparation for construction of building foundations should be completed in accordance with the following recommendations:

- The topsoil and silt and sand at the site should be subexcavated from within the building footprint, plus an additional 1 m on all sides, to a depth of at least 0.5 m below the underside of footing elevation;
- Prior to backfilling, the base of the subexcavation should be inspected by a qualified geotechnical engineer to confirm that all organic or otherwise deleterious material has been removed. If significant organics or other unsuitable materials remain at the base of the subexcavation, removal of additional material will be required;
- Prior to backfilling, the exposed subgrade should be nominally recompacted to provide a stable bearing surface on which to place and compact backfill material. If the subgrade is soft and/or wet, it should be covered with a non-woven geotextile filter fabric prior to backfilling to prevent excessive disturbance to the subgrade during placement and compaction of backfill;
- Subexcavations should be backfilled with non-frost susceptible pit run gravel, placed in maximum 200 mm thick lifts, moisture conditioned and compacted to minimum 98% Standard Proctor Maximum Dry Density (SPMDD). The recommended gradation of pit run gravel is shown on Table 2;
- A minimum 150 mm thick bearing layer of 20 mm crushed base course gravel should be placed immediately below the underside of all footings or slab thickenings, moisture conditioned and compacted to 98% SPMDD to provide a smooth, level surface on which to cast concrete foundation elements. The recommended gradation of 20 mm crushed base course gravel is shown on Table 2;

**Table 2: Recommended Gradation for Granular Fill Materials**

| Pit Run Gravel | | 20 mm Crushed Base Course | |
|---|---|---|---|
| **Particle Size (mm)** | **% Passing (by weight)** | **Particle Size (mm)** | **% Passing (by weight)** |
| 80 | 100 | - | - |
| 25 | 55 – 100 | 20 | 100 |
| 12.5 | 42 – 84 | 12.5 | 64 – 100 |
| 5.00 | 26 – 65 | 5.00 | 36 – 72 |
| 1.25 | 11 – 47 | 1.25 | 12 – 42 |
| 0.315 | 3 – 30 | 0.315 | 4 – 22 |
| 0.080 | 0 – 8 | 0.080 | 3 – 6 |

- As noted above, the exact location of the structure has not yet been determined and therefore it is possible that the building location may overlie one or more of the backfilled testpits. If loose testpit backfill is encountered within the building footprint during subexcavation, we recommend that an additional 0.5 m be removed and replaced with compacted pit run gravel; and
- The ground elevation at finished grade should be at least 300 mm above the surrounding grade to maintain positive drainage away from the building foundations.

## 4.2 Foundation Recommendations

### 4.2.1 Limit States Design

The 2010 edition of the *National Building Code of Canada* (NBCC 2010) stipulates that foundation design must be conducted using Limit State Design (LSD) methods. Under LSD, two loading cases must be considered by geotechnical and structural designers: 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 the soil can withstand without suffering bearing failure. The allowable SLS bearing pressure is the pressure required to limit settlement to a tolerable amount. Both ULS and SLS resistances are highly dependent on soil properties, footing size and shape, and burial depth.

Additionally, under LSD, 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 bearing failure (ULS) and horizontal (sliding) displacement are provided below on Table 3, per Table 6.1 of the *Canadian Highway Bridge Design Code* (CAN/CSA-S6-06). Per CAN/CSA-S6-06, SLS resistances should consider unfactored loads, and therefore no resistance factor is required.

**Table 3: Geotechnical Resistance Factors – Shallow Foundations**

| Item | Resistance Factor |
|---|---|
| Vertical Bearing Resistance (ULS) | 0.5 |
| Horizontal (Sliding) Resistance | 0.8 |

### 4.2.2 Foundation Recommendations

As noted above, a structural slab-on-grade with thickened spread and strip footings is the preferred foundation system for this project. Recommendations for design and construction of shallow foundations for the proposed structure are provided below:

- The term “shallow foundations” refers to thickened spread and/or strip footings within a structural slab-on-grade. For the purposes of geotechnical footing design, Tetra Tech EBA has assumed a footing thickness of 0.2 m and a depth of cover of 0.3 m from finished grade to the underside of footing. The bearing resistances provided below also assume that site preparation is completed in accordance with the recommendations provided in Section 4.1;
- Unfactored Resistances provided are based on minimum footing dimensions of 0.4 m for strip footings and 1.0 m for spread (square) footings. If significantly different footing sizes are preferred for this project, or if higher bearing resistances are required to support the building design loads, EBA should be retained to review and adjust the calculated bearing resistances, as necessary;

- Unfactored ULS and SLS bearing resistances of 200 and 300 kPa should be used for the design of strip and spread footings, respectively. SLS bearing resistances are calculated based on an allowable elastic settlement of 25 mm, which is generally sufficient to limit total and differential settlement to tolerable levels for typical building projects;

- Concrete foundation elements should be cast onto a clean, compacted, granular surface. It is important that no loose and/or disturbed material be allowed to remain on the bearing surface. As discussed above in Section 4.1, foundation bearing surfaces should consist of crushed base course gravel, moisture conditioned and compacted to a minimum of 98% SPMDD;

- Because the base of the subexcavation is expected to terminate in frost susceptible silt and sand over most of the building footprint, insulation must be installed around the perimeter of the building to protect the subgrade soils from potential frost action. Recommended insulation details are shown schematically on Figure 2. Alternatively, insulation can be omitted if the depth of subexcavation is extended to the lesser of 2.4 m or the top of the sand and gravel layer;

- The working area should be protected from the inflow of surface water at all times. Concrete foundation elements should not be cast onto saturated or seasonally frozen soil;

- As discussed above in Section 4.1, final site grading should direct all water away from the foundation elements of the structure. Ponding and/or infiltration of water adjacent to the building foundations should be prevented, as this could have detrimental effects on the performance of the foundation elements. Runoff from the roof should be directed onto splash pads and away from the building. This is particularly important in the late fall, just prior to freeze-up; and

- It is recommended that concrete placed during foundation construction be designed in accordance with CSA A23.1 requirements for F-2 exposure class concrete (30 MPa with 4-7% air entrainment). Any exterior concrete, such as sidewalks or aprons, should be design in accordance with CSA A23.1 requirements for C-2 exposure class concrete (32 MPa with 5-8% air entrainment). Since no aggregate reactivity issues are associated with aggregates used by the two main local suppliers, Type GU cement (no fly ash) is considered acceptable.

## 4.3 Seismic Site Classification

NBCC 2010 requires that a seismic site classification be established for proposed buildings. As such, we recommend that the site be considered as Site Class E, per Table 4.1.8.4A in NBCC 2010.

## 4.4 Site-Specific Slope Hazard Assessment

As described in our proposal, submitted in response to YG's Service Request on June 18, 2014, a site-specific slope hazard assessment is not included in the current project scope. However, based on email communications between YG and the City of Whitehorse (CoW), forwarded to EBA by YG, we understand that a site-specific slope hazard assessment will likely be required by CoW before approving the necessary development permits for this project.

As noted in our proposal, EBA has conducted numerous slope hazard assessments at similar sites along the silt bluffs in Whitehorse, and we would be pleased to provide a scope and cost estimate to complete a hazard assessment at the current project site once the requirement for such a study has been confirmed with CoW.

# 5.0 CONSTRUCTION TESTING AND MONITORING

All foundation design recommendations presented are site specific and based on the assumption that an adequate level of construction monitoring during foundation excavation and installation will be provided, and that all construction will be carried out by a suitably qualified, experienced contractor. An adequate level of construction monitoring also ensures the recommendations based on geotechnical data obtained at the test pit locations are applicable to the entire building site. Appropriate Quality Assurance and Quality Control (QA/QC) testing should be undertaken during construction to confirm that construction is completed in accordance with the recommendations provided in this report.

Furthermore, it is recommended that EBA be given the opportunity to review the details of the final design related to the geotechnical aspects of the building foundation, prior to construction. Past experience has shown that this action may prevent inconsistencies, poor performance, and/or increased costs that may lead to disputes.

# 6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of Yukon and their agents. Tetra Tech EBA Inc. (EBA) 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 the 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. Use of this report is subject to the terms and conditions stated in the signed contract and to EBA's General Conditions, which 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.

Respectfully submitted,
Tetra Tech EBA Inc.


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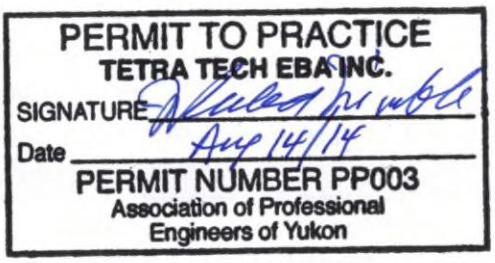


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/cr

# FIGURES


LEGEND

- TESTPIT LOCATION
- SUBJECT PROPERTY

0 50m

Scale: 1:1,000 @ 8.5"x11"

CLIENT

Yukon Government

TETRA TECH EBA

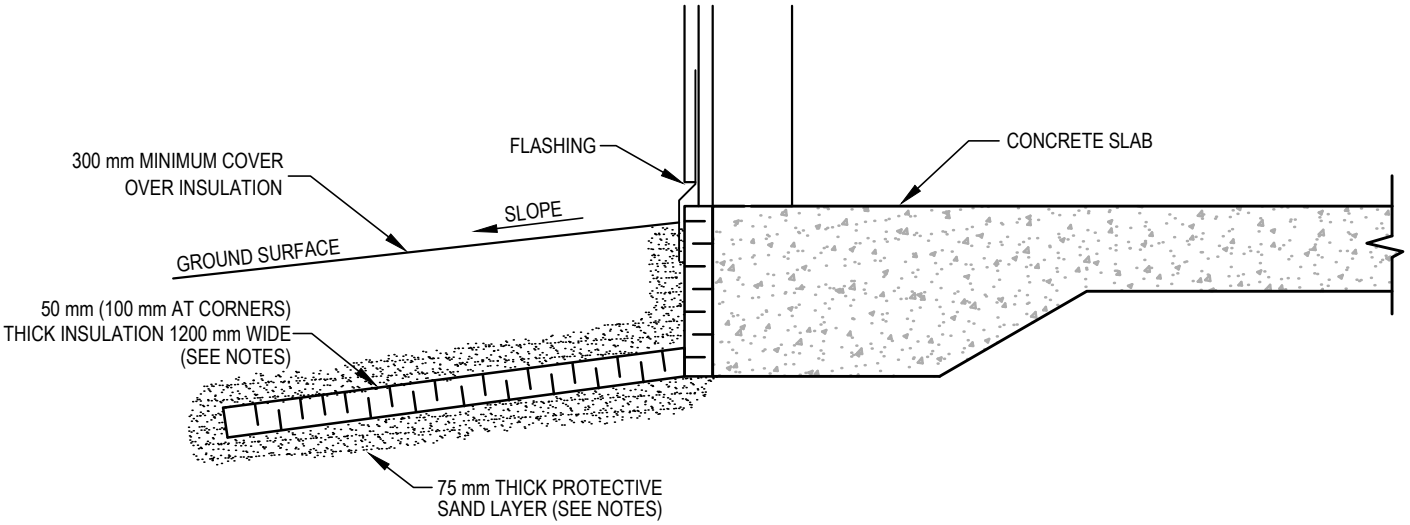
**ST. ELIAS GROUP HOME GEOTECHNICAL EVALUATION**
**WHITEHORSE, YUKON**

**SITE PLAN SHOWING TESTPIT LOCATIONS**

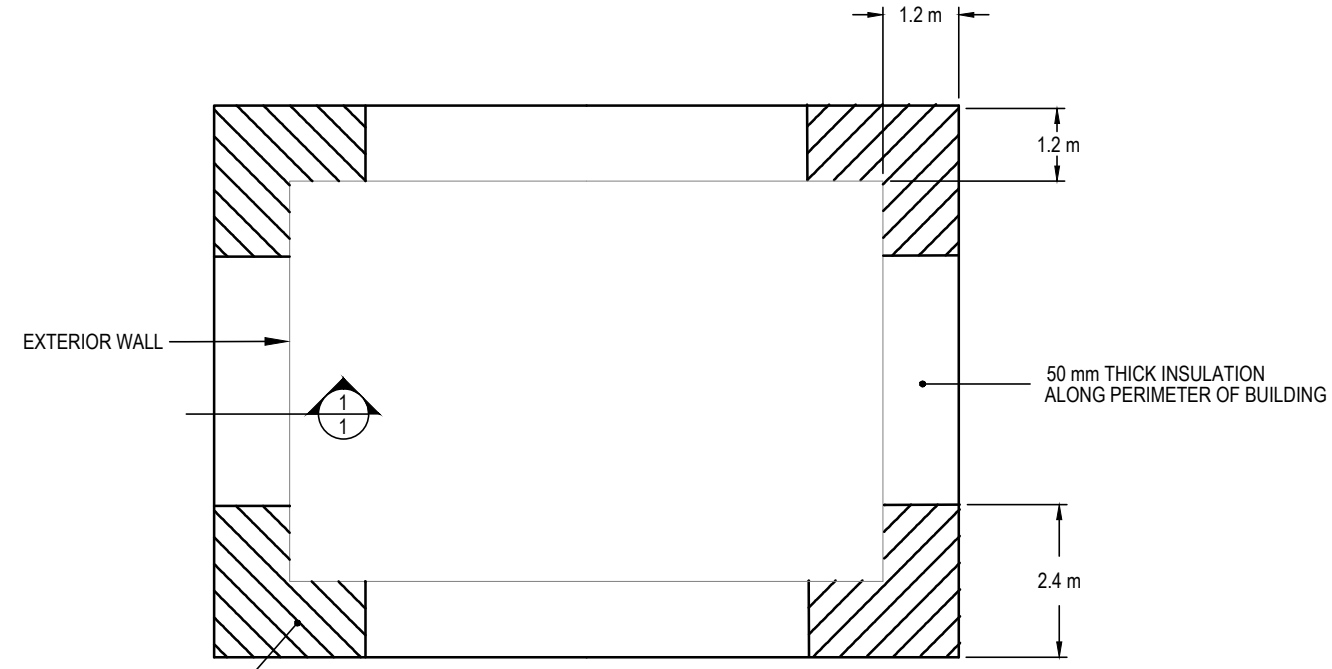
| PROJECT NO. | DWN | CKD | REV |
|---|---|---|---|
| W14103422-01 | CB | CPC | 0 |

| OFFICE | DATE |
|---|---|
| EBA-WHSE | July 25, 2014 |

**Figure 1**




1/1 SECTION
STRUCTURAL SLAB-ON-GRADE
N.T.S.




PLAN
N.T.S.

NOTES: THE INSULATION SHOULD BE MOISTURE RESISTANT AND SUITABLE FOR BURIAL (i.e. DOW CHEMICAL HI OR SM SERIES STYROFOAM OR POLYURETHANE).

A MINIMUM BEDDING THICKNESS OF 75 mm OF FINE TO MEDIUM SAND SHOULD BE PLACED ABOVE AND BELOW THE INSULATION FOR PROTECTION.

CLIENT

Yukon Government

TETRA TECH EBA

**ST. ELIAS GROUP HOME GEOTECHNICAL EVALUATION**
**WHITEHORSE, YUKON**

**SLAB ON GRADE PERIMETER INSULATION DETAILS**

| PROJECT NO. | DWN | CKD | REV |
|---|---|---|---|
| W14103422-01 | CB | AW | 0 |

| OFFICE | DATE |
|---|---|
| EBA-WHSE | July 31, 2014 |

**Figure 2**

# APPENDIX A
## TETRA TECH EBA'S GENERAL CONDITIONS

# GENERAL CONDITIONS

## GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

### 1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA’s Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA’s Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

### 2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

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

### 3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

### 4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods 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 EBA 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.

### 5.0 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.

### 6.0 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 historic environment. Tetra Tech EBA 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 investigation and review may be necessary.

## 7.0 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.

## 8.0 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.

## 9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and 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 are known.

## 10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as 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.

## 11.0 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 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.

## 12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses 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 assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

## 13.0 SAMPLES

Tetra Tech EBA 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.

## 14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

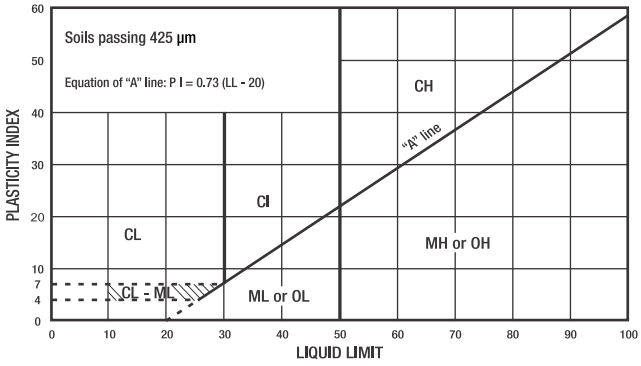
# APPENDIX B

## TEST PIT LOGS AND GEOTECHNICAL LABORATORY TESTING RESULTS

# MODIFIED UNIFIED SOIL CLASSIFICATION

| MAJOR DIVISION | | | GROUP SYMBOL | TYPICAL DESCRIPTION | LABORATORY CLASSIFICATION CRITERIA | | |
|---|---|---|---|---|---|---|---|
| COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve* | GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | Classification on basis of percentage of fines: Less than 5% Pass 75 µm sieve; More than 12% Pass 75 µm sieve; 5% to 12% Pass 75 µm sieve. 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 | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand-silt mixtures | | Atterberg limits plot below "A" line or plasticity index less than 4 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | Atterberg limits plot above "A" line or plasticity index greater than 7 | |
| | SANDS More than 50% of coarse fraction passes 4.75 mm sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | | $C_U = D_{60}/D_{10}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | |
| | | | SP | Poorly graded sands and gravelly sands, little or no fines | | Not meeting both criteria for SW | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | | Atterberg limits plot below "A" line or 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 or plasticity index greater than 7 | |
| FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve* | SILTS | Liquid limit <50 | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity | For classification of fine-grained soils and fine fraction of coarse-grained soils. | | |
| | | Liquid limit >50 | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | |
| | CLAYS Above "A" line on plasticity chart negligible organic content | Liquid limit <30 | CL | Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays | | | |
| | | Liquid limit 30-50 | CI | Inorganic clays of medium plasticity, silty clays | | | |
| | | Liquid limit >50 | CH | Inorganic clays of high plasticity, fat clays | | | |
| | ORGANIC SILTS AND CLAYS | Liquid limit <50 | OL | Organic silts and organic silty clays of low plasticity | | | |
| | | Liquid limit >50 | OH | Organic clays of medium to high plasticity | | | |
| HIGHLY ORGANIC SOILS | | | PT | Peat and other highly organic soils | | | |

PLASTICITY CHART




*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

## SOIL COMPONENTS

| FRACTION | SIEVE SIZE PASSING | SIEVE SIZE RETAINED | DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS: PERCENTAGE | DESCRIPTOR |
|---|---|---|---|---|
| GRAVEL | | | | |
| coarse | 75 mm | 19 mm | >35 % | "and" |
| fine | 19 mm | 4.75 mm | 21 to 35 % | "y-adjective" |
| SAND | | | | |
| coarse | 4.75 mm | 2.00 mm | 10 to 20 % | "some" |
| medium | 2.00 mm | 425 µm | | |
| fine | 425 µm | 75 µm | >0 to 10 % | "trace" |
| SILT (non plastic) or CLAY (plastic) | 75 µm | | as above but by behavior | |

## OVERSIZE MATERIAL

Rounded or subrounded

| | |
|---|---|
| COBBLES | 75 mm to 300 mm |
| BOULDERS | > 300 mm |

Not rounded

| | |
|---|---|
| ROCK FRAGMENTS | >75 mm |
| ROCKS | > 0.76 cubic metre in volume |

Tt_Modified Unified Soil Classification.cdr

TETRA TECH

# MOISTURE CONTENT TEST RESULTS

ASTM D2216

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | |
| Project No.: | W14103422-01 | Date Tested: | July 24, 2014 |
| Client: | YG - Highways and Public Works | Tested By: | AMT |
| Address: | Whitehorse, Yukon | Page: | 1 of 1 |

| B.H. Number | Sample Number | Moisture Content (%) | Visual Description of Soil |
|---|---|---|---|
| TP01 | SA01 | 10.4 | |
| | SA02 | 14.8 | |
| | SA03 | 19.2 | |
| | SA04a | 3.1 | |
| | SA04b | 23.4 | |
| | SA05 | 24.2 | |
| | SA06 | 25.3 | |
| | SA07 | 27.8 | |
| | | | |
| TP02 | SA01 | 11.4 | |
| | SA02 | 3.4 | |
| | SA03 | 2.7 | |
| | SA04 | 4.8 | |
| | SA05 | 26.3 | |
| | SA06 | 23.5 | |
| | SA07 | 22.7 | |
| | | | |
| TP03 | SA01 | 4.9 | |
| | SA02 | 23.5 | |
| | SA03 | 15.2 | |
| | SA04 | 3.4 | |
| | SA05 | 3.1 | |
| | SA06 | 23.4 | |
| | SA07 | 23.8 | |
| | SA08 | 23.9 | |

Reviewed By: _____ P.Eng.

| Geotechnical Evaluation | CLIENT: Government of Yukon | PROJECT NO. - TESTPIT NO. |
|---|---|---|
| St. Elias Adult Group Home | EXCAVATOR: Cat 420E Backhoe | W14103422-TP01 |
| Whitehorse, YT | 6730730N; 496972E; Zone 8 | |

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | GROUND ICE DESCRIPTION AND COMMENTS | BULK DENSITY (kg/m³) 1400 1600 1800 2000 / SPT (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80 | CLAY (%) 20 40 60 80 / SILT (%) 20 40 60 80 / SAND (%) 20 40 60 80 / GRAVEL (%) 20 40 60 80 | Depth (ft) |
|---|---|---|---|---|---|---|---|
| 0 | ORGANICS | | | UNFROZEN | | | 0 |
| | SILT - sandy, trace of subrounded gravel, well graded, dry, greyish brown | | | | | | |
| | | | SA01 | | | | |
| | - no gravel, damp, grey | | | | | | |
| 1 | | | SA02 | | | | |
| | - becomes moist | | SA03 | | | | 5 |
| 2 | SAND and GRAVEL - trace of silt, well graded, rounded gravel, moist, dark brown | | SA04A | | | | |
| | SILT - clayey, damp, stiff (est.), medium plastic, grey | | SA04B | | | | |
| 3 | - becomes moist | | SA05 | | | | 10 |
| | | | SA06 | | | | |
| 4 | | | SA07 | | | | |
| | END OF TESTPIT @ 4.2 m (target depth) | | | | | | 15 |
| 5 | | | | | | | 16 |

TETRA TECH EBA

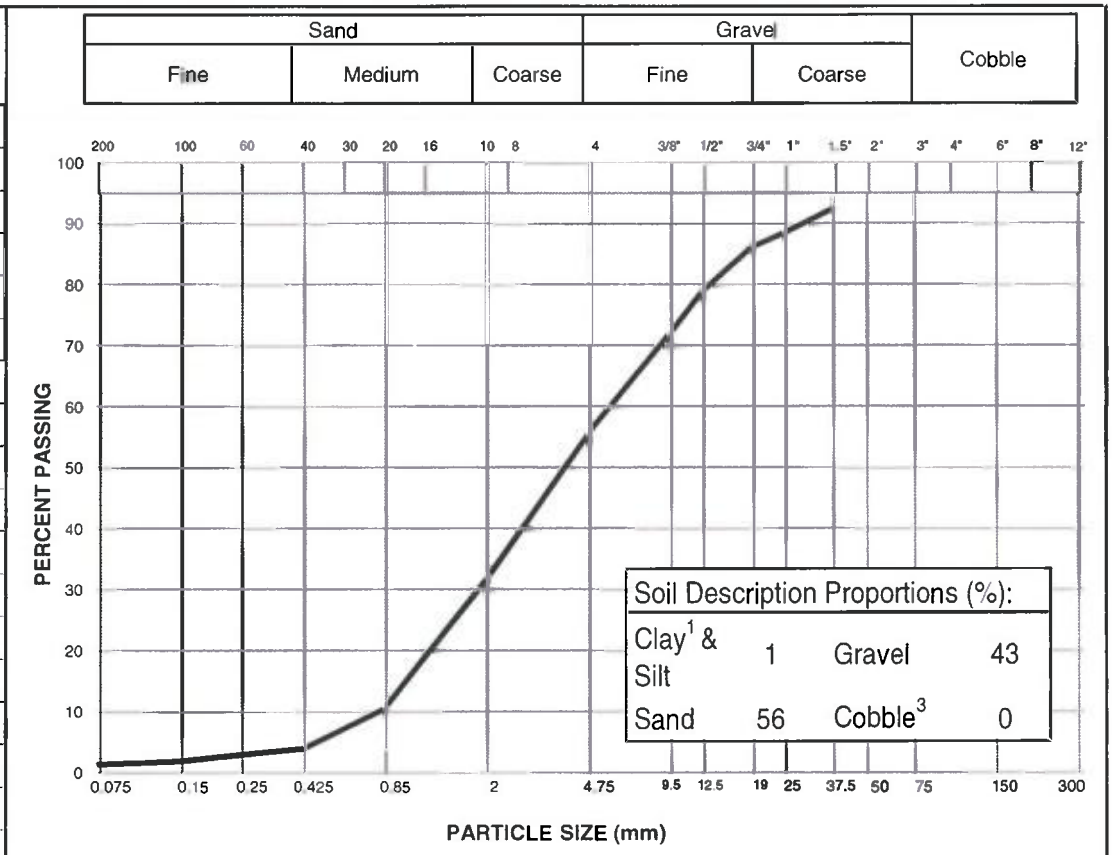
| | |
|---|---|
| LOGGED BY: KJ | COMPLETION DEPTH: 4.2m |
| REVIEWED BY: AWW | COMPLETE: 7/22/2014 |
| DRAWING NO: See Figure 1 | Page 1 of 1 |

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA04a |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP01 |
| Client: | YG - Highways and Public Works | Sample Depth: | 2.0 - 2.1 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 29, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | SAND and GRAVEL - trace silt | Sampled By: | KJ |
| | | USC Classification: | GP Cu: 7.3 |
| Moisture Content: | 3.1% | | Cc: 0.8 |

| Particle Size (mm) | Percent Passing |
|---|---|
| 300 | |
| 200 | |
| 150 | |
| 100 | |
| 75 | |
| 50 | |
| 38 | 93 |
| 25 | 89 |
| 19 | 86 |
| 12.5 | 79 |
| 10 | 73 |
| 5 | 57 |
| 2 | 32 |
| 0.85 | 11 |
| 0.425 | 4 |
| 0.25 | 3 |
| 0.15 | 2 |
| 0.075 | 1.5 |




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

Specification: _____

**Remarks:** _____

**Reviewed By:** _____ P.Eng.



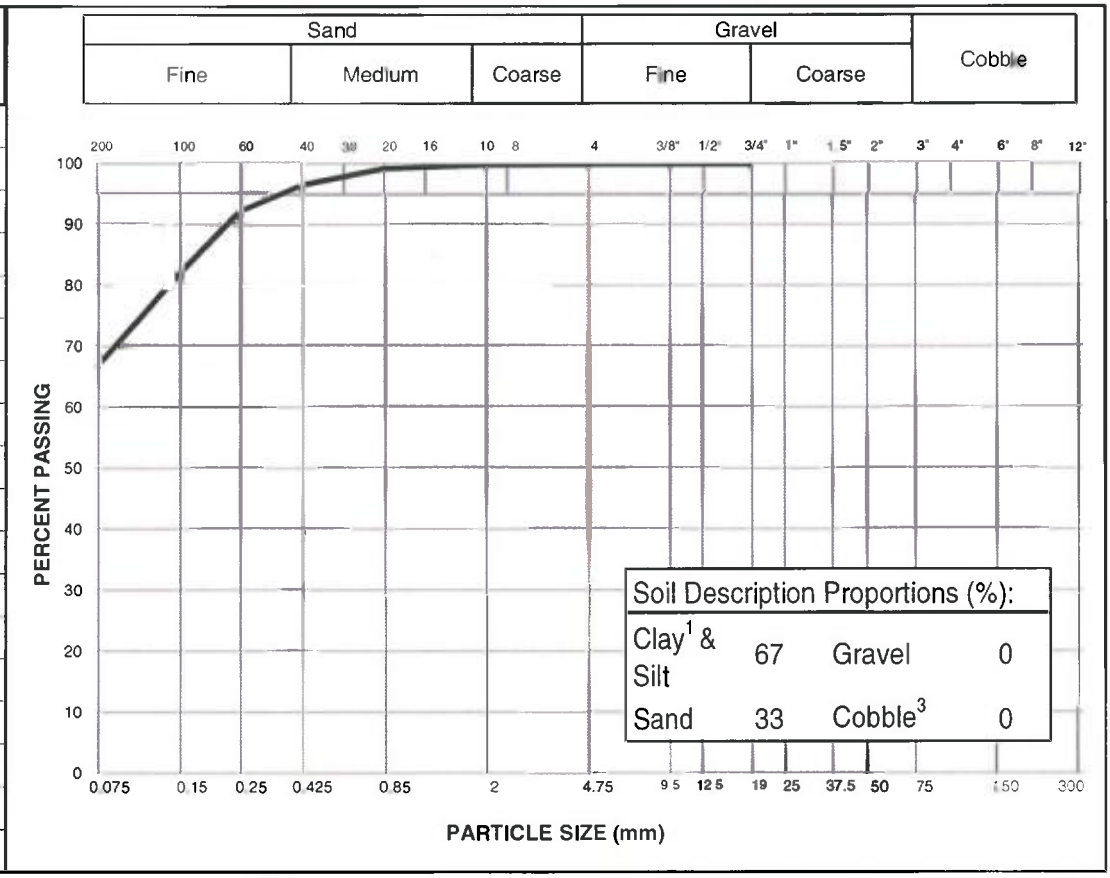
TETRA TECH

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA02 |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP01 |
| Client: | YG - Highways and Public Works | Sample Depth: | 1.0 - 1.1 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 29, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | SILT - sandy | Sampled By: | KJ |
| | | USC Classification: | ML Cu: #N/A |
| Moisture Content: | 14.8% | | Cc: #N/A |

| Particle Size (mm) | Percent Passing |
|---|---|
| 300 | |
| 200 | |
| 150 | |
| 100 | |
| 75 | |
| 50 | |
| 38 | |
| 25 | |
| 19 | 100 |
| 12.5 | 100 |
| 10 | 100 |
| 5 | 100 |
| 2 | 100 |
| 0.85 | 99 |
| 0.425 | 97 |
| 0.25 | 92 |
| 0.15 | 82 |
| 0.075 | 67.0 |




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

Specification: _____

**Remarks:** _____

**Reviewed By:** _____ P.Eng.



TETRA TECH

| Geotechnical Evaluation | CLIENT: Government of Yukon | PROJECT NO. - TESTPIT NO. |
|---|---|---|
| St. Elias Adult Group Home | EXCAVATOR: Cat 420E Backhoe | W14103422-TP02 |
| Whitehorse, YT | 6730790N; 496976E; Zone 8 | |

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | GROUND ICE DESCRIPTION AND COMMENTS | Depth (ft) |
|---|---|---|---|---|---|
| 0 | ORGANICS - sandy, roots | | | UNFROZEN | 0 |
| | SILT and SAND - trace of subrounded gravel, well graded, damp, greyish brown | | SA01 | | |
| | GRAVEL and SAND - coarse sand, rounded gravel, damp, reddish brown | | | | |
| 1 | | | SA02 | | |
| | - becomes moist | | SA03 | | 5 |
| 2 | - becomes wet | | SA04 | | |
| | SILT - clayey, moist, stiff (est.), medium plastic | | SA05 | | |
| 3 | | | SA06 | | 10 |
| 4 | | | SA07 | | |
| | END OF TEST PIT @ 4.0 m (target depth) | | | | 15 |
| 5 | | | | | 16 |

BULK DENSITY (kg/m³) 1400 1600 1800 2000

SPT (N) 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

CLAY (%) 20 40 60 80

SILT (%) 20 40 60 80

SAND (%) 20 40 60 80

GRAVEL (%) 20 40 60 80

TETRA TECH EBA

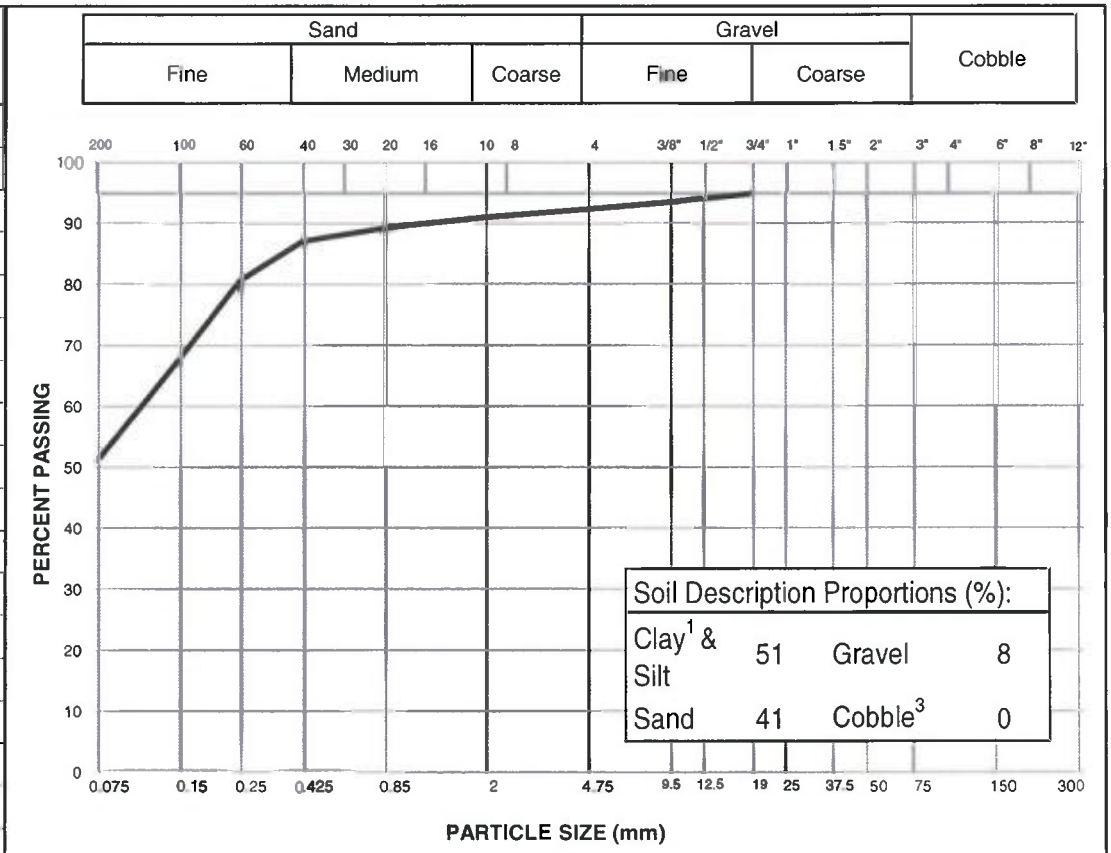
| | |
|---|---|
| LOGGED BY: KJ | COMPLETION DEPTH: 4m |
| REVIEWED BY: AWW | COMPLETE: 7/22/2014 |
| DRAWING NO: See Figure 1 | Page 1 of 1 |

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA01 |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP02 |
| Client: | YG - Highways and Public Works | Sample Depth: | 0.5 - 0.6 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 29, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | SILT and SAND - trace gravel | Sampled By: | KJ |
| | | USC Classification: | ML Cu: #N/A |
| Moisture Content: | 11.4% | | Cc: #N/A |

| Particle Size (mm) | Percent Passing |
|---|---|
| 300 | |
| 200 | |
| 150 | |
| 100 | |
| 75 | |
| 50 | |
| 38 | |
| 25 | |
| 19 | 95 |
| 12.5 | 94 |
| 10 | 94 |
| 5 | 93 |
| 2 | 91 |
| 0.85 | 89 |
| 0.425 | 87 |
| 0.25 | 81 |
| 0.15 | 68 |
| 0.075 | 51.3 |




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

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

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

**Remarks:** _____

**Reviewed By:** _____ P.Eng.



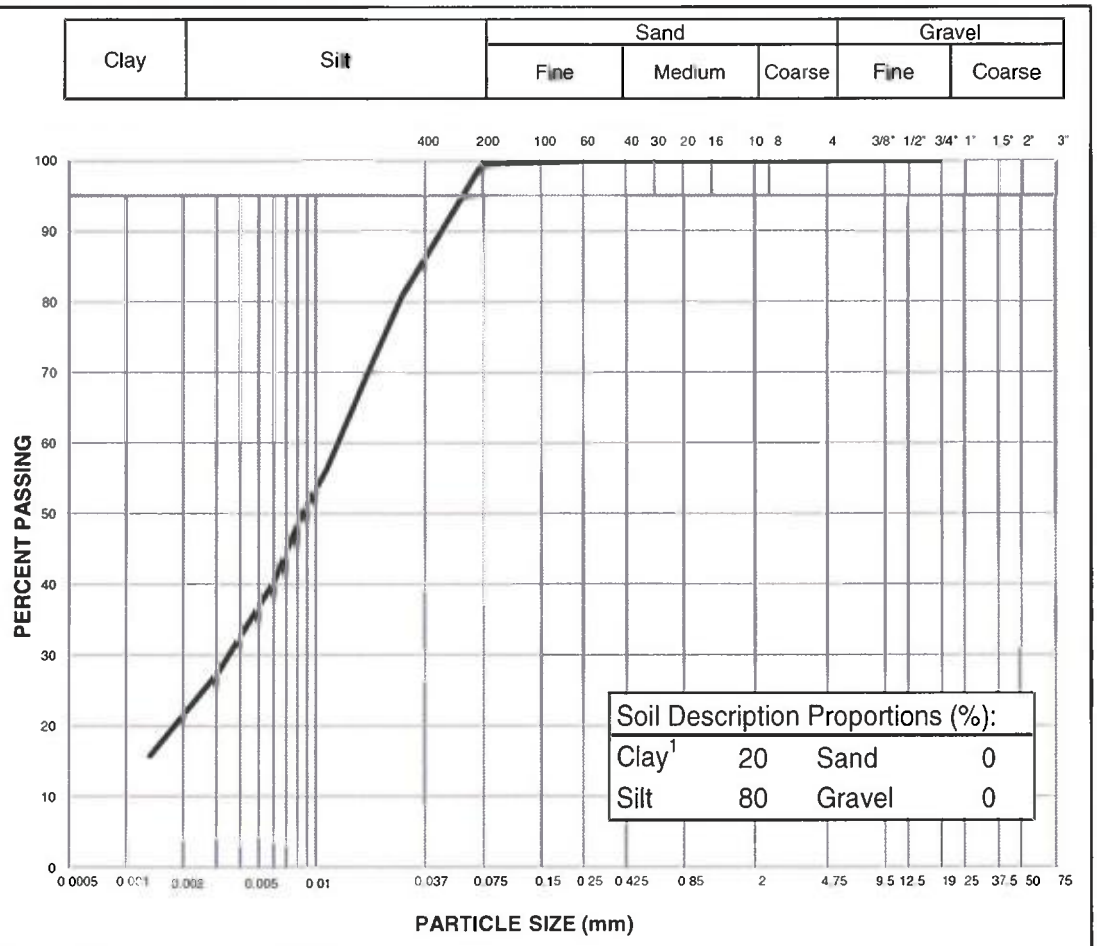
TETRA TECH

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA05 |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP02 |
| Client: | YG - Highways and Public Works | Sample Depth: | 2.5 - 2.6 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 30, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | SILT - clayey | Sampled By: | KJ |
| | | USC Classification: | ML Cu: #N/A |
| Moisture Content: | 26.3% | | Cc: #N/A |

| Particle Size (mm) | Percent Passing |
|---|---|
| 75 | |
| 50 | |
| 38 | |
| 25 | |
| 19 | 100 |
| 12.5 | 100 |
| 10 | 100 |
| 5 | 100 |
| 2 | 100 |
| 0.85 | 100 |
| 0.425 | 100 |
| 0.25 | 100 |
| 0.15 | 100 |
| 0.075 | 99.6 |
| 0.0291 | 81.2 |
| 0.0192 | 70.3 |
| 0.0117 | 56.4 |
| 0.0085 | 49.5 |
| 0.0062 | 40.6 |
| 0.0031 | 27.7 |
| 0.0014 | 15.8 |




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

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

Specification: _____

**Remarks:** _____

**Reviewed By:** _____ P.Eng.

| Geotechnical Evaluation | CLIENT: Government of Yukon | PROJECT NO. - TESTPIT NO. |
|---|---|---|
| St. Elias Adult Group Home | EXCAVATOR: Cat 420E Backhoe | W14103422-TP03 |
| Whitehorse, YT | 6730818N; 496965E; Zone 8 | |

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | GROUND ICE DESCRIPTION AND COMMENTS | BULK DENSITY (kg/m³) 1400 1600 1800 2000 / SPT (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80 | CLAY (%) 20 40 60 80 / SILT (%) 20 40 60 80 / SAND (%) 20 40 60 80 / GRAVEL (%) 20 40 60 80 | Depth (ft) |
|---|---|---|---|---|---|---|---|
| 0 | ORGANICS - topsoil, roots | | | UNFROZEN | | | 0 |
| | SAND - gravelly, silty, trace of clay, well graded, rounded, dry, light brown | | | | | | |
| | | | SA01 | | | | |
| 1 | | | SA02 | | | | |
| | - becomes some silt, trace gravel, dry, reddish brown | | SA03 | | | | 5 |
| 2 | GRAVEL - sandy, trace of silt, rounded, dry, reddish brown. | | SA04 | | | | |
| | - becomes damp | | SA05 | | | | |
| 3 | SILT - clayey, damp, stiff (est.), medium plastic | | SA06 | | | | 10 |
| | - becomes moist | | SA07 | | | | |
| 4 | | | SA08 | | | | |
| | END OF TEST PIT @ 4.2 m (target depth) | | | | | | 15 |
| 5 | | | | | | | 16 |

TETRA TECH EBA

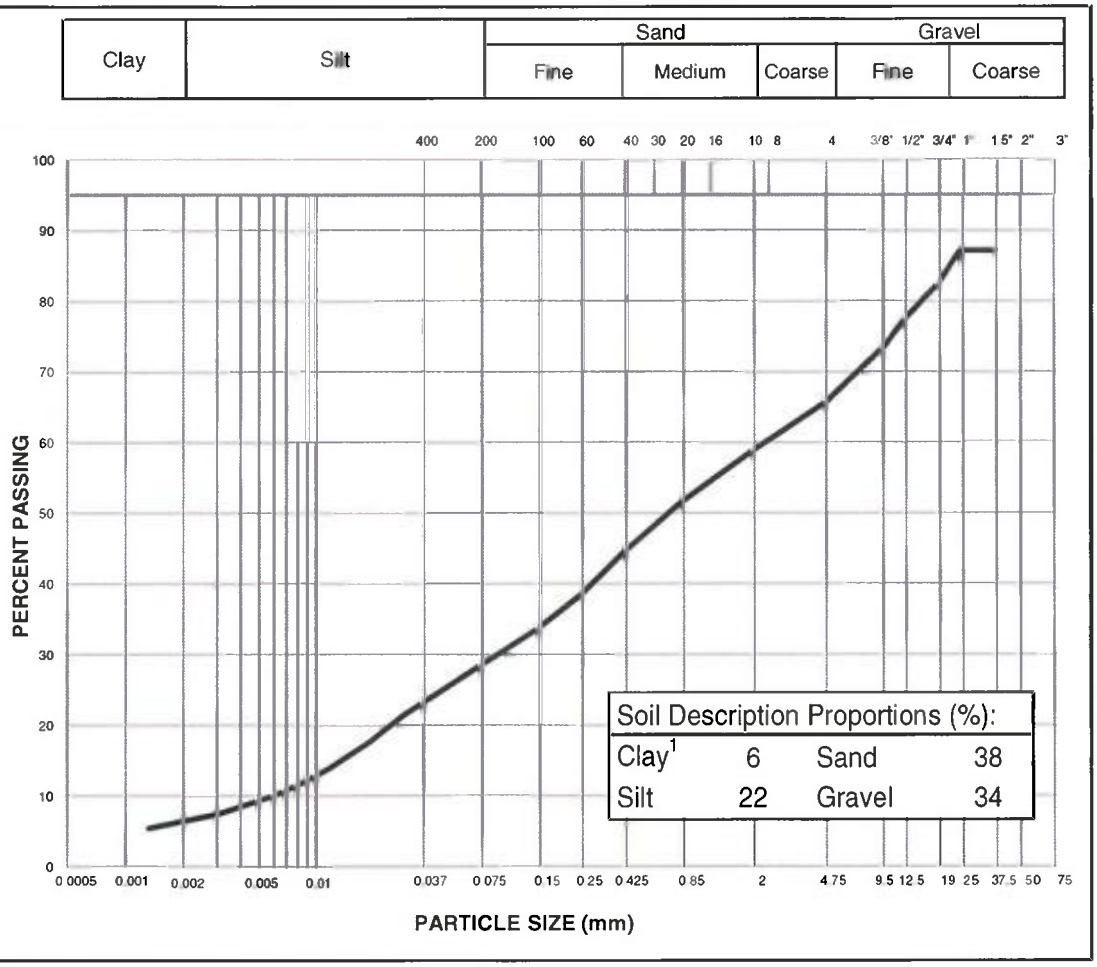
| | |
|---|---|
| LOGGED BY: KJ | COMPLETION DEPTH: 4.2m |
| REVIEWED BY: AWW | COMPLETE: 7/22/2014 |
| DRAWING NO: See Figure 1 | Page 1 of 1 |

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA01 |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP03 |
| Client: | YG - Highways and Public Works | Sample Depth: | 0.5 - 0.6 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 30, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | SAND and GRAVEL - silty, trace clay | Sampled By: | KJ |
| | | USC Classification: | GM Cu: 408.5 |
| Moisture Content: | 4.9% | | Cc: 0.6 |

| Particle Size (mm) | Percent Passing |
|---|---|
| 75 | |
| 50 | |
| 38 | 87 |
| 25 | 87 |
| 19 | 82 |
| 12.5 | 77 |
| 10 | 74 |
| 5 | 66 |
| 2 | 59 |
| 0.85 | 52 |
| 0.425 | 45 |
| 0.25 | 38 |
| 0.15 | 34 |
| 0.075 | 28.5 |
| 0.0300 | 21.6 |
| 0.0200 | 17.8 |
| 0.0121 | 14.0 |
| 0.0087 | 12.0 |
| 0.0063 | 10.2 |
| 0.0032 | 7.6 |
| 0.0014 | 5.5 |




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

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

Specification:

**Remarks:**

**Reviewed By:** _____ P.Eng.



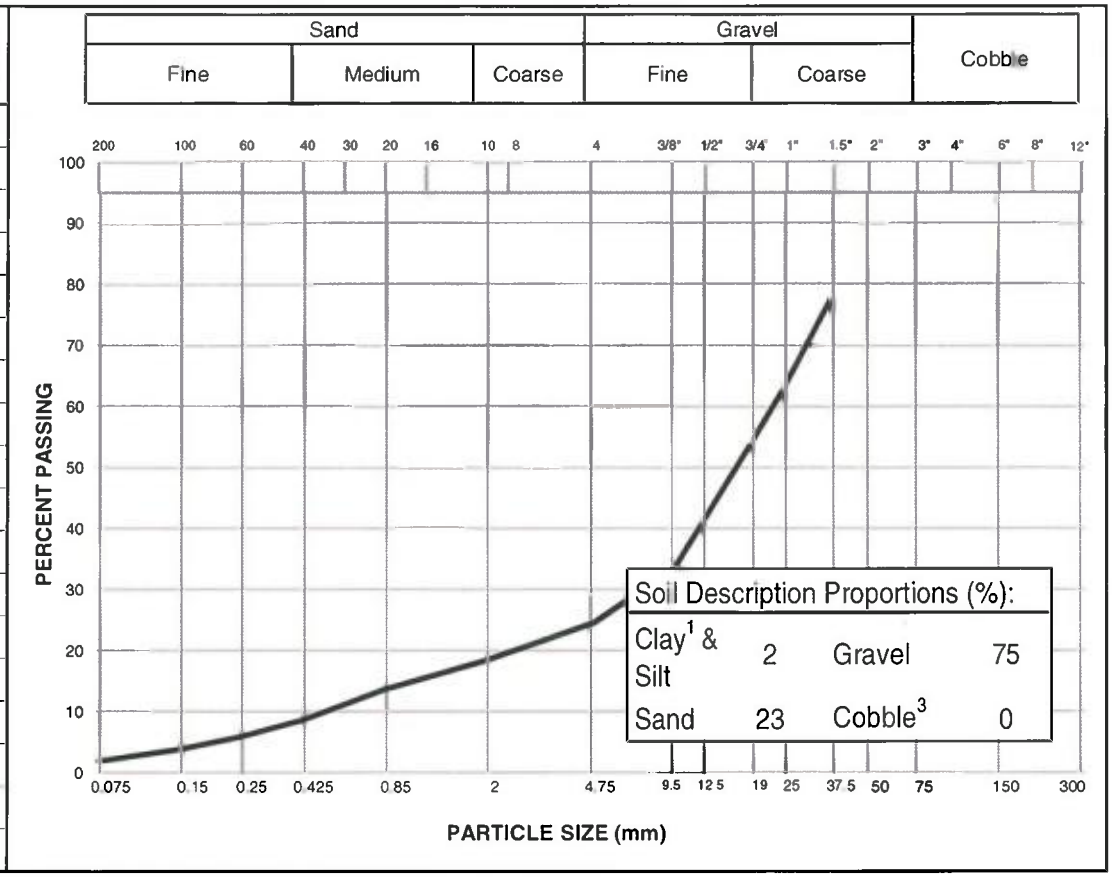
TETRA TECH

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

| | | | |
|---|---|---|---|
| Project: | St. Elias Group Home Replacement | Sample No.: | SA04 |
| Project No.: | W14103422-01 | Material Type: | |
| Site: | | Sample Loc.: | TP03 |
| Client: | YG - Highways and Public Works | Sample Depth: | 2.0 - 2.1 m |
| Client Rep.: | Zubair Qureshi | Sampling Method: | Grab |
| Date Tested: | July 29, 2014 By: AMT | Date sampled: | July 22, 2014 |
| Soil Description[2]: | GRAVEL - sandy, trace silt | Sampled By: | KJ |
| | | USC Classification: | GP Cu: 43.0 |
| Moisture Content: | 3.4% | | Cc: 5.0 |

| Particle Size (mm) | Percent Passing |
|---|---|
| 300 | |
| 200 | |
| 150 | |
| 100 | |
| 75 | |
| 50 | |
| 38 | 78 |
| 25 | 63 |
| 19 | 54 |
| 12.5 | 41 |
| 10 | 34 |
| 5 | 25 |
| 2 | 18 |
| 0.85 | 14 |
| 0.425 | 9 |
| 0.25 | 6 |
| 0.15 | 4 |
| 0.075 | 2.0 |




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

Specification: _____

**Remarks:** _____

**Reviewed By:** _____ P.Eng.



TETRA TECH

# APPENDIX C

## ENVIRONMENTAL LABORATORY TESTING RESULTS

Tetra Tech EBA Inc.
ATTN: Adam Wallace
61 Wasson Place
Whitehorse YT Y1A 0H7

Date Received: 28-JUL-14
Report Date: 06-AUG-14 10:54 (MT)
Version: FINAL

Client Phone: 867-668-3068

# Certificate of Analysis

**Lab Work Order #: L1493357**

Project P.O. #: NOT SUBMITTED
Job Reference: W14103422-01
C of C Numbers: 10-266867
Legal Site Desc:

Brent Mack
Account Manager

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | Sample ID | L1493357-1 | L1493357-2 | L1493357-3 | | |
|---|---|---|---|---|---|---|
| | Description | Soil | Soil | Soil | | |
| | Sampled Date | 22-JUL-14 | 22-JUL-14 | 22-JUL-14 | | |
| | Sampled Time | 11:05 | 12:00 | 13:30 | | |
| | Client ID | TESTPIT TP01-SA02 1.0-1.1M | TESTPIT TP02-SA03 1.5-1.6M | TESTPIT TP03-SA03 1.4-1.5M | | |
| **Grouping** | **Analyte** | | | | | |
| **SOIL** | | | | | | |
| **Physical Tests** | Moisture (%) | 11.8 | 3.46 | 13.7 | | |
| | pH (1:2 soil:water) (pH) | 8.74 | 8.26 | 8.08 | | |
| **Metals** | Antimony (Sb) (mg/kg) | 0.60 | 0.39 | 0.89 | | |
| | Arsenic (As) (mg/kg) | 3.39 | 5.87 | 5.77 | | |
| | Barium (Ba) (mg/kg) | 126 | 76.7 | 173 | | |
| | Beryllium (Be) (mg/kg) | 0.37 | 0.31 | 0.37 | | |
| | Cadmium (Cd) (mg/kg) | 0.061 | 0.093 | 0.219 | | |
| | Chromium (Cr) (mg/kg) | 46.2 | 42.9 | 36.9 | | |
| | Cobalt (Co) (mg/kg) | 9.13 | 7.80 | 6.65 | | |
| | Copper (Cu) (mg/kg) | 24.3 | 16.2 | 22.7 | | |
| | Lead (Pb) (mg/kg) | 7.09 | 5.23 | 11.6 | | |
| | Mercury (Hg) (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Molybdenum (Mo) (mg/kg) | <0.50 | 0.96 | 0.64 | | |
| | Nickel (Ni) (mg/kg) | 49.1 | 29.9 | 29.1 | | |
| | Selenium (Se) (mg/kg) | <0.20 | <0.20 | 0.43 | | |
| | Silver (Ag) (mg/kg) | <0.10 | <0.10 | 0.85 | | |
| | Thallium (Tl) (mg/kg) | 0.093 | 0.054 | 0.063 | | |
| | Tin (Sn) (mg/kg) | <2.0 | <2.0 | <2.0 | | |
| | Uranium (U) (mg/kg) | 0.821 | 0.713 | 1.65 | | |
| | Vanadium (V) (mg/kg) | 42.9 | 56.7 | 44.3 | | |
| | Zinc (Zn) (mg/kg) | 43.0 | 43.8 | 48.3 | | |
| **Volatile Organic Compounds** | Benzene (mg/kg) | <0.040 | <0.040 | <0.040 | | |
| | Ethylbenzene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Methyl t-butyl ether (MTBE) (mg/kg) | <0.20 | <0.20 | <0.20 | | |
| | Styrene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Toluene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | ortho-Xylene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | meta- & para-Xylene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Xylenes (mg/kg) | <0.075 | <0.075 | <0.075 | | |
| | Surrogate: 4-Bromofluorobenzene (SS) (%) | 95.7 | 97.6 | 93.0 | | |
| | Surrogate: 1,4-Difluorobenzene (SS) (%) | 93.8 | 97.9 | 91.8 | | |
| **Hydrocarbons** | EPH10-19 (mg/kg) | <200 | <200 | <200 | | |
| | EPH19-32 (mg/kg) | <200 | <200 | <200 | | |
| | LEPH (mg/kg) | <200 | <200 | <200 | | |
| | HEPH (mg/kg) | <200 | <200 | <200 | | |
| | Volatile Hydrocarbons (VH6-10) (mg/kg) | <100 | <100 | <100 | | |
| | VPH (C6-C10) (mg/kg) | <100 | <100 | <100 | | |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | Sample ID | L1493357-1 | L1493357-2 | L1493357-3 | | |
|---|---|---|---|---|---|---|
| | Description | Soil | Soil | Soil | | |
| | Sampled Date | 22-JUL-14 | 22-JUL-14 | 22-JUL-14 | | |
| | Sampled Time | 11:05 | 12:00 | 13:30 | | |
| | Client ID | TESTPIT TP01-SA02 1.0-1.1M | TESTPIT TP02-SA03 1.5-1.6M | TESTPIT TP03-SA03 1.4-1.5M | | |
| **Grouping** | **Analyte** | | | | | |
| **SOIL** | | | | | | |
| **Hydrocarbons** | Surrogate: 3,4-Dichlorotoluene (SS) (%) | 105.6 | 96.7 | 103.1 | | |
| **Polycyclic Aromatic Hydrocarbons** | Acenaphthene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Acenaphthylene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Anthracene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Benz(a)anthracene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Benzo(a)pyrene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Benzo(b)fluoranthene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Benzo(g,h,i)perylene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Benzo(k)fluoranthene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Chrysene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Dibenz(a,h)anthracene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Fluoranthene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Fluorene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Indeno(1,2,3-c,d)pyrene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | 2-Methylnaphthalene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Naphthalene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Phenanthrene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Pyrene (mg/kg) | <0.050 | <0.050 | <0.050 | | |
| | Surrogate: Acenaphthene d10 (%) | 128.6 | 79.3 | 89.5 | | |
| | Surrogate: Chrysene d12 (%) | 129.0 | 71.5 | 95.1 | | |
| | Surrogate: Naphthalene d8 (%) | 127.5 | 79.3 | 88.3 | | |
| | Surrogate: Phenanthrene d10 (%) | 126.8 | 75.9 | 91.1 | | |
| **Glycols** | Diethylene Glycol (mg/kg) | <10 | <10 | <10 | | |
| | Ethylene Glycol (mg/kg) | <10 | <10 | <10 | | |
| | 1,2-Propylene Glycol (mg/kg) | <10 | <10 | <10 | | |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# Reference Information

**QC Samples with Qualifiers & Comments:**

| QC Type Description | Parameter | Qualifier | Applies to Sample Number(s) |
|---|---|---|---|
| Laboratory Control Sample | 1,2-Propylene Glycol | LCS-ND | L1493357-1, -2, -3 |

**Qualifiers for Individual Parameters Listed:**

| Qualifier | Description |
|---|---|
| LCS-ND | Lab Control Sample recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected. |

## Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| **EPH-TUMB-FID-VA** | Soil | EPH in Solids by Tumbler and GCFID | BC MOE EPH GCFID |

Analysis is in accordance with BC MOE Lab Manual method "Extractable Petroleum Hydrocarbons in Solids by GC/FID", v2.1, July 1999. Soil samples are extracted with a 1:1 mixture of hexane and acetone using a rotary extraction technique modified from EPA 3570 prior to gas chromatography with flame ionization detection (GC-FID). EPH results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH).

**GLY-EXT-FID-VA** Soil Glycols in Soil by Wrist Shaker GCFID SW-846, METHOD 8015B, EPA

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 8015B, published by the United States Environmental Protection Agency (EPA). The procedure involves extraction of a subsample of the sediment/soil with deionized water, followed by treatment of the extract with a strong base (NaOH) and benzoyl chloride to form the corresponding benzoate esters. The benzoate esters are then extracted with iso-octane and the extract is analyzed by capillary column gas chromatography with flame ionization detection (FID).

**HG-200.2-CVAF-VA** Soil Mercury in Soil by CVAFS EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

**LEPH/HEPH-CALC-VA** Soil LEPHs and HEPHs BC MOE LABORATORY MANUAL (2005)

Light and Heavy Extractable Petroleum Hydrocarbons in Solids. These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated
by subtracting selected Polycyclic Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for Naphthalene and Phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(a,h)anthracene, Indeno(1,2,3-c,d)pyrene, and Pyrene
are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Solids by GC/FID" (Version 2.1, July 20, 1999).

**MET-200.2-CCMS-VA** Soil Metals in Soil by CRC ICPMS EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

**MOISTURE-VA** Soil Moisture content ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

**PAH-TMB-H/A-MS-VA** Soil PAH - Rotary Extraction (Hexane/Acetone) EPA 3570/8270

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

**PH-1:2-VA** Soil pH in Soil (1:2 Soil:Water Extraction) BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH

# Reference Information

probe.

| | | | |
|---|---|---|---|
| **VH-HSFID-VA** | Soil | VH in soil by Headspace GCFID | EPA8260B, 5021, 5035, BC MOE |

This analysis involves the extraction of a subsample of the sediment/soil with methanol. Aliquots of the methanol extract are then added to water and reagents, then heated in a sealed vial to equilibrium. The headspace from the vial is analyzed for Volatile Hydrocarbons (VH) by capillary column gas chromatography with flame-ionization detection (GC/FID). The methanol extraction and VH analysis are carried out in accordance with the British Columbia Ministry of Environment, Lands and Parks (BCMELP) Analytical Method for Contaminated Sites "Volatile Hydrocarbons in Solids by GC/FID" (Version 2.1 July 1999).

| | | | |
|---|---|---|---|
| **VH-SURR-FID-VA** | Soil | VH Surrogates for Soils | BCMELP CSR ANALYTICAL METHOD 2 |
| **VOC7-L-HSMS-VA** | Soil | VOCs in soil by Headspace GCMS | EPA8260B, 5021, 5035, BC MOE |

The soil methanol extract is added to water and reagents, then heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. Target compound concentrations are measured using mass spectrometry detection.

| | | | |
|---|---|---|---|
| **VOC7/VOC-SURR-MS-VA** | Soil | VOC7 and/or VOC Surrogates for Soils | EPA METHODS 8260B & 524.2 |
| **VPH-CALC-VA** | Soil | VPH is VH minus select aromatics | BC MOE LABORATORY MANUAL (2005) |

These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Volatile Petroleum Hydrocarbons in Solids or Water" (Version 2.1, July 20, 1999). According to this method, the concentrations of specific Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes and Styrene) are subtracted from the collective concentration of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10). Analysis of Volatile Hydrocarbons adheres to all prescribed elements of BCMELP method "Volatile Hydrocarbons in Solids by GC/FID" (Version 2.1, July 20, 1999).

| | | | |
|---|---|---|---|
| **XYLENES-CALC-VA** | Soil | Sum of Xylene Isomer Concentrations | EPA 8260B & 524.2 |

Calculation of Total Xylenes

Total Xylenes is the sum of the concentrations of the ortho, meta, and para Xylene isomers. Results below detection limit (DL) are treated as zero. The DL for Total Xylenes is set to a value no less than the square root of the sum of the squares of the DLs of the individual Xylenes.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| VA | ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA |

**Chain of Custody Numbers:**

10-266867

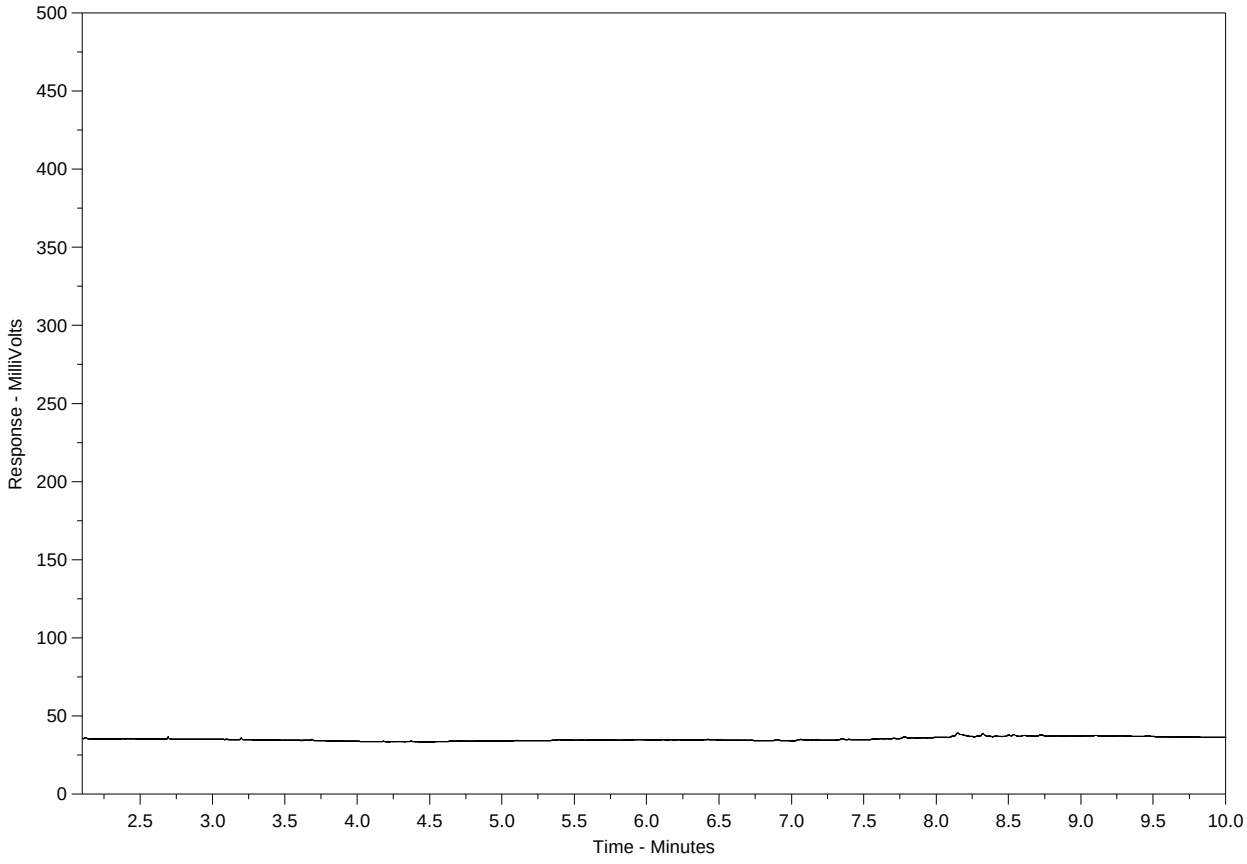
**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*
*mg/kg - milligrams per kilogram based on dry weight of sample.*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*
*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*
*mg/L - milligrams per litre.*
*< - Less than.*
*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

# Hydrocarbon Distribution Report

ALS Sample ID: L1493357-1
Client Sample ID: TESTPIT TP01-SA02 1.0-1.1M




| nC10 | nC19 | nC32 |
|---|---|---|
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils / Lube Oils / Grease → | |
| ← Diesel / Jet Fuels → | | |

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

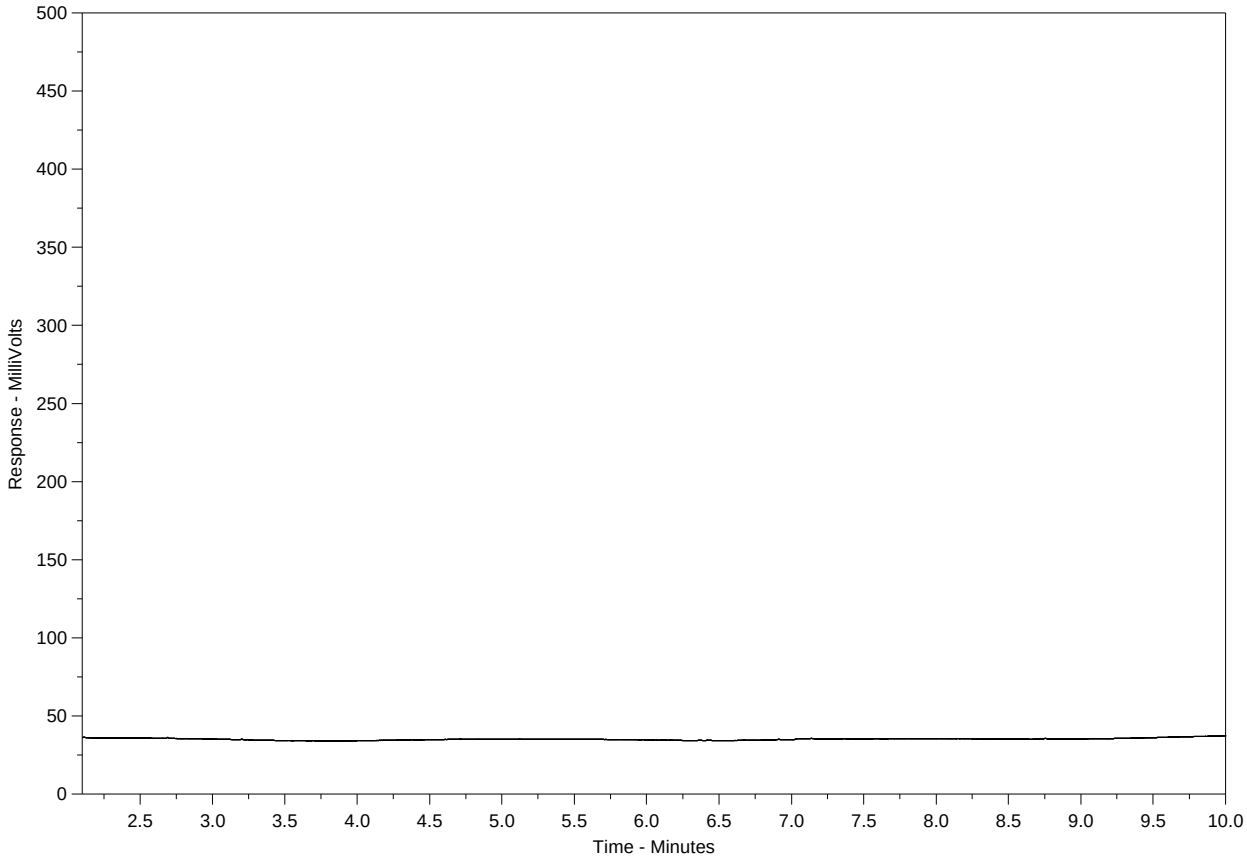
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

# Hydrocarbon Distribution Report

ALS Sample ID: L1493357-2
Client Sample ID: TESTPIT TP02-SA03 1.5-1.6M




| nC10 | nC19 | nC32 |
|---|---|---|
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils / Lube Oils / Grease → | |
| ← Diesel / Jet Fuels → | | |

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

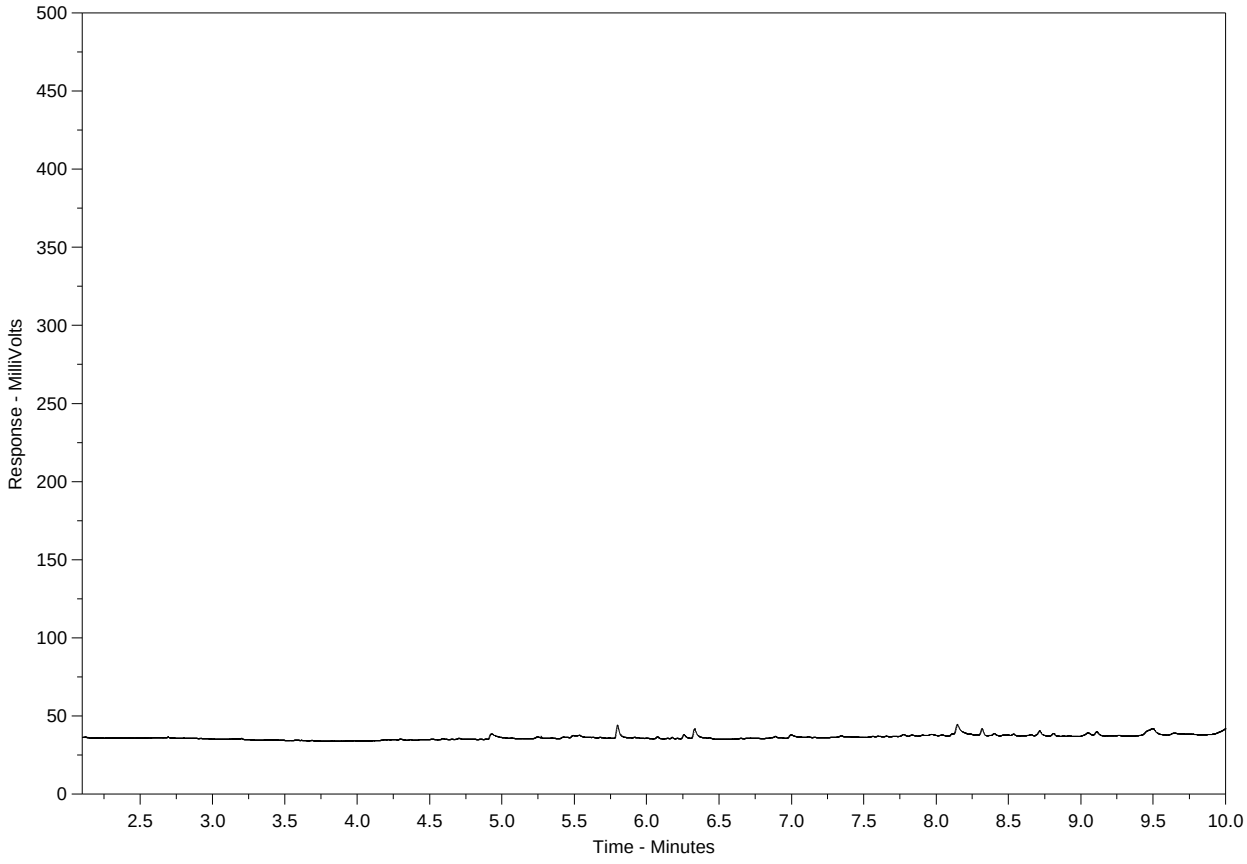
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

# Hydrocarbon Distribution Report

ALS Sample ID: L1493357-3
Client Sample ID: TESTPIT TP03-SA03 1.4-1.5M




| nC10 | nC19 | nC32 |
|---|---|---|
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils / Lube Oils / Grease → | |
| ← Diesel / Jet Fuels → | | |

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

10-266867

ALS Environmental

Chain of Custody / Analytical R
Canada Toll Free: 1 800 6
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L1493357-COFC

Page ___ of ___

| Report To | Report Format / Distribution | Service Request: (Rush subject to availability - Contact ALS to confirm TAT) |
|---|---|---|
| Company: Tetra Tech EBA | Standard: X Other (specify): | X Regular (Standard Turnaround Times - Business Days) |
| Contact: Adam Wallace | Select: PDF X Excel Digital Fax | Priority (2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT |
| Address: 6th Wasson Pl. | Email 1: adam.wallace@tetratech.com | Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT |
| | Email 2: chad.cowan@tetratech.com | Same Day or Weekend Emergency - Contact ALS to confirm TAT |
| Phone: 867.668.[illegible]9218 Fax: 867 668 4349 | | |
| Invoice To: Same as Report ? (circle) Yes or No (if No, provide details) | Client / Project Information | Analysis Request |
| Copy of Invoice with Report? (circle) Yes or No | Job #: W4103422-01 | ( Indicate Filtered or Preserved, F/P ) |
| Company: | PO / AFE: | |
| Contact: | LSD: | |
| Address: | | |
| Phone: Fax: | Quote #: | |
| Lab Work Order # (lab use only): | ALS Contact: Sampler: | |

| Sample # | Sample Identification (This description will appear on the report) | Date (dd-mmm-yy) | Time (hh:mm) | Sample Type | Hydrocarbons | Metals | Number of Containers |
|---|---|---|---|---|---|---|---|
| TP01-SA02 | Testpit TP01 - SA02 - 1.0-1.1m | 22-Jul-14 | 11:05 | Soil | / | / | |
| TP02-SA03 | Testpit TP02 - SA03 1.5-1.6m | 22-Jul-14 | 12:00 | Soil | / | / | |
| TP03-SA03 | Testpit TP03 - SA03 1.4-1.5m | 22-Jul-14 | 1:30 | Soil | / | / | |

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

| SHIPMENT RELEASE (client use) | | | SHIPMENT RECEPTION (lab use only) | | | | SHIPMENT VERIFICATION (lab use only) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Released by: | Date: | Time: | Received by: | Date: | Time: | Temperature: | Verified by: | Date: | Time: | Observations: Yes / No ? If Yes add SIF |
| | | | | 22-Jul-14 | 11:35 | 9.4 °C | | | | |

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front