

March 13, 2014

ISSUED FOR USE  
FILE: W14103335-01

City of Whitehorse  
Planning Services  
4210 - 4<sup>th</sup> Avenue  
Whitehorse, YT Y1A 1K1

**Attention:** Mr. Ben Campbell, MCIP, RPP – Planner II

**Subject:** Downtown South - 6<sup>th</sup> Avenue – Between Taylor Street and Drury Street  
Predesign Level Geotechnical Evaluation

## 1.0 INTRODUCTION

Tetra Tech EBA Inc. (EBA) has recently completed a geotechnical evaluation of conditions along the west side of 6<sup>th</sup> Avenue (Lots 13 to 16; Block S between the Taylor Street and Drury Street intersections). Geotechnical evaluation work for this project was completed in response to a request from the City of Whitehorse – Planning Services. Authorization to proceed was received from Mr. Ben Campbell, MCIP, RPP – Planner II of City of Whitehorse Planning Services.

Presented in this report is a summary of the geotechnical evaluation work performed; the limited environmental sampling and analysis completed; a detailed review of the terrain risk assessment work completed in 2002; a summary of conditions encountered and conceptual and predesign level recommendations pertaining to site development.

## 2.0 GEOTECHNICAL DRILLING PROGRAM

On December 13, 2013, a geotechnical drilling program was completed at the subject site. A total of 3 boreholes were advanced to a depth of 5.8 m. All boreholes were drilled with a Nodwell mounted CME 75 drill rig subcontracted from Donjek Services of Whitehorse, Yukon. EBA's site representative was Mr. Myles Plaunt, CET, of EBA's Whitehorse office. The locations of all boreholes drilled are presented on Figure 1, attached.

Sampling included the collection of near surface samples (generally at 0.2 m), followed by subsequent sampling at 1.5 m intervals throughout the depth of each borehole drilled. Additional samples were also collected as dictated by varying soil conditions. All samples were returned to EBA's Whitehorse laboratory for index testing (natural moisture content determination and particle size distribution testing).

Borehole W14103335-BH02 was drilled along what is believed to be an old railway track bed so, although not included in the original scope of work, a surficial sample was collected and submitted to ALS Global for metals, for total hydrocarbons and herbicide analysis (constituents which are commonly found along railway corridors) to support the environmental assessment work being completed by EBA concurrent to this geotechnical evaluation.

## 3.0 LABORATORY TESTING PROGRAM

Laboratory testing included the natural moisture content determination of all samples and particle size distribution testing (by sieve analysis and/or hydrometer) of select representative samples. Moisture content results are presented on the borehole logs and the report forms for the particle size analysis tests are presented following the associated borehole log.

## 4.0 SITE CONDITIONS

The subject site is an undeveloped four lot parcel located along the west side of 6<sup>th</sup> Avenue extending south from the playground/skating rink area located adjacent to the Taylor Street intersection to the drainage ditch located across from the Drury Street intersection. General and location specific geotechnical conditions are described below.

The study area is located in the far southwest corner of the downtown core along the base of the escarpment. The site is fairly flat (gently undulating) but altered by historic development and land use. The south half of the site has grass ground cover with a few shrubs and the north half of the site has sparse, immature tree cover.

Throughout the downtown core of Whitehorse, floodplain deposition accounts for fairly dramatic variations in soil stratigraphy. In addition, since this site is located in close proximity to the toe of the escarpment, surface sloughing and other erosional processes have resulted in a soil stratigraphy that is even more complex than would be encountered throughout the portions of downtown Whitehorse that are beyond the erosional influences historically noted along the escarpment.

Conditions noted at each of the borehole locations are described below:

- Borehole W14103335-BH01 was drilled at the south end of the subject site. Current site elevations (current grades are significantly higher than the adjoining property to the south) suggest that fill has been placed throughout much of the south end of the site and this was verified during drilling where two generations of fill (silty, sand fill encountered between 0.0 and 1.0 m; underlain by silt fill, which was noted from 1.0 to 2.1 m) were noted. At 2.1 m, brown silt and sand was encountered. This soil unit is indicative of the surficial soils found throughout much of downtown Whitehorse. Between 3.0 and 3.5 m (the transition was difficult to define because drilling remained consistent), a layer of glaciolacustrine silt was encountered and extended to a depth of 4.8 m where sandy gravel (alluvium) was noted. The granular alluvial soils extended to the 5.8 m termination depth. Throughout the majority of the downtown core, one would expect to encounter the brown, silt and sand soil unit over the alluvium, which in turn would be underlain by the glaciolacustrine silt. However, during the completion of other geotechnical evaluations that are close to the escarpment, it is not uncommon to see a layering of various soil types which are not typical to the usual downtown Whitehorse floodplain deposits. With that in mind, the glaciolacustrine silt that was noted between 3.3 and 4.8 m may have been deposited by historical erosional forces along the face of the escarpment.
- Borehole W14103335-BH02 was excavated along a trail that used to define an old railway track bed. Conditions included 0.5 m of granular embankment fill over glaciolacustrine soils (again, this soil unit likely originated from the face of the escarpment). Further evidence of the area being altered was noted at a depth of 2.0 where a lens of sand and silt with a trace of gravel was encountered. At 5.5 m, the alluvial gravel soil unit was encountered and continued to the 5.8 m borehole termination depth. The gravel was saturated suggesting the presence of ground water at depth.
- Borehole W14103335-BH03 was advanced at the north end of the site. Silt fill with some debris (metal, etc.) was noted throughout the top metre with glaciolacustrine silt (likely slope wash) extending from 1.0 to 2.5 m where the alluvial gravel was again encountered. The gravel became saturated at 4.5 m, again suggesting the presence of groundwater. Below the alluvium, glaciolacustrine silt was encountered and extended to the borehole termination depth of 5.8 m. It is important to note that the underlying glaciolacustrine silt would also be encountered if the other two boreholes were drilled deeper. What is encouraging is that in this borehole, the thickness of the alluvial gravel was significant, thereby increasing the potential for foundation construction.

As mentioned above, all borehole locations are presented on Figure 1 attached, and the detailed borehole logs and associated laboratory test results are presented in Appendix B.

## 5.0 RAILWAY TRACK BED – CONTAMINANT ASSESSMENT

The White Pass and Yukon Route railroad was completed in July of 1900 (the driving of the golden spike in Carcross, Yukon). As historically documented, the railway provided essential infrastructure which serviced the freight and passenger requirements of the Yukon's population as well as the mining industry.

While collecting site information for this geotechnical evaluation (as well as for the concurrent Level I Environmental Site Assessment work completed by this office), air photos revealed the presence of a Y-shaped railway spur on the site (anecdotal information was not able to establish exact dates when this railway spur was commissioned and subsequently decommissioned). Since the railway is historically linked to the mining industry, it was felt that there was some potential to have railway cars filled with ore from Yukon mine sites parked on this spur awaiting transport to the port in Skagway, Alaska. Since sampling and testing along other track bed areas in Whitehorse has delineated elevated levels of metals and other contaminants, it was felt that it would be useful to include some sampling and basic analytical testing in this evaluation (since it affects the development potential of the site and would support recommendations presented in the Level I Environmental Assessment).

As mentioned above, a sample of the surficial soils collected at the borehole W14103335-BH02 location was submitted for analyses by ALS Global. Analyses included Metals in Soil (CSR); EPH in Soils by Tumbler (for hydrocarbons) and GCFID (for herbicides). Results include:

- Metals in Soil testing confirmed elevated levels of lead (2200 mg/kg was measured – Yukon Environment Residential/Parkland standard is 500 mg/kg); silver (38.8 mg/kg was measured – Yukon Environment Residential/Parkland standard is 20 mg/kg); and antimony (32.6 mg/kg was measured – Yukon Environment Residential/Parkland standard is 20 mg/kg).
- EPH testing did not exceed Yukon Environment standards, and;
- GCFID testing did not exceed Yukon Environment standards.

The ALS Global report forms are attached to this report

## 6.0 TERRAIN HAZARD ASSESSMENT

In 2002, EBA worked closely with the City of Whitehorse – Engineering Services, on the “Whitehorse Escarpment Slope Stability and Hazard Assessment” project (EBA File 0201-00-1200002). The escarpment overlooking Downtown Whitehorse was assessed and terrain and terrain risk classifications were assigned to describe conditions along the entire length. The terrain classification assigned to the study area can be summarized as:

- The silty surficial soils encountered beyond the current toe-of-slope are colluvial, suggesting gravitational slope movement and historic landslide deposition.
- Since the existing slopes within the boundaries of the study area are now considered gentle, future mass movement (creeping, sliding, slumping, etc.) is likely to be very slow.
- Any rapid debris flow noted in the future would be the result of saturated soils or erosion caused by freeze thaw processes.
- The area is considered moderately well drained (gentle slopes allow for positive drainage across the site).

- In its undeveloped state, there are no slope stability issues on the site.
- ***Therefore, the study area is considered to have low terrain hazard potential.***

## 7.0 DEVELOPMENT POTENTIAL

Since engineering solutions can be found to support the majority of site development plans, the potential for development of the study area is considered good. However, economic considerations may lower the overall potential rating. Consider that:

- The presence of contaminated soil has been verified along the old railway track bed. Additional environmental work to delineate the level and extent of contamination may result in remediation measures which may be fairly costly. At least it is anticipated that metals contamination in soil will be limited to the near surface soils along or close to the old railway track bed.
- The origin of the near surface soils (either fill or colluvium from the escarpment) along with the soil consistency (in situ density) are a concern when considering foundation systems. The depositional history (colluvial) and possible placement of uncontrolled fill throughout portions of the site may not be conducive to shallow foundation systems such as thickened monolithic slab-on-grade where higher levels of compaction would be required to support multi-level residential structures. If a shallow foundation system is preferred, significant engineered fill construction (subcut and backfill) will be necessary to ensure adequate levels of compaction throughout the soils supporting building foundations). However, deeper foundation systems founded on the underlying alluvial gravels (possibly driven piles) will provide better support for larger structures and such foundation systems will provide resistance to any “slow moving” mass soil movement which may occur in the future.

## 8.0 RECOMMENDATIONS FOR ADDITIONAL WORK

It is believed that the Level I Environmental Assessment suggested consideration be given to the completion of a Level II Environmental Assessment. This usually comprises actual sampling and analytical testing to support the clean-up of the site to residential standards. Interested ownership groups will likely want to proceed with this evaluation (especially if they are seeking funding).

Once the site is no longer considered a “contaminated site”, the conceptual to final design phases of site development can then proceed and once details of development are established, additional geotechnical evaluation work can be completed to support shallow and/or deep foundation system design, underground utilities construction and surface works (access road, sidewalks/entrance aprons and parking area construction).

## 9.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Whitehorse and others working on this project. Tetra Tech EBA Inc. 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 those listed above, 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 General Conditions included in this report.

The information and recommendations presented herein are based on geotechnical information from the current investigation conducted at the subject site. The conditions presented herein are believed to be representative for the site. However, if conditions differing from those presented in this report are encountered during subsequent phases of site development, we request that Tetra Tech EBA Inc. be notified so that the geotechnical recommendations can be re-evaluated in light of new findings.

## 10.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, or clarification of any of the recommendations presented is required, please contact the undersigned at your convenience.

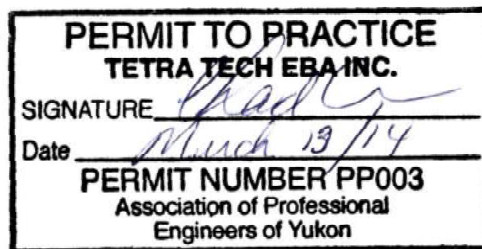
Sincerely,  
Tetra Tech EBA Inc.



Myles Plaunt, CET  
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Project Director – Yukon, Arctic Region  
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# FIGURES

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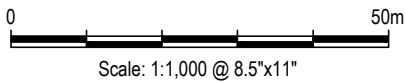
Figure 1 Site Plan Showing Borehole Locations

Q:\Whitehorse\Data\0201\drawings\Whitehorse\W141\W14103335-01 Downtown South Geotech Evaluation\W14103335-01 Fig.1\_R0.dwg [FIGURE 1] March 13, 2014 - 12:00:01 pm (BY: BUCHAN, CAMERON)



**LEGEND**

◆ - BOREHOLE LOCATION



CLIENT



**TETRA TECH EBA**

**DOWNTOWN SOUTH GEOTECHNICAL EVALUATION  
6TH & DRURY STREET - WHITEHORSE, YUKON**

**SITE PLAN SHOWING BOREHOLE LOCATIONS**

PROJECT NO. W14103335-01	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE February 27, 2014		

**Figure 1**

# APPENDIX A

## TETRA TECH EBA'S GENERAL CONDITIONS AND SOIL CLASSIFICATION

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# GENERAL CONDITIONS

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## GEOTECHNICAL REPORT

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

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### 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.

# MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA			
<b>COARSE-GRAINED SOILS</b> More than 50% retained on 75 µm sieve*	<b>GRAVELS</b> 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	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW		
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures			
		CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line or plasticity index greater than 7 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols	
		SANDS WITH FINES	SC	Clayey sands, sand-clay mixtures			
	<b>SANDS</b> More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SP	Poorly 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 Not meeting both criteria for SW		
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures			
		SANDS WITH FINES	SC	Clayey sands, sand-clay mixtures	Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line or plasticity index greater than 7 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols		
		SANDS WITH FINES	SC	Clayey sands, sand-clay mixtures			
		<b>FINE-GRAINED SOILS (by behavior)</b> 50% or more passes 75 µm sieve*	<b>SILTS</b> 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.  <div style="text-align: center;"> <b>PLASTICITY CHART</b> </div>
				>50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
<b>CLAYS</b> 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			
	30-50		CI	Inorganic clays of medium plasticity, silty clays			
	>50		CH	Inorganic clays of high plasticity, fat clays			
<b>ORGANIC SILTS AND CLAYS</b> Liquid limit	<50		OL	Organic silts and organic silty clays of low plasticity			
	>50		OH	Organic clays of medium to high plasticity			
<b>HIGHLY ORGANIC SOILS</b>			PT	Peat and other highly organic soils	*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					OVERSIZE MATERIAL	
FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS		Rounded or subrounded  COBBLES 75 mm to 300 mm BOULDERS > 300 mm	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR		
GRAVEL	coarse	75 mm	19 mm	>35 %	"and"	Not rounded
	fine	19 mm	4.75 mm	21 to 35 %	"y-adjective"	
SAND	coarse	4.75 mm	2.00 mm	10 to 20 %	"some"	ROCK FRAGMENTS >75 mm ROCKS > 0.76 cubic metre in volume
	medium	2.00 mm	425 µm	>0 to 10 %	"trace"	
	fine	425 µm	75 µm			
SILT (non plastic) or CLAY (plastic)	75 µm		<b>as above but by behavior</b>			

# APPENDIX B


## BOREHOLE LOGS, LABORATORY TEST RESULTS & ALS ANALYTICAL

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Geotechnical Investigation	CLIENT: City of Whitehorse, Planning Services	PROJECT NO. - BOREHOLE NO.
6th Avenue; Taylor to Drury Street		W14103335-BH01
Whitehorse, YT	6730572N; 496988E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m <sup>3</sup> )		CLAY (%)		SILT (%)		SAND (%)		Depth (ft)
				1400	1600	1800	2000	20	40	60	80	
0	SNOW COVER and GRASS GROUND COVER SAND (FILL) - silty, trace gravel, damp below frost, medium brown		SEASONALLY FROZEN									0
			UNFROZEN									
1	SILT - some fine sand, moist becoming wet with depth, firm becoming soft (est.), olive grey (this soil unit is likely fill as well)											5
2	- coal inclusion noted at 2.0 m SAND - some silt to silty, trace of wood debris, damp, compact, medium brown											10
3	SILT (GLACIOLACUSTRINE) - trace fine sand, moist becoming wet, damp, compact (est.), medium brown											15
4												
5	GRAVEL (ALLUVIUM) - sandy, silty, damp to moist, compact (est.), medium brown											20
6	END OF BOREHOLE @ 5.8 m (target depth)											21
6.5												

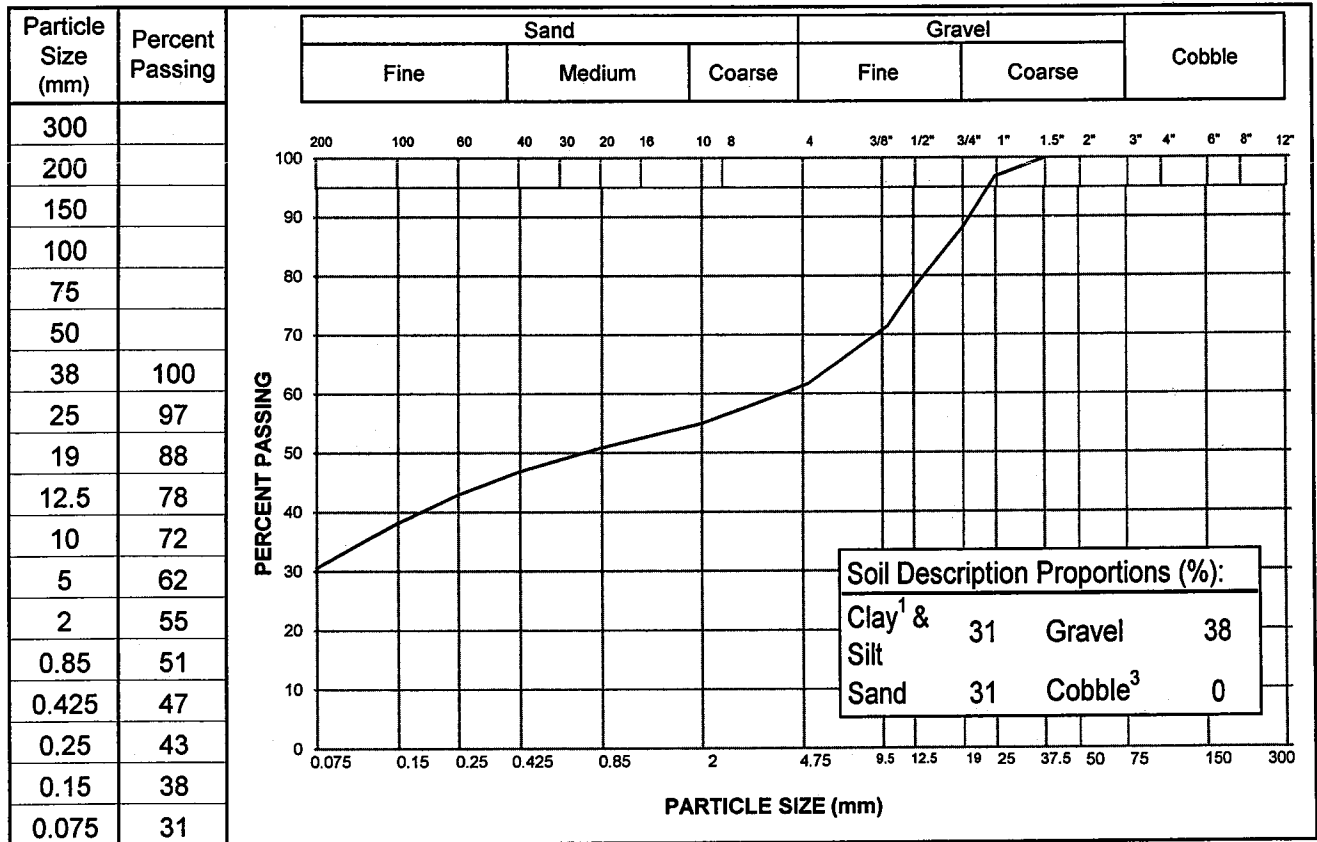
 <b>TETRA TECH EBA</b>	LOGGED BY: MCP	COMPLETION DEPTH: 5.8m
	REVIEWED BY: CPC	COMPLETE: 12/13/2013
	DRAWING NO:	Page 1 of 1

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Geotechnical Investigation	Sample No.:	
Project No.:	W14103335-01	Material Type:	
Site:	6th Avenue; Taylor to Drury Street, Whitehorse, YT	Sample Loc.:	BH01
Client:	City of Whitehorse, Planning Services	Sample Depth:	5.5 - 5.8 m
Client Rep.:	Ben Campbell	Sampling Method:	Grab
Date Tested:	December 17, 2013	By:	AMT
		Date sampled:	December 13, 2013
Soil Description <sup>2</sup> :	GRAVEL - sandy, silty	Sampled By:	MCP
		USC Classification:	Cu: n/a
			Cc: n/a

Moisture Content: 10.2%



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

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


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

Reviewed By:

Geotechnical Investigation	CLIENT: City of Whitehorse, Planning Services	PROJECT NO. - BOREHOLE NO.
6th Avenue; Taylor to Drury Street		W14103335-BH02
Whitehorse, YT	6730606N; 496979E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m <sup>3</sup> )		CLAY (%)		SILT (%)		SAND (%)		Depth (ft)
				1400	1600	1800	2000	20	40	60	80	
0	OLD TRACK BED SAND and GRAVEL (FILL) - trace to some silt, moist when thawed, brown		SEASONALLY FROZEN									0
	SILT (GLACIOLACUSTRINE) - trace fine sand, damp below seasonal frost, firm below frost (est.), light olive grey		UNFROZEN									
1												
2	- lens of medium grained sand and silt at 2.0 m											
3	- moisture content increasing with depth and becoming softer (est.), mottled olive grey with brown											
4												
5												
6	GRAVEL and SAND (ALLUVIUM) - some silt, saturated (likely water table), greyish brown											
6	END OF BOREHOLE @ 5.8 m (target depth)											
6.5												

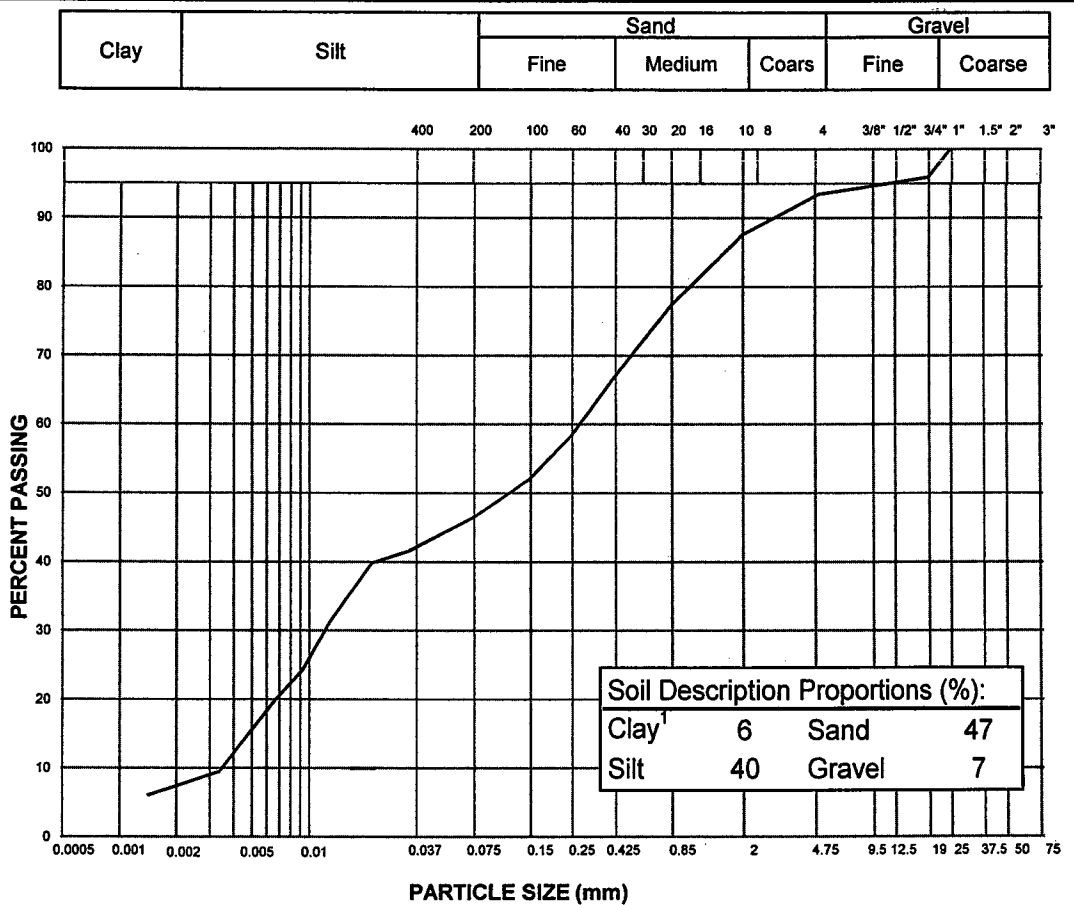
 <b>TETRA TECH EBA</b>	LOGGED BY: MCP	COMPLETION DEPTH: 5.8m
	REVIEWED BY: CPC	COMPLETE: 12/13/2013
	DRAWING NO:	Page 1 of 1

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project: Geotechnical Investigation	Sample No.:	
Project No.: W14103335-01	Material Type:	
Site: 6th Avenue; Taylor to Drury Street, Whitehorse, YT	Sample Loc.:	BH02
Client: City of Whitehorse, Planning Services	Sample Depth:	2.0 - 2.1 m
Client Rep.: Ben Campbell	Sampling Method:	Grab
Date Tested: December 17, 2013 By: AMT	Date sampled:	December 13, 2013
Soil Description <sup>2</sup> : SAND and SILT - trace gravel, trace clay	Sampled By:	MCP
Moisture Content: 9.8%	USC Classification:	Cu: 79.5 Cc: 0.2

Particle Size (mm)	Percent Passing
75	
50	
38	
25	100
19	96
12.5	96
10	96
5	94
2	88
0.85	77
0.425	67
0.25	59
0.15	52
0.075	47
0.0339	41.6
0.0215	39.9
0.0128	31.2
0.0093	24.3
0.0067	19.9
0.0034	9.5
0.0014	6.1



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

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

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

Reviewed By:


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Geotechnical Investigation	CLIENT: City of Whitehorse, Planning Services	PROJECT NO. - BOREHOLE NO.
6th Avenue; Taylor to Drury Street		W14103335-BH03
Whitehorse, YT	6730614N; 496996E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input checked="" type="checkbox"/> NO RECOVERY	<input checked="" type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m <sup>3</sup> )		CLAY (%)		SILT (%)		SAND (%)		Depth (ft)
				1400	1600	1800	2000	20	40	60	80	
0	SILT (FILL) - some sand, medium brown		SEASONALLY FROZEN									0
	- metal debris noted											
1	SILT (GLACIOLACUSTRINE) - trace to some fine sand, damp, firm, light olive grey		UNFROZEN									5
	- organic inclusions noted in silt matrix											
	- silt becomes sandy, fine grained, damp, mottled grey with brown											
2												
3	GRAVEL and SAND (ALLUVIUM) - some to trace silt, damp, becomes moist to wet by 4.2 m, greyish brown											10
4												
	- wet to saturated, possible water table											15
5	SILT (GLACIOLACUSTRINE) - trace fine sand, saturated, soft, olive grey											
6	END OF BOREHOLE @ 5.8 m (target depth)											20
6.5												21

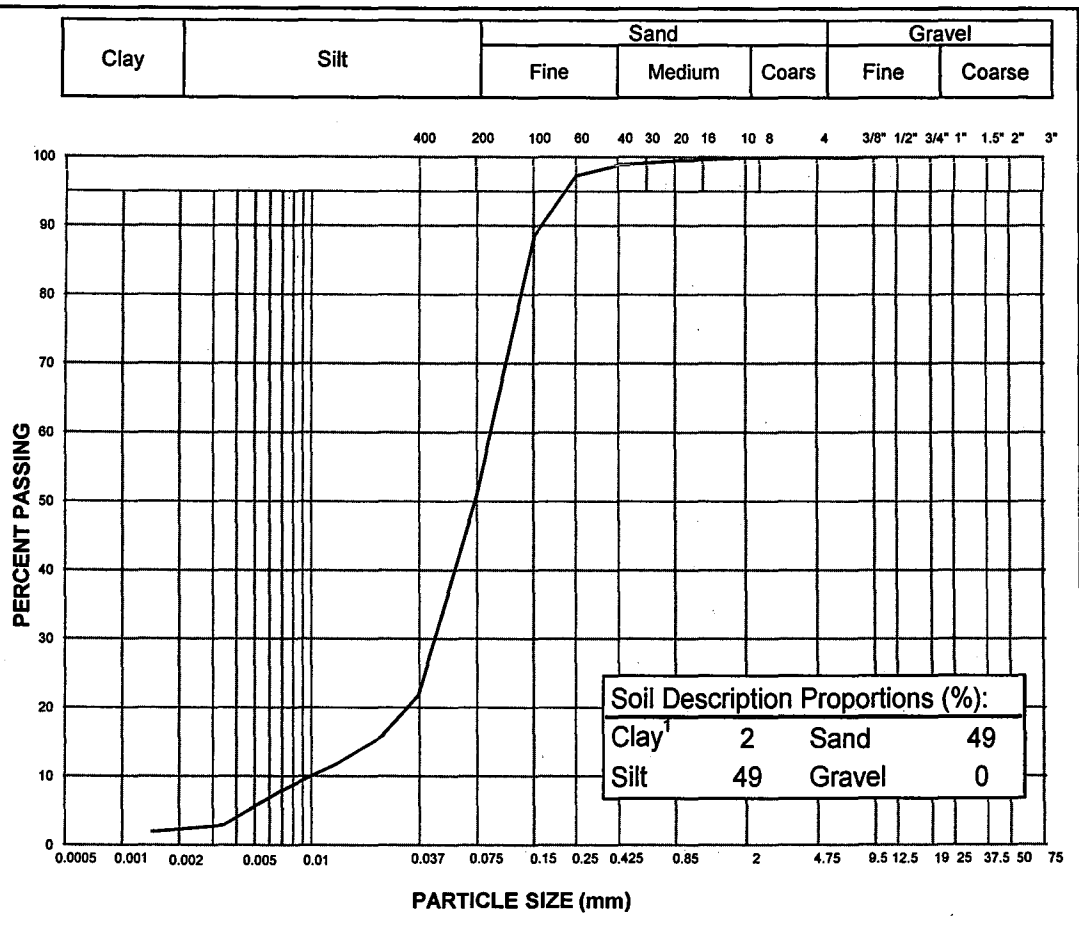
 <b>TETRA TECH EBA</b>	LOGGED BY: MCP	COMPLETION DEPTH: 5.8m
	REVIEWED BY: CPC	COMPLETE: 12/13/2013
	DRAWING NO:	Page 1 of 1

# PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Geotechnical Investigation	Sample No.:	
Project No.:	W14103335-01	Material Type:	
Site:	6th Avenue; Taylor to Drury Street, Whitehorse, YT	Sample Loc.:	BH03
Client:	City of Whitehorse, Planning Services	Sample Depth:	2.5 - 2.8 m
Client Rep.:	Ben Campbell	Sampling Method:	Grab
Date Tested:	December 17, 2013	By:	AMT
		Date sampled:	December 13, 2013
Soil Description <sup>2</sup> :	SAND and SILT - trace clay	Sampled By:	MCP
		USC Classification:	Cu: 9.3 Cc: 2.4
Moisture Content:	8.3%		

Particle Size (mm)	Percent Passing
75	
50	
38	
25	
19	
12.5	
10	100
5	100
2	100
0.85	100
0.425	99
0.25	97
0.15	88
0.075	51
0.0366	21.8
0.0236	15.8
0.0137	11.9
0.0098	9.9
0.0069	7.9
0.0034	3.0
0.0014	2.0



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

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

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

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

Reviewed By:

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Tetra Tech EBA Inc.  
ATTN: Myles Plaunt  
61 Wasson Place  
Whitehorse YT Y1A 0H7

Date Received: 18-DEC-13  
Report Date: 02-JAN-14 11:36 (MT)  
Version: FINAL

Client Phone: 867-668-3068

## Certificate of Analysis

Lab Work Order #: L1405119  
Project P.O. #: NOT SUBMITTED  
Job Reference: W14103335-01  
C of C Numbers: 10-267416  
Legal Site Desc:

**Comments:** Please note ALS identified sample L1405119-1 was analyzed for Herbicides as per instruction.

---

Brent Mack  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L1405119-1	Soil	14-DEC-13	12:00	BH02 0.0-0.3
<b>Grouping</b>						
<b>SOIL</b>						
<b>Physical Tests</b>	Moisture (%)					7.26
	pH (1:2 soil:water) (pH)					7.96
<b>Metals</b>	Antimony (Sb) (mg/kg)					32.6
	Arsenic (As) (mg/kg)					15.5
	Barium (Ba) (mg/kg)					136
	Beryllium (Be) (mg/kg)					0.34
	Cadmium (Cd) (mg/kg)					29.5
	Chromium (Cr) (mg/kg)					39.3
	Cobalt (Co) (mg/kg)					8.80
	Copper (Cu) (mg/kg)					49.4
	Lead (Pb) (mg/kg)					2200
	Mercury (Hg) (mg/kg)					0.094
	Molybdenum (Mo) (mg/kg)					1.56
	Nickel (Ni) (mg/kg)					31.6
	Selenium (Se) (mg/kg)					0.29
	Silver (Ag) (mg/kg)					38.8
	Thallium (Tl) (mg/kg)					0.105
	Tin (Sn) (mg/kg)					2.3
	Uranium (U) (mg/kg)					1.22
	Vanadium (V) (mg/kg)					47.7
	Zinc (Zn) (mg/kg)					1940
<b>Hydrocarbons</b>	EPH10-19 (mg/kg)					<200
	EPH19-32 (mg/kg)					<200
<b>Herbicides</b>	Bromoxynil (mg/kg)					<0.010 <sup>DLIS</sup>
	Clopyralid (mg/kg)					<0.010 <sup>DLIS</sup>
	2,4-D (mg/kg)					<0.010 <sup>DLIS</sup>
	Dicamba (mg/kg)					<0.010 <sup>DLIS</sup>
	2,4-DB (mg/kg)					<0.010 <sup>DLIS</sup>
	2,4-DP (Dichlorprop) (mg/kg)					<0.010 <sup>DLIS</sup>
	Dinoseb (mg/kg)					<0.010 <sup>DLIS</sup>
	MCPA (mg/kg)					<0.010 <sup>DLIS</sup>
	MCPB (mg/kg)					<0.010 <sup>DLIS</sup>
	Mecoprop (mg/kg)					<0.010 <sup>DLIS</sup>
	Picloram (mg/kg)					<0.010 <sup>DLIS</sup>
	2,4,5-T (mg/kg)					<0.010 <sup>DLIS</sup>
	2,4,5-TP (mg/kg)					<0.010 <sup>DLIS</sup>
	Triclopyr (mg/kg)					<0.010 <sup>DLIS</sup>

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

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> L1405119-1 <b>Description</b> Soil <b>Sampled Date</b> 14-DEC-13 <b>Sampled Time</b> 12:00 <b>Client ID</b> BH02 0.0-0.3				
<b>G</b>					
<b>SOIL</b>					
<b>Herbicides</b>	Surrogate: 2,4-Dichlorophenylacetic Acid (%)	104.6			
<b>Pesticides</b>	Ethalfuralin (mg/kg)	<0.010 <sup>DLIS</sup>			
	Fluazifop-p-butyl (mg/kg)	<0.010 <sup>DLIS</sup>			
	Diclofop-methyl (mg/kg)	<0.010 <sup>DLIS</sup>			
	Triallate (mg/kg)	<0.010 <sup>DLIS</sup>			
	Trifluralin (mg/kg)	<0.010 <sup>DLIS</sup>			
	Surrogate: D14-Terphenyl (%)	102.3			

\* 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)
Duplicate	2,4,5-T	DLIS	L1405119-1
Duplicate	2,4,5-TP	DLIS	L1405119-1
Duplicate	2,4-D	DLIS	L1405119-1
Duplicate	2,4-DB	DLIS	L1405119-1
Duplicate	2,4-DP (Dichlorprop)	DLIS	L1405119-1
Duplicate	Bromoxynil	DLIS	L1405119-1
Duplicate	Clopyralid	DLIS	L1405119-1
Duplicate	Dicamba	DLIS	L1405119-1
Duplicate	Dinoseb	DLIS	L1405119-1
Duplicate	MCPA	DLIS	L1405119-1
Duplicate	MCPB	DLIS	L1405119-1
Duplicate	Mecoprop	DLIS	L1405119-1
Duplicate	Picloram	DLIS	L1405119-1
Duplicate	Triclopyr	DLIS	L1405119-1
Duplicate	EPH10-19	DUP-H	L1405119-1
Duplicate	EPH19-32	DUP-H	L1405119-1

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLIS	Detection Limit Adjusted: Insufficient Sample
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EPH-TUMB-FID-VA</b>	Soil	EPH in Solids by Tumbler and GCFID	BC MOE EPH GCFID
<p>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).</p>			
<b>HERBSCR-WT</b>	Soil	Herbicides in Soil	SW846 8270
<b>HG-200.2-CVAF-VA</b>	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7
<p>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).</p> <p>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.</p>			
<b>MET-200.2-CCMS-VA</b>	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A
<p>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 (modified from EPA Method 6020A).</p> <p>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.</p>			
<b>MISCSCR-WT</b>	Soil	Miscellaneous Pesticides	SW846 8270
<b>MOISTURE-VA</b>	Soil	Moisture content	ASTM D2974-00 Method A
<p>This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.</p>			
<b>MOISTURE-WT</b>	Soil	% Moisture	Gravimetric: Oven Dried
<b>PH-1:2-VA</b>	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

## Reference Information

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 probe.

\*\* 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
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

10-267416

### 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 ww* - 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.

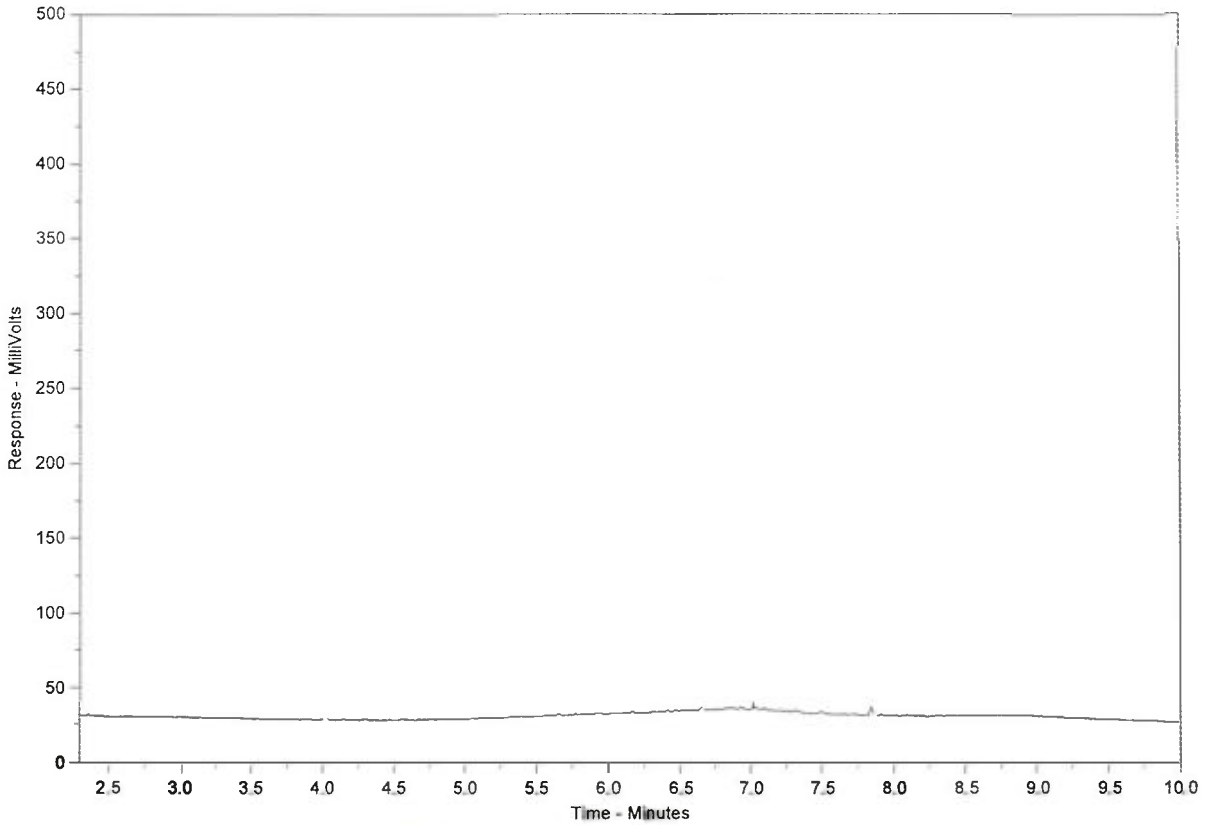
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

# Hydrocarbon Distribution Report



ALS Sample ID: L1405119-1  
 Client Sample ID: BH02 0.0-0.3



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](http://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.

