LEVELTON CONSULTANTS LTD.
Unit 108 – 3677 Highway 97N
Kelowna, BC V1X 5C3
T: 250.491.9778 F: 250.491.9729
kelowna@levelton.com
www.levelton.com

August 10, 2015

Levelton File # R715-1159-00

Public Works Government Services Canada
219 – 800 Burrard St.
Vancouver, BC
V6Z 0B9

Attention: Tom Dunphy

Project: Drainage Improvements – Parks Canada Maintenance Compound, Rogers Pass, BC
Subject: Pavement Assessment Report

Dear Sir,

1.0 Introduction

In general accordance with our proposal P715-1566-00 dated June 26, 2015, Levelton Consultants Ltd. (Levelton) has prepared this geotechnical report presenting the results of our site assessment and subsurface investigation for the Rogers Pass Compound. The Levelton scope of work did not include assessment of the soil or groundwater at the project site with respect to environmental considerations. Authorization to proceed with the scope of work presented in the proposal was received from Public Works Government Services Canada (PWGSC) on July 6, 2015.

Based on the information that has been provided to us, we understand that PWGSC intends to redevelop the Rogers Pass Compound. Levelton was provided with a copy of a Pre-Design Report prepared by ISL Engineering and Land Services Ltd. titled "Rogers Pass Maintenance Compound Stormwater Improvement.", dated April 2008. We understand the proposed redevelopment project will generally follow the framework laid out in this report and may include:

- Re-grading and paving of asphalt surfaced area to the west, north and east of the Abrasives Storage Shed;
- A new loading apron on the north end of the Abrasives Storage Shed;
- Re-grading and paving of the asphalt lane from the Abrasives Storage Shed to the Vehicle Storage Shed;

- Re-grading and paving of the asphalt surfaced area between the Vehicle Storage Shed, Administration Building, and Garage/Offices, as well as the area north of the Garage;
- Re-grading and paving of the asphalt lane from the Administration Building to the Sewage Treatment Shed;
- Construction of various drainage swales and berms; and
- Potential below grade utilities.

2.0 Scope of Work

Levelton's scope of work for this project comprised the following:

- Visual review of the existing surface finishes in the various compound areas to identify the types and condition of the surfacing;
- Subsurface explorations throughout the compound to determine the nature and thickness of the various surfacing structure elements (surfacing material, base and sub-base) and to assess the subgrade soil conditions; and
- Preparation of this report.

3.0 Field Work

3.1 Visual Review

The condition of the existing surfacing on various areas of the compound was visually reviewed by Levelton geotechnical personnel on July 9 and 10, 2015 to identify the types of surface finishes implemented throughout the subject compound and the apparent surface condition of the various areas. Discussion regarding observations made during the visual review are provided in Section 4.1 of this report.

3.2 Subsurface Explorations

In order to evaluate the composition and thickness of the existing road structure elements and the nature of the underlying subgrade throughout the subject compound, Levelton conducted a total of 10 (ten) test pits (TP15-01 to TP15-10) using a backhoe excavator supplied by PWGSC and a single hand dug test pit (TP15-11). The test pits were generally apportioned to the various areas of the compound as follows:

- At Abrasives Storage Shed – test pits TP15-01 to TP15-02;
- Along main driveway from Rec Building to Water Treatment Building – test pits TP15-03, TP15-04, TP15-09, and TP15-10;
- At Vehicle Storage Area, Garages and Offices – test pits TP15-05 to TP15-08; and,
- At Helicopter Pad / New Snow Storage – test pit TP15-11 (hand dug).

The approximate locations of the test pits are shown on the attached Figure 1. The test pits extended to depths of about 0.5 to 2.0 m below grade. All of the test pits were located on or immediately adjacent to the existing road area surface finishes.

The soil and groundwater conditions encountered at the test pits were logged in the field by a member of Levelton's geotechnical staff. Disturbed soil samples were collected from the excavated soil for visual classification and moisture content determination purposes. Grain size analysis was conducted on four selected samples.

The test pits were backfilled with the excavated soil following the investigation.

Detailed description of the soil and groundwater conditions encountered at the test pits is provided on the attached soil logs. The soil logs also graphically illustrate the moisture content of disturbed soil samples collected from the test pits. The grain size analysis reports are attached to this report following the soil logs. A summary discussion regarding the conditions encountered at the test pits is provided in Section 4.2 of this report.

4.0 Findings

4.1 Visual Review

The finished grades throughout the compound generally consisted of gravel and asphaltic surfaces. In many cases the asphaltic finishes do not appear to be uniformly placed hot-mix asphalt; the asphaltic material is friable and easily excavated through. Based on discussions with site personnel we understand, anecdotally, that the majority of the compound was surfaced in the past with compacted asphalt millings obtained from local highway construction. The observed asphaltic surface appears to be consistent with this explanation.

4.1.1 Abrasives Storage Shed Area

Surface finishes are in place on the east, north and west of the Abrasives Storage Shed. The west and north of the shed building is surfaced with an asphaltic material, while the east side of the shed is a graded gravel area. The asphaltic areas are in highly variable condition, with apparent delamination of this surface lifts in some areas, potholes, and ruts. The asphalt limits are clearly defined at the south end of the west side of the storage shed, and gradually get less defined to the north, with thickening amounts overlying gravels.

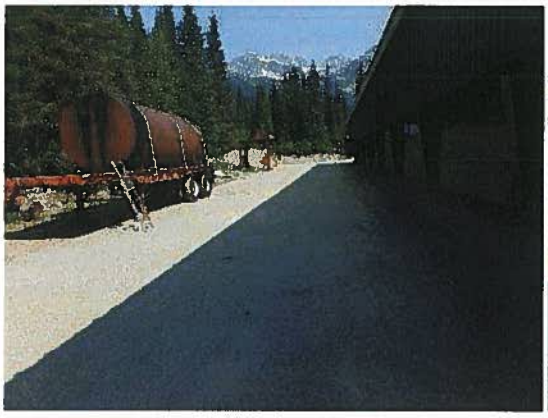

Photo 1 – West of Abrasives Storage Shed

Photo 2 – North of Abrasives Storage Shed

At some point to the north and east of the storage shed, the asphaltic surface terminates and the road structure becomes a gravel surfaced equipment laydown and travel area. The gravel surfacing is rutted with potholes and evidence of ponding water.

Photo 3 – East of Abrasives Storage Shed

Photo 4 – East of Abrasives Storage Shed

4.1.2 Main Driveway and Lane

The main lane travels across the compound from south to north connecting the Abrasives Storage Shed at the south end to the office and garage area near the center of the compound and the dormitory area near the north end of the compound. These areas featured asphalt surface finishes that appear to be conventionally placed hot-mix asphalt. The general condition of the asphalt appears to be fair, with signs of heavy surface wear including exposure of coarse aggregate and physical damage. Some cracking and potholes were observed in localized areas along the lane, as well as utility trench patches.

Photo 5 – At Dormitory Rec Building

Photo 6 – At Vehicle Storage Building

Photo 7 – At Office Building

Photo 8 – North limits

4.1.3 Garage and Office Area

The garage and office areas feature mixed surface finishes including asphalt pavement, rough asphaltic surfacing, and gravel.

It appears that hot-mix paving has been conducted in the past through the courtyards area and to the west of the office building. These paved areas are generally in poor condition with extensive cracking, potholes, delamination of surface lifts, and un-patched utility trenches. A number of localized sections in this area, including the gas station and apron features surrounding the Vehicle Storage Buildings, feature concrete surface finishes.

Photo 9 – Compound Courtyard

Photo 10 – West of Office Building

The compound area to the east of the Vehicle Storage Buildings is a combination of gravel surfacing and asphaltic finishes. Both these surfaces are in very poor condition with extensive potholes, ponding water, and irregular surface grades. The apparent gravel area to the southeast of the Vehicle Storage Buildings had an asphaltic layer just below the gravel surface that was encountered during our test pit investigation.

Photo 11 – Southeast of Vehicle Storage Buildings

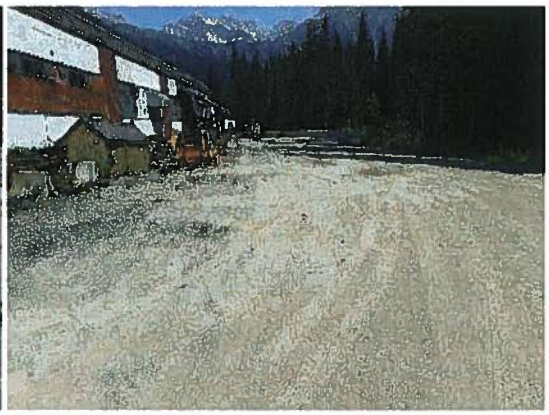

Photo 12 – East of Vehicle Storage Buildings

The compound to the north and east of the garage/office building features asphaltic surface finishes in poor condition. The areas are exhibiting the typical potholing, surface delaminations and evidence of ponding water observed in other areas. Levelton observed percolation of water up through the asphaltic surface at the south end of this area. We understand a known utility leak is causing the percolation. The asphalt surface in this area is heavily damaged, with extensive alligator cracking and potholing as well as ponding surface water.

Photo 13 – East of Garage/Office

Photo 14 – North of Garage/Office

4.1.4 Helipad / Snow Storage

The entrance driveway and Helipad/Snow Storage area have recently been reconstructed and paved with conventional hot-mix asphalt. The paved finishes in these areas are in good condition.

Photo 15 – Helipad / Snow Storage Area

4.2 Soil and Groundwater Conditions

The soils encountered at the Levelton test pits are generally inferred to consist of fill materials overlying native granular soils.

Asphaltic finishes were encountered at every test pit, except TP15-02, and ranged from about 75 to 350 mm in thickness. As discussed previously, the asphaltic finishes appear to consist of both hot-mix asphalt, and another form of friable asphalt that may be compacted pavement millings, or an oiled granular fill. TP15-02 featured a surface course of dense sand and gravel in lieu of the asphalt finish.

The asphalt surface was generally underlain by sand fill with varying gravel content that is inferred to be a road structure base course or grading course; the sand fill was 150 to 450mm thick. In test pits TP15-02 to TP15-10, sandy gravel and sand and gravel deposits with larger cobbles and boulders were encountered below the sand fill. The gravel, cobbles and boulders in this deposit are a distinctive shale-like rock that is laminated and easily friable. Based on site grades, conflicts with historic utilities, and similarity in soil and rock conditions, it is inferred that this sand and gravel is fill that was placed to roughly grade the compound at some point in the past. In TP15-02, 03, 04, 06, 07, and 10, the inferred fill continued until termination of these test pits at depths of 0.6 to 2 m below grade.

At TP15-01, the test pit encountered a 0.4m thick layer of mixed fill below the inferred base sand extending to a depth of 0.7 m. The fill consisted of burnt wood and coal ash with rocks and boulders. Underlying the fill, the test pit encountered a 100 mm thick deposit of silt topsoil underlain by inferred native sand and gravel with cobbles extending to a depth of 1.5 m. The gravel and cobbles at this test pit are round competent rock, unlike the gravel and boulders in the inferred fill encountered at other test pits. At TP15-05, the test pit similarly encountered a 0.3 m thick deposit of silt topsoil at a depth of 1.2 m underlain by native sand and gravel with roots and wood that extended to the termination of the test pit at a depth of 2 m. TP15-08 transitioned from sand and gravel fill to native sand and gravel with roots and wood that extended to the bottom of the test pit at a depth of about 1.7 m.

TP15-09 encountered a deposit of sand and coal ash below the sand and gravel fill that extended to a depth of 1.5 m.

TP15-11 was conducted by hand excavation at the edge of the newly paved Helipad/Snow Storage Area. The test pit encountered 60 mm of asphalt underlain by 150 mm of base gravelly sand, underlain by 450 mm of subbase sand and gravel. The test pit was terminated at 0.5 m in sand and gravel, assumed to be subgrade fill.

Based on the excavation effort, it is our opinion that the native sand and gravel, where encountered, was generally compact to dense, while the overlying granular fills were dense to very dense. The sand and coal ash fills, where encountered, were highly variable and are judged to be loose, based on excavation effort.

No groundwater seepage was observed in the test pits during the time they remained open.

5.0 Conclusions and Recommendations

We understand it is proposed to redevelop the Rogers Pass Compound to improve the overland drainage flows across the finished grades. We are anticipating that the majority of the site will be re-graded to achieve this design objective. We have developed our recommendations based on assumed grade changes of 0 to 0.5 m throughout the compound.

Based on our understanding of the proposed drainage improvements at the Rogers Pass we have provided a discussion on underground utilities that addresses shallow culverts and storm water infrastructure.

Based on our visual review of the compound surfaces it appears that the road structures are generally performing as intended. The roads and other surfaced areas appear to be in good condition structurally, but are heavily worn on the surface. Generally, the existing subsurface bearing soils throughout the compound consist of dense granular soils that are suitable for the construction of asphalt road structures. Based on these conditions it is our opinion that the near surface fill soils on the majority of the site are generally suitable to remain in place as a subbase material, and we have based our new pavement structure on installing new base course gravels and asphalt surfacing.

5.1 Site Preparation

Subgrade preparation in the proposed re-grading areas should consist of removal of the surface materials to allow for required grades, followed by placement of new base course gravel and asphalt. Based on the results of our subsurface investigation, stripping depths would generally be nominal.

Where the exposed subgrade consists of granular native soils and fill, we recommend that the subgrade be compacted with vibratory equipment to re-densify any soils disturbed during stripping/excavation, followed by proof rolling with a loaded dump truck under the review of a Geotechnical Engineer, prior to placing new fill. Areas that rut or deflect excessively under the proof rolling should be subexcavated to competent subgrade and grade reinstated with fill conforming to the specification for Select Granular Subbase (SGSB) contained in Section 202, Table 202-C "Aggregate Gradations" of the Ministry of Transportation and Infrastructure (MoTI)

specifications, compacted to not less than 100% of the material's Standard Proctor Maximum Dry Density as per ASTM D698.

During stripping, the site should be graded to provide positive drainage to temporary ditches for the control of surface runoff in order to avoid having surface water pond on the stripped subgrade.

5.2 Engineered Fill

In this report, engineered fill refers to permanent fill that will be placed below the proposed roadways/pavements and concrete slabs, which could be utilized in some high traffic loading areas.

We recommend that imported engineered fill required as subgrade fill to establish the desired elevation in areas that will be paved conform to the specification for Select Granular Subbase (SGSB) provided above. The material should be compacted to not less than 100% of the material's Standard Proctor Maximum Dry Density as per ASTM D698.

In-place density testing should be conducted on the fill by the Geotechnical Engineer as it is placed to confirm that adequate compaction is achieved.

The Geotechnical Engineer should be provided with the opportunity to review, test and approve all sources of imported engineered fill prior to their delivery to the site.

The site fills and native granular soils are highly variable and therefore, in general, we do not recommend they be used as engineered/subbase fill. They could possibly be used as bulk fill if areas require fills in excess of 0.5 m. The granular site soils would be suitable for use as trench fill provided particle larger than 150 mm in size are not placed within 300 mm of pipes as they could result in point loads resulting in deflection or damage to pipes.

Soils that contain organic material are not suitable for re-use as engineered fill.

It is recommended that any site soils proposed for re-use as fill be reviewed by the Geotechnical Engineer at the time of excavation and prior to placement to assess their suitability. Stockpiles of site soils identified by the Geotechnical Engineer as being suitable for re-use as engineered fill should be covered with polyethylene sheeting, and grades surrounding the stockpiles should be such that surface water runoff is directed around or away from the stockpiles.

5.3 Freezing of Road Structure and Subgrade Soils

The climatic conditions of the site are such that freezing and thawing of materials will occur seasonally, resulting in some heave and deflection of the asphalt surface. This will result in a reduced pavement life. Sealing of cracks in the pavement surface should be undertaken as they develop, and at least on a yearly basis.

Frost heave is propagated by ice crystals forming within a soil matrix; forcing the material to increase in volume and heave upwards. The magnitude of heave is based on the gradation of the soil, availability of free water in the

soil, and anticipated depth of frost penetration. Frost heave is expected to be a concern for materials with greater than 6% fines (materials passing the 0.075mm sieve); generally, free draining materials such as the recommended granular road fills are resistant to frost heave.

The anticipated frost penetration depth for the Rogers Pass region is up to 2.5m in depth. This depth will exceed the encountered granular fill materials and cause freezing of the underlying native soils. Based on our subsurface investigation we predict that the native soils underlying surficial fills will generally consist of granular materials that will low to medium susceptibility of frost heave. Additionally, none of the test holes encountered ground water at the excavated depths; the lack of availability of free water in the freezing zone will further resist frost heave.

The magnitude of frost heave at the Rogers Pass site is difficult to predict due to the highly variable fill materials near the surface. Based on the available information it is predicted that frost heave effects would be within tolerance limits for road structure pavements. The longer term effects of cyclical frost heaving will cause accelerated wear on the asphalt pavements and it is expected that seasonal maintenance will be required to prolong pavement structure life.

5.4 Proposed Pavement Structure

Where required for re-grading we suggest the following pavement structure:

- 100 mm of 19 mm Class 1 Medium Mix to MoTI Section 502, Table 502-C-1 – Asphalt Mix Aggregate Gradation Limits , overlying;
- 150 mm of 25 mm minus WGB to MoTI specifications in Table 202-C, base course, overlying;
- Compacted and proof rolled site material or compacted engineered fill as outlined in Sections 5.1 and 5.2 above.

For areas subjected to only light vehicle loading the asphalt thickness could be reduced to 75 mm.

The import granular fills should be compacted to not less than 100% of their Standard Proctor Maximum Dry Density, as confirmed by in-place soil density testing.

In heavy loading areas, consideration should be given to placing a rigid pavement structure consisting of a 150 mm thick reinforced concrete slab atop 150 mm of 25 mm minus WGB to MoTI specifications in Table 202-C, base course compacted to not less than 100% Standard Proctor Maximum Dry Density placed atop suitable subgrade.

5.5 Underground Utilities

Temporary excavations for the installation of proposed underground utilities at the site should conform to WorkSafe BC requirements. It is recommended that the sides of unsupported temporary excavations for utility installation that are greater than 1.2 m in depth not be steeper than 3H:4V (Horizontal:Vertical) where worker

access is required. Where steeper slopes are necessary, suitable trench shoring cages should be used, or the excavation should be reviewed and approved in writing by a Geotechnical Engineer prior to allowing worker access into or adjacent to such excavations.

Based on the test pits, it is anticipated that the soil at the base of trenches excavated for installation of underground services will be variable, but will generally consist of competent granular soils, and improvement of the trench subgrade is generally not expected to be necessary. Where the subgrade consists of granular soils, we recommend that any protruding cobbles or boulders be removed from the base of the trench and that the subgrade be compacted with vibratory equipment prior to placement of the pipe bedding.

Based on the information obtained from the test pits, it is anticipated that specialized temporary excavation dewatering will not be necessary for construction of underground utilities. It is expected that surface water and groundwater seepage entering trenches could be adequately controlled using sump pits and pumps.

We recommend that pipe bedding material conform to gradation for Embedment Material as per MoTI specifications in table 303-A. The pipe bedding should be placed in discrete lifts a maximum of 150 mm in thickness and be compacted with vibratory equipment to not less than 95 percent of the material's Standard Proctor Maximum Dry Density.

Trench backfill should consist of well-graded granular material with a maximum particle size of 150 mm and a maximum of 8% fines (material passing the 0.075 mm sieve). Trench backfill should be placed in discrete lifts a maximum of 200 mm in thickness and be compacted to not less than 95% of the material's Standard Proctor Maximum Dry Density, as confirmed by in-place soil density tests conducted by the Geotechnical Engineer.

It is anticipated that the native granular soils and granular fills encountered at the test pits would generally be suitable for use as trench backfill. However, at some of the test pits, the granular soils were noted to contain cobbles and boulders, and it is recommended that particles larger than 150 mm in diameter be selectively removed from the excavated material so as not to impinge on utilities during backfilling of the trench with this material. If consideration is given to using excavated site soils as trench backfill, it is recommended that the Geotechnical Engineer review the soils as they are being excavated to assess their suitability.

Frost penetration depth at the subject site is estimated to be 2.5m. Utilities installed within this depth of the surface will potentially be affected by frost heaving and freezing. Culverts should be adequately sized to prevent blockages from freezing and aligned at a suitable slope to prevent seasonal movements from compromising positive drainage.

6.0 Closure

This geotechnical report has been prepared by Levelton exclusively for Public Works Government Services Canada and their appointed agents. The opinions and recommendations provided in this report reflect our judgement in light of the information available to us at the time that it was prepared.

Any use of this report by third parties, or any reliance on or decisions made based on it, are the responsibility of such third parties. Levelton does not accept responsibility for damages suffered, if any, by a third party as a result of their use of or reliance on this report.

The soil logs attached to this report provide description of the conditions encountered at discrete test pit locations. Actual pavement, soil, and groundwater conditions at the site may vary from those encountered at the test pits.

Contractors should make their own interpretation of the soil logs and the site conditions for the purposes of bidding and performing work at the site.

The attached Terms of Reference are an integral part of this geotechnical report.

We trust the information presented in this report meets your immediate requirements. If you have any questions or require additional information, please do not hesitate to contact our office.

Levelton Consultants Ltd.

Original Signed by:

Per: Paul Ell, P.Eng.
Senior Geotechnical Engineer

Thomas Dueckman, EIT
Junior Engineer

Reviewed by:
Michael Gutwein, P.Eng.
Senior Geotechnical Engineer

Attachments: Terms of Reference
Figures 1
Soil Logs
Grain Size Analysis Reports

c/c Andrew Gower, P.Eng., P.E.
Wedler Engineering LLP

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b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to Levelton. Levelton has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Levelton cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

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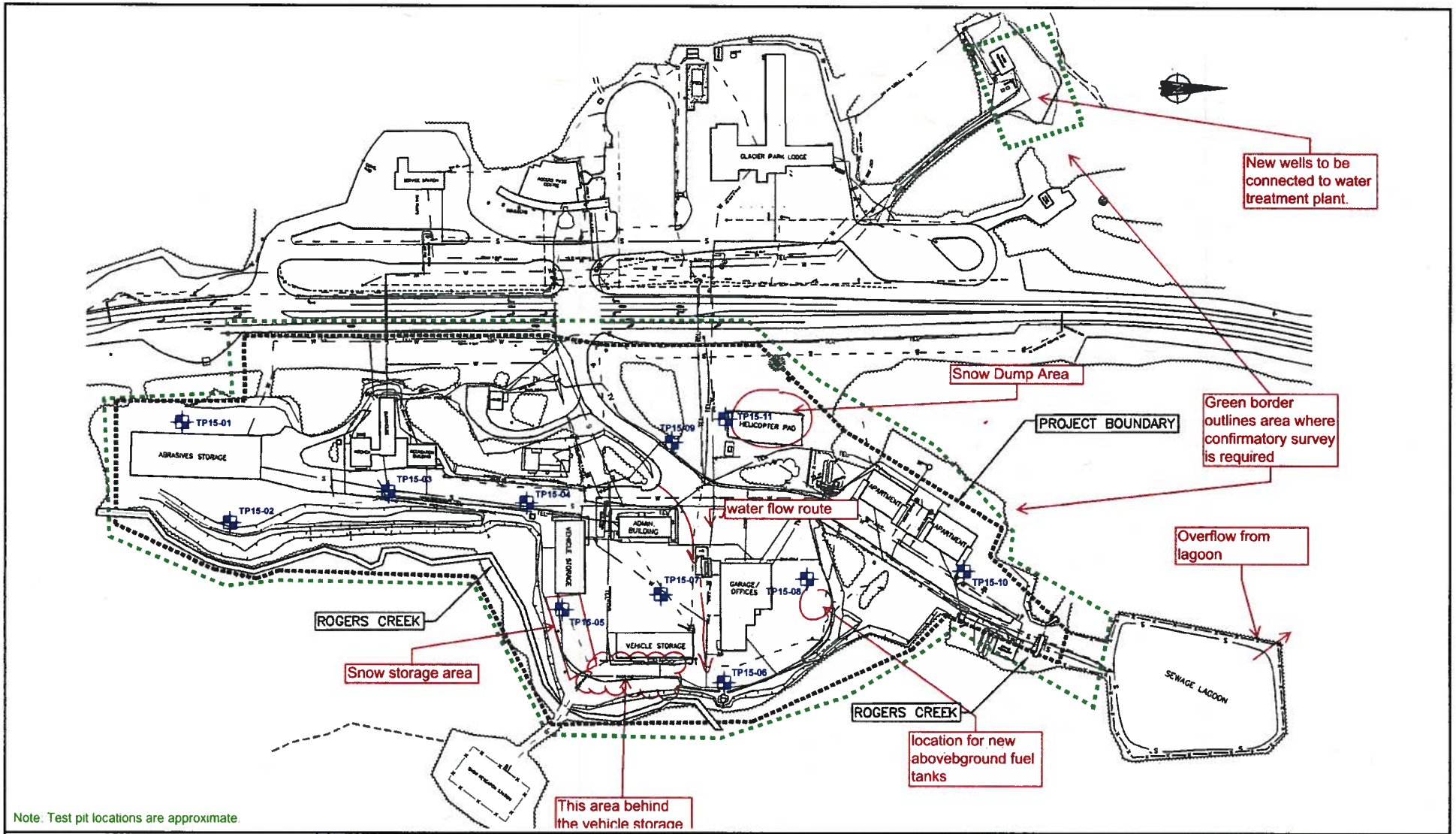

Note: Test pit locations are approximate.

LEGEND

TP15-XX TEST PIT

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	DRAWN	CHECK

ADAPTED FROM: ISL Engineering & Land Services

PROJECT/DWG NO: G2007R2

DATE: November 2007

TITLE: **Site Plan - Test Pit Locations**

PROJECT: Rogers Pass Public Works Yard - Pavement Assessment

ADDRESS: Rogers Pass Compound, BC

CLIENT: PWGSC

SEAL:

LEVELTON
108 - 3677 Hwy 97N,
Kelowna, BC, V1X 5C3
p: 250-491-9778 f: 250-491-9729
www.levelton.com

DESIGN: TD	DATE: July 2015
CHECK: PE	SCALE: NTS
DRAWN: TD	FILE NO: R715-1159-00
DWG NO:	Figure 1

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#108 - 3677 Highway 97N
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Rogers Pass Compound
BC
Pavement Assessment

TP15-01

Project No: R715-1159-00
Lat: 51.29950 Long: -117.51920

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (very dense asphalt millings)			G	
		Compact brown gravelly SAND, FILL trace silt, dry.			G	
	2	Soft SILT, FILL, burnt organics, branches and wood, coal, moist.			G	
		Boulder 1m wide by 0.4m high.			G	
	4	Soft dark brown organic SILT, moist.			G	
		Compact brown silty SAND, moist.			G	
	6	Compact mottled brown sandy GRAVEL, round cobbles, some silt, wet.			G	
2		Bottom of test pit at 1.50 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 09/07/2015
By: TD

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Kelowna, B.C. V1X 5C3
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Rogers Pass Compound
BC
Pavement Assessment

TP15-02

Project No: R715-1159-00
Lat: 51.29980 Long: -117.51840

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
0	0	Dense tan SAND and GRAVEL, some silt, dry			G	
0.6	2	Very dense brown GRAVEL and SAND, round cobbles, some silt, moist			G	
1.2	4	Very dense dark grey brown sandy GRAVEL, round cobbles and boulders, some silt, moist			G	
1.8	6				G	
1.80		Bottom of test pit at 1.80 meters				

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 09/07/2015
By: TD

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Levelton Consultants Ltd.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: 250-491-9778
Fax: 250-491-9729
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Rogers Pass Compound
BC
Pavement Assessment

TP15-03
Pg 1 of 1
Project No: R715-1159-00
Lat: 51.30050 Long: -117.51860

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (very dense asphalt millings)			G	
		Asphalt (dense asphalt millings or oiled gravel)			G	
	2	Dense mottled brown SAND and GRAVEL, some silt, moist			G	
	4	Dense mottled brown sandy GRAVEL, weakly laminated cobbles and boulders, some silt, moist metal debris at 0.5m			G	
	6	large boulders (0.1m3) at 1.2m and 1.6m			G	
2		Bottom of test pit at 1.70 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 09/07/2015
By: TD

1 LOG PER PAGE R715-1159-00 ROGERS PASS LOGS.GPJ LEVELTON.GDT 10/8/15

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#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: 250-491-9778
Fax: 250-491-9729
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Rogers Pass Compound
BC
Pavement Assessment

TP15-04

Project No: R715-1159-00

Lat: 51.30120 Long: -117.51850

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (very dense compacted millings)			G	
		Asphalt (compact asphalt millings or oiled gravel)			G	
	2	Dense mottled brown SAND and GRAVEL, some silt, moist				
		Utility Conflict				

10 20 30 40 50 60 70 80 90

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

4 6 8

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- ● Moisture Content %
- ▶ Plastic Limit %
- ◀ Liquid Limit %
- ▼ Ground Water Level
- ⊗ Shear strength in kPa (Torvane or Penetrometer)
- ✕ Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Test Pit

Date Drilled: 09/07/2015

By: TD

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#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
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Rogers Pass Compound
BC
Pavement Assessment

TP15-05

Project No: R715-1159-00
Lat: 51.30150 Long: -117.51750

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Dense brown SAND and GRAVEL, some silt, **FILL**, dry			G	
		Asphalt (dense asphalt millings or oiled gravel)			G	
	2	Compact brown silty SAND, some gravel, **FILL**, dry			G	
		Dense mottled brown sandy GRAVEL weakly laminated cobbles and boulders, some silt, **FILL**, moist			G	
	4	Firm dark brown sandy organic SILT, **FILL**, roots and wood, moist			G	
	6	Compact dark brown silty SAND and GRAVEL, some roots and wood, moist			G	
2		Bottom of test pit at 2.00 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 In. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 09/07/2015
By: TD

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Levelton Consultants Ltd.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: 250-491-9778
Fax: 250-491-9729
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Rogers Pass Compound
BC
Pavement Assessment

TP15-06

Project No: R715-1159-00
Lat: 51.30230 Long: -117.51740

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
0	0	Asphalt (very dense asphalt millings)			G	
		Dense brown SAND and GRAVEL, FILL, some silt, dry			G	
0.6	2	Asphalt (dense asphalt millings or oiled gravel)			G	
		Dense brown gravelly SAND, some silt, dry				
1.2	4	Dense brown sandy GRAVEL, rounded cobbles and boulders, some silt, moist			G	
1.30		Bottom of test pit at 1.30 meters				

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 09/07/2015
By: TD

LEVELTON
Levelton Consultants Ltd.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: 250-491-9778
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Rogers Pass Compound
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Pavement Assessment

TP15-07

Project No: R715-1159-00
Lat: 51.30210 Long: -117.51770

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (very dense asphalt millings)			G	
		Asphalt (dense asphalt millings or oiled gravel)			G	
	2	Dense brown gravelly SAND, some silt, dry				
	4	Dense mottled brown GRAVEL and SAND weakly laminated cobbles and boulders, trace silt, moist			G	
	6				G	
2		Bottom of test pit at 2.00 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 10/07/2015
By: TD

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Levelton Consultants Ltd.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: 250-491-9778
Fax: 250-491-9729
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Rogers Pass Compound
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Pavement Assessment

TP15-08

Project No: R715-1159-00
Lat: 51.30250 Long: -117.51800

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (very dense asphalt millings)			G	
	2	Dense brown gravelly SAND, weakly laminated cobbles, trace silt, moist			G	
	4	Dense brown sandy GRAVEL, many weakly laminated cobbles and boulders, trace silt, moist			G	
	6	Dense brown SAND and GRAVEL, wood branches and roots, some silt, moist			G	
2		Bottom of test pit at 1.70 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 10/07/2015
By: TD

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Levelton Consultants Ltd.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
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Rogers Pass Compound
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Pavement Assessment

TP15-09
Pg 1 of 1
Project No: R715-1159-00
Lat: 51.30180 Long: -117.51910

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
	0	Asphalt (new overlay)			G	
	0	Asphalt (very dense asphalt millings)			G	
	2	Compact tan gravelly SAND, FILL, trace silt, dry				
	2	Dense cemented silty GRAVEL, FILL, weakly laminated cobbles and boulders, some sand, dry			G	
	4	Compact SAND, FILL, black ash/coal, debris including bricks and cable, dry.			G	
		Bottom of test pit at 1.50 meters				

10 20 30 40 50 60 70 80 90

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C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 10/07/2015
By: TD

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Levelton Consultants Ltd.
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Kelowna, B.C. V1X 5C3
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Rogers Pass Compound
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Pavement Assessment

TP15-10
Pg 1 of 1
Project No: R715-1159-00
Lat: 51.30340 Long: -117.51780

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (old overlay)			G	
		Asphalt (dense asphalt millings)			G	
	2	Dense brown gravelly SAND, some silt, moist			G	
	4	Dense brown GRAVEL, weakly laminated cobbles, some sand, some silt, moist			G	
		Bottom of test pit at 1.50 meters				
2	6					
	8					
	10					
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 10/07/2015
By: TD

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#108 - 3677 Highway 97N
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Tel: 250-491-9778
Fax: 250-491-9729
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Rogers Pass Compound
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Pavement Assessment

TP15-11

Project No: R715-1159-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Asphalt (new pavement)			G	
		Compact brown gravelly SAND, some silt, **FILL**, dry			G	
	2	Dense brown SAND and GRAVEL, some silt, **FILL**, dry				
	4	Dense grey SAND and GRAVEL, some silt, moist				
	6	Bottom of test pit at 0.50 meters				
2	8					
	10					
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit %
- Liquid Limit %
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 10/07/2015
By: TD

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Fraser Valley Group and Southern Interior

LEVELTON

#110, 34077 Gladys Avenue
Abbotsford, BC V2S 2E8
Tel: (604) 855-0206
Fax: (604) 853-1186
Email: abbotsford@levelton.com

#301, 19292-60 Avenue
Surrey, BC V3S 3M2
Tel: (604) 533-2992
Fax: (604) 533-0768
Email: surrey@levelton.com

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729
Email: kelowna@levelton.com

Client: PWGSC
Project: Rogers Pass - Pavement Assessment
Site Address: Rogers Pass, BC

File No.: R715-1159-00
Task:

Report of Grain Size Analysis

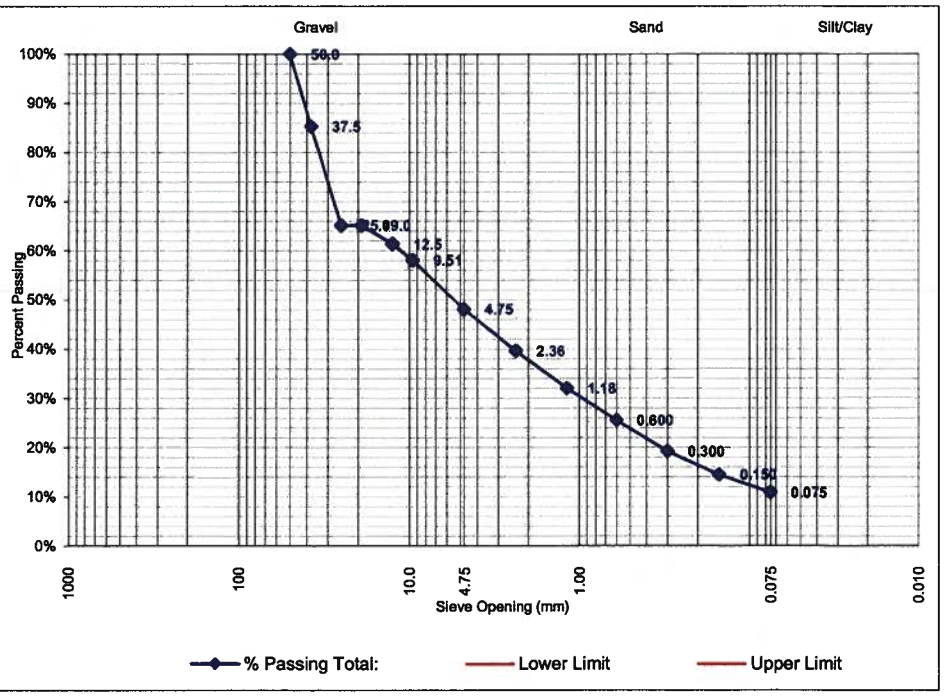
Sample Location: TP15-02, G2
Supplier:
Material Type: GRAVEL and Sand, some silt
Usage:
Specification:

Sampled By: TD
Tested By: MP
Date Sampled: July 9, 2015
Date Tested: July 20, 2015
Sieve No. 1

Moisture Content (as received): 5%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0	100.0%		
37.5	85.3%		
25.0	65.1%		
19.0	65.1%		
12.5	61.3%		
9.51	58.1%		
4.75	48.1%		
2.36	39.6%		
1.18	32.0%		
0.600	25.6%		
0.425			
0.300	19.3%		
0.150	14.5%		
0.075	10.9%		



Remarks: _____

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No engineering interpretation of the results is expressed or implied.
Engineering review and interpretation of these results can be provided upon written request.

Per: _____

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#110, 34077 Gladys Avenue
Abbotsford, BC V2S 2E8
Tel: (604) 855-0206
Fax: (604) 853-1186
Email: abbotsford@levelton.com

#301, 19292-60 Avenue
Surrey, BC V3S 3M2
Tel: (604) 533-2992
Fax: (604) 533-0768
Email: surrey@levelton.com

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729
Email: kelowna@levelton.com

Client: PWGSC
Project: Rogers Pass - Pavement Assessment
Site Address: Rogers Pass, BC

File No.: R715-1159-00
Task:

Report of Grain Size Analysis

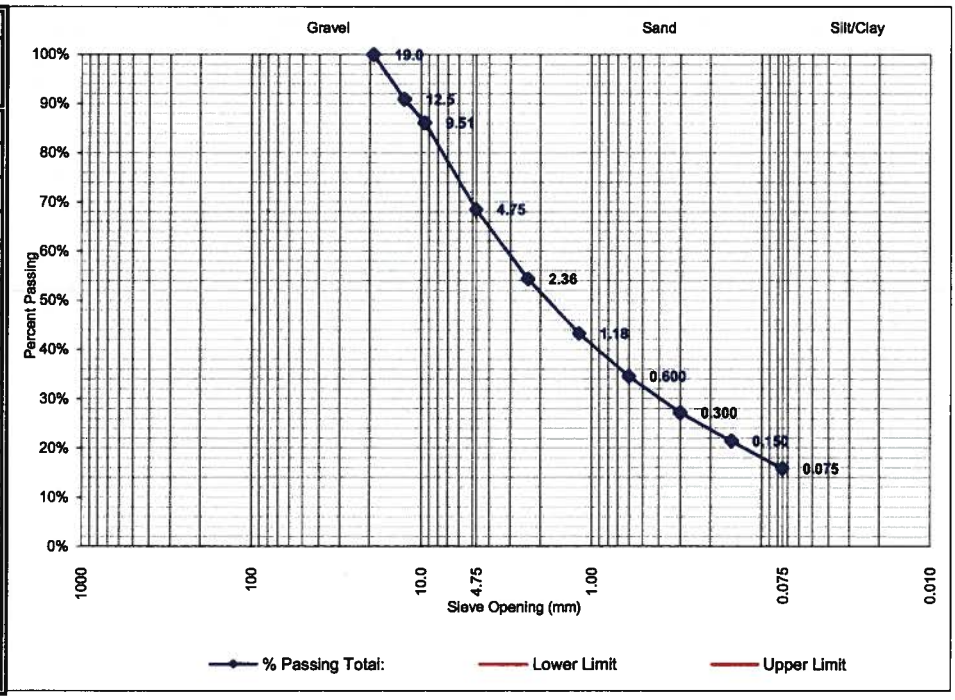
Sample Location: TP15-06, G2
Supplier:
Material Type: Gravelly SAND, some silt
Usage:
Specification:

Sampled By: TD
Tested By: MP
Date Sampled: July 9, 2015
Date Tested: July 20, 2015
Sieve No. 2

Moisture Content (as received): 8%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0			
19.0	100.0%		
12.5	90.9%		
9.51	86.1%		
4.75	68.5%		
2.36	54.3%		
1.18	43.3%		
0.600	34.6%		
0.425			
0.300	27.2%		
0.150	21.4%		
0.075	15.8%		



Remarks: _____

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Engineering review and interpretation of these results can be provided upon written request.

Per: _____

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LEVELTON

#110, 34077 Gladys Avenue
Abbotsford, BC V2S 2E8
Tel: (604) 855-0206
Fax: (604) 853-1186
Email: abbotsford@levelton.com

#301, 19292-60 Avenue
Surrey, BC V3S 3M2
Tel: (604) 533-2992
Fax: (604) 533-0768
Email: surrey@levelton.com

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729
Email: kelowna@levelton.com

Client: PWGSC
Project: Rogers Pass - Pavement Assessment
Site Address: Rogers Pass, BC

File No.: R715-1159-00
Task:

Report of Grain Size Analysis

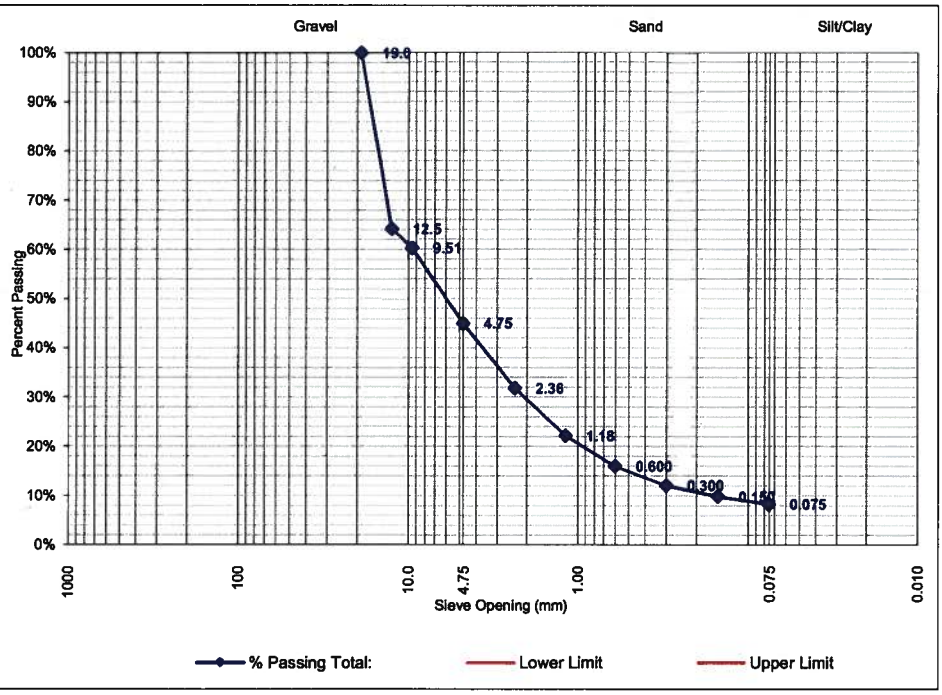
Sample Location: TP15-07, G3
Supplier:
Material Type: GRAVEL and Sand, trace silt
Usage:
Specification:

Sampled By: TD
Tested By: MP
Date Sampled: July 9, 2015
Date Tested: July 20, 2015
Sieve No. 3

Moisture Content (as received): 4%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0			
19.0	100.0%		
12.5	64.2%		
9.51	60.3%		
4.75	44.9%		
2.36	31.8%		
1.18	22.1%		
0.600	16.0%		
0.425			
0.300	12.0%		
0.150	9.8%		
0.075	8.2%		



Remarks: _____

Levelton Consultants Ltd.

Reporting of these results constitutes a testing service only.
No engineering interpretation of the results is expressed or implied.
Engineering review and interpretation of these results can be provided upon written request.

Per: _____

Levelton Consultants Ltd.

Fraser Valley Group and Southern Interior

LEVELTON

#110, 34077 Gladys Avenue
Abbotsford, BC V2S 2E8
Tel: (604) 855-0206
Fax: (604) 853-1186
Email: abbotsford@levelton.com

#301, 19292-60 Avenue
Surrey, BC V3S 3M2
Tel: (604) 533-2992
Fax: (604) 533-0768
Email: surrey@levelton.com

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729
Email: kelowna@levelton.com

Client: PWGSC
Project: Rogers Pass - Pavement Assessment
Site Address: Rogers Pass, BC

File No.: R715-1159-00
Task:

Report of Grain Size Analysis

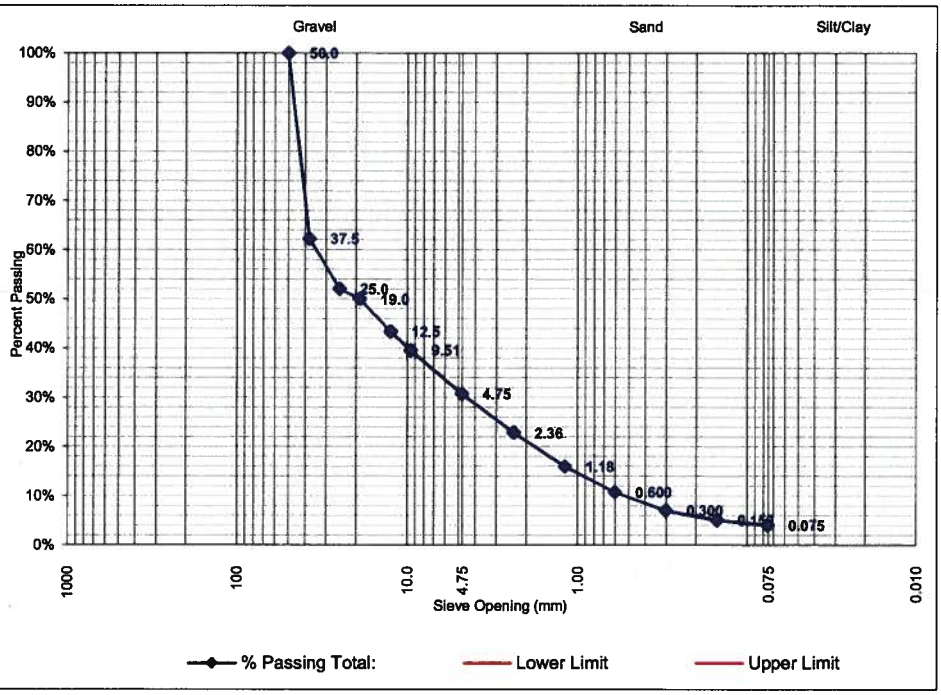
Sample Location: TP15-08, G3
Supplier:
Material Type: Sandy GRAVEL, trace silt
Usage:
Specification:

Sampled By: TD
Tested By: MP
Date Sampled: July 9, 2015
Date Tested: July 20, 2015
Sieve No. 4

Moisture Content (as received): 5%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0	100.0%		
37.5	62.2%		
25.0	52.0%		
19.0	50.0%		
12.5	43.3%		
9.51	39.5%		
4.75	30.7%		
2.36	22.8%		
1.18	15.9%		
0.600	10.7%		
0.425			
0.300	7.0%		
0.150	5.1%		
0.075	4.0%		



Remarks: _____

Levelton Consultants Ltd.

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Engineering review and interpretation of these results can be provided upon written request.

Per: _____

APPENDICES

Project no.: 161-07388-00
November 4, 2016

Public Works Government Services Canada
219 – 800 Burrard St.
Vancouver, BC V6Z 0B9

Attention: Tom Dunphy,

Subject: **Geotechnical Engineering Technical Memorandum - Snow Retention Wall Foundations**

Drainage Improvements - Parks Canada Maintenance Compound, Rogers Pass, BC

Dear Sir,

INTRODUCTION

As requested, WSP Canada Inc. (WSP) has prepared this geotechnical engineering technical memorandum for the above-referenced project.

This memorandum has been prepared based on our proposal P16-11060-93 dated April 22, 2016 for the purpose of providing information to the Civil Engineer (Wedler Engineering LLP) regarding the suitability of the soil conditions along the east perimeter of the site to construct a snow retention wall.

According to the preliminary design information provided by the Civil Engineer we understand the snow retention wall will consist of two wall systems. The majority of the wall will consist of precast A-frame structures placed on the asphalt pavement surface and anchored into the subgrade soils. One portion of wall, between the Abrasives Storage and Vehicle Storage 1 buildings, will consist of a panel wall system. We understand the panel wall will consist of a 4m high wall system with pre-cast concrete panels 3.6m wide supported by structural columns, likely consisting of steel beams or built up sections. The steel beams will be placed in holes bored into the site soils and concreted in place to create pile foundations.

Our scope of work on this project was to review our previous geotechnical report for the site area (prepared as Levelton Consultants Ltd. (Levelton) prior to our acquisition by WSP), conduct additional geotechnical sub-surface investigation along the proposed wall alignment, and preparation of this technical memorandum.

WSP Canada Inc.
108 – 3677 Hwy 97N
Kelowna, BC

Phone: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

BACKGROUND – PREVIOUS INVESTIGATION (2015)

A previous geotechnical report for the subject site has been issued on August 10, 2015 (Levelton file number R715-1159-00). On July 9 and 10, 2015 ten (10) test pits TP15-01 to TP15-10 were conducted using a track-mounted excavator to depths of approximately 0.5 to 2.0 m below grade throughout the maintenance compound.

Soils encountered within the Levelton test pits generally consisted of dense to very dense coarse granular fills to approximately 0.6 to 2.0 m below grade, overlying compact native granular soils to the bottom of the test pits at 1.5 to 2.0m deep. At intermittent locations the test pits encountered burried wood debris and organics at the transition between fill and native granular deposits.

INVESTIGATION

On October 20 and 21, 2016 an additional geotechnical subsurface investigation consisting of four (4) machine dug test holes was conducted at the subject site. The test holes were excavated by a tracked excavator to a depth of 4.0m below existing grade to review the soil conditions. The test pits were excavated along the east perimeter of the site following the general alignment of the proposed snow retention wall. A site plan showing the 2016 test hole locations is included in Figure 1 following this memorandum.

WSP observed the test pitting and collected representative soil samples from the excavated materials. Moisture contents were determined on each of the samples collected from the test holes. The moisture contents of the fills were determined to range from 6 to 53 percent. Grain size analyses were conducted on a sample collected from varying depths of excavations. The results of the grain size analyses are included on the attached laboratory test reports following this memorandum.

Detailed descriptions of the subsurface soil conditions are included in the soil logs attached to this memorandum. A brief description of the observed soil conditions is as follows:

Compact to Dense granular fills – The surficial soils at each test pit consisted of dense sand and gravel and gravelly sand fill from 1 to 3m deep. In some cases the fill materials included larger cobbles and boulders. TP16-03 included 250mm of asphalt surfacing overlying the fill materials.

Loose Sand Topsoil – Underlying the fill each test pit encountered a 0.3m thick layer of inferred topsoil, consisting of sand with organics, wood debris and ash.

Native Silt – Underlying the inferred topsoil layer TP16-02 and TP16-03 encountered deposits of firm to stiff silt to a depth of 3.5m where it was terminated.

Native Sand – Underlying the topsoil layers in TP16-01 and TP16-04 and the silt layer in TP16-02 each test pit encountered a deposit of compact to very dense granular soil ranging from sandy silty gravel to sand some gravel trace silt. TP16-01, TP16-02 and TP16-04 were terminated in the granular deposits at a depth of 3.5 to 4m.

Groundwater was encountered in the test pits TP16-02 and TP16-03 at depths of 3.8m and 3m respectively. It is expected that the ground water elevation would fluctuate with the local seasonal and climatic changes.

RECOMMENDATIONS

Based on the previous geotechnical information available for the site, and the results of our investigation, it is our opinion that design and construction of the proposed snow retention wall is feasible. The wall could be supported on the proposed cast-in-place concrete pile foundations.

WALL LOADING

A conservative model of lateral loading from snow stockpiling can be estimated by assuming an at rest pressure distribution, based on soil mechanics. For this analysis it is assumed that the snow banks have an internal friction angle equal to the conventional slope steepness limit for avalanches to trigger (30° from horizontal) and a compressed unit weight equal to the density of ice (8.8kN/m^3). Assuming these values, and the snow is stockpiled to the top of the 4m high wall, a triangular pressure distribution of 0 kPa at the top of wall increasing to 17.6 kPa at the wall base can be calculated. This pressure distribution will create an equivalent load of 35.2 kN per linear meter of wall acting at 1.3m up from the wall base. Given a 3.6m wall support spacing the support columns will be subject to a load of 126.7 kN at 1.3m from the column base.

Additional loading cases that may impact the wall design include impact loading from vehicles and wind loading. These loading cases have not been considered in this memorandum, but should be addressed by the wall designer.

FOUNDATION DESIGN

FOUNDATION CAPACITY

Our preliminary analysis is based on the encountered soil conditions along the proposed wall alignment, and the preliminary foundation design information including an anticipated cast-in-place concrete cylindrical pile on the order of 0.5m diameter and a depth of 5m below surrounding grade. As a preliminary guideine WSP judges that the foundations could be designed as end bearing piles with a factored toe bearing pile capacity of 1280 kPa. WSP can refine the capacity calculations once more detailed design information is available.

LATERAL RESISTANCE

WSP conducted a preliminary lateral pile analysis to determine the soil response caused by the anticipated lateral loading conditions. The soil properties were estimated based on our test hole information, site observations and laboratory testing results. The preliminary lateral pile analysis utilized the following soil profile:

Depth (m)	Soil Description	Effective Unit Weight (kN/m^3)	Internal Friction Angle (°)	Undrained Cohesion (kPa)
0-2	Compact Sand and Gravel Fill	19	32	
2-3.5	Stiff sandy Silt	17	28	50
3.5-5	Dense Sand, some gravel	11	35	

An analysis of pile head deflection was performed for the soil conditions above, the snow loading discussed in the previous section and the proposed pile geometry of 0.5m diameter piles installed to 5m depths. The analysis showed a head deflection of approximately 8mm can be expected under these conditions. Typically 6mm is considered the failure threshold for pile supported structures. A second analysis was performed with the piles enlarged to 0.75m diameter; a head deflection of 5mm can be expected under these conditions. WSP can refine the lateral resistance calculations and lateral deflection analysis when more design information is available.

FIELD REVIEWS

The geotechnical engineer should be given the opportunity to review the wall support post borings to confirm the soil conditions.

CLOSURE

The attached Terms of Reference form an integral part of this technical memorandum.

We trust that the information presented in this memorandum meets your immediate requirements. If you have any questions or require further information, please do not hesitate to contact us.

Yours truly,

Reviewed By:

Original Signed By:

Per: Thomas Dueckman, PEng.
Project Engineer

Original Signed By:

Per: Paul R. Ell, P.Eng.
Senior Geotechnical Engineer

Attachments: *Terms of Reference for Geotechnical Reports*
Figure 1 – Site Plan
Soil Logs
Grain Size Analysis Reports

CC: Wedler Engineering LLP – Attn. Sam Rogers, EIT

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

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a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.

b. **Reliance on Information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

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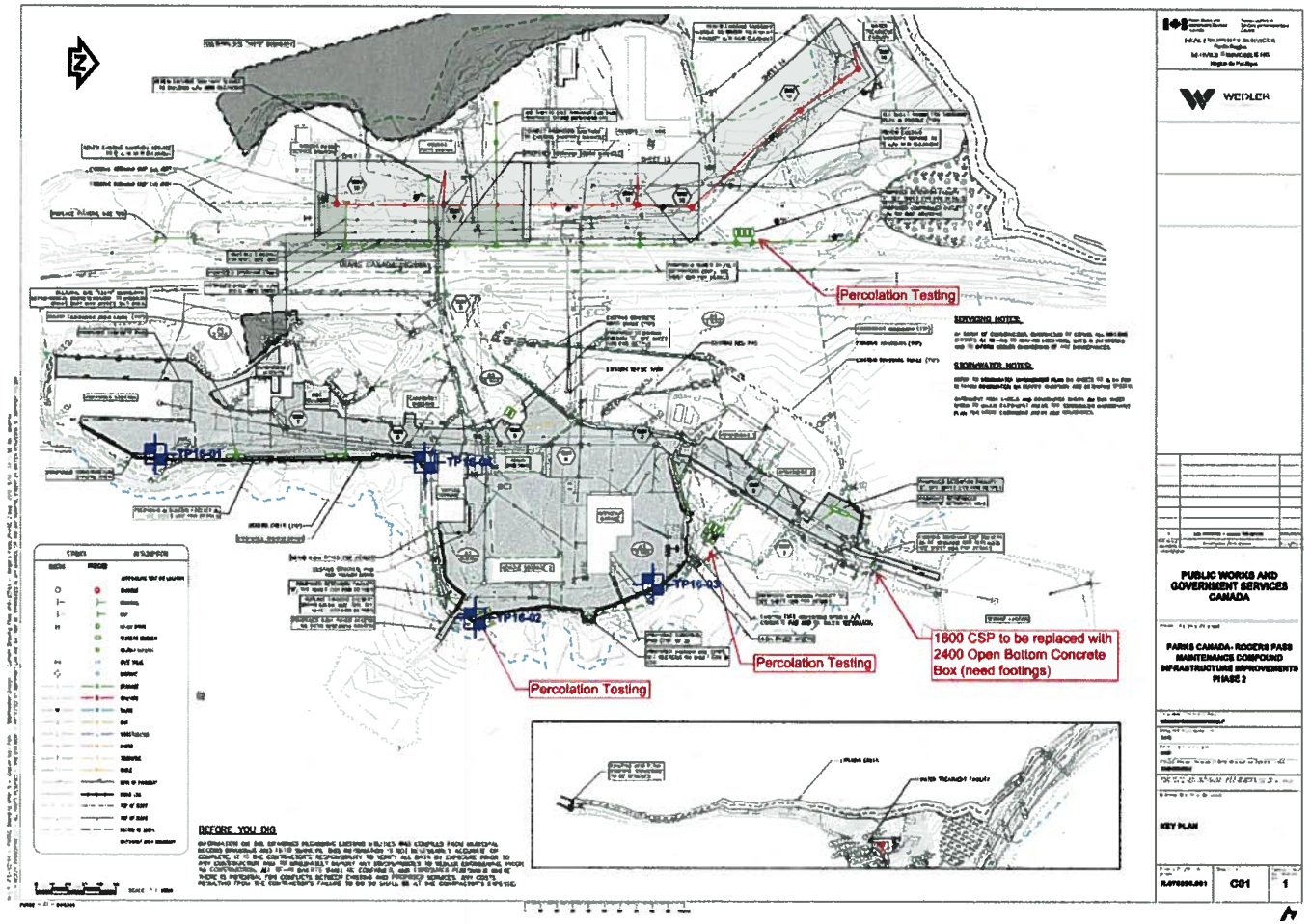
The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except WSP. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by WSP.

The Client recognizes and agrees that WSP prepared and submitted electronic files using specific software or hardware systems, or both. WSP makes no representation about the compatibility of these files with the current or future software and hardware systems of the Client, the Approved Users or any other party. The Client further agrees that WSP is under no obligation, unless otherwise expressly specified, to provide the Client, the Approved Users and any other party, or any or all of them, with specific software and hardware systems that are compatible with any electronic submitted by WSP. The Client further agrees that should the Client, an Approved User or a third party require WSP to provide specific software or hardware systems, or both, compatible with the electronic files prepared and submitted by WSP, for any reason whatsoever included but not restricted to an order from a court, then the Client will pay WSP for all reasonable costs related to the provision of the specific software or hardware systems, or both. The Client further agrees to indemnify and hold harmless WSP, its officers, directors, employees, agents, representative or sub-consultant, or any or all of them, against any claim or any nature whatsoever brought against WSP, whether in contract or in tort, arising or related to the provision or use or any specific software or hardware provided by WSP.



LEGEND

TP16-X TEST PIT

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	DRAWN	CHECK

ADAPTED FROM: Wedler Engineering LLP

PROJECT/DWG NO.: R.076550.001 - C01

DATE: August 2016

TITLE: **Site Plan - Test Pit Locations**

PROJECT: Rogers Pass Maintenance Compound

ADDRESS: Hwy 1, Rogers Pass, BC

CLIENT: Public Works Government Services Canada

SEAL:

108 - 3677 Hwy 97N,
Kelowna, BC, V1X 5C3
p: 250-491-9778 f: 250-491-9729
www.wspgroup.com

DESIGN: TD	DATE: Nov 2016
CHECK: PE	SCALE: NTS
DRAWN: TD	FILE NO: 161-07388-00

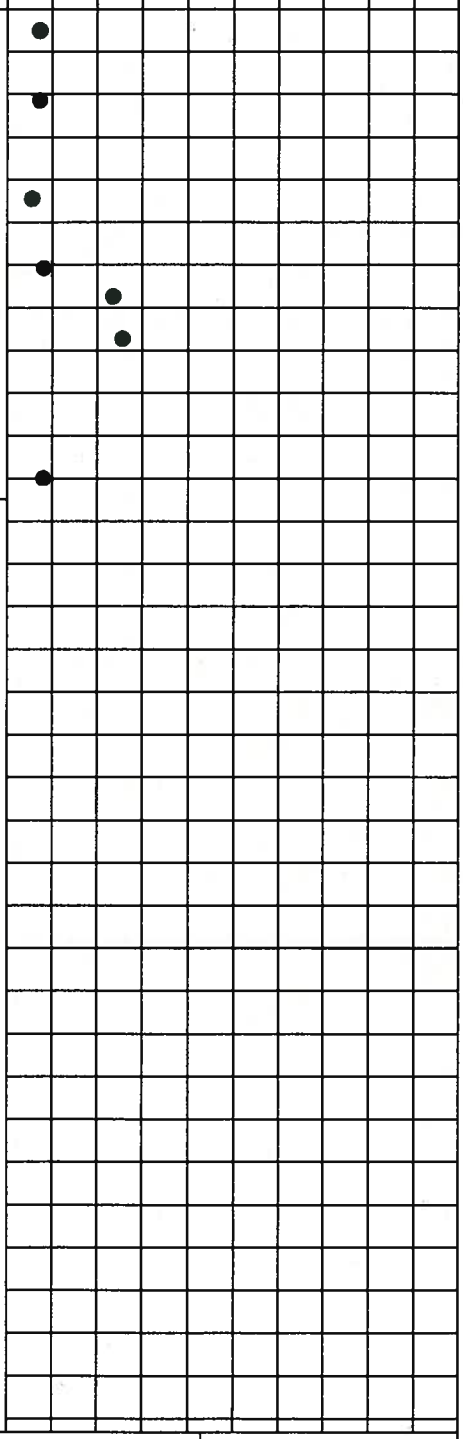
DWG NO.: Figure 1

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Compound
Public Works Government Services Canada
Hwy 1
Rogers Pass, BC,

TP16-01
Pg 1 of 1
Project No: 161-07388-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Dense brown SAND and gravel, FILL, trace silt, moist.			GG-1	
	2	Dense brown sandy GRAVEL, FILL, boulders and cobbles, trace silt, moist.			GG-2	
	4	Dense redish brown SAND, FILL, some gravel, boulders, trace silt, moist.			GG-3	
	6				GG-4	
2		Loose dark brown SAND, TOPSOIL, wood waste, organics, cobbles, moist.			GG-5	
	8	Dense red brown SAND, some gravel, some silt, moist.			GG-6	
	10	Very dense tan sandy silty GRAVEL, till-like, moist.			GG-7	
	12	Bottom of test pit at 3.5 meters				
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 20/10/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

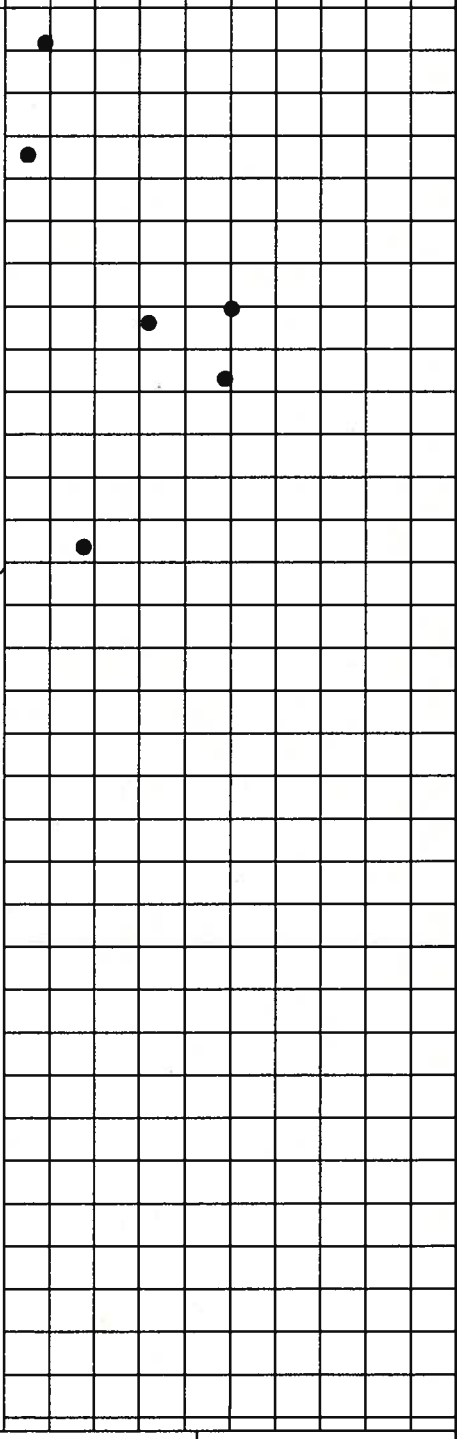
1 LOG PER PAGE 11/4/16

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Compound
Public Works Government Services Canada
Hwy 1
Rogers Pass, BC,

TP16-02
Pg 1 of 1
Project No: 161-07388-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Compact brown SAND and gravel, cobbles, trace silt, FILL, moist.			GG-1	
	2					
	4				GG-2	
	6					
2		Loose dark brown SAND, some gravel, wood waste, organics, TOPSOIL, moist.			GG-3	
	8	Firm mottled SILT and sand, moist.			GG-4	
		Stiff grey SILT, large tree trunk.			GG-5	
	10					
	12					
4		Dense grey SAND some gravel, trace silt, wet.			GG-6	P1 Oct 20 2016
	14	Bottom of test pit at 4.0 meters				
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) — Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 20/10/2016
Logged by: TD
Checked by:

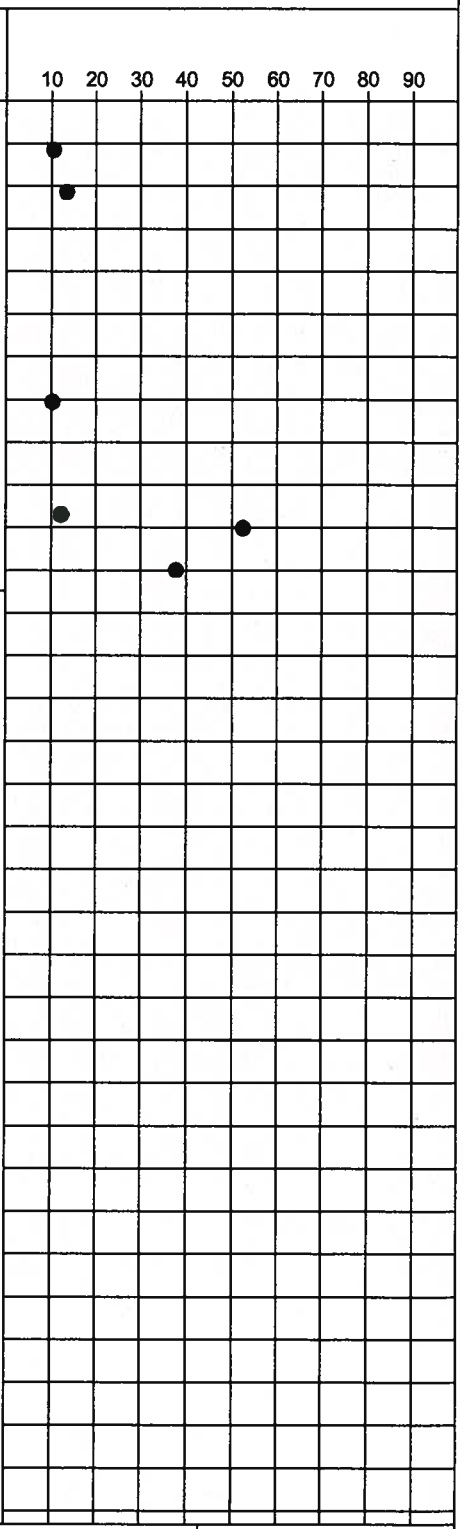
1 LOG PER PAGE 11/4/16

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Compound
Public Works Government Services Canada
Hwy 1
Rogers Pass, BC,

TP16-03
Pg 1 of 1
Project No: 161-07388-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Asphalt - 250mm				
		Dense brown gravelly SAND, trace silt, FILL, moist.			GG-1	
	2	Dense brown gravelly SAND, cobbles and boulders, trace silt, FILL, moist.			GG-2	
	4	plywood @ 1.8m underlain by 200mm thick layer of wood debris (cut branches)				
	6					
2					GG-3	
	8					
	10	Loose dark brown SAND, some gravel, TOPSOIL, wood waste, organics, moist.			GG-4 GG-5	▼P1 Oct 20 2016
		Stiff grey sandy SILT, wet.			GG-6	
	12	Bottom of test pit at 3.5 meters				
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) ▶ ● ◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
⊗⊗ Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
✕ Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
⊠ Remolded strength in kPa
■ Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 20/10/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

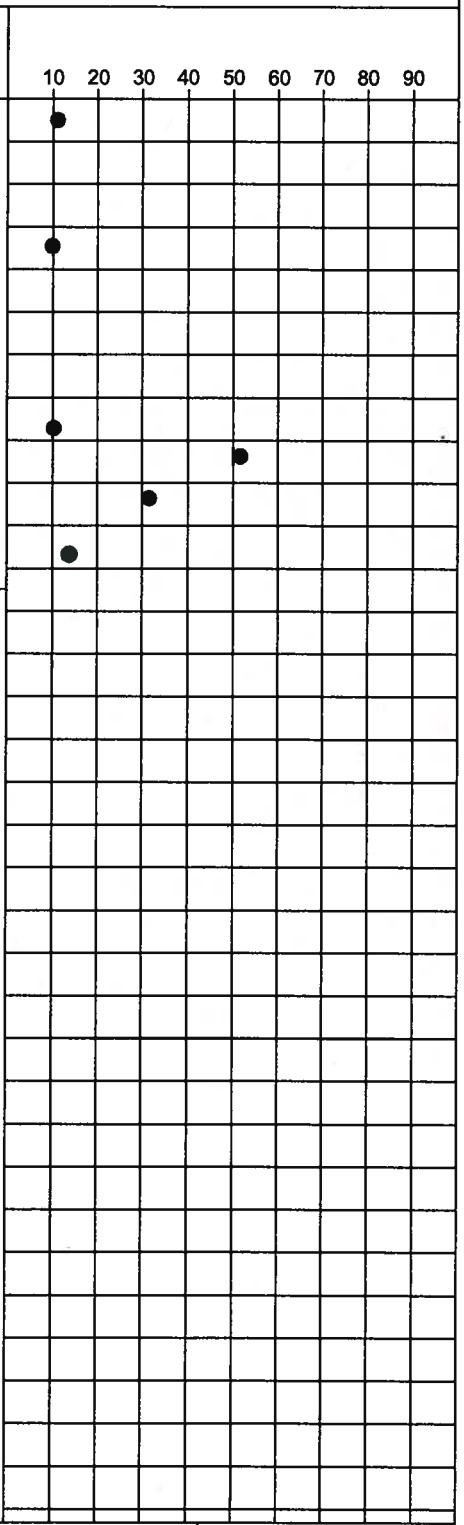
1 LOG PER PAGE 11/4/16

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Compound
Public Works Government Services Canada
Hwy 1
Rogers Pass, BC,

TP16-04
Pg 1 of 1
Project No: 161-07388-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
0	0	Dense brown gravelly SAND, some silt, FILL, moist.			GG-1	
		Dense brown SAND and gravel, cobbles and boulders, trace silt, FILL, large buried tree stumps, moist.				
	2					
	4				GG-2	
	6					
2	8				GG-3	
		Compact black SAND, TOPSOIL, ash and wood debris, moist.			GG-4	
	10	Compact mottled SAND, some silt, moist.			GG-5	
		Compact red coarse SAND, wet.			GG-6	
	12	Dense grey SAND, some silt, some gravel, moist.				
		Bottom of test pit at 3.5 meters				
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) — Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 20/10/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 11/4/16

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

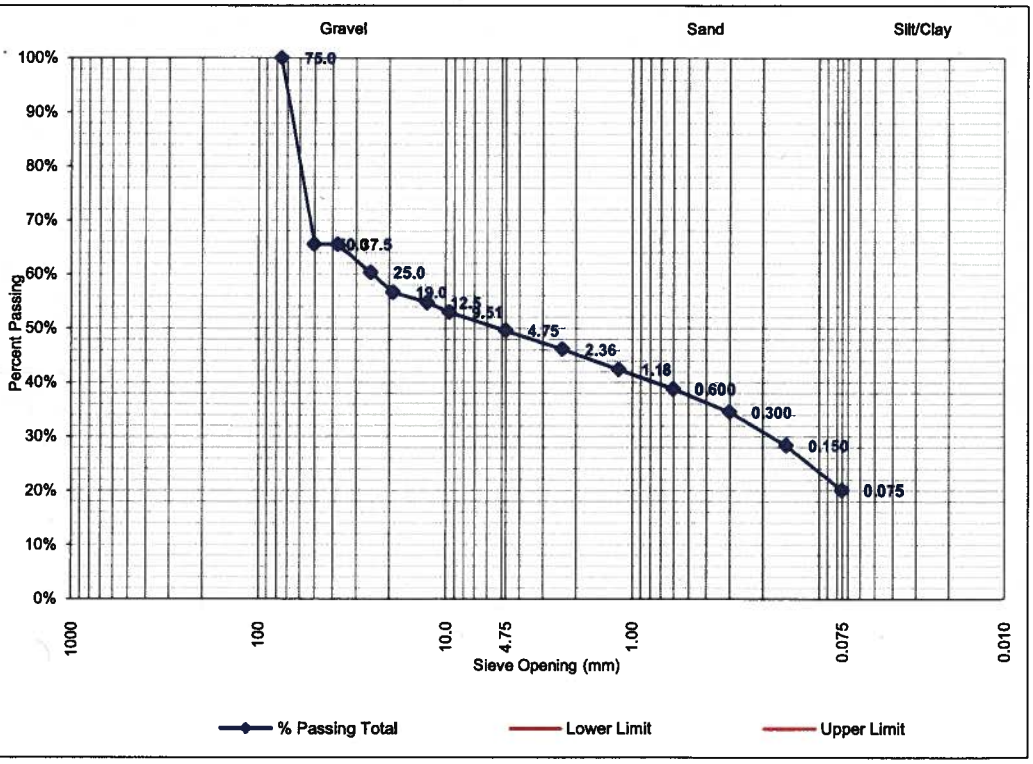
Sample Location: TP16-01, G7
Supplier:
Material Type: Sandy silty GRAVEL
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 1

Moisture Content (as received): 6%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0	100.0%		
50.0	65.5%		
37.5	65.5%		
25.0	60.3%		
19.0	56.7%		
12.5	54.8%		
9.51	53.0%		
4.75	49.6%		
2.36	46.1%		
1.18	42.4%		
0.600	38.8%		
0.425			
0.300	34.5%		
0.150	28.4%		
0.075	20.1%		



Remarks: _____

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Engineering review and interpretation of these results can be provided upon written request.

Per: _____

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

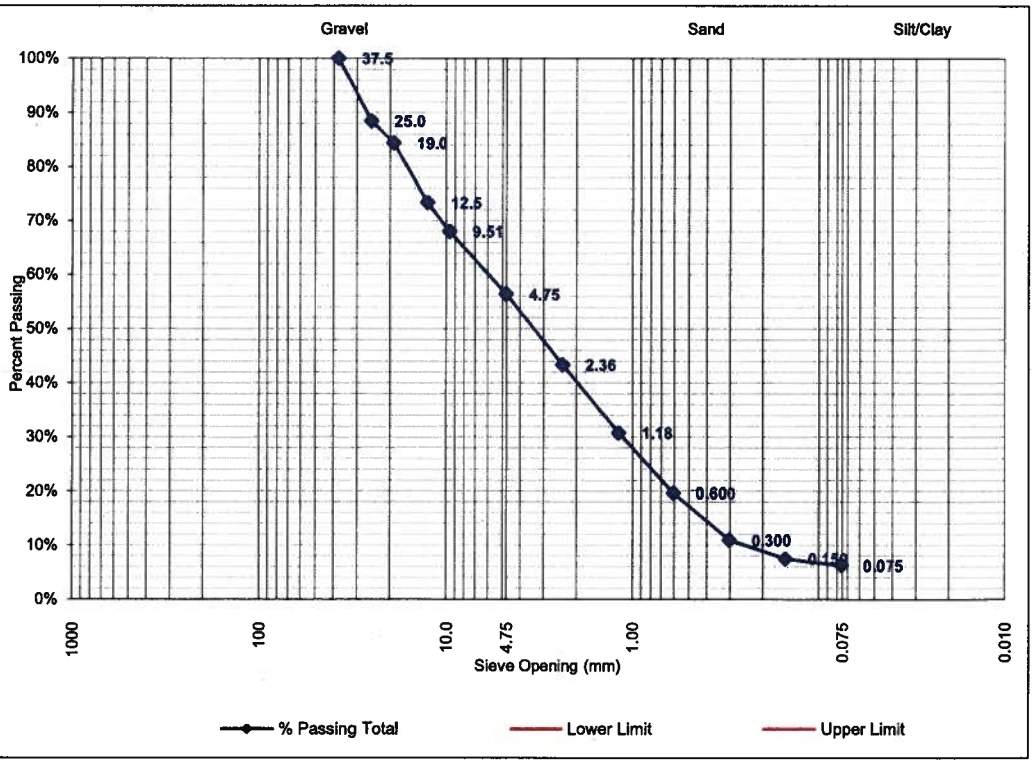
Sample Location: TP16-02, G2
Supplier:
Material Type: SAND and gravel, trace silt
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 2

Moisture Content (as received): 5%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5	100.0%		
25.0	88.4%		
19.0	84.4%		
12.5	73.3%		
9.51	67.9%		
4.75	56.3%		
2.36	43.3%		
1.18	30.7%		
0.600	19.6%		
0.425			
0.300	10.9%		
0.150	7.5%		
0.075	6.2%		



Remarks: _____

WSP Canada Inc.

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Per: _____

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

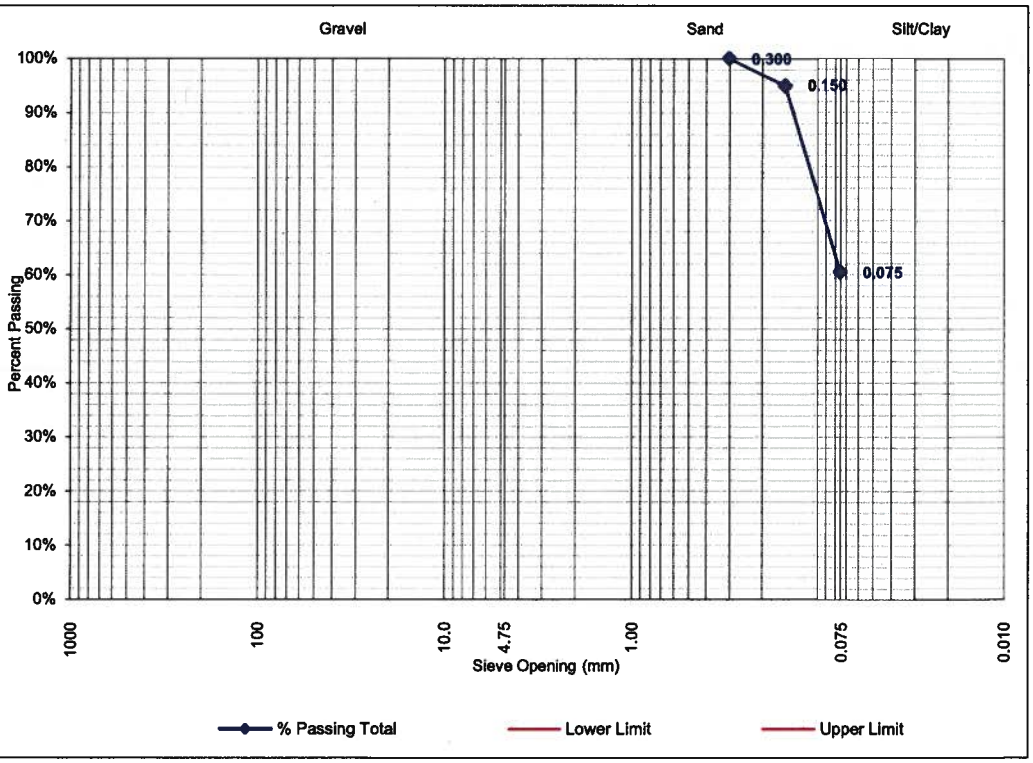
Sample Location: TP16-02, g4
Supplier:
Material Type: SILT and sand
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 3

Moisture Content (as received): 32%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0			
19.0			
12.5			
9.51			
4.75			
2.36			
1.18			
0.600	100.0%		
0.425			
0.300	100.0%		
0.150	95.0%		
0.075	60.4%		



Remarks: _____

WSP Canada Inc.

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Per: _____

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

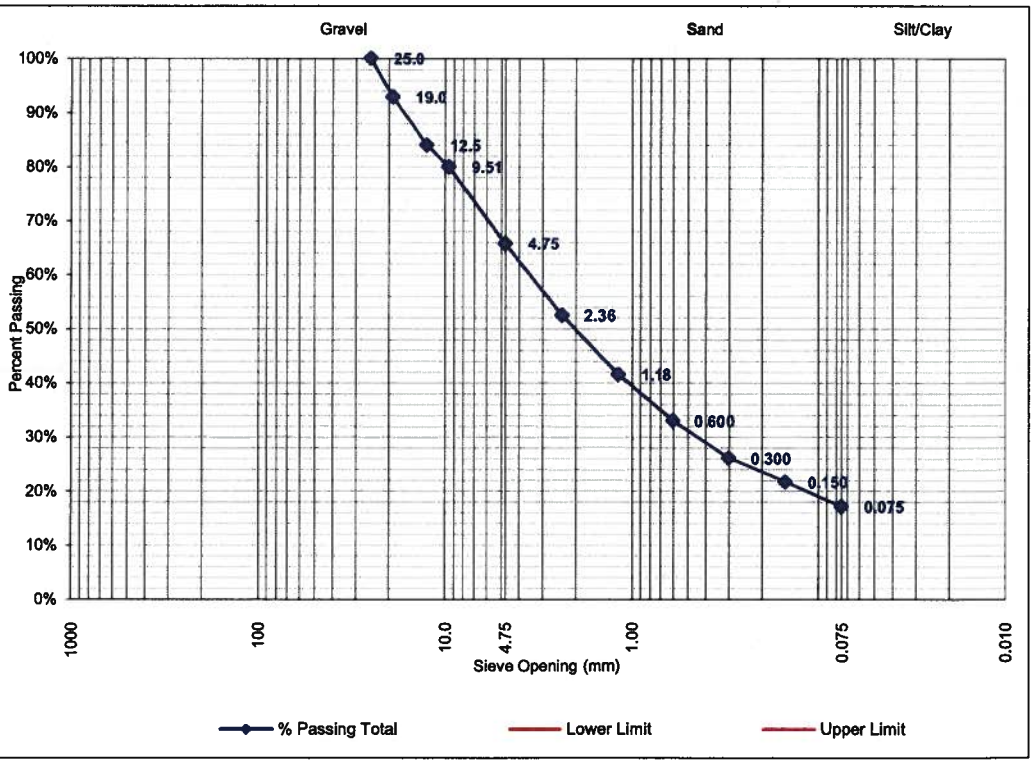
Sample Location: TP16-03, G3
Supplier:
Material Type: Gravelly SAND, some silt
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 4

Moisture Content (as received): 12%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0	100.0%		
19.0	92.9%		
12.5	84.0%		
9.51	80.0%		
4.75	65.8%		
2.36	52.5%		
1.18	41.6%		
0.600	33.0%		
0.425			
0.300	26.1%		
0.150	21.8%		
0.075	17.2%		



Remarks: _____

WSP Canada Inc.

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Per: _____

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

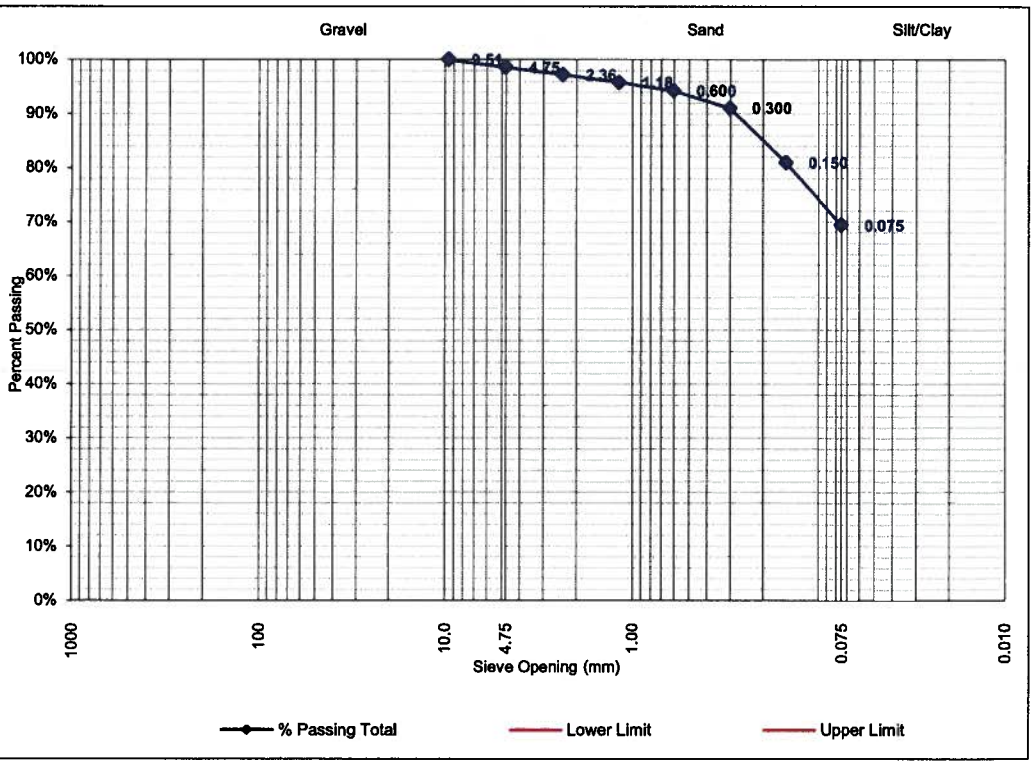
Sample Location: TP16-03, G6
Supplier:
Material Type: Sandy SILT, trace gravel
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 5

Moisture Content (as received): 47%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0			
19.0			
12.5			
9.51	100.0%		
4.75	98.6%		
2.36	97.2%		
1.18	95.8%		
0.600	94.2%		
0.425			
0.300	91.0%		
0.150	80.9%		
0.075	69.3%		



Remarks: _____

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#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

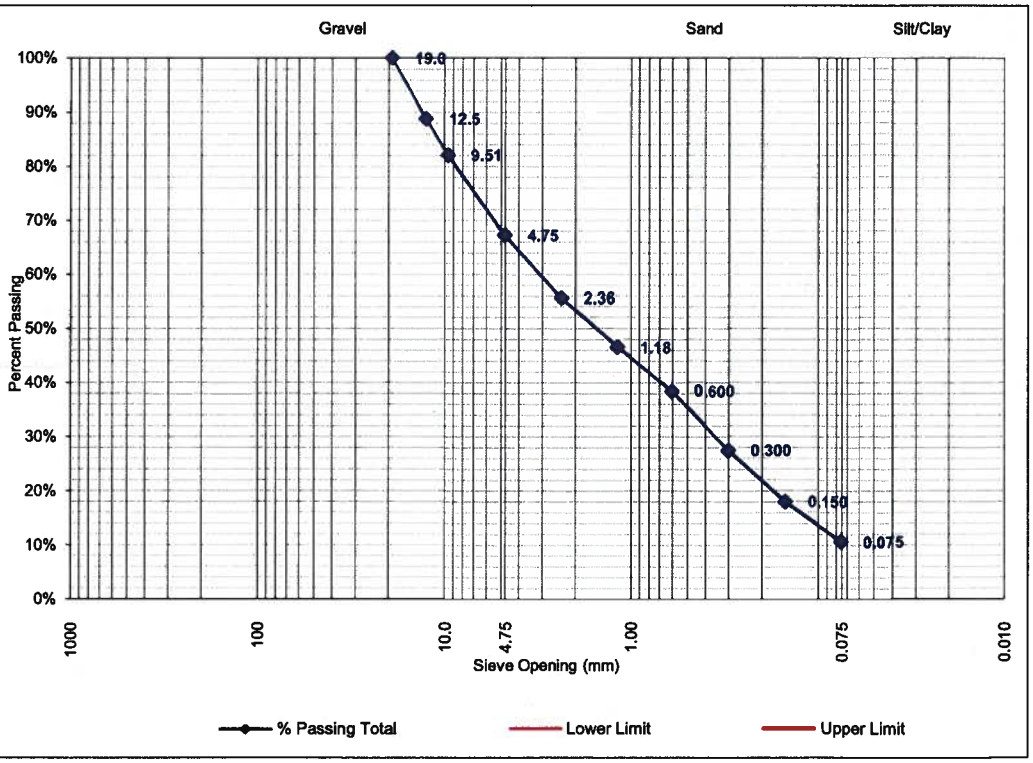
Sample Location: TP16-04, G6
Supplier:
Material Type: Gravelly SAND, some silt
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. 6

Moisture Content (as received): 14%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0			
19.0	100.0%		
12.5	88.8%		
9.51	82.1%		
4.75	67.2%		
2.36	55.6%		
1.18	46.5%		
0.600	38.4%		
0.425			
0.300	27.4%		
0.150	18.0%		
0.075	10.6%		



Remarks: _____

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Per: _____

APPENDICES

Project no.: 161-07388-00
November 4, 2016

Public Works Government Services Canada
219 – 800 Burrard St.
Vancouver, BC V6Z 0B9

Attention: Tom Dunphy,

Subject: **Geotechnical Engineering Technical Memorandum - Culvert Replacement**

Drainage Improvements - Parks Canada Maintenance Compound, Rogers Pass, BC

Dear Sir,

INTRODUCTION

As requested, WSP Canada Inc. (WSP) has prepared this geotechnical engineering technical memorandum for the above-referenced project.

This memorandum has been prepared based on our proposal P16-11060-93 dated April 22, 2016 for the purpose of providing information to the Civil Engineer (Wedler Engineering LLP) regarding the suitability of the soil conditions at the sewage lagoon access road to replace the existing 1600mm CSP culvert with a new 2400mm open bottom concrete box culvert. We understand the new culvert will be installed at approximately the same depth as the existing culvert.

Our scope of work on this project was to review our previous geotechnical report for the site area (prepared as Levelton Consultants Ltd. (Levelton) prior to our acquisition by WSP), conduct an additional geotechnical sub-surface investigation adjacent to the proposed culvert replacement, and preparation of this technical memorandum.

BACKGROUND

A previous geotechnical report for the subject site has been issued on August 10, 2015 (Levelton file number R715-1159-00). On July 9 and 10, 2015 ten (10) test pits TP15-01 to TP15-10 were conducted using a track-mounted excavator to depths of approximately 0.5 to 2.0 m below grade throughout the maintenance compound.

WSP Canada Inc.
108 – 3677 Hwy 97N
Kelowna, BC

Phone: +1 250-491-9778
Fax +1 250-491-9729
www.wspgroup.com

Soils encountered within the Levelton test pits generally consisted of dense to very dense coarse granular fills to approximately 0.6 to 2.0 m below grade, overlying compact native granular soils to the bottom of the test pits at 1.5 to 2.0m deep. At intermittent locations the test pits encountered burried wood debris and organics at the transition between fill and native granular deposits.

INVESTIGATION

On October 20, 2016 an additional geotechnical subsurface investigation consisting of a single machine dug test hole was conducted at the subject site. The test hole was excavated by a tracked machine with a smooth mouth cleanout bucket to a depth of 2.0m below existing grade to review the soil conditions. The test pit was excavated on the north side of the existing culvert off the east side of the embankment for the existing sewage lagoon access road. The top of the excavation was approximately 1m below the road embankment elevation, and approximately 0.3m below the top of the existing CSP culvert.

WSP observed the test pitting and collected soil samples from the excavated materials. Moisture contents were determined on each of the samples collected from the test hole. The moisture contents of the fills were determined to range from 12 to 43 percent. A grain size analysis was conducted on a sample collected from the base of the test pit. The results of the grain size analysis indicate the native soil deposit at or near the base elevation for the proposed culvert consisted of gravel and sand. Similar deposits were observed in the creek bed at the existing culvert road crossing.

A description of the encountered soil conditions at the test pit is included in the following table:

Depth (m)	Lithology	Soil Sample Moisture Content (%)
0 to 0.2	Compact gravelly silty SAND, with organics.	36.2 @ 0.1m
0.2 to 0.7	Compact gravelly SAND, some silt.	12.3 @ 0.3m
0.7 to 1.8	Compact mottled grey SAND, some silt.	42.6 @ 0.9m 26.6 @ 1.4m
1.8 to 2.0	Dense grey GRAVEL and sand	14.8 @ 1.8m

Ground water was encountered in the test pit at a depth of approximately 1.8m below surface grade, (or approximately 2.8m below road embankment grade). The observed groundwater seepage rate was moderate at the excavation termination depth. It is expected that the ground water elevation would fluctuate with the local seasonal and climatic changes.

During the field investigation the water elevation in the creek channel at the culvert location was approximately 1m below the elevation of the top of the test pit.

RECOMMENDATIONS

Based on the previous geotechnical information available for the site, and the results of our investigation, it is our opinion that the proposed open bottom concrete box culvert could be supported of strip footings bearing directly on the native granular soils encountered at subgrade elevation, or on geotechnical recommended fill materials bearing on the native subgrades.

Based on the groundwater elevation it is likely that the foundation elevation will be near or slightly below the anticipated ground water table during construction of the new culvert foundations. Additionally, working in very close proximity to the existing creek will possibly allow surface water to enter the foundation excavations. Construction staging should be considered to prevent creek flow from diverting into adjacent excavations.

If groundwater seepage is encountered at subgrade elevation a 300mm thick overexcavation should be conducted and subgrade reinstated with 25mm crushed rock placed on the subgrade below the proposed foundations; the crushed rock should be kept free of standing water. It is anticipated that groundwater seepage could be controlled by sumps and pumping and specialized dewatering is not expected to be required.

Based on the encounted soil conditions at the proposed culvert location and the subgrade preparation methods discussed above WSP judges that the foundations could be designed for a 100 kPa serviceability limit states bearing resistance.

The culvert should be backfilled with engineered fill consisting of material conforming to the specification for Select Granular Subbase (SGSB) contained in Section 202, Table 202-C "Aggregate Gradations" of the Ministry of Transportation and Infrastructure (MoTI) specifications, compacted to not less than 100% of the material's Standard Proctor Maximum Dry Density (SPMDD) as per ASTM D698.

The geotechnical engineer should be given the opportunity to review the subgrade soil conditions, proposed backfill source materials and compaction of the placed backfill.

CLOSURE

The attached Terms of Reference form an integral part of this technical memorandum.

We trust that the information presented in this memorandum meets your immediate requirements. If you have any questions or require further information, please do not hesitate to contact us.

Yours truly,

Reviewed By:

Original Signed By:

Per: Thomas Dueckman, PEng.
Project Engineer

Original Signed By:

Per: Paul R. Ell, P.Eng.
Senior Geotechnical Engineer

Attachments: *Terms of Reference for Geotechnical Reports*
Grain Size Analysis Report

CC: Wedler Engineering LLP – Attn. Sam Rogers, EIT

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WSP prepared the Report for the Client for the specific site, development, building, design or building assessment objectives and purpose that the Client described to WSP. The applicability and reliability of any of the information, observations, findings, suggestions, recommendations and opinions contained in the Report are only valid to the extent that there was no material alteration to or variation from any of the said descriptions provided by the Client to WSP unless the Client specifically requested WSP to review and revise the Report in light of such alteration or variation.

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

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a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.

b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. **Additional Involvement by WSP**: To avoid misunderstandings, WSP should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by WSP. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, WSP should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by WSP. Any reduction from the level of services recommended by WSP will result in WSP providing qualified opinions regarding adequacy of the work.

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When WSP submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon WSP. The hard copy versions submitted by WSP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by WSP shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except WSP. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by WSP.

The Client recognizes and agrees that WSP prepared and submitted electronic files using specific software or hardware systems, or both. WSP makes no representation about the compatibility of these files with the current or future software and hardware systems of the Client, the Approved Users or any other party. The Client further agrees that WSP is under no obligation, unless otherwise expressly specified, to provide the Client, the Approved Users and any other party, or any or all of them, with specific software and hardware systems that are compatible with any electronic submitted by WSP. The Client further agrees that should the Client, an Approved User or a third party require WSP to provide specific software or hardware systems, or both, compatible with the electronic files prepared and submitted by WSP, for any reason whatsoever included but not restricted to an order from a court, then the Client will pay WSP for all reasonable costs related to the provision of the specific software or hardware systems, or both. The Client further agrees to indemnify and hold harmless WSP, its officers, directors, employees, agents, representative or sub-consultant, or any or all of them, against any claim or any nature whatsoever brought against WSP, whether in contract or in tort, arising or related to the provision or use or any specific software or hardware provided by WSP.

WSP Canada Inc.

#108, 3677 Hwy 97N
Kelowna, BC V1X 5C3
Tel: (250) 491-9778
Fax: (250) 491-9729

Client: Public Works Government Services Canada
Project: Rogers Pass Drainage Improvements
Site Address: Rogers Pass, BC

File No.: 161-07388-00
Task:

Report of Grain Size Analysis

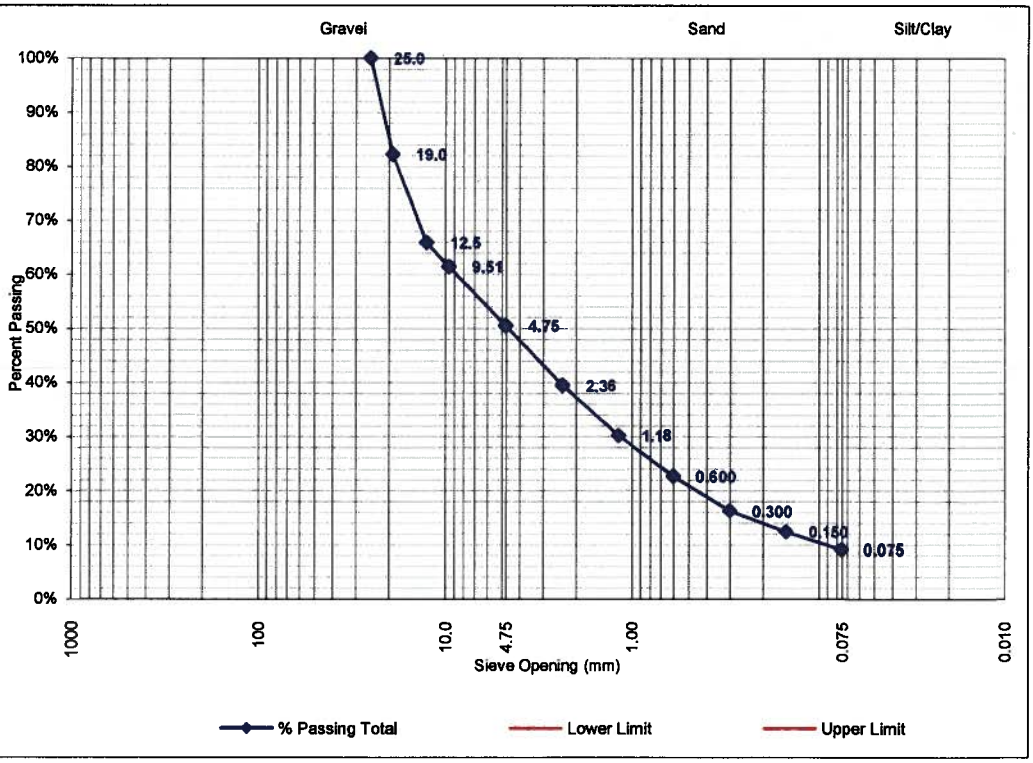
Sample Location: TP16 - 01, G5
Supplier:
Material Type: GRAVEL and SAND, trace silt
Usage:
Specification:

Sampled By: TD
Tested By: SF
Date Sampled: October 20, 2016
Date Tested: October 25, 2016
Sieve No. -

Moisture Content (as received): 13%

Washed Sieve

Screen Opening (mm):	% Passing Total:	Specification	
		Upper Limit	Lower Limit
150.0			
100.0			
75.0			
50.0			
37.5			
25.0	100.0%		
19.0	82.2%		
12.5	65.9%		
9.51	61.4%		
4.75	50.5%		
2.36	39.5%		
1.18	30.2%		
0.600	22.7%		
0.425			
0.300	16.3%		
0.150	12.4%		
0.075	9.1%		



Remarks: _____

WSP Canada Inc.

Reporting of these results constitutes a testing service only.
No engineering interpretation of the results is expressed or implied.
Engineering review and interpretation of these results can be provided upon written request.

Per: _____

APPENDICES

Project no.: 161-07388-00
February 3, 2017

Public Works Government Services Canada
219 – 800 Burrard St.
Vancouver, BC V6Z 0B9

Attention: Tom Dunphy,

Subject: **Geotechnical Engineering Technical Memorandum - Test Pit Investigation North of Highway 1**

Drainage Improvements - Parks Canada Maintenance Compound, Rogers Pass, BC

Dear Sir,

INTRODUCTION

As requested, WSP Canada Inc. (WSP) has prepared this geotechnical engineering technical memorandum for the above-referenced project.

This memorandum has been prepared based on our proposal P16-11060-93 dated April 22, 2016 for the purpose of providing information to the Civil Engineer (Wedler Engineering LLP) regarding the soil conditions throughout the portion of the site North of Highway 1. We understand it is proposed to revise the grading and surface finishes on this portion of the site to improve storm water and snow melt drainage. The construction will include selective demolition of existing asphalt, installation of above and below grade storm water drainage features and installation of new asphalt pavement.

WSP has prepared a previous report for the portion of the Rogers Pass site South of Highway 1, under the company name Levelton Consultants Ltd., dated August 10, 2015 (file # R715-1159-00). This technical memorandum is considered supplemental to that original report and should be read together with the original report.

Our scope of work was to review the background information for the site, conduct a geotechnical sub-surface investigation throughout the existing developed area north of Highway 1, and prepare this technical memorandum.

INVESTIGATION

On July 4 and 7, 2016 a geotechnical subsurface investigation consisting of seven (7) machine dug test holes was conducted at the subject site by WSP. Six (6) of the holes were conducted north of Highway 1, on the Glacier Lodge site, and one (1) test hole was conducted south of Highway 1, on the Parks Canada Maintenance Compound site. The test holes were excavated by a tracked excavator to a depth of 3.0m below existing grade to review the soil conditions. Percolation testing was conducted at select test pits to determine the infiltration rate of the in-situ soils. A site plan showing the 2016 test hole locations is included in Figure 1 following this memorandum.

WSP Canada Inc.
108 – 3677 Hwy 97N
Kelowna, BC

Phone: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

WSP observed the test pitting and collected representative soil samples from the excavated materials. Moisture contents were determined on each of the samples collected from the test holes.

Detailed descriptions of the subsurface soil conditions are included in the soil logs attached to this memorandum. A brief description of the observed soil conditions is as follows:

Asphalt – TP16-01, 02 and 05 were conducted through or immediately adjacent to the paved surfacing in front of the Glacier Park Lodge building. The test pits encountered asphalt pavement ranging from 50mm to 100mm thick.

Compact to Dense granular fills – The surficial soils at each test pit consisted of dense sand and gravel and gravelly sand fill from 0.4 to 1.5m deep. In some cases the fill materials included larger cobbles and boulders.

Stained Fill / asphalt – Underlying the fill TP16-01, 05 and 06 encountered an indistinguishable layer of stained fill, asphalt, or oiled gravel 50mm to 0.7m thick.

Organics – Underlying the granular fills TP16-01 and 02 encountered deposits of loose black coal / charcoal and wood debris from 0.4 to 0.5m thick.

Native Sands and gravels – Underlying the granular fills, and organics each test pit encountered a deposit of compact to very dense granular soil ranging from sand to sandy gravel. All the test pits were terminated in these native granular deposits at depths of 2.0 to 3m.

Groundwater was not encountered in the test pits at the time of the investigation. It is expected that the ground water elevation would fluctuate with the local seasonal and climatic changes.

PERCOLATION TESTING

Percolation testing was conducted at TP16-02 and TP16-07. The tests were conducted in general conformance to the Percolation Test Procedure method published by the BC Ministry of Health.

In this procedure an observation hole is hand excavated at the desired infiltration depth, the hole is filled to a certain level with water and time readings are taken as the water level in the hole decreases by 2.5cm increments. Multiple readings are taken to observe the effects that saturation of the material has on the percolation rate. The resulting times can be used to calculate an in-situ infiltration rate for the subject soil deposit.

The results of the percolation testing are presented in the table below:

Test Pit	Depth of Test	Average Percolation Rate	Average Infiltration Rate
TP16-02	1m BSG*	1.3 minutes per 2.5cm	3.2×10^{-4} m/s
TP16-07	1m BSG	7 minutes per 2.5cm	6.0×10^{-5} m/s

*BSG: below surrounding grade

RECOMMENDATIONS

Based on the previous geotechnical information available for the site, and the results of our investigation, it is our opinion that design and construction of the proposed asphalt surfacing and drainage improvements is feasible given the following recommendations.

These recommendations are supplemental to the recommendations of the original 2015 report. Where recommendations are not explicitly stated in this memorandum, the recommendations of the original 2015 report will apply.

SITE PREPARATION

Subgrade preparation in the proposed re-grading areas should consist of removal of the surface materials to allow for required grades, followed by placement of new base course gravel and asphalt. Based on the results of our subsurface investigation, stripping depths would generally be nominal in the existing paved areas, and on the order of 200 to 300mm in the shoulder areas adjacent to the existing pavements.

Where the exposed subgrade consists of granular native soils and fill, we recommend that the subgrade be compacted with vibratory equipment to re-densify any soils disturbed during stripping/excavation, followed by proof rolling with a loaded dump truck under the review of a Geotechnical Engineer, prior to placing new fill. Areas that rut or deflect excessively under the proof rolling should be subexcavated to competent subgrade and grade reinstated with fill conforming to the specification for Select Granular Subbase (SGSB) contained in Section 202, Table 202-C "Aggregate Gradations" of the Ministry of Transportation and Infrastructure (MoTI) specifications, compacted to not less than 100% of the material's Standard Proctor Maximum Dry Density as per ASTM D698.

During stripping, the site should be graded to provide positive drainage to temporary ditches for the control of surface runoff in order to avoid having surface water pond on the stripped subgrade.

ENGINEERED FILL

In this report, engineered fill refers to permanent fill that will be placed below the proposed roadways/pavements.

We recommend that engineered fill required as subgrade fill to establish the desired elevation in areas that will be paved conform to the specification for Select Granular Subbase (SGSB) provided above. The material should be compacted to not less than 100% of the material's Standard Proctor Maximum Dry Density as per ASTM D698.

In-place density testing should be conducted on the fill by the Geotechnical Engineer as it is placed to confirm that adequate compaction is achieved.

The Geotechnical Engineer should be provided with the opportunity to review, test and approve all sources of imported engineered fill prior to their delivery to the site.

The granular site fills and native granular soils would generally be considered suitable for re-use as engineered fill. Certain deposits, particularly in the transition zone between the upper existing fill and the lower native granular deposits, are considered unsuitable for re-use as fill due to them containing organics and miscellaneous debris. These deposits are generally more than 1.5m below grade, and are not expected to be encountered during surface grading. If these deposits are encountered they should be separated from the excavated granular materials and disposed of.

It is recommended that any site soils proposed for re-use as fill be reviewed by the Geotechnical Engineer at the time of excavation and prior to placement to assess their suitability. Stockpiles of site soils identified by the Geotechnical Engineer as being suitable for re-use as engineered fill should be covered with polyethylene sheeting, and grades surrounding the stockpiles should be such that surface water runoff is directed around or away from the stockpiles.

CLOSURE

This geotechnical engineering technical memorandum has been prepared by WSP Canada Inc. exclusively for Public Works Government Services Canada and their appointed agents. The opinions and recommendations contained in this letter reflect our judgement in light of the information that has been provided to us at the time that it was prepared.

Any use of this report by third parties, or any reliance on or decisions made based on it, are the responsibility of such third parties. WSP does not accept responsibility for damages suffered, if any, by a third party as a result of their use of this report.

The soil logs attached to this report provide description of the soil conditions encountered at discrete test hole locations. Actual soil conditions remote from the test holes may vary across the site. Contractors should make their own interpretation of the soil logs and the site conditions for the purposes of bidding and performing work at the site.

The attached Terms of Reference form an integral part of this report

We trust this information meets your immediate requirements. If you have any questions or require further information, please contact the undersigned.

Yours truly,

Reviewed By:

Original Signed By:

Per: Thomas Dueckman, PEng.
Project Engineer

Original Signed By:

Per: Paul R. Ell, P.Eng.
Senior Geotechnical Engineer

Attachments: *Terms of Reference for Geotechnical Reports*
Figure 1 – Site Plan
Soil Logs

CC: Wedler Engineering LLP – Attn. Sam Rogers, EIT

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC.

1. STANDARD OF CARE

WSP Canada Inc. ("WSP") prepared and issued this geotechnical report (the "Report") for its client (the "Client") in accordance with generally-accepted engineering consulting practices for the geotechnical discipline. No other warranty, expressed or implied, is made. Unless specifically stated in the Report, the Report does not address environmental issues.

The terms of reference for geotechnical reports issued by WSP (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

2. COMPLETENESS OF THE REPORT

All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, the communications between WSP and the Client, and to any other reports, writings, proposals or documents prepared by WSP for the Client relative to the specific site described in the Report, all of which constitute the Report.

TO PROPERLY UNDERSTAND THE INFORMATION, OBSERVATIONS, FINDINGS, SUGGESTIONS, RECOMMENDATIONS AND OPINIONS CONTAINED IN THE REPORT, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WSP CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT AND ITS VARIOUS COMPONENTS.

3. BASIS OF THE REPORT

WSP prepared the Report for the Client for the specific site, development, building, design or building assessment objectives and purpose that the Client described to WSP. The applicability and reliability of any of the information, observations, findings, suggestions, recommendations and opinions contained in the Report are only valid to the extent that there was no material alteration to or variation from any of the said descriptions provided by the Client to WSP unless the Client specifically requested WSP to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information, observations, findings, suggestions, recommendations and opinions contained in the Report, or any component forming the Report, are for the sole use and benefit of the Client and the team of consultants selected by the Client for the specific project that the Report was provided. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION OR COMPONENT WITHOUT THE WRITTEN CONSENT OF WSP. WSP will consent to any reasonable request by the Client to approve the use of this Report by other parties designated by the Client as the "Approved Users". As a condition for the consent of WSP to approve the use of the Report by an Approved User, the Client must provide a copy of these Terms of Reference to that Approved User and the Client must obtain written confirmation from that Approved User that the Approved User will comply with these Terms of Reference, such written confirmation to be provided separately by each Approved User prior to beginning use of the Report. The Client will provide WSP with a copy of the written confirmation from an Approved User when it becomes available to the Client, and in any case, within two weeks of the Client receiving such written confirmation.

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

5. INTERPRETATION OF THE REPORT

a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.

b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

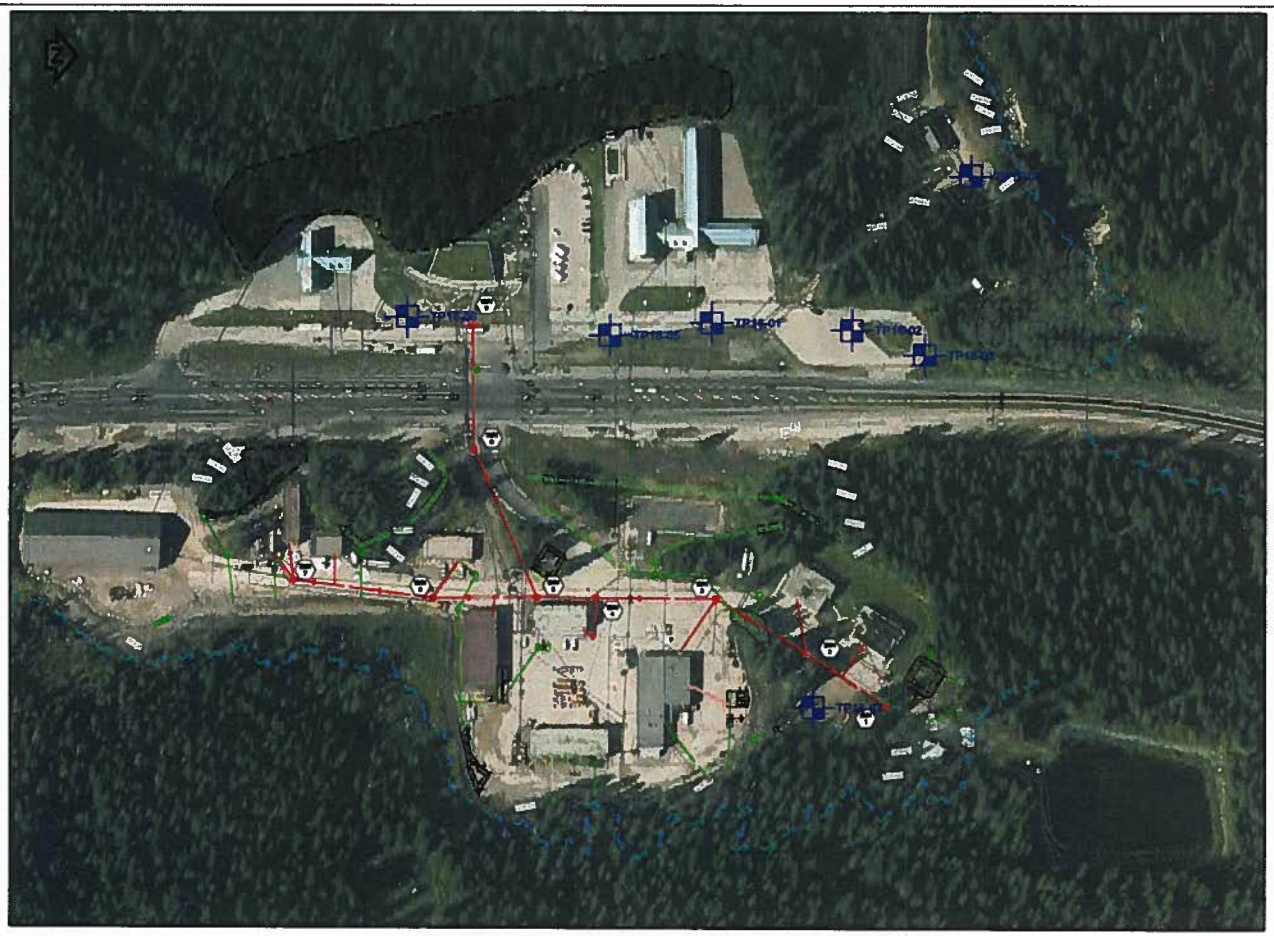
c. **Additional Involvement by WSP**: To avoid misunderstandings, WSP should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by WSP. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, WSP should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by WSP. Any reduction from the level of services recommended by WSP will result in WSP providing qualified opinions regarding adequacy of the work.

6. ALTERNATE REPORT FORMAT

When WSP submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon WSP. The hard copy versions submitted by WSP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by WSP shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except WSP. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by WSP.

The Client recognizes and agrees that WSP prepared and submitted electronic files using specific software or hardware systems, or both. WSP makes no representation about the compatibility of these files with the current or future software and hardware systems of the Client, the Approved Users or any other party. The Client further agrees that WSP is under no obligation, unless otherwise expressly specified, to provide the Client, the Approved Users and any other party, or any or all of them, with specific software and hardware systems that are compatible with any electronic submitted by WSP. The Client further agrees that should the Client, an Approved User or a third party require WSP to provide specific software or hardware systems, or both, compatible with the electronic files prepared and submitted by WSP, for any reason whatsoever included but not restricted to an order from a court, then the Client will pay WSP for all reasonable costs related to the provision of the specific software or hardware systems, or both. The Client further agrees to indemnify and hold harmless WSP, its officers, directors, employees, agents, representative or sub-consultant, or any or all of them, against any claim or any nature whatsoever brought against WSP, whether in contract or in tort, arising or related to the provision or use or any specific software or hardware provided by WSP.



NOTE:
Test holes were conducted on July 4 and 7, 2016

FOR INFORMATION ONLY

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région du Pacifique

WEDLER ENGINEERING

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

PARKS CANADA- ROGERS PASS MAINTENANCE COMPOUND INFRASTRUCTURE IMPROVEMENTS PHASE 1

KEY PLAN WITH ORTHO UNDERLAY

R.076550.001 | SK1 | 2

LEGEND

TP16-X TEST PIT

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	DRAWN	CHECK

ADAPTED FROM: Wedler Engineering LLP
PROJECT/DWG. NO: R.076550.001 - SK1
DATE: June 2016

TITLE: **Site Plan - Test Pit Locations**
PROJECT: Rogers Pass Maintenance Compound
ADDRESS: Hwy 1, Rogers Pass, BC
CLIENT: Public Works Government Services Canada

SEAL:

WSP
108 - 3877 Hwy 97N,
Kelowna, BC, V1X 5C3
p: 250-491-9778 f: 250-491-9729
www.wspgroup.com

DESIGN	TD	DATE	Feb 2017
CHECK	PE	SCALE	NTS
DRAWN	TD	FILE NO	161-07388-00
DWG NO			Figure 1

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-01
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683598 Easting: 463696

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
0	0	Asphalt			GG-1	
		Compact light brown SAND and gravel, trace silt.			GG-2	
	2	Dense brown SAND and gravel, some silt.				
		Dense red brown gravelly SAND, some silt, ocasional cobbles.			GG-3	
	4				GG-4	
					GG-5	
		Dense sand and gravel with heavy staining; appears bitumen based. Inferred compacted asphalt millings or oiled gravel.			GG-6	
	6	Loose to compact black silty SAND, some gravel.			GG-7	
2		Loose black coal and natural wood debris.				
	8	Compact brown gravelly SAND, some silt			GG-8	
	10	Bottom of test pit at 3.0 meters				
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 04/07/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 2/3/17

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-02
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683674 Easting: 463704

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Asphalt.				
		Dense light brown SAND and gravel, trace to some silt.			GG-1	
	2				GG-2	
		Dense grey silty SAND and gravel, blocky, some cobbles and boulders.			GG-3	
	4					
		Percolation testing at 1m. Percolation rate average =			GG-4	
	6	Loose black coal and natural wood debris.				
2		Dense brown SAND and gravel, trace silt, lots of cobbles and boulders.			GG-5	
	8					
		Bottom of test pit at 2.6 meters				
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

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Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) — Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 04/07/2016
Logged by: TD
Checked by:

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1 LOG PER PAGE 2/3/17

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#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-03
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683710 Easting: 463709

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Loose dark brown silty SAND, topsoil.				
	2	Compact brown SAND and gravel, some cobbles.				
	4	Some boulders after 0.8m deep.				
2	6	Dense tan sandy GRAVEL, some silt, lots of cobbles and boulders.				
	8					
	10	Bottom of test pit at 3.0 meters				
4	12					
	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
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G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 04/07/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 2/3/17

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-04
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683720 Easting: 463622

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Dense brown silty SAND and gravel.				
		Dense red brown sandy GRAVEL, some silt.				
	2	Loose organics and wood debris.				
		Compact white SAND, some gravel, lots of cobbles.				
	4	Dense red brown sandy GRAVEL, lots of cobbles and boulders.				
		Very large rock surface at 2.0m. Inferred to be a large boulder.				
	6					
2		Bottom of test pit at 2.0 meters				
	8					
	10					
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					
8						
	26					
	28					
	30					
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10 20 30 40 50 60 70 80 90

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Disturbed
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Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 04/07/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 2/3/17

WSP Canada Inc.
#106 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-05
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683544 Easting: 463701

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Asphalt.				
		Compact light brown SAND and gravel, trace silt, some cobbles.				
	2	Compact brown SAND and gravel, some silt, lots of cobbles.				
	4	Some boulders below 1m.				
	6	Dense sand and gravel with heavy staining; appears bitumen based. Inferred compacted asphalt millings or oiled gravel.				
2	8	Compact mottled grey SAND, some silt, some cobbles.				
	10	Bottom of test pit at 3.0 meters				
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

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Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 07/07/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 2/3/17

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-06
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683435 Easting: 463697

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
0	0	Compact brown silty SAND topsoil.				
		Dense brown SAND and gravel, some silt.				
	2	Dense sand and gravel with heavy staining; appears bitumen based. Inferred compacted asphalt millings or oiled gravel.				
	4	Compact mottled grey SAND, some silt, some gravel				
		Compact grey SAND and gravel, trace silt, some cobbles.				
2	6					
	8	Compact light grey SAND, some silt.				
	10	Bottom of test pit at 2.8 meters				
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) — Moisture Content (%) — Liquid Limit (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 07/07/2016
Logged by: TD
Checked by:

1 LOG PER PAGE 2/3/17

WSP Canada Inc.
#108 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3
Tel: +1 250-491-9778
Fax: +1 250-491-9729
www.wspgroup.com

Rogers Pass Maintenance Yard Drainage Improvements
PWGSC
Rogers Pass Maintenance Yard, Highway 1

TP16-07
Pg 1 of 1
Project No: 161-07388-00
Northing: 5683676 Easting: 463896

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		Compact brown SAND and gravel, some silt.				
	2	Soft dark brown ORGANIC SILT and natural wood debris.				
		Dense light brown SAND, some silt, some gravel.				
	4	Some cobbles below 1.2m.				
		Compact interlayered mottled grey and purple silty SAND.				
2	6					
	8	Compact rusty GRAVEL, trace sand, trace silt.				
	10	Bottom of test pit at 3.0 meters				
4	12					
	14					
	16					
	18					
6	20					
	22					
	24					
8	26					
	28					
	30					
	32					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST

Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
Shear strength in kPa (Unconfined)
Shear strength in kPa (Field vane)
Remolded strength in kPa
Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 07/07/2016
Logged by: TD
Checked by:

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

1 LOG PER PAGE 2/3/17

APPENDICES

1.0 GENERAL

1.1 IN THESE NOTES THE OWNER IS PUBLIC WORKS GOVERNMENT SERVICES CANADA., TEL. 604-775-8659.

1.2 IN THESE NOTES, THE DESIGN ENGINEER IS WSP CANADA INC. (WSP), TEL. 250-491-9776.

1.3 IN THESE NOTES, THE CIVIL ENGINEER IS WEDLER ENGINEERING LP., TEL. 250-334-3283

1.4 THESE NOTES ARE TO BE READ IN CONJUNCTION WITH THE DESIGN DRAWINGS. WRITTEN DIMENSIONS SHALL GOVERN OVER SCALED DIMENSIONS.

1.5 THE RETAINING WALL AND DESIGNS ARE INTENDED TO PROVIDE LONG TERM, STABLE SUPPORT OF STOCKPILED SNOW BERMS PLACED AGAINST THE WALL. THE DESIGN LOADING IS BASED ON THE ASSUMPTIONS AND ANALYSIS REPORTED IN WSP CANADA REPORT 161-07388-00, DATED NOVEMBER 4, 2016.

1.6 THE DESIGN OF THE RETAINING WALL FOUNDATIONS REQUIRED TO RESIST THE DESIGN LOADS IS BASED ON THE GROUND CONDITIONS REPORTED IN WSP CANADA REPORT 161-07388-00, DATED NOVEMBER 4, 2016.

1.7 THESE DRAWINGS AND NOTES ARE BASED ON THE RETAINING WALL LAYOUT PLAN, AND PRELIMINARY RETAINING WALL DESIGNS PREPARED BY THE CIVIL ENGINEER, PROVIDED TO US ON NOVEMBER 22, 2016. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY ALL DIMENSIONS AND TO REPORT ANY DISCREPANCIES TO THE DESIGN ENGINEER AND THE CIVIL ENGINEER.

1.8 THE CONTRACTOR WILL BE RESPONSIBLE FOR METHODS AND SEQUENCING OF CONSTRUCTION APPROPRIATE TO MAINTAIN EXCAVATION STABILITY, INSTALLATION AND TO ACHIEVE THE DESIGN REQUIREMENTS PRESENTED ON THESE DRAWINGS. EXCAVATION DIMENSIONS, ELEVATIONS, SETBACKS AND CLEARANCES NOTED ON THESE DRAWINGS INDICATE GENERAL INTENT ONLY. THE CONTRACTOR IS RESPONSIBLE FOR ESTABLISHING FINAL EXCAVATION DIMENSIONS AND FOR RESOLVING ALL CONFLICTS IN NOTED DIMENSIONS.

1.9 IT IS THE CONTRACTOR'S RESPONSIBILITY TO ACCURATELY SURVEY THE LAYOUT OF THE RETAINING WALL ALIGNMENTS. ADDITIONAL COSTS DUE TO INACCURATE LAYOUT OR OVER-EXCAVATION SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

1.10 THE CONTRACTOR SHALL CONFIRM THE LOCATION OF ALL SURROUNDING UNDERGROUND SERVICES WHICH CAN BE DAMAGED BY THE PROPOSED INSTALLATION PRIOR TO BEGINNING RETAINING WALL CONSTRUCTION. CONFLICTS AFFECTING THE INSTALLATION SHALL BE REPORTED TO THE DESIGN ENGINEER AND THE CIVIL ENGINEER AS SOON AS POSSIBLE TO ALLOW FOR ALTERATION OF THE DESIGN IF REQUIRED. THE DESIGN ENGINEER WILL NOT ACCEPT RESPONSIBILITY FOR DELAY CLAIMS RISING FROM UTILITY CONFLICTS.

1.11 IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY AND NOTIFY THE DESIGN ENGINEER OF ANY UNDERGROUND SERVICES THAT CAN BE DAMAGED BY THE PROPOSED CONSTRUCTION.

1.12 THE CONTRACTOR SHALL SCHEDULE, COORDINATE AND CONDUCT THE WORK WITH THE OWNER OR THEIR REPRESENTATIVE IN ACCORDANCE WITH THE OWNER'S REQUIREMENTS.

1.13 IT IS POSSIBLE EXCAVATION WILL PRODUCE SMALL MOVEMENT OF ADJACENT GROUND WHICH COULD CAUSE SOME DAMAGE TO ADJACENT INSTALLATIONS. GOOD PRACTICE INCLUDES THAT THE OWNER AND OR THE CONTRACTOR ARRANGE FOR REVIEWS OF THE CONDITIONS OF EXISTING OR ADJACENT STRUCTURES BEFORE EXCAVATION IS STARTED AND AFTER THE CONSTRUCTION IS COMPLETE TO DOCUMENT ANY DAMAGES OCCURING FROM THE CONSTRUCTION.

1.14 THE DESIGN ENGINEER SHALL OBSERVE THE CONSTRUCTION OF THE RETAINING WALL SYSTEMS SHOWN ON THESE DRAWINGS. HOWEVER, THE CONTRACTOR SHALL CONDUCT THEIR OWN QUALITY CONTROL REVIEWS OF THE CONSTRUCTION ON A DAILY BASIS AND IMMEDIATELY REPORT ANY IRREGULARITIES, CONSTRUCTION ERRORS OR UNFORESEEN SITE CONDITIONS TO THE DESIGN ENGINEER.

1.15 THE CONTRACTOR SHALL BUILD AND MAINTAIN PROPERLY SECURED HOARDING AROUND THE SITE FOR THE SAFETY OF SITE PERSONNEL AND THE PUBLIC IN THE SITE VICINITY.

1.16 THE DESIGN ENGINEER IS TO HAVE ACCESS TO THE SITE WHENEVER REQUIRED AND IS THE SOLE JUDGE OF WHEN THE DESIGN ENGINEER'S PRESENCE IS NECESSARY AND WHETHER A TECHNICIAN, STAFF ENGINEER, OR SENIOR ENGINEER IS REQUIRED ON SITE.

2.0 MATERIALS

2.1 **CAST-IN-PLACE CONCRETE SPECIFICATION:**

CEMENT:	CSA A3001-08: PORTLAND TYPE GU
SUPPLEMENTARY CEMENTING MATERIAL:	CSA A3001-08: TYPE F OR TYPE CI
AGGREGATE SIZE:	ASTM C136, GRADATION NO. 2
MINIMUM COMPRESSIVE STRENGTH:	25 MPA @ 28 DAYS
SLUMP:	80 +/- 20 MM (AT DISCHARGE INTO PUMP)
AIR CONTENT:	5.5 +/- 1.5% (AT DISCHARGE INTO PUMP)
MAXIMUM W/CM:	0.45

2.2 **WOOD:**

ALL WOOD BLOCKING USED FOR BEARING BLOCKS AND SHIMMING SHALL BE PRESSURE TREATED DIMENSIONAL LUMBER.

2.3 **PRECAST CONCRETE PANELS**

2.3.1 PRECAST CONCRETE MANUFACTURER AND THE ERECTOR MUST BE CERTIFIED UNDER THE REQUIREMENTS OF CSA A251 AND HAVE A MINIMUM OF FIVE YEARS EXPERIENCE IN SIMILAR WORK.

2.3.2 CONCRETE STRENGTH, REINFORCEMENT LAYOUT AND BEARING EDGE DETAILS SHALL BE AS SPECIFIED ON THESE DRAWINGS. ADDITIONAL PANEL DESIGN FEATURES SUCH AS LIFTING HOOKS ETC. SHALL BE UP TO THE DISCRETION OF THE CONTRACTOR OR SUPPLIER.

2.3.3 CONCRETE TO FORM THE PRECAST PANELS SHALL BE DESIGNED BY THE CONTRACTOR OR SUPPLIER AS PER CSA A23.1-09 TO MEET THE FOLLOWING PERFORMANCE CRITERIA:

2.3.3.1 COMPRESSIVE STRENGTH, 35 MPA AT 28 DAYS

2.3.3.2 EXPOSURE CLASS: C-1

2.3.4 IF INSTALLATION OR TRANSPORTATION LOADING REQUIRES A MORE ROBUST PANEL DESIGN THAN SHOWN ON THESE DRAWINGS THE CONTRACTOR OR SUPPLIER SHOULD INFORM THE DESIGN ENGINEER AS SOON AS POSSIBLE. THE DESIGN ENGINEER WILL NOT TAKE RESPONSIBILITY FOR FAILURE OF THE PRECAST CONCRETE PANEL DURING TRANSPORTATION OR CONSTRUCTION.

2.3.5 THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO THE DESIGN ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION OF ANY PRECAST CONCRETE PANELS.

2.3.6 THE SHOP DRAWINGS SHALL SHOW THE LAYOUT OF ALL COMPONENTS AND COMPLETE DETAILS NECESSARY FOR THE FABRICATION AND ERECTION OF THE COMPONENT PARTS INCLUDING DETAILS OF ALL CONNECTIONS.

2.3.7 SHOP DRAWINGS WILL INCLUDE CONCRETE MIX DESIGN AND CURING REGIMEN EMPLOYED TO MEET THE PERFORMANCE CRITERIA SPECIFIED ABOVE.

2.3.8 QUALITY CONTROL TESTING OF ALL PRECAST CONCRETE WORK IS THE RESPONSIBILITY OF THE CONTRACTOR OR SUPPLIER. CERTIFIED COPIES OF TESTING REPORTS SHOULD BE SUBMITTED TO THE DESIGN ENGINEER IMMEDIATELY AFTER COMPLETION.

2.3.9 QUALITY ASSURANCE TESTING SHALL BE CONDUCTED AT THE DISCRETION OF THE OWNER. THE CONTRACTOR OR SUPPLIER IS RESPONSIBLE FOR FACILITATING QUALITY ASSURANCE TESTING IF REQUESTED BY THE OWNER.

2.3.10 THE DIMENSIONAL TOLLERANCES OF THE PRECAST PANELS ARE 6MM IN LENGTH, AND 6MM IN WIDTH AND DEPTH, FROM THE DIMENSIONS SPECIFIED ON THESE DRAWINGS. PANELS DELIVERED TO SITE OUTSIDE OF THESE TOLERANCES MAY BE REJECTED FROM INSTALLATION BY THE DESIGN ENGINEER AND REPLACED AT THE CONTRACTOR OR SUPPLIERS EXPENSE.

2.4 **DEFORMED REINFORCING BARS:**

2.4.1 DEFORMED REINFORCING BARS SHALL BE 400 MPA DEFORMED NEW BILLET STEEL, AND CONFORM TO CSA G30.18-M7.

2.4.2 A MINIMUM BAR OVERLAP OF 600MM SHALL BE USED FOR DEFORMED BAR LAP SPLICES.

2.5 **STEEL WIDE FLANGE BEAMS:**

2.5.1 STEEL WIDE FLANGE BEAMS SHALL CONSIST OF NEW 350 MPA STEEL, AND CONFORM TO CSA G40.21 350W.

2.5.2 STEEL WIDE FLANGE BEAMS SHALL BE PROTECTED FROM CORROSION BY HOT DIP GALVANIZING IN CONFORMANCE WITH ASTM A123.

3.0 INSTALLATION

3.1 **GENERAL:**

3.1.1 CAREFUL SEQUENCING OF THE DRILLING, INSTALLATION OF STEEL BEAMS AND CONCRETE PLACEMENT IS NECESSARY FOR SAFE EXECUTION OF THE DESCRIBED WORKS. THE DRAWINGS GIVE INSTRUCTION WITH REGARD TO THE GENERAL INSTALLATION. HOWEVER, IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE THE ACTUAL CONSTRUCTION SEQUENCE AND TO PROVIDE THAT SEQUENCE TO THE DESIGN ENGINEER AND OWNER'S REPRESENTATIVE FOR APPROVAL PRIOR TO CONSTRUCTION. ONCE ESTABLISHED, THE CONSTRUCTION SEQUENCE MAY NOT BE ALTERED UNLESS WRITTEN APPROVAL IS PROVIDED BY THE DESIGN ENGINEER.

3.2 **PRECAST CONCRETE PANEL WALL**

3.2.1 THE STEEL SUPPORT COLUMNS (W FLANGE BEAMS) SHALL BE INSTALLED VERTICALLY AT THE RELATIVE LOCATIONS SHOWN ON THESE DRAWINGS. THE COLUMN EXCAVATIONS ARE TO BE CENTERED WITHIN 25MM OF THE LOCATIONS INDICATED ON THESE DRAWINGS.

3.2.2 THE EXCAVATION FOR THE STEEL BEAM FOUNDATION (CONCRETE ENCASED BEAM) SHALL BE INSTALLED USING A 600MM MINIMUM OUTSIDE DIAMETER AUGER OR BORING HEAD. SPECIFIC INSTALLATION METHOD SHALL BE AT THE DISCRETION OF THE CONTRACTOR AND MAY REQUIRE CASING OF THE AUGERED / BORED HOLE TO PREVENT SLOUGHING OF THE SIDE WALLS.

3.2.3 SPECIFIC DRILLING, BORING, OR HYDROVACCUMING EQUIPMENT AND METHODS SHALL BE AT THE DISCRETION OF THE CONTRACTOR. IT SHOULD BE NOTED THAT DENSE DEPOSITS OF COARSE GRANULAR MATERIALS ARE PRESENT AT THE SITE AND THE CONTRACTOR SHOULD REVIEW AVAILABLE SOILS INFORMATION TO SELECT AN APPROPRIATE INSTALLATION METHOD.

3.2.4 BEAMS SHALL BE POSITIONED IN THE BORED HOLES, ENSURING THE EMBEDED AND EXPOSED LENGTHS ARE AS SPECIFIED IN THIS DRAWING SET. ALLOWABLE INCLINATION TOLERANCE SHALL BE WITHIN 0.5 DEGREES OF VERTICAL.

3.2.5 THE EMBEDDED BEAM LENGTH SHALL BE EXCAVED IN CONCRETE CONTOURING TO THE ROUGH AUGURED / BORED EXCAVATION. CONCRETE WILL BE ALLOWED TO CURE FOR AT LEAST 7-DAYS PRIOR TO PROCEEDING WITH WALL PANEL INSTALLATION.

3.2.6 PANELS WILL BE POSITIONED BETWEEN THE FLANGES OF ADJACENT SUPPORT COLUMNS (W FLANGE BEAMS). PANELS WILL BE FRICTION FIT IN PLACE WITH PRESSURE TREATED WOODEN BEARING BLOCKS. AT THIS TIME IT IS ANTICIPATED THAT 4X4 POSTS WILL FIT BETWEEN THE PRECAST PANEL AND THE FRONT AND BACK PLATE OF THE STEEL BEAM. THE BEAMS MAY REQUIRE TRIMMING OR SHIMMING AND SHOULD BE FORCED INTO PLACE WITH A SLEDGEHAMMER TO ENSURE A TIGHT FIT.

4.0 FIELD REVIEW AND TESTING

4.1 **GENERAL**

4.1.1 THE DESIGN ENGINEER SHALL REVIEW INSTALLATION OF STEEL REINFORCEMENT WORKS TO CONFIRM THE COMPLETED WORKS COMPLY WITH DESIGN INTENTIONS.

PROFESSIONAL ENGINEERS PROVINCE OF BRITISH COLUMBIA P. R. ELL ENGINEERING

MARCH/23/2017

1	16	3	2017	REMOVED ALPABLOCK	MP	PE
0	0	0	2017	ISSUED FOR CLIENT REVIEW	TD	PE
NO.	D	M	Y	SUBMISSION DESCRIPTION	DRAWN	CHECK

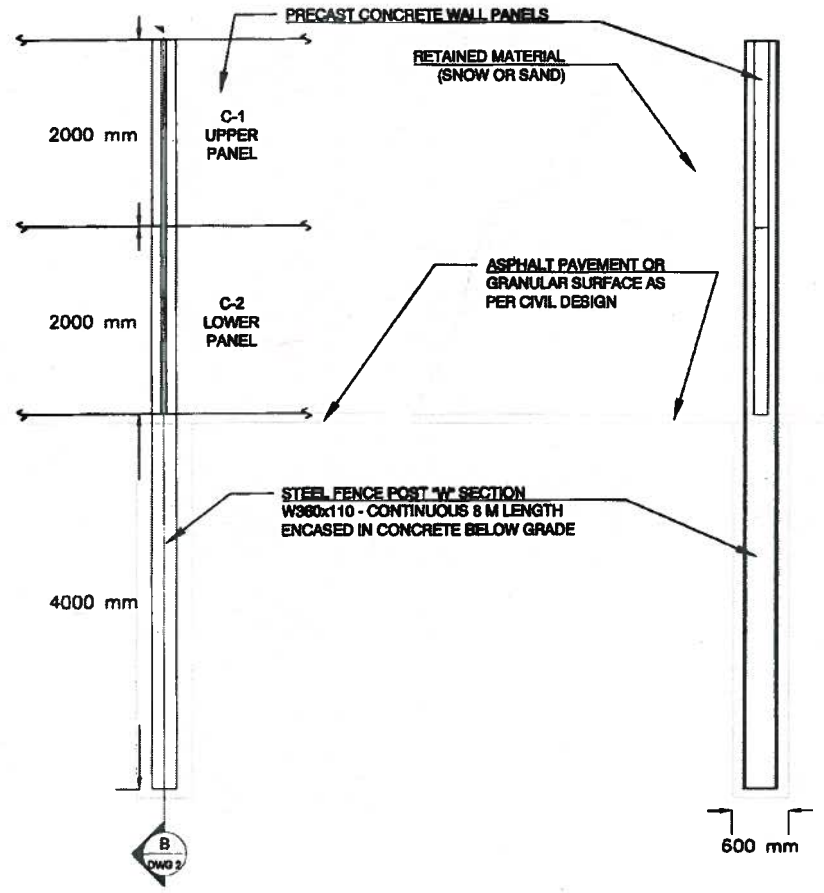
ADOPTED FROM: -
PROJECT NO: -
DATE: -

This drawing is the sole property of WSP Canada Inc. and cannot be used or distributed in any way without the expressed written consent of WSP. The general contractor shall verify all dimensions and report any discrepancies to WSP.

ISSUE: ROGERS PASS RETAINING WALLS - NOTES
PROJECT: ROGERS PASS MAINTENANCE COMPOUND
ADDRESS: ROGERS PASS, BC
CLIENT: PUBLIC WORKS GOVERNMENT SERVICES CANADA C/O WEDLER

WSP

DESIGN: TD	DATE: FEB 2017
CHECK: PE	SCALE: NTS
DRAWN: TD	FILE NO.: 161-07388-00
SHEET NO.:	1



DET 2 / DWG 2 TYPICAL PRECAST PANEL WALL DETAIL

B / DWG 2 TYPICAL PRECAST PANEL WALL PROFILE

MARCH 23/2017

NO.	BY	CHK	YR	REVISION DESCRIPTION	DRAWN	CHECK
1	MP	PE	2017	REMOVED ALPABLOCK		
0	TD	PE	2017	ISSUED FOR CLIENT REVIEW		

ADDITIONAL PHASE: -
PROJECT NO.: -
DATE: -

ROGERS PASS RETAINING WALLS - DETAILS

PROJECT: ROGERS PASS MAINTENANCE COMPOUND

ADDRESS: ROGERS PASS, BC

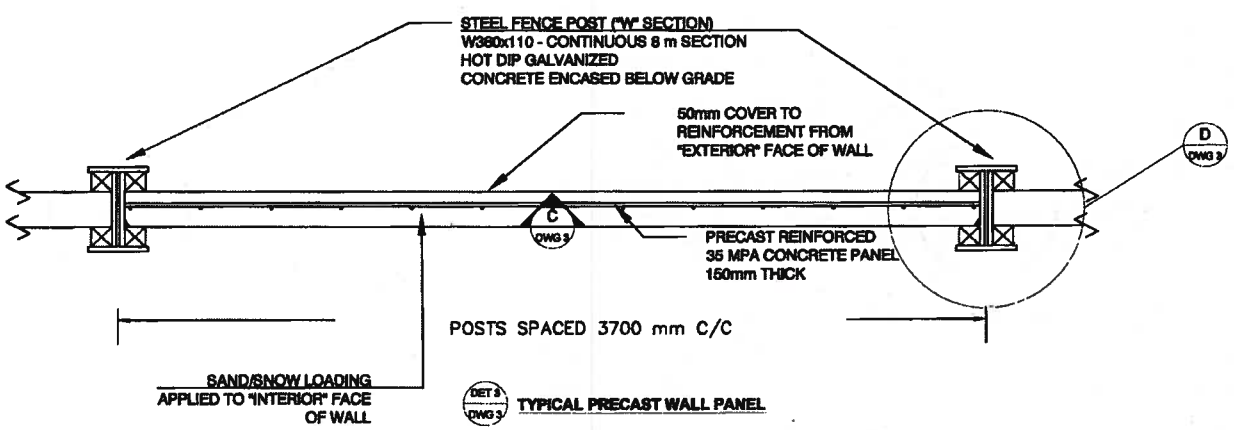
CLIENT: PUBLIC WORKS GOVERNMENT SERVICES CANADA C/O WEDLER

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA P. R. ELL

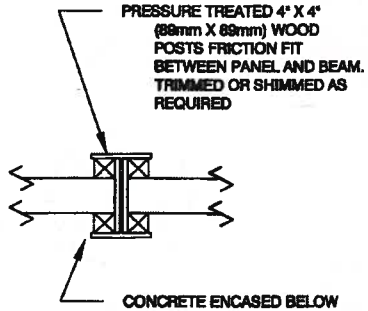
WSP

DRAWN	TD
DATE	FEB 2017
DESIGN	PE
SCALE	NTS
CHECKED	TD
FILE NO.	161-07388-00

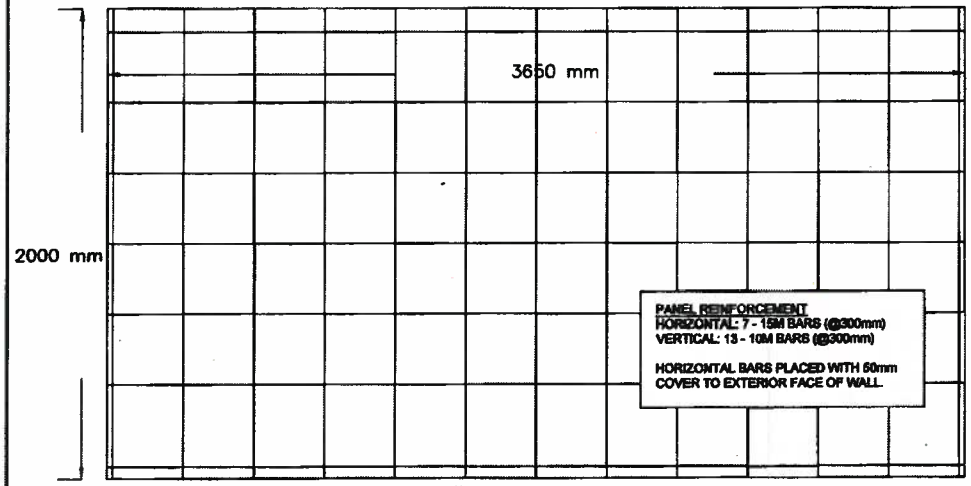
DRAWING NO. 2



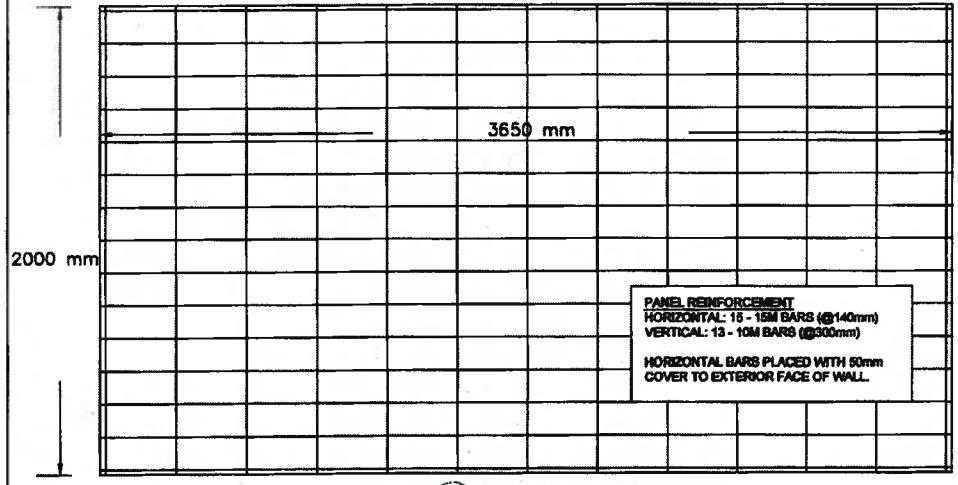
DET 3 / DWG 3 **TYPICAL PRECAST WALL PANEL**



D / DWG 3 **TYPICAL PRECAST WALL POST TO PANEL CONECTION DETAIL**



C-1 / DWG 3 **PRECAST WALL UPPER PANEL REINFORCEMENT**



C-2 / DWG 3 **PRECAST WALL LOWER PANEL REINFORCEMENT**

NOTES:

REV						
1	14	8	2017	REMOVED ALPANLOCK	MP	PE
0	9	2	2017	ISSUED FOR CLIENT REVIEW	TD	PE
REV	D	M	Y	ISSUE/REVISION DESCRIPTION	DRAWN	CHECK

ADAPTED FROM: -

PROJECT NO: -

DATE: -

TITLE: **ROGERS PASS RETAINING WALLS - DETAILS**

PROJECT: ROGERS PASS MAINTENANCE COMPOUND

ADDRESS: ROGERS PASS, BC

CLIENT: PUBLIC WORKS GOVERNMENT SERVICES CANADA C/O WEDLER

SEAL: PROVINCE OF BRITISH COLUMBIA

March 23/2017

WSP

DRAWN: TD	DATE: FEB 2017
CHKD: PE	SCALE: NTS
DESIGN: TD	PROJECT NO: 161-07368-00

DRAWING NO: 3

APPENDICES

TECHNICAL MEMORANDUM

DATE 9 August 2016 **REFERENCE No.** 1660221-002-TM-Rev0

TO Jordan Stones
Public Works and Governmental Services

FROM Pana Athanasopoulos **EMAIL** pathanas@golder.com

ENVIRONMENTAL STOCKPILE CHARACTERIZATION AT ROGERS PASS WEST, ROGERS PASS, GLACIER NATIONAL PARK, BC

At the request of Public Works and Government Services Canada (PWGSC), and as part of the overall planning for Phase 2 of the Rogers Pass Infrastructure Improvements Project (Project) by Wedler Engineering LLP (Wedler; Prime Consultant for the Project), PWGSC requested that Golder Associates Ltd. (Golder) be present during test pit excavations along the proposed new sanitary sewer main at Rogers Pass West, on the west side of Highway 1 (herein referred to as the "Site"), to document environmental soil conditions, including potential hydrocarbon contamination, and to obtain in-situ and stockpile soil samples for analysis of contaminants of potential concern (COPC).

A total of five test pits were excavated by VVI Construction Ltd. (VVI; General Contractor for Phase 1 of the Project) on 4 July 2016 and on 8 July 2016. Refer to the attached drawing for the five test pit locations (named TP16-01 through TP16-05 for the purposes of this technical memorandum). The soils excavated from each test pit were stockpiled on-Site in individual stockpiles adjacent to each test pit location. Golder collected soil samples from the stockpiled soils, for off-Site disposal purposes.

This technical memorandum summarizes the stockpile soil characterization program, and includes tabulated analytical soil stockpile results, a comparison of the analytical results to applicable provincial standards triggering soil relocation agreements, and the laboratory Certificate of Analysis (COA) report. It can be used by VVI for arranging off-Site disposal of the stockpiled soil.

A separate technical memorandum will be provided to PWGSC that summarizes the in-situ soil characterization program.

Golder Associates Ltd.
590 McKay Avenue, Suite 300, Kelowna, British Columbia, Canada V1Y 5A8
Tel: +1 (250) 860 8424 Fax: +1 (250) 860 9874 www.golder.com
Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Regulatory Framework

It is our understanding that the stockpiled soil will be disposed of on land under provincial jurisdiction, and not on federal lands; thus, the classification of soil disposed of on provincial lands fall under the jurisdiction of the BC MOE, pursuant to the *Environmental Management Act* (SBC 2003 CHAPTER 53, assented to October 23, 2003). The two key regulations under the *Environmental Management Act* relating to the assessment and remediation of contaminated sites are the *Contaminated Sites Regulation* ("CSR"; B.C. Reg. 375/96, O.C. 1480/96, includes amendments up to B.C. Reg. 184/2016, 19 July 2016), and the *Hazardous Waste Regulation* ("HWR"; B.C. Reg. 63/88 O.C. 268/88, includes amendments up to B.C. Reg. 179/2016, 19 July 2016). Therefore, the stockpile soil analytical results have been compared to the following provincial standards:

- BC CSR Schedule 7 standards triggering Contaminated Soil Relocation Agreements[1] (CSRA) for the following scenarios:
  - Soil relocation to non-agricultural land;
  - Soil relocation to agricultural land; and,
  - Waste disposal prohibited without MoE Authorization.
- BC CSR Schedule 10 generic numerical AL/PL/RL and CL/IL[2] soil standards.
- BC CSR Schedule 4 and 5 CL and IL soil standards.
- Hazardous Waste Regulation standards.

Methods

The sampling program was conducted in a manner generally consistent with that recommended by the MOE in their technical guidance document titled *Guidance Document #1 - Technical Guidance on Contaminated Sites – Site Characterization and Confirmation Testing (TG#1)*.

On 4 July 2016, soils excavated from test pits TP16-01, TP16-02 and TP16-03 were stockpiled adjacent to each test pit location. The combined ex-situ volume of the stockpiled soils was approximately 20 m^3. A composite sample of the stockpiled soils was obtained by collecting one discrete sample from each of the three stockpiles[3], and then combining the three discrete stockpile samples to form one composite stockpile sample (SP16-01).

On 8 July 2016, soils excavated from test pits TP16-04 and TP16-05 were stockpiled adjacent to each test pit location. The combined ex-situ volume of the stockpiled soils was approximately 15 m^3. A composite sample of the stockpiled soils was obtained by collecting one discrete sample from each of the two stockpiles[3], and then combining the two discrete stockpile samples to form one composite stockpile sample (SP16-02).

[1] A Contaminated Soil Relocation Agreement (CSRA) is an agreement between the owner of a source site, the owner/operator of a receiving site, and the provincial Director of Waste Management, which allows the relocation of soils from a contaminated (source) site to a suitable deposit (receiving) site.

[2] AL = agricultural land use; PL = park land use; RL = residential land use; CL = commercial land use; IL = industrial land use

[3] where each discrete stockpile sample comprised three subsamples from that stockpile.

Hydrocarbon vapour headspace readings in the composite stockpile samples were monitored using a Photo Ionization Detector (PID).

Analytical testing was conducted by Maxxam Analytical (Maxxam) of Burnaby, BC. Based on known contaminants of concern at the Site, the composite stockpile soil samples were analyzed by Maxxam for benzene, toluene, ethylbenzene and xylenes (BTEX), light and heavy extractable petroleum hydrocarbons (LEPH/HEPH), polycyclic aromatic hydrocarbons (PAHs), and metals. A copy of the laboratory COA report is attached.

For the purpose of arranging off-Site disposal of the stockpiled soil, the stockpile analytical results were initially compared to the CSR Schedule 7 and 10 standards (attached Table 1). Where the stockpile soil analytical results are less than the CSR Schedule 7 and 10 standards, soil from the Site may be relocated to non-agricultural or agricultural land (i.e., receiving site), as applicable, without a CSRA.

Where the stockpile soil analytical results are greater than the BC CSR Schedule 7 or 10 standards (but less than the HWR standards), then the options for off-Site disposal of the stockpiled soil would be either: i) a CSRA or MOE Authorization would need be obtained to relocate soil to a receiving site, provided that the soil analytical results meet numerical or risk-based land use standards at the receiving site; or ii) the stockpiled soil may be relocated to a facility authorized to accept contaminated soil (i.e., appropriately permitted landfill or treatment facility).

For characterization purposes, where the stockpiled soil may be relocated to permitted facility, the stockpile soil analytical results are compared to the BC CSR Schedule 4, 5 and 10 CL and IL soil standards and to the BC *HWR* (Table 2 attached) and classified as follows (BC MoE *TG#1*):

Stockpiled Soil Quality Classification	**Soil Concentrations Relative to CSR Standards and *HWR***
Commercial Quality (<CL)	soils concentrations less than the CSR CL soil standards
Industrial Quality (>CL<IL)	soils concentrations exceed the CSR CL soil standards but less than the CSR IL soil standards
Waste Quality (>IL<HW)	soils concentrations exceed the CSR IL soil standards, but less than *HWR*
Hazardous Waste (HW)	as defined by the BC *HWR*

Results

A total of approximately 35 m^3 of soil was excavated from the Site during the test pit excavations on 4 and 8 July 2016. Hydrocarbon vapour headspace readings in the composite stockpile samples were 0 ppm.

The stockpile soil analytical results are presented in:

- Table 1: compared to the CSR Schedule 7 and 10 standards; and,
- Table 2: compared to the CSR Schedule 4, 5 and 10 standards and the HWR standards.

The stockpile soil analytical results indicate the following:

- Table 1: Benzene, total xylene, phenanthrene and/or pyrene soil concentrations in both stockpile samples exceed one or more of the CSR Schedule 7 standards.
- Table 2: Benzene soil concentrations in both stockpile samples exceed the CSR CL and IL standards for benzene. The reported soil concentrations do not exceed the BC HWR soil standards.

Recommendations

As benzene soil concentrations in both stockpile samples exceed the CSR Schedule 7 standards for "*Soil Relocation to Non-Agricultural Land*", "*Soil Relocation to Agricultural Land*" and "*Waste disposal prohibited without Authorization*", MOE Authorization (and likely additional investigations at the receiving site) would be required to relocate soils to a receiving site. Thus, it is recommended that the 35 m^3 of excavated soil be transported off-Site and disposed of at a permitted facility authorized to accept the soils without a CSRA.

Based on the analytical results, the stockpile soil quality can be classified as *Waste Quality* (i.e., > IL, < HW).

The stockpiled soils can be taken to the Columbia Shuswap Regional District Landfill in Golden or Salmon Arm, BC. A "Hydrocarbon Contaminated Soil Disposal Application" will be required for disposal of these soils at either landfill (application to be filled out by VVI).

Limitations

The information presented herein was prepared for the exclusive use for PWGSC, to provide sufficient characterization data to allow PWGSC to evaluate soil quality that was sampled on the date indicated with respect to Provincial standards and regulations for the purposes of off-Site disposal. This information may be used by Wedler and VVI for the purposes of off-Site disposal of soils excavated from the Site (Rogers Pass West) during test pit excavations on 4 July 2016 and 8 July 2016.

This program has followed the standard of care expected of professionals undertaking similar work in British Columbia under similar conditions. No other warranty is expressed or implied. If the sampling and analysis program described herein were repeated, it is expected that similar data would be generated.

If new information is generated by others and becomes available to PWGSC, Golder should be contacted to review the results and provide an opinion as to the findings, and their implications on the sampling and characterization presented in this technical memorandum.

Closure

We trust the information contained in this report meets your requirements at this time. Should you have any questions please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Kelsey Tanaka, AScT
Environmental Technologist

Pana Athanasopoulos, M.Sc., P.Geo.
Senior Hydrogeologist

Darlene Atkinson, M.Sc., P.Eng.
Associate, Senior Environmental Engineer

KT/PA/DA/kv

Attachments: Drawing Showing Test Pit Locations (Base Plan from Wedler)
Table 1: Stockpile Soil Analytical Results Compared to BC CSR Schedule 7 and 10 Standards
Table 2: Stockpile Soil Analytical Results Compared to BC CSR Schedule 4, 5 and 10 Standards and BC HWR Standards
Maxxam Certificate of Analysis Reports

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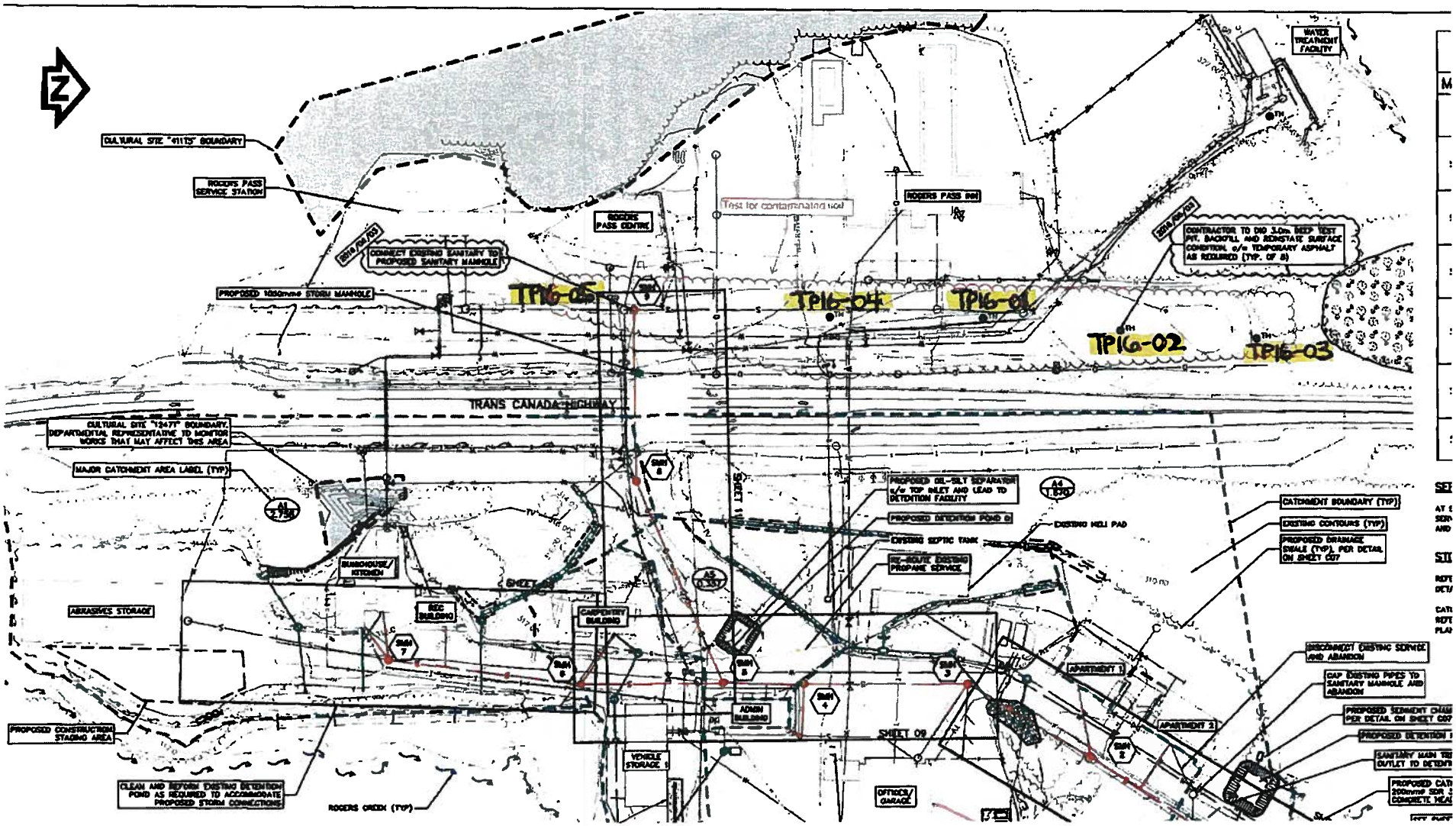
TP16-05
TP16-04
TP16-01
TP16-02
TP16-03
TRANS CANADA HIGHWAY
ROGERS PASS SERVICE STATION
ROGERS PASS CENTRE
ROGERS PASS INN
WATER TREATMENT FACILITY
CULTURAL SITE "41115" BOUNDARY
CULTURAL SITE "12471" BOUNDARY, DEPARTMENTAL REPRESENTATIVE TO MONITOR WORKS THAT MAY AFFECT THIS AREA
PROPOSED 1050mmø STORM MANHOLE
CONNECT EXISTING SANITARY TO PROPOSED SANITARY MANHOLE
CONTRACTOR TO DIG 3.0m DEEP TEST PIT, BACKFILL AND REINSTATE SURFACE CONDITION, c/w TEMPORARY ASPHALT AS REQUIRED (TYP. OF 8)
MAJOR CATCHMENT AREA LABEL (TYP)
PROPOSED OIL-SILT SEPARATOR c/w TOP INLET AND LEAD TO DETENTION FACILITY
PROPOSED DETENTION POND D
EXISTING HELI PAD
EXISTING SEPTIC TANK
RE-ROUTE EXISTING PROPANE SERVICE
CATCHMENT BOUNDARY (TYP)
EXISTING CONTOURS (TYP)
PROPOSED DRAINAGE SWALE (TYP), PER DETAIL ON SHEET C07
SUNHOUSE/ KITCHEN
REC BUILDING
CARPENTRY BUILDING
ABRASIVES STORAGE
ADMIN BUILDING
VEHICLE STORAGE
OFFICES/ GARAGE
APARTMENT 1
APARTMENT 2
DISCONNECT EXISTING SERVICE AND ABANDON
CAP EXISTING PIPES TO SANITARY MANHOLE AND ABANDON
PROPOSED CONSTRUCTION STAGING AREA
CLEAN AND REFORM EXISTING DETENTION POND AS REQUIRED TO ACCOMMODATE PROPOSED STORM CONNECTIONS
ROGERS CREEK (TYP)
SHEET 09
SHEET 10
TH
TP16-01
Approximate Test Pit Locations and Test Pit ID.
Base Plan from Wedler Engineering L.P.

Table 1
Stockpile Soil Analytical Results Compared to BC CSR Schedule 7 and 10 Standards
Rogers Pass West, Glacier National Park, BC

Location	CSR Schedule 7			CSR Schedule 10		Stockpile 1	Stockpile 2
Golder Sample ID	Soil Relocation to Non-Agricultural Land	Soil Relocation to Agricultural Land	Waste Disposal Prohibited Without Authorization	Agricultural, Urban Park, Residential Soil Standard	Commerical, Industrial Soil Standard	SP16-01	SP16-02 SA1
Laboratory ID						OZ5337	PA6597
Date Sampled						04-Jul-16	06-Jul-16
Approximate Stockpile Volume						20 m^3	15 m^3
Field Parameters							
Hydrocarbon Vapours (ppm)						0	0
Physical Parameters							
moisture (%)						9.3	12
pH (pH units)						7.91	7.57
Total Metals							
aluminum						6830	7640
antimony	20	20	40			0.26	0.26
arsenic	15	15	15			3.64	2.33
barium	400	400	400			37.5	57.7
beryllium	4	4	8			<0.40	<0.40
bismuth						0.16	0.14
cadmium	1.5	1.5	1.5			0.086	0.051
calcium						7020	5330
chromium	60 VI&III/Total	50 III/Total / 80 VI	65 III / 80 VI/Total			16.3	17.8
cobalt	50	40	300			9.26	7.81
copper	90	90	90			18.4	18.9
iron						22000	20000
lead	100	100	100			11.6	15.9
lithium				1,600	20,000	15.1	15.9
magnesium						5240	4210
manganese				1,800	19,000	420	226
mercury (inorganic)	15	0.5	150			<0.050	<0.050
molybdenum	10	5	40			0.36	0.42
nickel	100	150	500			24.1	21.6
phosphorus						274	358
potassium						311	444
selenium	3	2	10			<0.50	<0.50
silver	20	20	40			<0.050	0.067
sodium						<100	<100
strontium (stable)				47,000	100,000	17.8	19.2
thallium		2				<0.050	<0.050
tin	50	5	300	5 IN or 50 INORG.	300	0.32	0.24
titanium						46.1	84.4
uranium				16	200	0.845	0.750
vanadium	200	200				8.7	8.5
zinc	150	150	150			38.6	33.4
zirconium						0.54	<0.50
Polycyclic Aromatic Hydrocarbons (PAH)							
acenaphthene						0.0085	<0.0050
acenaphthylene						0.0074	<0.0050
anthracene						0.037	0.0053
benzo(a)anthracene	1	0.1	10			0.062	0.023
benzo(a)pyrene	1	0.1	10			0.075	<0.020
benzo(b)fluoranthene	1	0.1	10			0.071	0.023
benzo(b&j)fluoranthene						0.11	0.023
benzo(g,h,i)perylene						0.060	<0.050
benzo(k)fluoranthene	1	0.1	10			0.033	<0.020
chrysene						0.12	0.034
dibenz(a,h)anthracene	1	0.1	10			<0.050	<0.050
fluoranthene						0.20	0.052
fluorene						0.020	<0.020
indeno(1,2,3-c,d)pyrene	1	0.1	10			<0.050	<0.050
naphthalene	5	0.1	50			0.096	0.098
2-Methylnaphthalene						0.16	0.20
phenanthrene	5	0.1	50			0.23	0.047
pyrene	10	0.1	100			0.18	0.049
Low Molecule Weight PAH's						0.56	0.36
High Molecule Weight PAH's						0.86	0.18
Total PAH						1.4	0.53
benzo(a)pyrene equivalency						0.13	0.044
Index of Additive Cancer Risk (IARC)						1.5	0.44
Non-Halogenated Volatiles							
benzene	0.04	0.04	0.04			0.025	0.03
ethylbenzene	1	1	20			0.049	0.5
methyl tertbutyl ether (MTBE)				320	700	<0.10	<0.10
styrene	5	0.1	50			<0.030	<0.030
toluene	1.5	1.5	2.5			0.20	0.27
meta- & para-xylene						0.19	2.1
ortho-xylene						0.047	0.16
Total xylene	5	0.1	20			0.24	2.3
F1 (C6-C10 - BTEX)						<10	10
F1 (C6-C10)						<10	14
F2 (C10-C16)						16	23
F3 (C16-C34)						440	470
F4 (C34-C50)						210	230
LEPH (C10-C19 - PAH)	1,000	1,000	2,000			<100	<100
HEPH (C19-C32 - PAH)	1,000	1,000	5,000			470	500
EPH (C10-C19)						<100	<100
EPH (C19-C32)						470	500
VPH (C6-C10 - BTEX)	200	200	200			<10	<10
VH (C6-C10)							13

Stockpile Soil Analytical Results Compared to BC CSR Schedule 7 and 10 Standards
Rogers Pass West, Glacier National Park, BC

Notes:

Results are expressed in micrograms per gram (µg/g), unless otherwise stated.

Standards shown are from the Contaminated Sites Regulation (CSR; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 4/2014) Schedule 7 Standards Triggering Contaminated Soil Relocation Agreements, and from the CSR Schedule 10 Generic Numerical Soil and Water Standards.

Soil must not be relocated with nonaqueous phase liquids present in quantities in excess of that acceptable to a director.

Soil must not be relocated with odorous substances present in quantities in excess of that acceptable to a director.

EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19; EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32.

LEPH = light extractable petroleum hydrocarbons; HEPH = heavy extractable petroleum hydrocarbons; PAH = polycyclic aromatic hydrocarbon.

VPH = volatile petroleum hydrocarbons; VH = volatile hydrocarbons

V = Valence-dependent standard

AL = agricultural land use

RL = residential land use

PL = park land use

Indicates soil concentration exceeds one or more of the CSR Schedule 7 or 10 standards.

Stockpile Soil Analytical Results Compared to BC CSR Schedule 4,5 and 10 Standards and BC HWR Standards
Rogers Pass West, Glacier National Park, BC

Location	BC CSR Schedule 4 and 5				BC CSR Schedule 10	BC HWR	Stockpile 1	Stockpile 2
Golder Sample ID							SP16-01	SP16-02 SA1
Laboratory ID	CL Standards	MCS	IL Standards	MCS	CL/IL Standards	Hazardous Waste Regulation	OZ5337	PA6597
Date Sampled							04-Jul-16	08-Jul-16
Approximate Stockpile Volume							20 m³	15 m³
Field Parameters								
Hydrocarbon Vapours (ppm)							0	0
Physical Parameters								
moisture (%)							9.3	12
pH (pH units)							7.91	7.57
Total Metals								
aluminum							6830	7640
antimony	40	G	40	G			0.26	0.26
arsenic	15	DW	15	DW			3.84	2.33
barium	400	DW	400	DW			37.5	57.7
beryllium	8	G	8	G			<0.40	<0.40
bismuth							0.16	0.14
cadmium	1.5 - 100	pH	1.5 - 500	pH			0.086	0.051
calcium							7020	5330
chromium	60	V	60	V			16.3	17.8
cobalt	300	G	300	G			9.26	7.81
copper	90 - 250	pH	90 - 250	pH			18.4	18.9
iron							22000	20000
lead	100 - 700	pH	100 - 2,000	pH			11.8	15.9
lithium					20,000		15.1	15.9
magnesium							5240	4210
manganese					16,000		420	228
mercury (inorganic)	40	I	150	T			<0.050	<0.050
molybdenum	40	G	40	G			0.36	0.42
nickel	500	G	500	G			24.1	21.6
phosphorus							274	358
potassium							311	444
selenium	10	G	10	G			<0.50	<0.50
silver	40	G	40	G			<0.050	0.067
sodium							<100	<100
strontium (stable)					100,000		17.8	19.2
thallium							<0.050	<0.050
tin	300	G	300	G	300		0.32	0.24
titanium							46.1	84.4
uranium					200		0.845	0.750
vanadium							8.7	8.5
zinc	150 - 600	pH	150 - 600	pH			38.6	33.4
zirconium							0.64	<0.50
Polycyclic Aromatic Hydrocarbons (PAH)								
acenaphthene							0.0085	<0.0050
acenaphthylene							0.0074	<0.0050
anthracene							0.037	0.0053
benzo(a)anthracene	10	G	10	G			0.082	0.023
benzo(a)pyrene	10	T	10	T			0.075	<0.020
benzo(b)fluoranthene	10	G	10	G			0.071	0.023
benzo(b&j)fluoranthene							0.11	0.023
benzo(g,h,i)perylene							0.060	<0.050
benzo(k)fluoranthene	10	G	10	G			0.033	<0.020
chrysene							0.12	0.034
dibenz(a,h)anthracene	10	G	10	G			<0.050	<0.050
fluoranthene							0.20	0.052
fluorene							0.020	<0.020
indeno(1,2,3-c,d)pyrene	10	G	10	G			<0.050	<0.050
naphthalene	50	G	50	G			0.096	0.098
2-Methlynaphthalene							0.16	0.20
phenanthrene	50	G	50	G			0.23	0.047
pyrene	100	G	100	G			0.18	0.049
Low Molecule Weight PAH's							0.56	0.35
High Molecule Weight PAH's							0.86	0.18
Total PAH							1.4	0.53
PAH TEQ						100	0.13	0.048
benzo(a)pyrene equivalency							0.13	0.044
Index of Additive Cancer Risk (IARC)							1.5	0.44
Non-Halogenated Volatiles								
benzene	0.04		0.04			*25*	[illegible]	[illegible]
ethylbenzene	7		7			*250*	0.049	0.5
methyl tertbutyl ether (MTBE)					700		<0.10	<0.10
styrene	50		50				<0.030	<0.030
toluene	2.5		2.5			*150*	0.20	0.27
meta- & para-xylene							0.19	2.1
ortho-xylene							0.047	0.16
Total xylene	20		20			*250*	0.24	2.3
LEPH (C10-C19 - PAH)	2,000		2,000			30,000*/*100,000*	<100	<100
HEPH (C19-C32 - PAH)	5,000		5,000				470	500
EPH (C10-C19)	*2,000*		*2,000*				<100	<100
EPH (C19-C32)	*5,000*		*5,000*				470	500
VPH (C6-C10 - BTEX)	200		200				<10	<10
VH (C6-C10)							-	13

Stockpile Soil Analytical Results Compared to BC CSR Schedule 4,5 and 10 Standards and BC HWR Standards
Rogers Pass West, Glacier National Park, BC

Notes:

Results are expressed in micrograms per gram (µg/g), unless otherwise stated.

Standards shown are from the Contaminated Sites Regulation (CSR; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 4/2014) Schedule 4 (Generic Numerical) and Schedule 5 (Matrix Numerical) Soil Standards, and the BC Hazardous Waste Regulation (HWR; B.C. Reg. 63/88, O.C. 268/88, includes amendments up to B.C. Reg. 179/2016, July 19, 2016).

CL = commercial land use; IL = industrial land use

Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; F = Fresh Water Aquatic Life; DW = Drinking Water; G = Generic; pH = standard is pH dependent.

MCS = most conservative standard based on applicable site-specific standards.

The standard for EPH_{C10-19} is equivalent to LEPHs, and the standard for EPH_{C19-32} is equivalent to HEPHs when no LEPHs or HEPHs analysis is undertaken, and the equivalent standard is indicated by the use of *Italics*.

EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19; EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32.

LEPH = light extractable petroleum hydrocarbons; HEPH = heavy extractable petroleum hydrocarbons; PAH = polycyclic aromatic hydrocarbon.

VPH = volatile petroleum hydrocarbons; VH = volatile hydrocarbons

Total PAH (TEQ) is sum of PAH constituent concentration multiplied by the applicable TEF (toxicity equivalency factor) for the PAH constituent.

V = Standard is valence dependent: III - trivalent chromium (Cr3+); VI - hexa-valent chromium (Cr6+).

TEQ = PAH TEQ (toxicity equivalent) is a number that allows the toxicity of substances containing different PAHs to be compared (calculated as per Schedule 1.1 of HWR).

<u>Underlined and Italicized</u> values are from Section 41.1 of the HWR.

[a] = HWR standard for total oil

Maxxam
A Bureau Veritas Group Company

Success through Science

Your P.O. #: 700359843
Your Project #: 1660221
Site Location: PC Rogers Pass
Your C.O.C. #: G109092, G109091

Attention:Pana Athanasopoulos

Golder Associates
Suite 300
590 McKay Avenue
Kelowna, BC
Canada V1Y 5A8

Report Date: 2016/08/05
Report #: R2230321
Version: 4 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B657693
Received: 2016/07/13, 08:45

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE LH VH F1 in Soil - Field Pres. (1)	1	N/A	2016/07/20	BBY8SOP-00010,	EPA 8260c R3 m
Volatile F1-BTEX	1	N/A	2016/07/21	BBY WI-00033	Auto Calc
CCME Hydrocarbons (F2-F4 in soil) (2)	1	2016/07/21	2016/07/22	BBY8SOP-00030	CCME PHC-CWS
Elements by ICPMS (total)	1	2016/07/20	2016/07/20	BBY7SOP-00017,	BC SALM,EPA 6020bR2m
Moisture	1	2016/07/18	2016/07/20	BBY8SOP-00017	BCMOE BCLM Dec2000 m
PAH in Soil by GC/MS (SIM) - CCME	1	2016/07/19	2016/07/20	BBY8SOP-00022	EPA 8270d R4 m
Index of Additive Cancer Risk Calc.	1	N/A	2016/07/21	BBY WI-00033	Auto Calc
Total PAH and B(a)P Calculation	1	N/A	2016/07/21	BBY WI-00033	Auto Calc
pH (2:1 DI Water Extract)	1	2016/07/20	2016/07/20	BBY6SOP-00028	BCMOE BCLM Mar2005 m
EPH less PAH in Soil By GC/FID	1	N/A	2016/07/21	BBY WI-00033	Auto Calc
EPH in Soil by GC/FID	1	2016/07/19	2016/07/21	BBY8SOP-00029	BCMOE EPH s 07/99 m
Volatile HC-BTEX for Soil	1	N/A	2016/07/21	BBY WI-00033	Auto Calc

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The extraction date for VOC, BTEX, VH, or F1 samples that are field preserved with methanol equals the date sampled, unless otherwise stated.

(2) All CCME results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Samantha Freglen, Project Manager
Email: SFreglen@maxxam.ca
Phone# (604)639-8418

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B657693
Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Ext. Pet. Hydrocarbon				
F2 (C10-C16 Hydrocarbons)	mg/kg	23	10	8337749
F3 (C16-C34 Hydrocarbons)	mg/kg	470	10	8337749
F4 (C34-C50 Hydrocarbons)	mg/kg	230	10	8337749
Reached Baseline at C50	mg/kg	Yes	N/A	8337749
Surrogate Recovery (%)				
O-TERPHENYL (sur.)	%	88		8337749

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam
A Bureau Veritas Group Company

Success Through Science

Maxxam Job #: B657693
Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

PHYSICAL TESTING (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Physical Properties				
Moisture	%	12	0.30	8332510
RDL = Reportable Detection Limit				

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B657693
Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CCME&CSR BTX/F1/VPH IN SOIL - FIELD PRES (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Calculated Parameters				
F1 (C6-C10) - BTEX	mg/kg	10	10	8331851
Volatiles				
VPH (VH6 to 10 - BTEX)	mg/kg	<10	10	8331857
Methyl-tert-butylether (MTBE)	mg/kg	<0.10	0.10	8335658
Benzene	mg/kg	0.35	0.0050	8335658
Toluene	mg/kg	0.27	0.020	8335658
Ethylbenzene	mg/kg	0.50	0.010	8335658
m & p-Xylene	mg/kg	2.1	0.040	8335658
o-Xylene	mg/kg	0.16	0.040	8335658
Styrene	mg/kg	<0.030	0.030	8335658
Xylenes (Total)	mg/kg	2.3	0.040	8335658
VH C6-C10	mg/kg	13	10	8335658
F1 (C6-C10)	mg/kg	14	10	8335658
Surrogate Recovery (%)				
1,4-Difluorobenzene (sur.)	%	99		8335658
4-Bromofluorobenzene (sur.)	%	100		8335658
D10-ETHYLBENZENE (sur.)	%	96		8335658
D4-1,2-Dichloroethane (sur.)	%	104		8335658
RDL = Reportable Detection Limit				

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Maxxam Job #: B657693
Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

LEPH & HEPH WITH PAH FOR CCME IN SOIL (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Calculated Parameters				
Index of Additive Cancer Risk(IARC)	N/A	0.44	0.10	8331854
Polycyclic Aromatics				
Naphthalene	mg/kg	0.098	0.010	8335127
2-Methylnaphthalene	mg/kg	0.20	0.020	8335127
Acenaphthylene	mg/kg	<0.0050	0.0050	8335127
Acenaphthene	mg/kg	<0.0050	0.0050	8335127
Fluorene	mg/kg	<0.020	0.020	8335127
Phenanthrene	mg/kg	0.047	0.010	8335127
Anthracene	mg/kg	0.0053	0.0040	8335127
Fluoranthene	mg/kg	0.052	0.020	8335127
Pyrene	mg/kg	0.049	0.020	8335127
Benzo(a)anthracene	mg/kg	0.023	0.020	8335127
Chrysene	mg/kg	0.034	0.020	8335127
Benzo(b&j)fluoranthene	mg/kg	0.023	0.020	8335127
Benzo(b)fluoranthene	mg/kg	0.023	0.020	8335127
Benzo(k)fluoranthene	mg/kg	<0.020	0.020	8335127
Benzo(a)pyrene	mg/kg	<0.020	0.020	8335127
Indeno(1,2,3-cd)pyrene	mg/kg	<0.050	0.050	8335127
Dibenz(a,h)anthracene	mg/kg	<0.050	0.050	8335127
Benzo(g,h,i)perylene	mg/kg	<0.050	0.050	8335127
Low Molecular Weight PAH`s	mg/kg	0.35	0.050	8331855
High Molecular Weight PAH`s	mg/kg	0.18	0.050	8331855
Total PAH	mg/kg	0.53	0.050	8331855
Benzo[a]pyrene equivalency	mg/kg	0.044	0.010	8331855
Calculated Parameters				
LEPH (C10-C19 less PAH)	mg/kg	<100	100	8331856
HEPH (C19-C32 less PAH)	mg/kg	500	100	8331856
Hydrocarbons				
EPH (C10-C19)	mg/kg	<100	100	8335255
EPH (C19-C32)	mg/kg	500	100	8335255
RDL = Reportable Detection Limit				

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Maxxam Job #: B657693
Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

LEPH & HEPH WITH PAH FOR CCME IN SOIL (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	91		8335127
D8-ACENAPHTHYLENE (sur.)	%	85		8335127
D8-NAPHTHALENE (sur.)	%	88		8335127
TERPHENYL-D14 (sur.)	%	96		8335127
O-TERPHENYL (sur.)	%	94		8335255
RDL = Reportable Detection Limit				

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Maxxam Job #: B657693
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Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Physical Properties				
Soluble (2:1) pH	pH	7.57	N/A	8334923
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	7640	100	8334920
Total Antimony (Sb)	mg/kg	0.26	0.10	8334920
Total Arsenic (As)	mg/kg	2.33	0.50	8334920
Total Barium (Ba)	mg/kg	57.7	0.10	8334920
Total Beryllium (Be)	mg/kg	<0.40	0.40	8334920
Total Bismuth (Bi)	mg/kg	0.14	0.10	8334920
Total Cadmium (Cd)	mg/kg	0.051	0.050	8334920
Total Calcium (Ca)	mg/kg	5330	100	8334920
Total Chromium (Cr)	mg/kg	17.8	1.0	8334920
Total Cobalt (Co)	mg/kg	7.81	0.30	8334920
Total Copper (Cu)	mg/kg	18.9	0.50	8334920
Total Iron (Fe)	mg/kg	20000	100	8334920
Total Lead (Pb)	mg/kg	15.9	0.10	8334920
Total Lithium (Li)	mg/kg	15.9	5.0	8334920
Total Magnesium (Mg)	mg/kg	4210	100	8334920
Total Manganese (Mn)	mg/kg	226	0.20	8334920
Total Mercury (Hg)	mg/kg	<0.050	0.050	8334920
Total Molybdenum (Mo)	mg/kg	0.42	0.10	8334920
Total Nickel (Ni)	mg/kg	21.6	0.80	8334920
Total Phosphorus (P)	mg/kg	358	10	8334920
Total Potassium (K)	mg/kg	444	100	8334920
Total Selenium (Se)	mg/kg	<0.50	0.50	8334920
Total Silver (Ag)	mg/kg	0.067	0.050	8334920
Total Sodium (Na)	mg/kg	<100	100	8334920
Total Strontium (Sr)	mg/kg	19.2	0.10	8334920
Total Thallium (Tl)	mg/kg	<0.050	0.050	8334920
Total Tin (Sn)	mg/kg	0.24	0.10	8334920
Total Titanium (Ti)	mg/kg	84.4	1.0	8334920
Total Uranium (U)	mg/kg	0.750	0.050	8334920

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B657693
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Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		PA6597		
Sampling Date		2016/07/08		
COC Number		G109092		
	UNITS	SP16-02 SA1	RDL	QC Batch
Total Vanadium (V)	mg/kg	8.5	2.0	8334920
Total Zinc (Zn)	mg/kg	33.4	1.0	8334920
Total Zirconium (Zr)	mg/kg	<0.50	0.50	8334920
RDL = Reportable Detection Limit				

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Golder Associates
Client Project #: 1660221
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.3°C

[Split Report V2R 2016/08/05 SF] Reporting sample PA6597 seperately.
[Revision V3R SF] Added EPH/LEPH/HEPH results to sample PA6599

Results relate only to the items tested.

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Maxxam Job #: B657693
Report Date: 2016/08/05

QUALITY ASSURANCE REPORT

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8335127	D10-ANTHRACENE (sur.)	2016/07/20	89	60 - 130	84	60 - 130	95	%				
8335127	D8-ACENAPHTHYLENE (sur.)	2016/07/20	89	50 - 130	89	50 - 130	93	%				
8335127	D8-NAPHTHALENE (sur.)	2016/07/20	92	50 - 130	89	50 - 130	93	%				
8335127	TERPHENYL-D14 (sur.)	2016/07/20	93	60 - 130	92	60 - 130	104	%				
8335255	O-TERPHENYL (sur.)	2016/07/20	102	50 - 130	98	50 - 130	99	%				
8335658	1,4-Difluorobenzene (sur.)	2016/07/20	97	60 - 140	96	60 - 140	99	%				
8335658	4-Bromofluorobenzene (sur.)	2016/07/20	97	60 - 140	98	60 - 140	98	%				
8335658	D10-ETHYLBENZENE (sur.)	2016/07/20	104	60 - 130	89	60 - 130	98	%				
8335658	D4-1,2-Dichloroethane (sur.)	2016/07/20	100	60 - 140	102	60 - 140	104	%				
8337749	O-TERPHENYL (sur.)	2016/07/22	75	50 - 130	75	50 - 130	110	%				
8332510	Moisture	2016/07/20					<0.30	%	2.4	20		
8334920	Total Aluminum (Al)	2016/07/20					<100	mg/kg	2.3	35	104	70 - 130
8334920	Total Antimony (Sb)	2016/07/20	87	75 - 125	94	75 - 125	<0.10	mg/kg	13	30	106	70 - 130
8334920	Total Arsenic (As)	2016/07/20	96	75 - 125	95	75 - 125	<0.50	mg/kg	NC	30	77	70 - 130
8334920	Total Barium (Ba)	2016/07/20	NC	75 - 125	102	75 - 125	<0.10	mg/kg	3.3	35	99	70 - 130
8334920	Total Beryllium (Be)	2016/07/20	99	75 - 125	98	75 - 125	<0.40	mg/kg	NC	30	93	70 - 130
8334920	Total Bismuth (Bi)	2016/07/20					<0.10	mg/kg				
8334920	Total Cadmium (Cd)	2016/07/20	106	75 - 125	106	75 - 125	<0.050	mg/kg	7.8	30	118	70 - 130
8334920	Total Calcium (Ca)	2016/07/20					<100	mg/kg			103	70 - 130
8334920	Total Chromium (Cr)	2016/07/20	98	75 - 125	99	75 - 125	<1.0	mg/kg	15	30	110	70 - 130
8334920	Total Cobalt (Co)	2016/07/20	103	75 - 125	103	75 - 125	<0.30	mg/kg	4.4	30	98	70 - 130
8334920	Total Copper (Cu)	2016/07/20	NC	75 - 125	103	75 - 125	<0.50	mg/kg	17	30	116	70 - 130
8334920	Total Iron (Fe)	2016/07/20					<100	mg/kg			100	70 - 130
8334920	Total Lead (Pb)	2016/07/20	NC	75 - 125	104	75 - 125	<0.10	mg/kg	2.0	35	108	70 - 130
8334920	Total Lithium (Li)	2016/07/20	98	75 - 125	100	75 - 125	<5.0	mg/kg			101	70 - 130
8334920	Total Magnesium (Mg)	2016/07/20					<100	mg/kg			106	70 - 130
8334920	Total Manganese (Mn)	2016/07/20	NC	75 - 125	99	75 - 125	<0.20	mg/kg	1.3	30	104	70 - 130
8334920	Total Mercury (Hg)	2016/07/20	NC	75 - 125	100	75 - 125	<0.050	mg/kg	0.38	35	105	70 - 130
8334920	Total Molybdenum (Mo)	2016/07/20	99	75 - 125	100	75 - 125	<0.10	mg/kg	2.8	35	114	70 - 130
8334920	Total Nickel (Ni)	2016/07/20	98	75 - 125	101	75 - 125	<0.80	mg/kg	2.8	30	106	70 - 130

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Maxxam Job #: B657693
Report Date: 2016/08/05

QUALITY ASSURANCE REPORT(CONT'D)

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8334920	Total Phosphorus (P)	2016/07/20					<10	mg/kg			93	70 - 130
8334920	Total Potassium (K)	2016/07/20					<100	mg/kg			101	70 - 130
8334920	Total Selenium (Se)	2016/07/20	98	75 - 125	95	75 - 125	<0.50	mg/kg	NC	30		
8334920	Total Silver (Ag)	2016/07/20	97	75 - 125	98	75 - 125	<0.050	mg/kg	NC	35	86	70 - 130
8334920	Total Sodium (Na)	2016/07/20					<100	mg/kg			95	70 - 130
8334920	Total Strontium (Sr)	2016/07/20	NC	75 - 125	97	75 - 125	<0.10	mg/kg	2.2	35	103	70 - 130
8334920	Total Thallium (Tl)	2016/07/20	97	75 - 125	97	75 - 125	<0.050	mg/kg			89	70 - 130
8334920	Total Tin (Sn)	2016/07/20	NC	75 - 125	94	75 - 125	<0.10	mg/kg	16	35	90	70 - 130
8334920	Total Titanium (Ti)	2016/07/20	NC	75 - 125	99	75 - 125	<1.0	mg/kg	0.70	35		
8334920	Total Uranium (U)	2016/07/20	99	75 - 125	100	75 - 125	<0.050	mg/kg			105	70 - 130
8334920	Total Vanadium (V)	2016/07/20	NC	75 - 125	99	75 - 125	<2.0	mg/kg	6.2	30	101	70 - 130
8334920	Total Zinc (Zn)	2016/07/20	NC	75 - 125	100	75 - 125	<1.0	mg/kg	0.67	30	102	70 - 130
8334920	Total Zirconium (Zr)	2016/07/20					<0.50	mg/kg				
8334923	Soluble (2:1) pH	2016/07/20			100	97 - 103			0.32	N/A		
8335127	2-Methylnaphthalene	2016/07/20	85	50 - 130	92	50 - 130	<0.020	mg/kg	7.0	50		
8335127	Acenaphthene	2016/07/20	91	50 - 130	98	50 - 130	<0.0050	mg/kg	NC	50		
8335127	Acenaphthylene	2016/07/20	86	50 - 130	91	50 - 130	<0.0050	mg/kg	NC	50		
8335127	Anthracene	2016/07/20	84	60 - 130	84	60 - 130	<0.0040	mg/kg	NC	50		
8335127	Benzo(a)anthracene	2016/07/20	76	60 - 130	92	60 - 130	<0.020	mg/kg	NC	50		
8335127	Benzo(a)pyrene	2016/07/20	80	60 - 130	90	60 - 130	<0.020	mg/kg	NC	50		
8335127	Benzo(b&j)fluoranthene	2016/07/20	78	60 - 130	96	60 - 130	<0.020	mg/kg	NC	50		
8335127	Benzo(b)fluoranthene	2016/07/20	77	60 - 130	93	60 - 130	<0.020	mg/kg	NC	20		
8335127	Benzo(g,h,i)perylene	2016/07/20	80	60 - 130	84	60 - 130	<0.050	mg/kg	NC	50		
8335127	Benzo(k)fluoranthene	2016/07/20	86	60 - 130	94	60 - 130	<0.020	mg/kg	NC	50		
8335127	Chrysene	2016/07/20	78	60 - 130	97	60 - 130	<0.020	mg/kg	NC	50		
8335127	Dibenz(a,h)anthracene	2016/07/20	82	60 - 130	83	60 - 130	<0.050	mg/kg	NC	50		
8335127	Fluoranthene	2016/07/20	81	60 - 130	90	60 - 130	<0.020	mg/kg	NC	50		
8335127	Fluorene	2016/07/20	85	50 - 130	91	50 - 130	<0.020	mg/kg	NC	50		
8335127	Indeno(1,2,3-cd)pyrene	2016/07/20	84	60 - 130	87	60 - 130	<0.050	mg/kg	NC	50		
8335127	Naphthalene	2016/07/20	83	50 - 130	87	50 - 130	<0.010	mg/kg	4.7	50		

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QUALITY ASSURANCE REPORT(CONT'D)

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8335127	Phenanthrene	2016/07/20	83	60 - 130	92	60 - 130	<0.010	mg/kg	NC	50		
8335127	Pyrene	2016/07/20	81	60 - 130	90	60 - 130	<0.020	mg/kg	NC	50		
8335255	EPH (C10-C19)	2016/07/21	107	50 - 130	103	50 - 130	<100	mg/kg	NC	40		
8335255	EPH (C19-C32)	2016/07/21	101	50 - 130	105	50 - 130	<100	mg/kg	NC	40		
8335658	Benzene	2016/07/20	112	60 - 140	107	60 - 140	<0.0050	mg/kg	NC	40		
8335658	Ethylbenzene	2016/07/20	108	60 - 140	102	60 - 140	<0.010	mg/kg	NC	40		
8335658	F1 (C6-C10)	2016/07/20			92	60 - 140	<10	mg/kg	NC	40		
8335658	m & p-Xylene	2016/07/20	108	60 - 140	103	60 - 140	<0.040	mg/kg	NC	40		
8335658	Methyl-tert-butylether (MTBE)	2016/07/20					<0.10	mg/kg	NC	40		
8335658	o-Xylene	2016/07/20	104	60 - 140	99	60 - 140	<0.040	mg/kg	NC	40		
8335658	Styrene	2016/07/20					<0.030	mg/kg	NC	40		
8335658	Toluene	2016/07/20	104	60 - 140	98	60 - 140	<0.020	mg/kg	NC	40		
8335658	VH C6-C10	2016/07/20			97	60 - 140	<10	mg/kg				
8335658	Xylenes (Total)	2016/07/20					<0.040	mg/kg	NC	40		
8337749	F2 (C10-C16 Hydrocarbons)	2016/07/22	108	50 - 130	102	70 - 130	<10	mg/kg	NC	40		
8337749	F3 (C16-C34 Hydrocarbons)	2016/07/22	111	50 - 130	107	70 - 130	<10	mg/kg	0.77	40		
8337749	F4 (C34-C50 Hydrocarbons)	2016/07/22	98	70 - 130	91	70 - 130	<10	mg/kg	3.5	40		
8337749	Reached Baseline at C50	2016/07/22	YES	N/A	YES	N/A	YES	mg/kg	NC	50		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Report Date: 2016/08/05

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Ph.D., P.Chem., Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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CHAIN-OF-CUSTODY RECORD

G 109092

BBY FCD-00077/05
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Invoice Information		Report Information		Project Information	
Company Name:	#17166 Public Works and Government Services	Company Name:	#34523 Golder Assoc.	Quotation #:	B51141
Contact Name:	Jordan Stones	Contact Name:	Pana Athanasopoulos	P.O. #/AFE#:	
Address:	641-800 Burrard Street Vancouver BC V6Z 2V8	Address:	300-590 McKay Ave. Kelowna BC V1Y 5A8	Project #:	1660221
Phone:	604-775-6810	Phone:	250 860 8424	Site Location:	Rogers Pass
Email:	Jordan.Stones@PWGSC-TPSGC.gc.ca	Email:	PAthanasopoulos@golder.com	Sampled By:	KT

Regulatory Criteria: ☐ BC CSR Soil ☐ BC CSR Water ☒ CCME (Specify) ☐ Other (Specify) ☐ Drinking Water ☐ BC Water Quality

Special Instructions: ☐ Return Cooler ☐ Ship Sample Bottles (Please Specify)

#	Sample Identification	Lab Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	Comments
1	SP16-02 SA1		8July16		Soil	Pana will
2	TP16-04 SA1		↓		↓	contact the
3	↓ SA2		↓		↓	lab with
4	↓ SA3		↓		↓	analyses
5	TP16-04 SAA		↓		↓	
6	TP16-05 SA1		↓		↓	
7	↓ SA2		↓		↓	
8	↓ SA3		↓		↓	
9	↓ SA4		↓		↓	
10	TP16-05 SA5		8July16		Soil	

Relinquished By (Signature/Print)	Date (YYYY/MM/DD)	Time (HH:MM)	Received By (Signature/Print)	Date (YYYY/MM/DD)	Time (HH:MM)
[signature] Ndonaira	11July16	16:00	[signature]	2016/07/13	10:45

COC-1020

B657693_COC

G 109091

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CHAIN OF CUSTODY RECORD

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5, Toll Free (800) 665-8566

BBY PCD-00077/05
Page 2 of 2

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: #7996 Public Works and Government Services	Company Name: 554523 Golder Assoc.	Quotation #: B51141	Regular (R) if no TAT specified
Contact Name: Jordan Stooks	Contact Name: Pana Athanasopoulos	P.O. #/ AFE#:	
Address: 641 - 800 Burrard Str Vancouver BC V6Z 2V8	Address: 300-940 Blvd Ave. Kelowna BC V1Y 5A8	Project #: 166022	TAT (Turnaround Time) Requested
Phone: (604) 775 6810	Phone: 250 860 8484	Site Location: ROGERS PASS	Rush TAT (Surcharges will be applied)
Email: Jordan.Stooks@PWGSC-TBEC.gc.ca	Email: AthanasopoulosC@Golder.com	Site #:	Same Day / 2 Days / 3 Days / 5 Days
		Sampled By: KIT	Date Required:

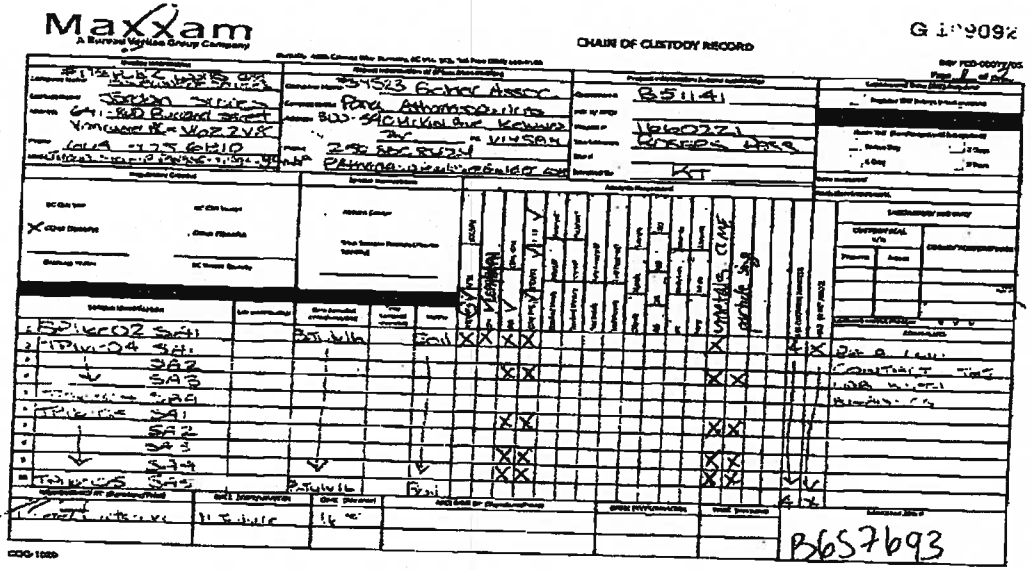
Regulatory Criteria	Special Instructions
BC CSR Soil / BC CSR Water / CCME (Specify) / Other (Specify) / Drinking Water / BC Water Quality	Return Cooler / Ship Sample Bottles (Please Specify)

Analysis Requested

	Sample Identification	Lab Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	COMMENTS
1	TP16-05 SAA		2016/07/11		Soil	PANA WILL CONTACT THE LAB
2						
3						
4						
5						
6						
7						
8						
9						
10						

SAMPLED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
Kit Kromka	11 July 16	16:00	Laurel Strathmore	2016/07/13	08:45	B657693_COC

COC-1020


MaxXam
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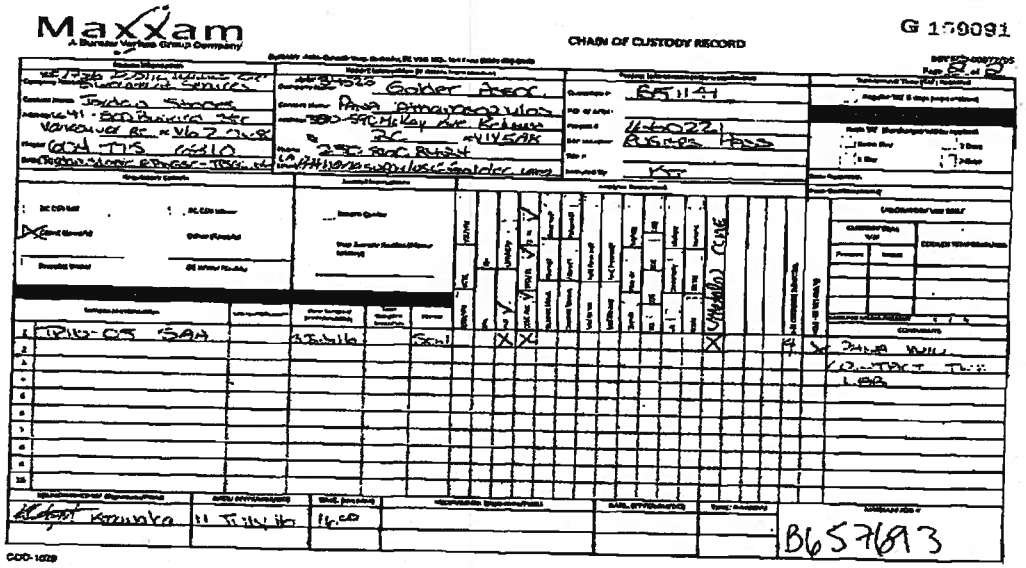
CHAIN OF CUSTODY RECORD
B657693


Maxxam
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CHAIN OF CUSTODY RECORD
G 159091
B657693
COC-1029

Maxxam
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Success Through Science

Your P.O. #: 700359843
Your Project #: 1660221
Site#: ROGERS PASS
Site Location: PC Rogers Pass
Your C.O.C. #: 499278-01-01, 499278-02-01

Attention:Pana Athanasopoulos

Golder Associates
Suite 300
590 McKay Avenue
Kelowna, BC
Canada V1Y 5A8

Report Date: 2016/08/09
Report #: R2232836
Version: 4 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B655649
Received: 2016/07/07, 08:35

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE LH VH F1 in Soil - Field Pres. (1)	1	N/A	2016/07/12	BBY8SOP-00010,	EPA 8260c R3 m
Volatile F1-BTEX	1	N/A	2016/07/13	BBY WI-00033	Auto Calc
CCME Hydrocarbons (F2-F4 in soil) (2)	1	2016/07/09	2016/07/13	BBY8SOP-00030	CCME PHC-CWS
Elements by ICPMS (total)	1	2016/07/11	2016/07/11	BBY7SOP-00017,	BC SALM,EPA 6020bR2m
Moisture	1	2016/07/09	2016/07/11	BBY8SOP-00017	BCMOE BCLM Dec2000 m
PAH in Soil by GC/MS (SIM) - CCME	1	2016/07/09	2016/07/12	BBY8SOP-00022	EPA 8270d R4 m
Index of Additive Cancer Risk Calc.	1	N/A	2016/07/13	BBY WI-00033	Auto Calc
Total PAH and B(a)P Calculation	1	N/A	2016/07/13	BBY WI-00033	Auto Calc
pH (2:1 DI Water Extract)	1	2016/07/11	2016/07/11	BBY6SOP-00028	BCMOE BCLM Mar200S m
EPH less PAH in Soil By GC/FID	1	N/A	2016/07/21	BBY WI-00033	Auto Calc
EPH in Soil by GC/FID	1	2016/07/20	2016/07/20	BBY8SOP-00029	BCMOE EPH s 07/99 m
Volatile HC-BTEX for Soil	1	N/A	2016/07/21	BBY WI-00033	Auto Calc

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The extraction date for VOC, BTEX, VH, or F1 samples that are field preserved with methanol equals the date sampled, unless otherwise stated.

(2) All CCME results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Samantha Fregien, Project Manager
Email: SFregien@maxxam.ca
Phone# (604)639-8418

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam
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Success Through Science

Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Ext. Pet. Hydrocarbon				
F2 (C10-C16 Hydrocarbons)	mg/kg	18	10	8326595
F3 (C16-C34 Hydrocarbons)	mg/kg	440	10	8326595
F4 (C34-C50 Hydrocarbons)	mg/kg	210	10	8326595
Reached Baseline at C50	mg/kg	Yes	N/A	8326595
Surrogate Recovery (%)				
O-TERPHENYL (sur.)	%	83		8326595

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

PHYSICAL TESTING (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Physical Properties				
Moisture	%	9.3	0.30	8324680
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CCME BTEX/F1IN SOIL - FIELD PRESERVED (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:1S		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Calculated Parameters				
F1 (C6-C10) - BTEX	mg/kg	<10	10	8324259
Volatiles				
Methyl-tert-butylether (MTBE)	mg/kg	<0.10	0.10	8326793
Benzene	mg/kg	0.057	0.0050	8326793
Toluene	mg/kg	0.20	0.020	8326793
Ethylbenzene	mg/kg	0.049	0.010	8326793
m & p-Xylene	mg/kg	0.19	0.040	8326793
o-Xylene	mg/kg	0.047	0.040	8326793
Styrene	mg/kg	<0.030	0.030	8326793
Xylenes (Total)	mg/kg	0.24	0.040	8326793
VH C6-C10	mg/kg	<10	10	8326793
F1 (C6-C10)	mg/kg	<10	10	8326793
Surrogate Recovery (%)				
1,4-Difluorobenzene (sur.)	%	95		8326793
4-Bromofluorobenzene (sur.)	%	103		8326793
D10-ETHYLBENZENE (sur.)	%	109		8326793
D4-1,2-Dichloroethane (sur.)	%	111		8326793
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CCME&CSR BTX/F1/VPH IN SOIL - FIELD PRES (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Volatiles				
VPH (VH6 to 10 - BTEX)	mg/kg	<10	10	8331857
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

LEPH & HEPH WITH PAH FOR CCME IN SOIL (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	**SP16-01**	**RDL**	**QC Batch**
Calculated Parameters				
Index of Additive Cancer Risk(IARC)	N/A	1.5	0.10	8324260
Polycyclic Aromatics				
Naphthalene	mg/kg	0.096	0.010	8326580
2-Methylnaphthalene	mg/kg	0.16	0.020	8326580
Acenaphthylene	mg/kg	0.0074	0.0050	8326580
Acenaphthene	mg/kg	0.0085	0.0050	8326580
Fluorene	mg/kg	0.020	0.020	8326580
Phenanthrene	mg/kg	0.23	0.010	8326580
Anthracene	mg/kg	0.037	0.0040	8326580
Fluoranthene	mg/kg	0.20	0.020	8326580
Pyrene	mg/kg	0.18	0.020	8326580
Benzo(a)anthracene	mg/kg	0.082	0.020	8326580
Chrysene	mg/kg	0.12	0.020	8326580
Benzo(b&j)fluoranthene	mg/kg	0.11	0.020	8326580
Benzo(b)fluoranthene	mg/kg	0.071	0.020	8326580
Benzo(k)fluoranthene	mg/kg	0.033	0.020	8326580
Benzo(a)pyrene	mg/kg	0.075	0.020	8326580
Indeno(1,2,3-cd)pyrene	mg/kg	<0.050	0.050	8326580
Dibenz(a,h)anthracene	mg/kg	<0.050	0.050	8326580
Benzo(g,h,i)perylene	mg/kg	0.060	0.050	8326580
Low Molecular Weight PAH`s	mg/kg	0.56	0.050	8323549
High Molecular Weight PAH`s	mg/kg	0.86	0.050	8323549
Total PAH	mg/kg	1.4	0.050	8323549
Benzo[a]pyrene equivalency	mg/kg	0.13	0.010	8323549
Calculated Parameters				
LEPH (C10-C19 less PAH)	mg/kg	<100	100	8331856
HEPH (C19-C32 less PAH)	mg/kg	470	100	8331856
Hydrocarbons				
EPH (C10-C19)	mg/kg	<100	100	8335255
EPH (C19-C32)	mg/kg	470	100	8335255
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

LEPH & HEPH WITH PAH FOR CCME IN SOIL (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	86		8326580
D8-ACENAPHTHYLENE (sur.)	%	78		8326580
D8-NAPHTHALENE (sur.)	%	80		8326580
TERPHENYL-D14 (sur.)	%	87		8326580
O-TERPHENYL (sur.)	%	96		8335255
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	SP16-01	RDL	QC Batch
Physical Properties				
Soluble (2:1) pH	pH	7.91	N/A	8325305
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	6830	100	8325302
Total Antimony (Sb)	mg/kg	0.26	0.10	8325302
Total Arsenic (As)	mg/kg	3.64	0.50	8325302
Total Barium (Ba)	mg/kg	37.5	0.10	8325302
Total Beryllium (Be)	mg/kg	<0.40	0.40	8325302
Total Bismuth (Bi)	mg/kg	0.16	0.10	8325302
Total Cadmium (Cd)	mg/kg	0.086	0.050	8325302
Total Calcium (Ca)	mg/kg	7020	100	8325302
Total Chromium (Cr)	mg/kg	16.3	1.0	8325302
Total Cobalt (Co)	mg/kg	9.26	0.30	8325302
Total Copper (Cu)	mg/kg	18.4	0.50	8325302
Total Iron (Fe)	mg/kg	22000	100	8325302
Total Lead (Pb)	mg/kg	11.6	0.10	8325302
Total Lithium (Li)	mg/kg	15.1	5.0	8325302
Total Magnesium (Mg)	mg/kg	5240	100	8325302
Total Manganese (Mn)	mg/kg	420	0.20	8325302
Total Mercury (Hg)	mg/kg	<0.050	0.050	8325302
Total Molybdenum (Mo)	mg/kg	0.36	0.10	8325302
Total Nickel (Ni)	mg/kg	24.1	0.80	8325302
Total Phosphorus (P)	mg/kg	274	10	8325302
Total Potassium (K)	mg/kg	311	100	8325302
Total Selenium (Se)	mg/kg	<0.50	0.50	8325302
Total Silver (Ag)	mg/kg	<0.050	0.050	8325302
Total Sodium (Na)	mg/kg	<100	100	8325302
Total Strontium (Sr)	mg/kg	17.8	0.10	8325302
Total Thallium (Tl)	mg/kg	<0.050	0.050	8325302
Total Tin (Sn)	mg/kg	0.32	0.10	8325302
Total Titanium (Ti)	mg/kg	46.1	1.0	8325302

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		OZ5337		
Sampling Date		2016/07/04 14:15		
COC Number		499278-02-01		
	UNITS	**SP16-01**	**RDL**	**QC Batch**
Total Uranium (U)	mg/kg	0.845	0.050	8325302
Total Vanadium (V)	mg/kg	8.7	2.0	8325302
Total Zinc (Zn)	mg/kg	38.6	1.0	8325302
Total Zirconium (Zr)	mg/kg	0.54	0.50	8325302
RDL = Reportable Detection Limit				

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.7°C

[Revised Report V2R, M_S, 2016/07/22] Additional analytical parameters included in this report.
[Split Report V3R, SF, 2016/08/05] Reporting sample OZ5337 seperately
[Revision V4R SF] Reporting EPH/LEPH/HEPH results of samples OZ5313 and OZ5317

Results relate only to the items tested.

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Maxxam Job #: B655649
Report Date: 2016/08/09

QUALITY ASSURANCE REPORT

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8326580	D10-ANTHRACENE (sur.)	2016/07/12	81	60 - 130	85	60 - 130	89	%				
8326580	D8-ACENAPHTHYLENE (sur.)	2016/07/12	82	50 - 130	81	50 - 130	84	%				
8326580	D8-NAPHTHALENE (sur.)	2016/07/12	83	50 - 130	79	50 - 130	82	%				
8326580	TERPHENYL-D14 (sur.)	2016/07/12	86	60 - 130	85	60 - 130	93	%				
8326595	O-TERPHENYL (sur.)	2016/07/12	78	50 - 130	68	50 - 130	107	%				
8326793	1,4-Difluorobenzene (sur.)	2016/07/12	95	60 - 140	94	60 - 140	95	%				
8326793	4-Bromofluorobenzene (sur.)	2016/07/12	102	60 - 140	103	60 - 140	101	%				
8326793	D10-ETHYLBENZENE (sur.)	2016/07/12	114	60 - 130	100	60 - 130	109	%				
8326793	D4-1,2-Dichloroethane (sur.)	2016/07/12	116	60 - 140	108	60 - 140	111	%				
8335255	O-TERPHENYL (sur.)	2016/07/20	102	50 - 130	98	50 - 130	99	%				
8324680	Moisture	2016/07/11					<0.30	%	6.3	20		
8325302	Total Aluminum (Al)	2016/07/11					<100	mg/kg	0.0081	35	95	70 - 130
8325302	Total Antimony (Sb)	2016/07/11	82	75 - 125	93	75 - 125	<0.10	mg/kg	4.1	30	110	70 - 130
8325302	Total Arsenic (As)	2016/07/11	97	75 - 125	96	75 - 125	<0.50	mg/kg	1.2	30	92	70 - 130
8325302	Total Barium (Ba)	2016/07/11	NC	75 - 125	95	75 - 125	<0.10	mg/kg	0.33	35	96	70 - 130
8325302	Total Beryllium (Be)	2016/07/11	102	75 - 125	99	75 - 125	<0.40	mg/kg	NC	30	107	70 - 130
8325302	Total Bismuth (Bi)	2016/07/11					<0.10	mg/kg	NC	30		
8325302	Total Cadmium (Cd)	2016/07/11	102	75 - 125	102	75 - 125	<0.050	mg/kg	3.6	30	117	70 - 130
8325302	Total Calcium (Ca)	2016/07/11					<100	mg/kg	3.0	30	99	70 - 130
8325302	Total Chromium (Cr)	2016/07/11	NC	75 - 125	98	75 - 125	<1.0	mg/kg	1.9	30	101	70 - 130
8325302	Total Cobalt (Co)	2016/07/11	93	75 - 125	100	75 - 125	<0.30	mg/kg	0.16	30	98	70 - 130
8325302	Total Copper (Cu)	2016/07/11	NC	75 - 125	96	75 - 125	<0.50	mg/kg	1.9	30	103	70 - 130
8325302	Total Iron (Fe)	2016/07/11					<100	mg/kg	1.1	30	98	70 - 130
8325302	Total Lead (Pb)	2016/07/11	95	75 - 125	95	75 - 125	<0.10	mg/kg	0.18	35	103	70 - 130
8325302	Total Lithium (Li)	2016/07/11	97	75 - 125	96	75 - 125	<5.0	mg/kg	NC	30	98	70 - 130
8325302	Total Magnesium (Mg)	2016/07/11					<100	mg/kg	0.20	30	99	70 - 130
8325302	Total Manganese (Mn)	2016/07/11	NC	75 - 125	98	75 - 125	<0.20	mg/kg	3.6	30	98	70 - 130
8325302	Total Mercury (Hg)	2016/07/11	101	75 - 125	100	75 - 125	<0.050	mg/kg	NC	35	110	70 - 130
8325302	Total Molybdenum (Mo)	2016/07/11	97	75 - 125	92	75 - 125	<0.10	mg/kg	1.4	35	110	70 - 130
8325302	Total Nickel (Ni)	2016/07/11	NC	75 - 125	96	75 - 125	<0.80	mg/kg	3.7	30	105	70 - 130

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Maxxam Job #: B655649
Report Date: 2016/08/09

QUALITY ASSURANCE REPORT(CONT'D)

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8325302	Total Phosphorus (P)	2016/07/11					<10	mg/kg	2.2	30	97	70 - 130
8325302	Total Potassium (K)	2016/07/11					<100	mg/kg	2.0	35	88	70 - 130
8325302	Total Selenium (Se)	2016/07/11	101	75 - 125	105	75 - 125	<0.50	mg/kg	NC	30		
8325302	Total Silver (Ag)	2016/07/11	95	75 - 125	97	75 - 125	<0.050	mg/kg	NC	35	91	70 - 130
8325302	Total Sodium (Na)	2016/07/11					<100	mg/kg	NC	35	90	70 - 130
8325302	Total Strontium (Sr)	2016/07/11	NC	75 - 125	89	75 - 125	<0.10	mg/kg	0.12	35	98	70 - 130
8325302	Total Thallium (Tl)	2016/07/11	NC	75 - 125	94	75 - 125	<0.050	mg/kg	0.27	30	93	70 - 130
8325302	Total Tin (Sn)	2016/07/11	85	75 - 125	84	75 - 125	<0.10	mg/kg	1.5	35	89	70 - 130
8325302	Total Titanium (Ti)	2016/07/11	NC	75 - 125	94	75 - 125	<1.0	mg/kg	3.1	35		
8325302	Total Uranium (U)	2016/07/11	96	75 - 125	94	75 - 125	<0.050	mg/kg	1.3	30	131 (1)	70 - 130
8325302	Total Vanadium (V)	2016/07/11	NC	75 - 125	98	75 - 125	<2.0	mg/kg	1.1	30	100	70 - 130
8325302	Total Zinc (Zn)	2016/07/11	NC	75 - 125	105	75 - 125	<1.0	mg/kg	1.2	30	107	70 - 130
8325302	Total Zirconium (Zr)	2016/07/11					<0.50	mg/kg	0.75	30		
8325305	Soluble (2:1) pH	2016/07/11			101	97 - 103			0.12	N/A		
8326580	2-Methylnaphthalene	2016/07/12	77	50 - 130	79	50 - 130	<0.020	mg/kg	NC	50		
8326580	Acenaphthene	2016/07/12	81	50 - 130	84	50 - 130	<0.0050	mg/kg	NC	50		
8326580	Acenaphthylene	2016/07/12	75	50 - 130	79	50 - 130	<0.0050	mg/kg	NC	50		
8326580	Anthracene	2016/07/12	73	60 - 130	84	60 - 130	<0.0040	mg/kg	NC	50		
8326580	Benzo(a)anthracene	2016/07/12	71	60 - 130	72	60 - 130	<0.020	mg/kg	NC	50		
8326580	Benzo(a)pyrene	2016/07/12	73	60 - 130	75	60 - 130	<0.020	mg/kg	NC	50		
8326580	Benzo(b&j)fluoranthene	2016/07/12	75	60 - 130	79	60 - 130	<0.020	mg/kg	NC	50		
8326580	Benzo(b)fluoranthene	2016/07/12	71	60 - 130	76	60 - 130	<0.020	mg/kg	NC	20		
8326580	Benzo(g,h,i)perylene	2016/07/12	77	60 - 130	74	60 - 130	<0.050	mg/kg	NC	50		
8326580	Benzo(k)fluoranthene	2016/07/12	73	60 - 130	74	60 - 130	<0.020	mg/kg	NC	50		
8326580	Chrysene	2016/07/12	74	60 - 130	75	60 - 130	<0.020	mg/kg	NC	50		
8326580	Dibenz(a,h)anthracene	2016/07/12	78	60 - 130	77	60 - 130	<0.050	mg/kg	NC	50		
8326580	Fluoranthene	2016/07/12	74	60 - 130	82	60 - 130	<0.020	mg/kg	NC	50		
8326580	Fluorene	2016/07/12	75	50 - 130	79	50 - 130	<0.020	mg/kg	NC	50		
8326580	Indeno(1,2,3-cd)pyrene	2016/07/12	79	60 - 130	77	60 - 130	<0.050	mg/kg	NC	50		
8326580	Naphthalene	2016/07/12	74	50 - 130	76	50 - 130	<0.010	mg/kg	NC	50		

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Maxxam Job #: B655649
Report Date: 2016/08/09

QUALITY ASSURANCE REPORT(CONT'D)

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8326580	Phenanthrene	2016/07/12	74	60 - 130	77	60 - 130	<0.010	mg/kg	NC	50		
8326580	Pyrene	2016/07/12	74	60 - 130	81	60 - 130	<0.020	mg/kg	NC	50		
8326595	F2 (C10-C16 Hydrocarbons)	2016/07/12	99	50 - 130	100	70 - 130	<10	mg/kg	NC	40		
8326595	F3 (C16-C34 Hydrocarbons)	2016/07/12	101	50 - 130	103	70 - 130	<10	mg/kg	NC	40		
8326595	F4 (C34-C50 Hydrocarbons)	2016/07/12	87	70 - 130	95	70 - 130	<10	mg/kg	NC	40		
8326595	Reached Baseline at C50	2016/07/12					YES	mg/kg	NC	50		
8326793	Benzene	2016/07/13	128	60 - 140	115	60 - 140	<0.0050	mg/kg	NC	40		
8326793	Ethylbenzene	2016/07/13	130	60 - 140	124	60 - 140	<0.010	mg/kg	8.2	40		
8326793	F1 (C6-C10)	2016/07/12			89	60 - 140	<10	mg/kg				
8326793	m & p-Xylene	2016/07/13	128	60 - 140	121	60 - 140	<0.040	mg/kg	NC	40		
8326793	Methyl-tert-butylether (MTBE)	2016/07/13					<0.10	mg/kg	NC	40		
8326793	o-Xylene	2016/07/13	125	60 - 140	120	60 - 140	<0.040	mg/kg	NC	40		
8326793	Styrene	2016/07/13					<0.030	mg/kg	NC	40		
8326793	Toluene	2016/07/13	127	60 - 140	116	60 - 140	<0.020	mg/kg	0.82	40		
8326793	VH C6-C10	2016/07/13			86	60 - 140	<10	mg/kg	NC	40		
8326793	Xylenes (Total)	2016/07/13					<0.040	mg/kg	1.9	40		
8335255	EPH (C10-C19)	2016/07/21	107	50 - 130	103	50 - 130	<100	mg/kg	NC	40		
8335255	EPH (C19-C32)	2016/07/21	101	50 - 130	105	50 - 130	<100	mg/kg	NC	40		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Reference Material exceeds acceptance criteria for U. 10% of analytes failure in multielement scan is allowed.

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Maxxam Job #: B655649
Report Date: 2016/08/09

Golder Associates
Client Project #: 1660221
Site Location: PC Rogers Pass
Your P.O. #: 700359843
Sampler Initials: KT

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Ph.D., P.Chem., Scientific Specialist

Rob Reinert, B.Sc., Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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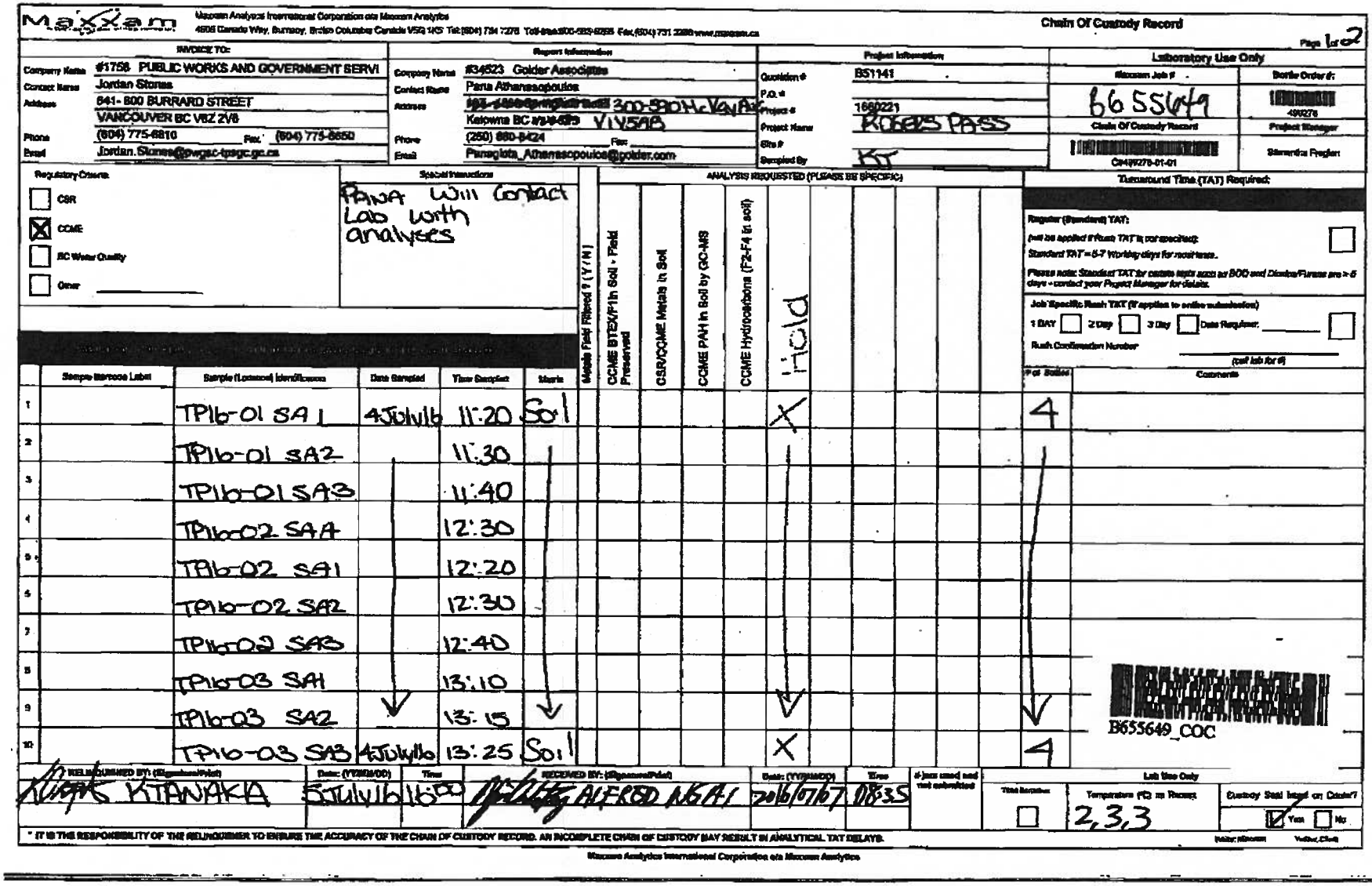

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Chain Of Custody Record

Page 1 of 2

INVOICE TO:
Company Name: #1758 PUBLIC WORKS AND GOVERNMENT SERVI
Contact Name: Jordan Stones
Address: 841- 800 BURRARD STREET VANCOUVER BC V6Z 2V8
Phone: (604) 775-6810 Fax: (604) 775-6650
Email: Jordan.Stones@pwgsc-tpsgc.gc.ca

Report Information
Company Name: #34523 Golder Associates
Contact Name: Pana Athanasopoulos
Address: 300-590 Harvey Ave Kelowna BC V1Y5A8
Phone: (250) 860-8424 Fax:
Email: Panaglota_Athanasopoulos@golder.com

Project Information
Quotation #: BS1141
P.O. #:
Project #: 1660221
Project Name: ROGERS PASS
Site #:
Sampled By: KT

Laboratory Use Only
Maxxam Job #: B655649
Bottle Order #: 499276
Chain Of Custody Record: C#499276-01-01
Project Manager: Simendra Pregen

Regulatory Criteria
- [ ] CSR
- [x] CCME
- [ ] BC Water Quality
- [ ] Other

Special Instructions
PANA Will Contact Lab with analyses

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Metals Field Filtered ? (Y/N)	CCME BTEX/F1in Soil - Field Preserved	CSR/CCME Metals in Soil	CCME PAH in Soil by GC-MS	CCME Hydrocarbons (F2-F4 in soil)	Hold						# of Bottles	Comments
1		TP16-01 SA1	4JULY16	11:20	Soil						X						4	
2		TP16-01 SA2		11:30														
3		TP16-01 SA3		11:40														
4		TP16-02 SA4		12:30														
5		TP16-02 SA1		12:20														
6		TP16-02 SA2		12:30														
7		TP16-02 SA3		12:40														
8		TP16-03 SA1		13:10														
9		TP16-03 SA2		13:15														
10		TP16-03 SA3	4JULY16	13:25	Soil						X						4	

Turnaround Time (TAT) Required:
Regular (Standard) TAT:
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.
Job Specific Rush TAT (If applies to entire submission)
1 DAY [ ] 2 Day [ ] 3 Day [ ] Date Required: _____
Rush Confirmation Number: _____ (call lab for #)

B655649_COC

RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
KIRK KITANAKA	5JULY16	16:00	ALFRED MGAI	2016/07/07	08:35		[ ]	2,3,3	[x] Yes [ ] No

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

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Chain Of Custody Record

Page 2 of 2

Invoice To:		Report Information		Project Information	
Company Name	#1756 PUBLIC WORKS AND GOVERNMENT SERVI	Company Name	#34523 Golder Associates	Quotation #	B61141
Contact Name	Jordan Stones	Contact Name	Pana Athanasopoulos	P.O. #	
Address	641-800 BURRARD STREET	Address	[illegible] 300-590 McKay AVE	Project #	1660221
	VANCOUVER BC V6Z 2V8		Kelowna BC V1Y 5V5	Project Name	ROGERS PASS
Phone	(604) 775-6810 Fax: (604) 775-6650	Phone	(250) 860-8424 Fax:	Site #	
Email	Jordan.Stones@pwgsc-tpsgc.gc.ca	Email	Panagiota_Athanasopoulos@golder.com	Sampled By	KT

Laboratory Use Only

Maxxam Job #	Bottle Order #:
B655649	488278
Chain Of Custody Record	Project Manager
C#488278-02-01	Savannah Raghan

Regulatory Criteria

- [ ] CSR
- [x] CCME
- [ ] BC Water Quality
- [ ] Other ________

Special Instructions: PANA WILL CONTACT LAB with analyses.

Turnaround Time (TAT) Required:

Regular (Standard) TAT: (will be applied if Rush TAT is not specified). Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission): 1 DAY ☐ 2 Day ☐ 3 Day ☐ Date Required: ________

Rush Confirmation Number: ________ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Metals Field Filtered ? (Y / N)	CCME BTEX/F1 in Soil - Field Preserved	CSR/CCME Metals in Soil	CCME PAH in Soil by GC-MS	CCME Hydrocarbons (F2-F4 in soil)	Hold						# of Bottles	Comments
1		SP16-01	4Jul16	14:15	Soil		X	X	X	X							4	
2		TP16-01SA4	4Jul16	11:50	Soil						X						2	
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
K Tanaka	5Jul16	16:00	ALFRED NGAI	2016/07/07	08:35	

Lab Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
☐	2,3,3	[x] Yes [ ] No

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

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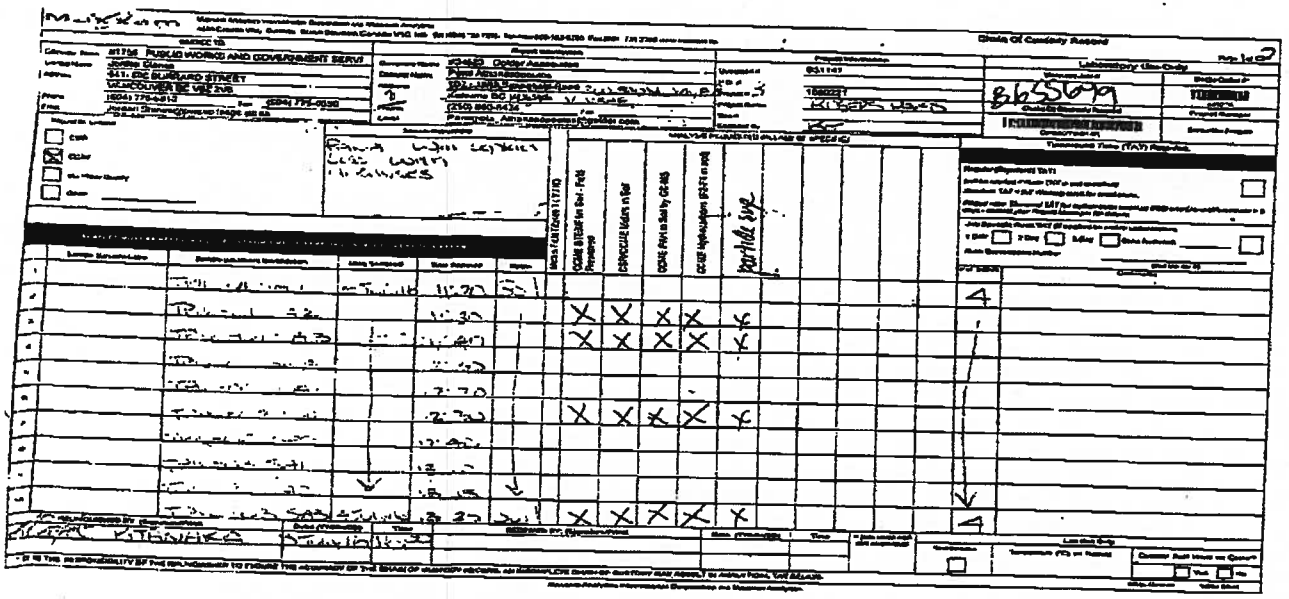
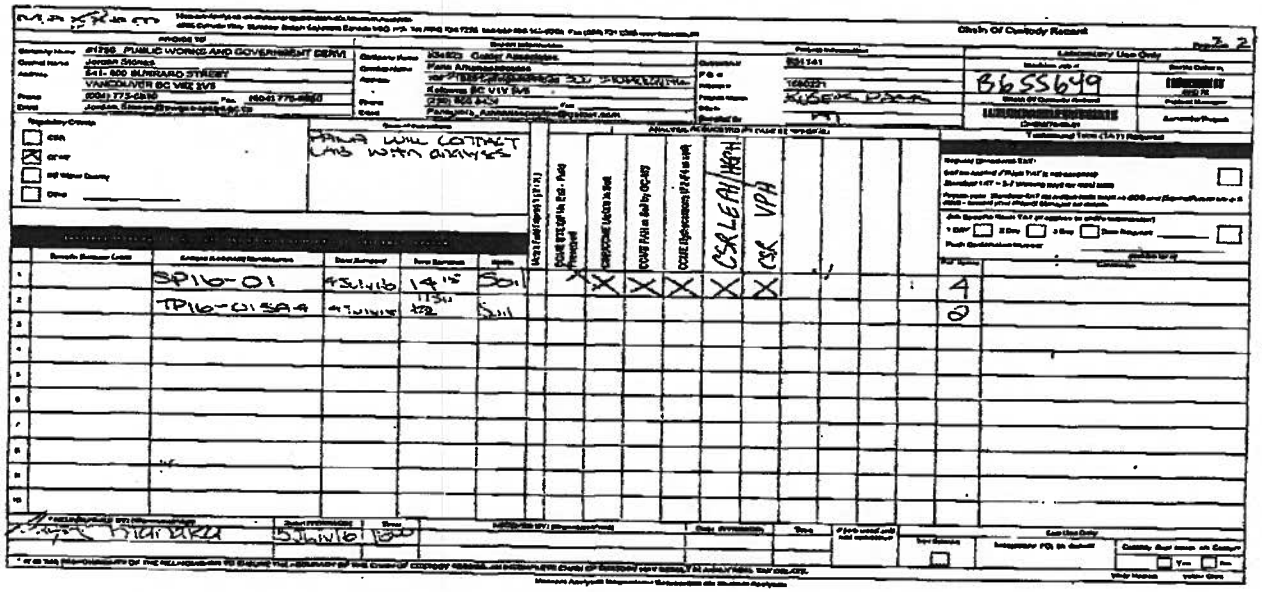
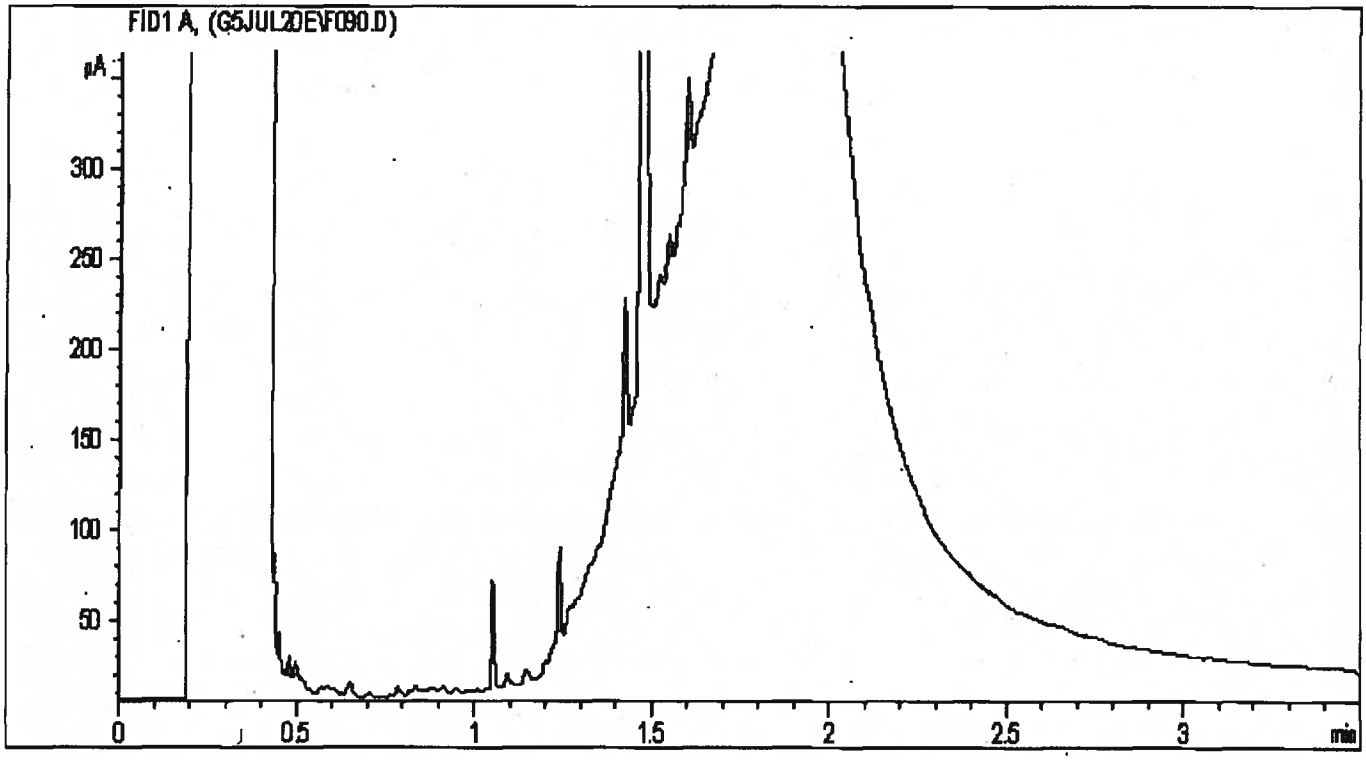
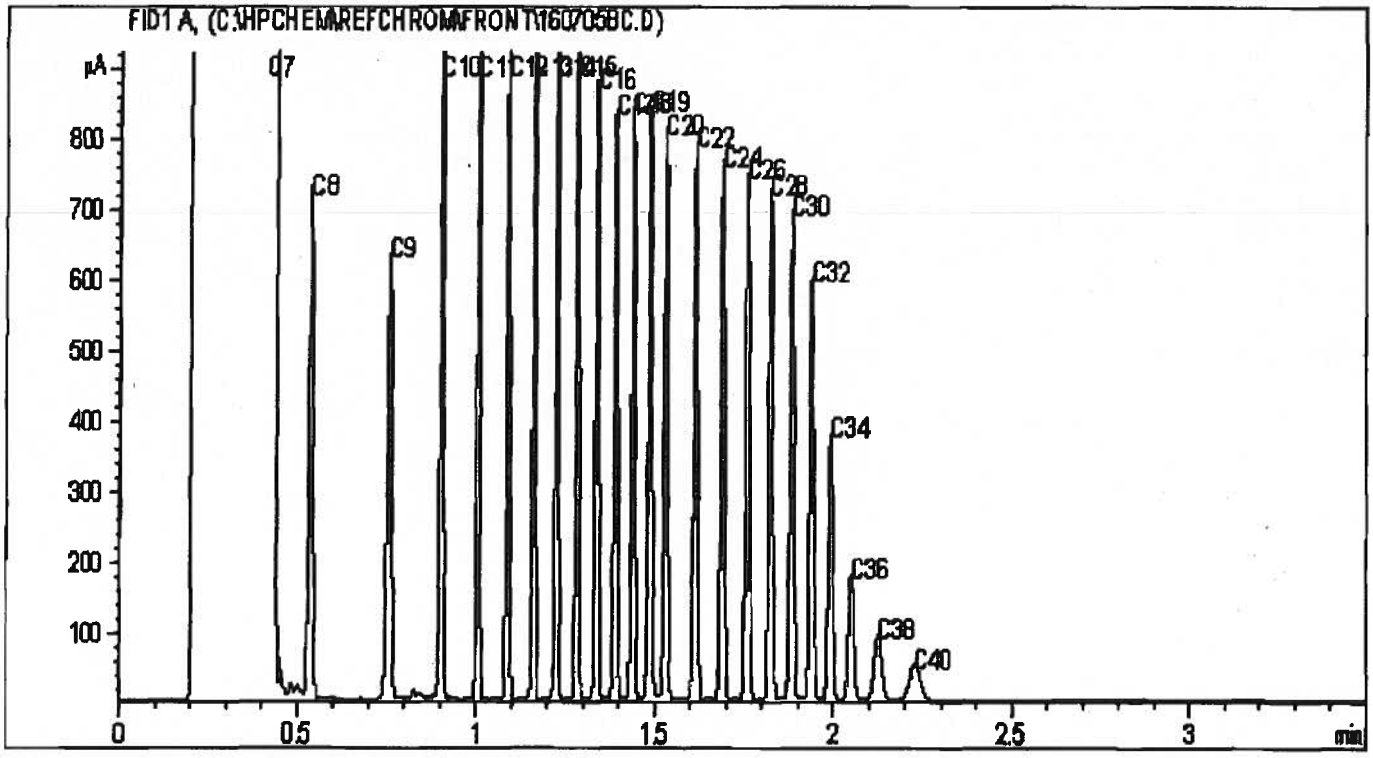


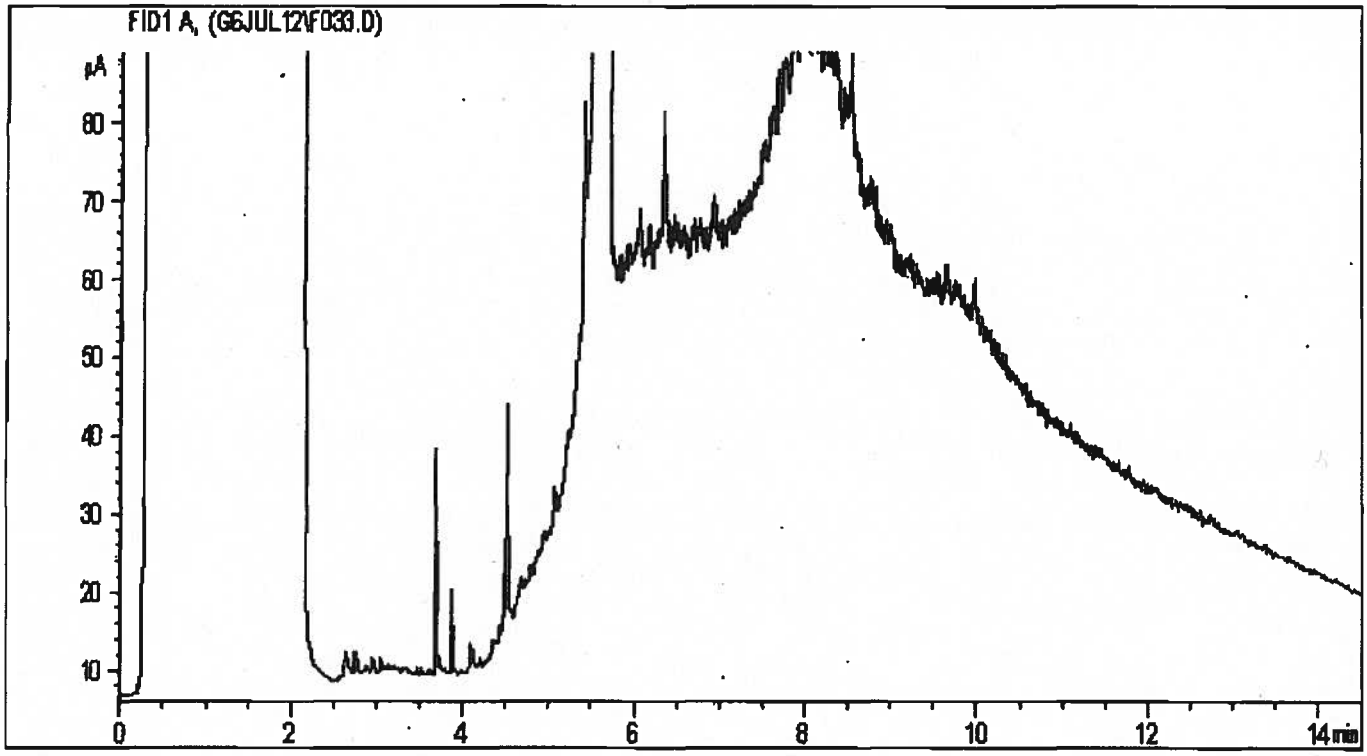

Chain Of Custody Record
#1755 PUBLIC WORKS AND GOVERNMENT SERVI
Jordan Stones
541- 600 BURRARD STREET
VANCOUVER BC V6C 2V8
(604) 775-0636
Laboratory Use Only
B655649
SP16-01
TP16-01
CSR LEAD/ARSENIC
CSR VPH



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES



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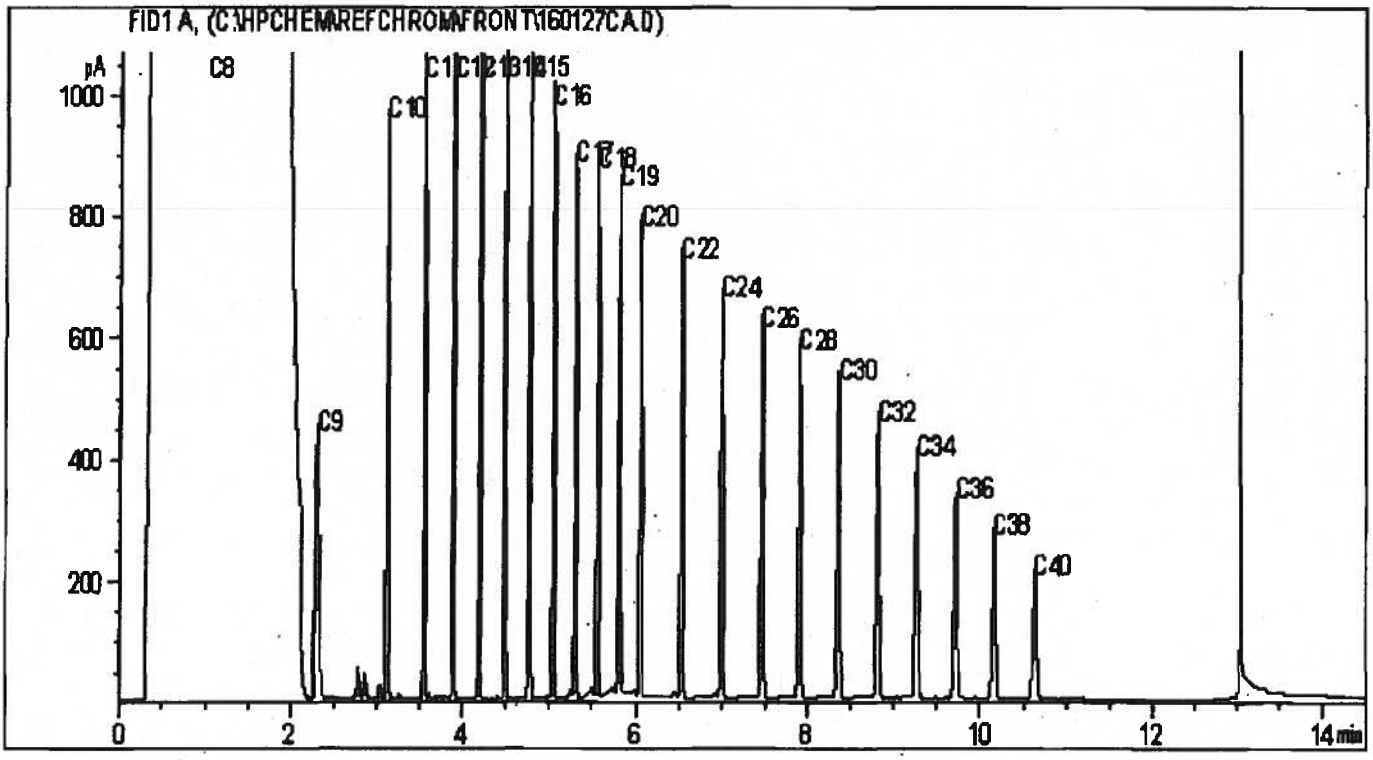
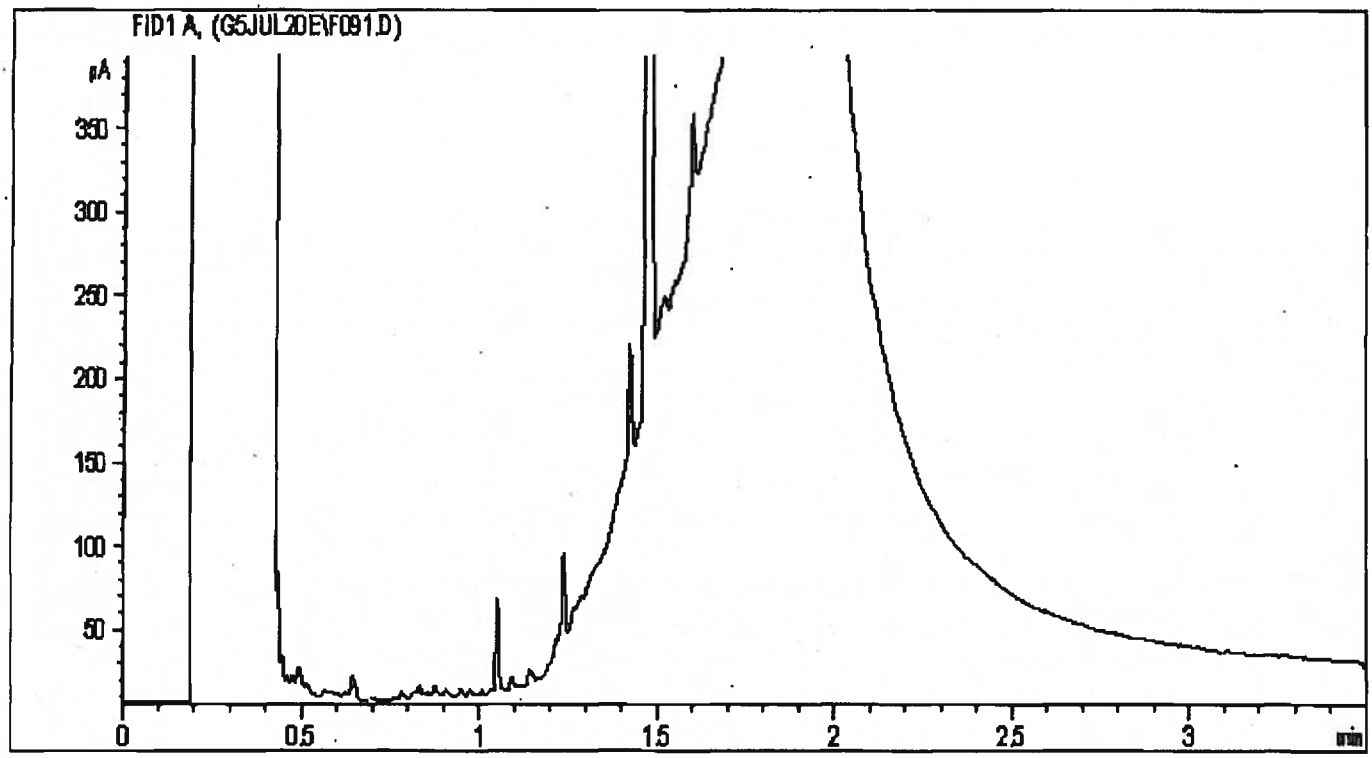
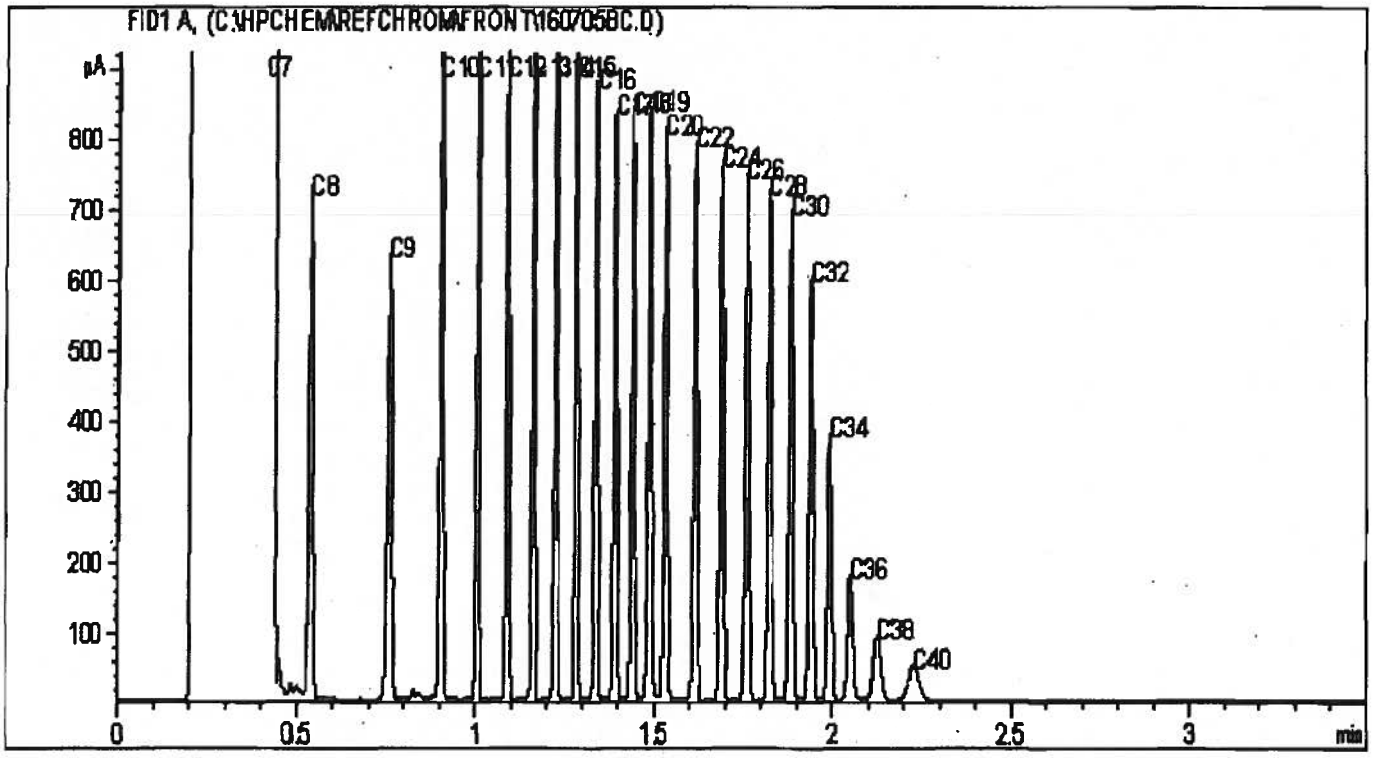


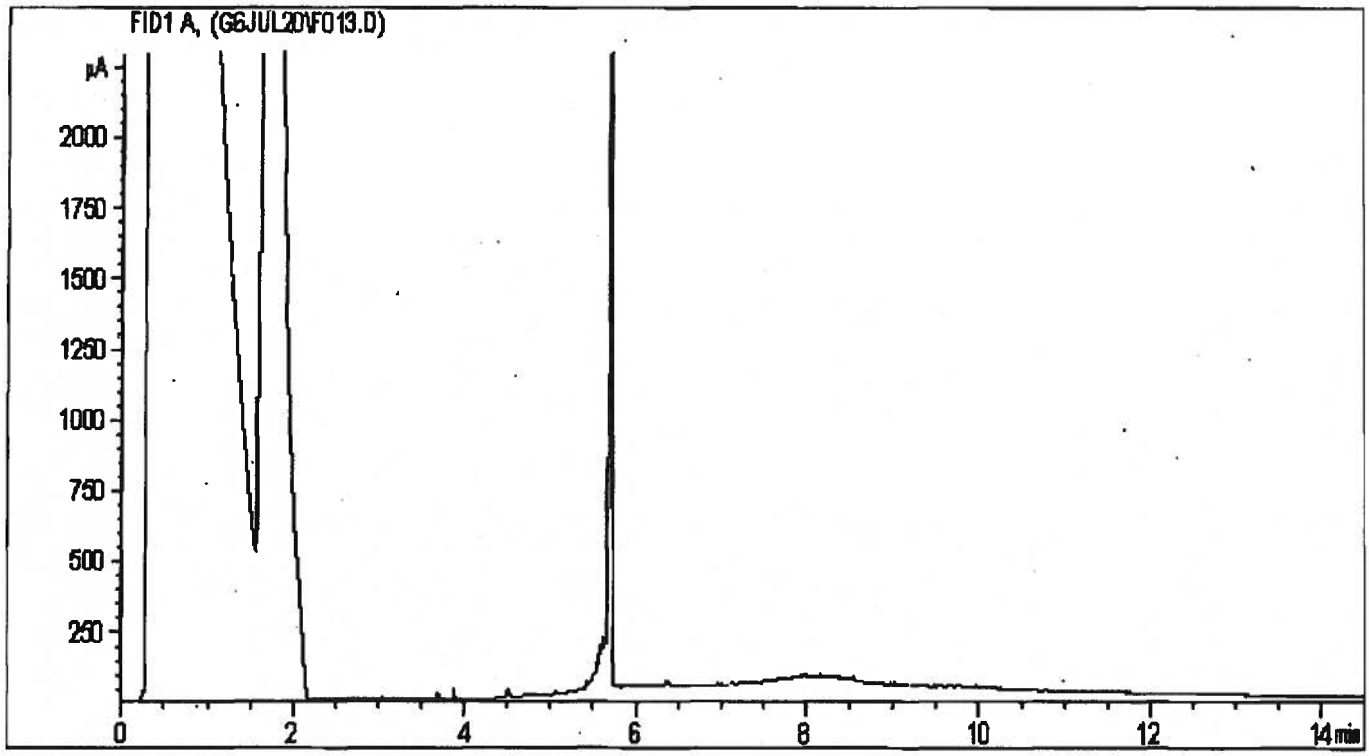
TYPICAL PRODUCT CARBON NUMBER RANGES



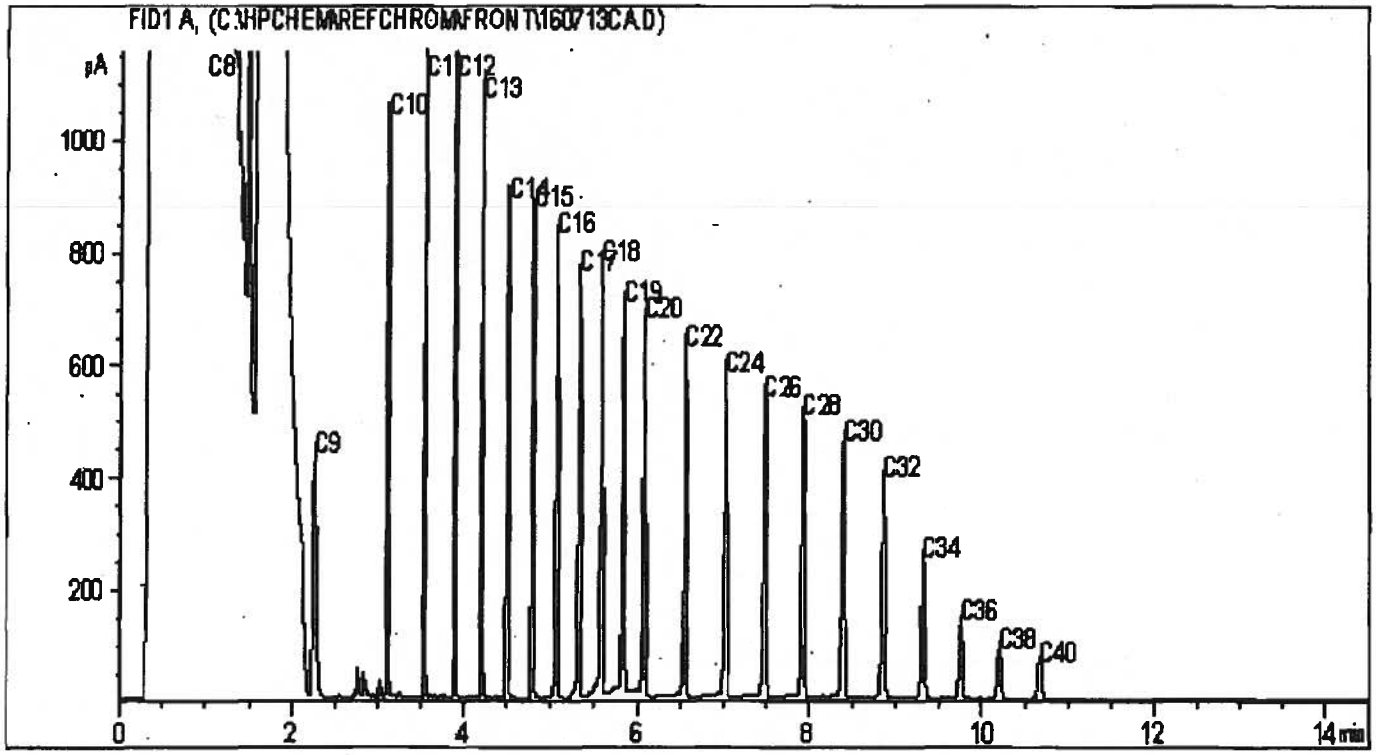
Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

APPENDICES

Parks Canada Basic Impact Analysis Template

Instructions for this form are available (see the Guidance and Tools section of the Parks Canada Impact Assessment intranet site or request from Parks Canada impact assessment staff).

1. PROJECT TITLE & LOCATION

Title

Rogers Pass Sewer and Stormwater Rehabilitation, Glacier National Park, Rogers Pass, BC

Location

This project will occur at Rogers Pass in Glacier National Park (GNP). Work will be carried out at two sites located on either side of the TransCanada Highway (TCH) :

(1) The Rogers Pass Compound (Compound) on the east side of the TCH; and,

(2) The Rogers Pass Discovery Center area (RPDC area) on the west side of the TCH.

The Compound contains 10 structures including administrative buildings, apartment buildings, a residence and mess facility that are used by the Canadian Forces, as well as garages and maintenance buildings and a large sand storage structure (Figure 1). The Compound is constructed on approximately 500 mm of gravel fill material that was placed on top of native soil. The majority of all excavation occurring during the Project will be within the elevation of the fill material.

The RPDC area on the west side of the highway consists of three primary buildings, the Rogers Pass Discovery Centre, the Glacier Park Lodge, and a service station. The Glacier Park Lodge and the service station are no longer operational and the fuel tanks at the service station were removed in 2010. A water treatment plant is also located on the east side of the TCH (Figure 1).

Rogers Creek is a fish bearing watercourse and flows adjacent to the east side of the Compound from south to north before it joins with Connaught Creek (also fish bearing) approximately 600 m north of the Compound.

2. PROPONENT INFORMATION

Parks Canada Agency (PCA)

Project Manager

Tom Dunphy, Public Works and Government Services Canada
Tom.Dunphy@pwgsc-tpsgc.ca
604-908-4529

Asset Manager

Ron Larsen, Mount Revelstoke and Glacier National Park (GNP)
Ron.larsen@pc.gc.ca
250-837-7514

Project Consultant

Andrew Gower, Wedler Engineering LLP
agower@wedler.com
250-334-3263

3. PROPOSED PROJECT DATES

The Project is proposed to occur in two phases that will be described in Section 5.

Phase I

Planned commencement:	2016-06
Planned completion:	2016-10

Phase II

Planned commencement:	2017-06
Planned completion:	2017-10

4. INTERNAL PROJECT FILE

MRG2015-14

5. PROJECT DESCRIPTION

Project Objective

The primary focus of the Project (the Project) is to upgrade the stormwater infrastructure and surface grading at the Compound and RPDC area and replace the sanitary sewer pipes within the Project area. Rogers Creek is located within 30 meters of the Compound. Upgrading the stormwater management system, and eliminating leakage from sewer pipes, is planned benefit the aquatic health in Rogers Creek and Connaught Creek. In particular, upgrading the stormwater infrastructure is intended to mitigate the migration of sediment, salt, and other contaminants that have potential to migrate via surface water run-off. Protecting the quality of surface runoff that enters Rogers Creek will promote healthy aquatic ecosystems and protect Bull Trout present in Rogers Creek and Connaught Creek.

Due to the large amounts of snowfall that the Rogers Pass area receives during the winter, large volumes of snow storage is required at the Compound during the winter. The melt of this snow during spring creates ponding and flooding issues at the Compound, which necessitates the regrading of the surfaces at the facility to encourage the controlled movement and attenuation of melt water.

The performance goal of the stormwater upgrades proposed in this Project is the removal of 80% of the annual Total Suspended Solids (TSS) and 90 to 95% of the free oil and hydrocarbon loading that is transported in the run-off in the Project footprint. These reductions in TSS and hydrocarbons will be performed by a multi-stage sediment removal process involving concrete sediment chambers for gravel, oil/silt separators for the sand/silt and oil/fuel and subsurface detention for flow attenuation. The functioning of the upgrades will reduce the concentration of TSS transported to Rogers Creek, and subsequently Connaught Creek upon completion of the Project (2017).

The sanitary sewer pipes on the west and east side of the TCH will also be replaced as part of the Project. Integrity issues were identified with the existing pipes and require replacement. Anticipated benefits include a decrease in water volumes directed through the Waste Water Treatment Plant (WWTP) and improved WWTP performance via increased biological activity in the Rotating Biological Contactor (RBC) Unit.

A secondary component of this project involves undertaking work associated with and funded by RPA 966 (Storage Tank System Regulatory Compliance). This work is being carried out as part of this project in order to maximize efficiencies and is guided by National Best Management Practices for Petroleum Storage Tank Systems.

Phase I Details

- Upgrading the stormwater infrastructure at the Compound on the east side of the TCH. Upgrading the infrastructure will have numerous components.
    - Construction of five stormwater detention facilities (detention facility A,B,C,D,E).
    - Excavation of a 2.0 m wide swale on the east side of the Compound to collect and move surface water runoff to detention facility D.
    - Construction of a concrete pad, trench drain and oil/silt separator at the vehicle storage 1 building, construction of a sediment chamber and oil/silt separator at stormwater detention facility D and E.

- Construction of a new fuel storage and dispensing system as well as a concrete pad and oil/water separator.
- Removal of the existing underground fuel tank and fuel dispensing system south of the offices/garage building.
- Installation of underground stormwater pipes to transport stormwater to detention facilities.
- Twin sanitary and storm services from all buildings within the Compound.
- Clearing of trees is required to facilitate the construction of stormwater detention facility E as well as the swale that is proposed to be constructed west of the Compound. The clearing required for the swale construction will be approximately 4 m wide. The total amount of clearing required is 1,200 m^2 of mature coniferous forest.

Phase II Details

Phase II of the Project is proposed to commence in the spring of 2017, with completion proposed for the fall of 2017. The design diagrams for Phase II (Wedler 2016) are shown in Appendix 1 and will include:

- Striping and stockpiling of the existing asphalt surface at the Compound. The surface will be regraded to work in conjunction with the stormwater infrastructure and will be resurfaced with asphalt or concrete.
- Construction of an approximately 4 m high containment wall around the east portion of the Compound to delineate the boundary of the facility and prevent disturbance to the riparian area of Rogers Creek.
- Replacement of an existing 5.8 m long, 1600 mm diameter corrugated steel pipe (CSP) culvert with a 6 m long, 2000 mm diameter open-bottom culvert on Rogers Creek near the existing sewage lagoon.
- Replacement of an existing 5.9 m long culvert on Rogers Creek near the snow research station with a 6 m long, 2000 mm diameter open-bottom culvert.
- Construction of a stormwater detention facility and stormwater outlet on the west side of the TCH.
- Covering all stormwater detention facilities with concrete.
- Construction of an oil/silt separator on the eastern perimeter of the Compound near detention facility B.

6. VALUED COMPONENTS LIKELY TO BE AFFECTED

Spatial boundaries define the geographic extents within which the potential environmental effects of the Project are considered and are used to define the study areas for the BIA. The description of environmental setting and assessment of potential Project effects on the valued components VCs considers the following defined study areas.

- Project footprint – The total Project footprint is 12.20 ha and includes the existing disturbed footprint of the Compound on the east side of the TCH, the former service station and the Rogers Pass Lodge on the west side of the TCH, as well as the RPDC. The existing footprint is 11.00 ha, plus an additional Project related footprint of 1.20 ha of tree clearing associated with the creation of stormwater retention pond E and the stormwater swales west of the Compound.
- Local Study Area (LSA) - a 1 km radius around the perimeter of the Project Footprint (473 ha) (Figure 2).

The Project footprint, associated with construction and operation of the Project, assesses the potential direct effects of the Project on the local environment while the LSA was established to assess the potential, largely indirect effects of the Project within the broader, directly adjacent local context. The LSA encompasses the Project footprint and extends in all directions for a radius of 1 km around the Project footprint. The LSA includes Rogers Creek and a 2,290 m section of Connaught Creek as well as the confluence of Connaught Creek with Rogers Creek (Figure 2). The following information was considered in determining the LSA:

- Rogers Creek joins with Connaught Creek downstream of the Compound and as a result, Connaught Creek would have potential to be influenced by water quality effects from Rogers Creek; and,
- 90% of the Project will occur on an existing footprint of the Compound and RPDC, which means the directly affected area surrounding the Project footprint is minimal (within 10% of existing footprint).

Golder conducted desktop searches for background information pertaining to components that may be potentially directly or indirectly affected by the Project and associated activities.

The following provides a list of sources searched:

- British Columbia Conservation Data Centre (BC CDC);
- Ecological Land Classification of Mount Revelstoke and Glacier National Parks British Columbia. Volume I: Integrated Resource Description (Achuff et al. 1984);
- Parks Canada Agency Biotics Web Explorer;
- BC Ministry of Environment Habitat Wizard; and,
- Mount Revelstoke and Glacier National Park Field Unit (MRG FU) provided data.

Information obtained during the background search was used to identify VCs considered to 'carry forward' in the BIA. Rationale for the inclusion or exemption of a component to be considered as a VC is provided in the sections below. One or more key indicators were selected to focus the effects for each VC. A key indicator represents a primary feature or issue related to the VC that has the potential to change as a result of the Project and can be described as an aspect or characteristic of the VC that, if changed as a result of the Project, may represent an effect on the VC.

VCs potentially affected by the Project were identified in consultation with MRG FU staff. VCs were selected based on the following criteria:

- The sensitivity or vulnerability of the key indicator;
- The uniqueness or rarity of the key indicator;
- Recognition of the importance of a key indicator by a statute, policy, regulation, or court;
- Risks to the health, safety or well-being of people;
- The likelihood to affect visitor experience; and,
- The likelihood of an indirect effect on an associated key indicator (i.e., a link exists between the affected key indicator and another key indicator, such as water quality affecting fish habitat).

A summary of VCs and key indicators and the rationale for their selection is presented in Table 1 and discussed in the following section.

Table 1 Valued Components, Key Indicators and Rationale for Selection

VC's	Key Indicator	Rationale for Selection
Air Quality	Particulate matter	Increase in airborne particulate matter may affect other VCs (flora, fauna)
Soil and Landforms	Soil, Groundwater and Vapour Quality	Exposure of salinity, metals and hydrocarbons during excavation
Aquatic Resources	Fish and Fish Habitat	Regulatory requirement; potential to cause serious harm to fish as defined under the federal *Fisheries Act.*
		Consideration of ecosystem conservation concerns; importance to ecosystem diversity and inter-relation to other environmental components (e.g., wildlife).
		Documented in vicinity Bull Trout and Mountain Whitefish are documented in Rogers Creek.
	Surface Water Quality	Maintain water quality for the protection of aquatic life.
		Potential for the introduction of deleterious substances that may affect other VCs (fish and fish habitat, flora, fauna)
	Bats (Little Brown Myotis, Northern Myotis	Project activities potentially occurring within the bat MRG RAP (April 1- August 31)
		Federal Status: Little Brown Myotis - SARA Schedule 1 (Endangered), Northern Myotis - SARA Schedule 1 (Threatened)
		Potential loss of maternity sites, day roosts and riparian areas.
	Olive-sided Flycatcher	Representative of forest openings, forest edges near natural openings (such as rivers, muskeg, bogs or swamps) or human-made openings (such as logged areas), burned forest or open to semi-open mature forest stand with tall trees or snags for perching (COSEWIC 2007).
		Federal Status - SARA Schedule 1 (Threatened) Documented in Vicinity.
	Western Toad	Important indicator of wetland and riparian habitats
		Potential change in suitable habitat, movement patterns, wildlife abundance. Documented in Vicinity.

VC's	Key Indicator	Rationale for Selection
Fauna	Western Toad	Riparian indicator species
	American Pine Marten	Documented in vicinity – important indicator of small mammal and ecosystem health.
	Grizzly Bear	Recreational importance (wildlife for visitor experience), ecological importance, and traditional importance. Documented in vicinity.
Flora	Invasive Plant Species	Potential to introduce invasive plant species during construction.
	Riparian Vegetation	Important indicator of water quality and aquatic health
	Whitebark Pine	Federal Status - SARA Schedule 1 (Endangered)
Cultural Resources	TransCanada Highway and CPR Archaeological Sites	Potential to disrupt two historic resource sites near the project
Visitor Experience	General	Potential alteration of the existing viewscape and traffic delays.

Air Quality

There are anticipated effects to air quality during construction of the Project from the use of construction equipment (excavation, tree clearing, machinery emissions), asphalt stripping activities and resurfacing as well as the generation of dust during machinery operation. Air quality will be carried forward as a VC into the effects assessment.

Aquatic Resources

Rogers Creek is a locally-named watercourse and is located along the eastern perimeter of the Compound. Rogers Creek is a first order stream and flows into Connaught Creek, which eventually joins with the Beaver River, which is a tributary of the Columbia River system and flows into Kinbasket Lake. Rogers Creek has a watershed area of 450 hectares and a length of 14.3 km (Bates and Gillespie 2005). It is a low gradient, high elevation stream that provides suitable spawning substrate for Bull Trout in isolated locations and provides excellent rearing opportunities (Bates and Gillespie 2005).

Previous bank restoration work has been performed by Parks Canada on Rogers Creek to enhance riparian vegetation and bank restoration works have been performed however riparian planting had minimal success (Bates and Gillespie 2005; *Streamworks 2005;* Boyle, Ecologist Team Leader, Parks Canada, 2016, *pers. comm.)*. This restoration is located east of the Project area on Rogers Creek.

Rogers Creek flows into Connaught Creek 600 m downstream of the Compound, Connaught Creek is a 4th order stream with a watershed area of 5160 hectares and a length of 13.9 km (not including Rogers Creek) (Alger and Donald 1984).

The Project has the ability to interact with two key indicators of aquatic health:

- Fish and Fish Habitat - Bull Trout and Mountain Whitefish have been identified in Rogers Creek and Connaught Creek.
- Surface Water Quality – a vital factor for the protection of aquatic health.

Due to the close proximity of Rogers Creek to the Compound, surface runoff has the potential to affect surface water quality within Rogers Creek and Connaught Creek. It is noted that the main reason for the Project is to provide additional protection measures, through infrastructure upgrades, for aquatic resources.

Fish and Fish Habitat

Bull Trout and Mountain Whitefish have been documented in Rogers Creek (Bates and Gillespie 2005) as well as in Connaught Creek (Alger and Donald 1984), which Rogers Creek flows into approximately 600 m downstream of the Project location (Table 2). The population of Bull Trout in Rogers Creek and Connaught Creek has low genetic diversity due to isolation above a falls on the Beaver River (Bates and Gillespie 2005). Fish sampling conducted by Parks Canada has resulted in the capture of Bull Trout in Connaught Creek using minnow traps and via backpack electrofishing (MRG FU 2016) (Figure 2). No species presence information was available in BC Habitat Wizard (BC MOE 2016a) of BC Fish Inventories Query (BC MOE 2016b).

Table 2 Management Concern of Fish Species documented in Connaught Creek and Rogers Creek

Common Name	Scientific Name	COSEWIC Status[a]	SARA Schedule[b]	SARA Legal Status	Provincial Listing [c]
Bull Trout	*Salvelinus confluentus*	Special Concern	n/a	n/a	Blue
Mountain Whitefish	*Prosopium williamsoni*	Not at Risk	n/a	n/a	Yellow

[a] Environment Canada 2016a
[b] Environment Canada 2016a
[c] BC MOE 2015; Blue = threatened; Yellow = special concern

Based on the species identified, BC MOE identifies the period of least risk for instream works by fish species for the Kootenay Region (Region 4) would be May 1 to September 30 for Mountain Whitefish and June 1 to August 31 for Bull Trout (BC MOE 2009). To provide protection to both species an instream work window of June 1 to August 31 would be recommended. None of the above species are federally listed under SARA (Environment Canada 2016). Bull Trout are listed provincially as 'Blue' (threatened) in British Columbia (BC MOE 2016c) and Bull Trout (Western Arctic Populations) are listed as 'Yellow' (special concern) (Environment Canada 2016).

Fish and fish habitat is a key indicator that has been selected to be assessed in the effects analysis.

Surface Water Quality

Potential effects of the Project on water quality include direct effects from the increase in total suspended solids (TSS) as result of instream activities that is required to replace two culverts in Rogers Creek. Increases in TSS could affect downstream environments in Rogers Creek or Connaught Creek. Indirect effects from increases in TSS or introduction of deleterious substances, such as hydrocarbons or increases in salinity could occur as result of runoff from the Compound entering Rogers Creek and having potential downstream effects on aquatic resources in Rogers Creek or Connaught Creek. Water temperature increases due to Project activities could potentially affect surface water quality, resulting in changes to the aquatic environment. Surface water quality has been selected as a VC and carried throughout the effects analysis.

Fauna

The Project is located in the ESSF Biogeoclimatic zone. The ESSFvc subzone is highly important to a variety of wildlife species. Seasonal migration to lower elevation zones with less snow cover is common for many larger mammals during the winter months. The ESSVc subzone provided important habitat features for Elk (*Cervus canadensis)*, Moose (*Alces alces)*, white tailed deer (*Odocoileus virginianus)*, coyote (*Canis latrans)*, American pine marten, weasel (*Mustela spp.)*, lynx (*Lynx canadensis)*, snowshoe hare (*Lepus americanus),* red backed vole (*Clethrionomys gapperi)*, and deer mouse (*Peromyscus maniculatus)* (Achuff et al., 1984). Seed-eating birds such as red crossbill (*Loxia curvirostra*), white-winged crossbill (*Loxia leucoptera*), pine siskin (*Carduelis pinus*) and Clark's nutcracker (*Nucifraga columbiana*) can be found in coniferous forests within the ESSFvc subzone (Meidinger and Pojar 1991).

Of the wildlife species that occur in the vicinity of the Project area, the wildlife species in Table 3 have been selected as key indicator species of the VC of Fauna. Figure 2 shows species that have been observed within a one kilomtre radius of the Project.

Table 3 Wildlife Key Indicator Species and Their Potential to be Affected by the Project

Common Name	Scientific Name	COSEWIC Status[a]	SARA Schedule [a]	SARA Legal Status[a]	Regularity within GNP[b]	Population [c]	Potential for Presence near Project
Fish							
Bull Trout	*Salvelinus confluentus*	Special Concern	n/a	n/a	Regularly Occurring	Year-round	High– suitable habitat and documented presence in vicinity
Amphibians							
Western Toad*	*Anaxyrus boreas*	Special Concern	Schedule 1	Special Concern	Regularly Occurring	Year-round	High – breeding habitat present at sewage lagoon in the Rogers Pass Compound; foraging habitat present
Birds							
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Schedule 1	Threatened	Regularly Occurring	Breeding	High– suitable habitat and documented presence in vicinity
Bats							
Little Brown Myotis	*Myotis lucifugus*	Endangered	Schedule 1	Endangered	-	-	Moderate – generally found in low densities with patchy distribution
Northern Myotis*	*Myotis septentrionalis*	Endangered	Schedule 1	Endangered	-	-	Moderate – generally found in low densities with patchy distribution, documented presence in vicinity
Furbearers/Carnivores							
American Black Bear*	*Ursus americanus*	n/a	n/a	n/a	Regularly Occurring	Unknown	High – documented presence in vicinity
Grizzly Bear*	*Ursus arctos*	Special Concern	n/a	n/a	Regularly Occurring	Unknown	High – documented presence in vicinity
American Pine Marten*	*Martes americana*	n/a	n/a	n/a	Regularly Occurring	Unknown	High – documented presence in vicinity

[a] COSEWIC – Committee on the Status of Endangered Wildlife in Canada; SARA - *Species at Risk Act* (Environment Canada 2016a)
[b] Regularly occurring - Occurrence of the Element is consistent in the Managed Area (e.g., it may migrate in and out of the area, but it returns on a regular basis).
Unknown/Undetermined - Regularity of the Element in the Managed Area has not been, or cannot be, determined.
[c] Year-round - A significant proportion of individuals of the Element are non-migratory or remain in the Managed Area throughout the year.
Breeding - Individuals of the Element occur in this Managed Area as part-time (seasonal) residents when breeding, and they are not year-round residents in any significant numbers.
Nonbreeding - Individuals of the Element occur in this Managed Area as part-time (seasonal) residents when not breeding, and they are not year-round or breeding season residents in any significant numbers.
Transient - Individuals of the Element are long distant migrants that regularly occur in the Managed Area as a transient during migration.
Unknown - The residency status of the individuals of the Element in the Managed Area has not been, or cannot be, determined.
* Denotes species has been confirmed within LSA.

Western Toad

The western toad (Schedule 1: 'Special Concern') is known to occur at all elevations within GNP and has been documented in wetland areas in the vicinity of the LSA (Figure 2). Western toad use a wide variety of aquatic and upland habitats including shallow, sandy margins of lakes, ponds, streams, river deltas, river backwaters, river estuaries and geothermal springs (COSEWIC 2012). This species also spends a large majority of their time in terrestrial habitats, including forested areas, moist shrub-lands, meadows and avalanche slopes (GoC 2015c). Western Toad young-of-the-year will also travel along wet, steep drainages during dispersal movements (Bull 2009). Western Toads also hibernate in upland areas, often in spaces created or modified by small mammals (COSEWIC 2012). Western toads breed during spring when minimum and maximum temperatures rise above 0°C and 10°C, respectively, or in late April to late May (COSEWIC 2012). Because the Project has the potential to directly impact western toads and their habitat, this species has been selected to carry forward through the effects analysis.

Olive-sided Flycatcher

The Olive-sided Flycatcher (Schedule 1: 'Threatened') is a migratory bird that breeds in British Columbia utilizing forest openings, forest edges near natural openings (such as rivers, muskeg, bogs or swamps) or human-made openings (such as logged areas), burned forest or open to semi-open mature forest stands with tall trees or snags for perching (COSEWIC 2007). The Project footprint is characterized by early to mid-seral stage coniferous forest on the edge of the natural opening generated by the anthropogenic opening created by the TCH, Compound and RPDC. Olive-sided Flycatchers have been documented in the vicinity of the Project (Boyle, Ecologist Team Leader, Parks Canada, 2016, *pers. comm.*). The causes for the declines in Olive-sided Flycatcher populations are unclear but are almost surely related to habitat loss and change (COSEWIC 2007). The Project has the potential to affect Olive-sided Flycatcher breeding habitat through the clearing of trees, therefore this species has been selected to carry forward through the effects analysis (Section 7).

Little Brown Myotis and Northern Myotis

Little Brown Myotis (Schedule 1: 'Endangered') and Northern Myotis (Schedule 1: 'Endangered') have been documented in GNP (Kellner 2014; PCA 2013). Trees and rock crevasses provide habitat for maternity sites, day roosts and access for foraging grounds (COSEWIC 2013), use of these roosts are typically between April and August. A preference of older growth forest has been documented and appears more important to roosting rather than type of forest (COSEWIC 2013). Older forest stands generally have increased snag availability and larger diameter trees which are used for day roosting. There is potential for the Project to affect bat roosting and/or forage sites through the clearing of trees; therefore, bats as a group have been selected to carry forward in the effects analysis (Section 7).

American Pine Marten

American Pine Martens (Marten) favor coniferous forests with high structural complexity. Throughout much of their range, they are commonly associated with mature, coniferous and mixed-coniferous forests with abundant coarse woody debris and a well-developed understory (Thompson et al., 2012). In the southern interior of BC, Martens primarily occur at higher elevations particularly in or near the ESSF Biogeoclimatic Zone where the Project is located (Hatler et al. 2008). Ecological Land Classification (ELC) units CT2 and GF2 are highly important to Martens because of the abundance and diversity of prey (Achuff et al., 1984).

Diet is influenced by seasonally and locally available food. Martens are opportunistic predators and typically hunt for small mammals (mice and voles), squirrels and hares. Berries and insects are consumed during the summer months when these are abundant.

Adult Martens are solitary animals except during the breeding season in late summer. Offspring are birthed in early spring (March and April) and are raised in dens formed out of hollow trees, stump, woody debris or squirrel nests. Young typically disperse in early fall. Martens have been selected to carry forward through the effects analysis (Section 7).

Black Bears and Grizzly Bears

Both American black bears and grizzly bears have been documented within 1 km of the Project (MRG FU 2016). Between 1951 to 2015, black bears have been observed 228 times and grizzly bears 58 times within 1 km of the Project area (MRG FU 2016). The Project will have minimal direct impacts on black bear and grizzly bear habitat; however, considering bear's opportunistic nature, construction activities (e.g., human garbage) have the potential of attracting bears to the area. Bears that become conditioned to human foods or that persist in areas where humans frequent may have to be destroyed. Black bears and Grizzly bears have been selected to carry forward through the effects analysis (Section 7).

Flora

The Project is located in the ESSF Biogeoclimatic zone. Within British Columbia, elevations for the ESSF zone range from about 1,500 to 2,300 masl. Topography is mountainous, often steep, and rugged. The ESSFvc subzone has a relatively cold climate, typically having a short, cool growing season with long and snowy winters.

An observation of Western St Johns-wort (*Hypericum scouleri*) occurred south of the Project area (Figure 2). Western St Johns-wort is not a listed species under COSEWIC or SARA and is a Yellow-listed species in the Province of BC (species are apparently secure and not at risk of extinction) (BC CDC 2016)

Vegetation of the ESSF zone is dominated by Engelmann Spruce (*Picea engelmannii*) and Subalpine Fir (*Abies lasiocarpa*), whereas Lodgepole Pine (*Picea contorta*) is abundant as a seral species after fire. At lower elevations, trees such as western White Pine (*Pinus monticola*), Inland Douglas-fir (*Pseudotsuga menziesii*), Western Hemlock (*Tsuga heterophylla*) and Western Red Cedar (*Thuja plicata*) occur occasionally (Steen and Coupé 1997). The understory vegetation in the ESSFvc subzone typically has a moderately dense shrub layer that favor acidic soils. Species that are characteristic of this subzone include: Oval-leaved Blueberry (*Vaccinium ovalifolium*), Oak Fern (*Gymnocarpium dryopteris*), One-leaved Foamflower (*Tiarella unifoliata*), Rosy Twistedstalk (*Streptopus roseus*), and Sitka Valerian (*Valeriana sitchensis*) (Meidinger and Pojar 1991).

Invasive Plants

Invasive alien plants (IAP) are present in GNP especially in front-country sites, including transportation corridors, gravel pits, day-use areas, old-park facilities and campgrounds (PCA 2008). The most extensive occurrences of IAP in GNP have been documented along lower elevations of the TCH (Tannas 2014). IAP have also begun to invade previously undisturbed areas such as riparian and low elevation meadow habitat (PCA 2015a). These areas are often habitat for rare plant species which are at risk of displacement by non-native species.

In 2015, MRG FU staff, through the Draft Mount Revelstoke and Glacier National Parks Invasive Alien Plant Management Plan (IAPMP) (PCA 2015a), updated the priority species list of IAP based on current survey data (Tannas 2014), updated regional distribution (Columbia Shuswap Invasive Species Society 2013) and updated provincial legislation (BC Weed Control Act 1996). The IAPMP resulted in IAP rankings of "High", "Moderate" and "Low" priority. A new category of "Very High" was also developed for any IAP species designated as BC Provincial Early Detection and Rapid Response (EDRR) species that occur in the MRG national parks.

Tannas (2014) conducted an IAP field survey throughout GNP including the rights-of-way on both sides of the TCH. IAP data collected from this survey has been compiled and analyzed for the portion of the LSA that borders the TCH. A total of eleven IAP species were identified within the LSA including one "Very High" and four "High" ranked species (Table 4).

Table 4 Summary of Invasive Alien Plants known to occur in the Local Study Area

Common Name	Scientific Name	BC Designation [a]	GNP Management Priority [b]	Number of Observations [c]
Perennial/Field sowthistle	*Sonchus arvensis*	Noxious - Provincial	Moderate	9
Mouse-ear Hawkweed	*Hieracium pilosella*	Noxious - Provincial	Very High	4
Tufted Vetch	*Vivia cracca*	Not listed	Moderate	8
Wild Caraway	*Carum carvi*	Not listed	High	2
Common Tansy	*Tanacetum vulgare*	Noxious - Regional	High	1
Orange Hawkweed	*Hieracium aurantiacum*	Noxious - Regional	High	1
American/Bird/Tufted Vetch	*Vicia cracca*	Nuisance	Moderate	2
Canada Thistle	*Cirsium arvense*	Noxious - Provincial	Moderate	
Oxeye Daisy	*Leucanthemum vulgare*	Noxious - Provincial	Moderate	10
Unknown Yellow Hawkweed	*Hieracium spp. (pratense)*	Noxious - Provincial	High	3

[a] BC Ministry of Forests and Range 2010; B.C. Ministry of Agriculture 2002.
[b] PCA 2015a
[c] Tannas 2014

Species ranked as "Very High" and "High" are described below as they represent the species of greatest management concern.

Mouse Ear Hawkweed (Very High) was field identified at four locations within the LSA (Tannas 2014). Given the aggressive nature of this species and difficulty of field identification. field sampled plants are currently being tested in a laboratory setting to confirm identification. This yellow flowered species is typically under 40 cm tall and is highly aggressive, invading native grassland and forested locations (Tannas 2014).

Caraway is an aggressive weed that is in the carrot family. This bunch type species does not creep but is a prolific seed producer. It has white flowers and can he highly aggressive in moist grasslands (Tannas 2014)

Common Tansy (High) was present at one location within the LSA (Tannas 2014). This species is a perennial forb that reproduces by both seed and short rhizomes and has yellow, numerous button-like flowers occurring in dense flat topped clusters at the top of stems (Alberta Invasive Species Council [AISC] 2014a). It grows best in full sun and fertile, well-drained soil.

Orange Hawkweed (High) was found at one location within the LSA (Tannas 2014). This species is a perennial forb, 10-60 cm tall with milky latex in the stems and leaves, orange ray flowers and reproduces by seeds and vegetatively by numerous horizontal stolons and rhizomes underground (AISC 2015). Hawkweeds prefer well drained, coarse textured soils, moderately low in organic matter, in mesic habitats and can also successfully grow under coniferous forest canopy (AISC 2015).

An unknown species of Yellow Hawkweed (High) was also documented within the LSA at 3 locations (Tannas 2014).

IAP have the potential to increase in colonization during construction activities and therefore have been selected as a VC to carry through the effects analysis (Section 7).

Riparian Vegetation

Rogers Creek flows along the eastern perimeter of the Compound and the riparian vegetation adjacent to Rogers Creek provides benefit to biodiversity of the area in the following ways:

- Stabilizes the bank of the creek and minimizes erosion during high flow events;
- Provides overhead cover and instream cover (woody debris) for fish species;
- Moderates the water temperature within the creek and limits solar radiation; and,
- Provides, food, nesting and refuge for wildlife species.

Vegetation clearing nearby and instream activities in Rogers Creek will remove riparian vegetation, which will have potential to affect the health of riparian vegetation adjacent to the operation facility and will therefore be carried through as a VC through the effects analysis.

Whitebark Pine

Whitebark Pine (Schedule 1: 'Endangered') (Environment Canada. 2016) typically inhabits high mountain forests within a narrow elevation zone from timberline, where it may occur as krummholz, down to mixed and/or closed subalpine forests. It can be found at elevations ranging from approximately 1590 to 2,250 masl (based on Park location data). As the Project is located at approximately 1,300 masl, which is below the species' elevational range, this species has not been selected to carry forward in the effects analysis.

Soil and Landforms

Soil Groundwater and Vapour Quality

Environmental investigations conducted at the Compound and RPDC area since circa 2001 by Golder and others have identified soil, groundwater and/or vapour quality that exceeds applicable federal guidelines (summarized in Golder, 2016). With respect to Project activities that required excavation, potentially-impacted soil, groundwater and/or vapour may be encountered as a result of the following historical and current activities:

RPDC area

- Historical use of the area beneath, and west of, the TCH as a railyard and station; and,
- Former operation of a service station west of the TCH.

Compound

- Storage and transfer of fuel at the existing fuelling station at the Compound;
- Handling and storage of fuel in a former above ground storage tank (AST) at the northeast corner of the vehicle storage 2 building;
- Historical maintenance activities, including potential equipment and fuel storage and the potential disposal of spent products (i.e., highway paints and maintenance products) south of the vehicle storage 2 building;
- Stockpiles of salt used for road maintenance located in vehicle storage 1 building and in the abrasives storage building; and,
- Other historical activities that have not been investigated to date.

Construction activities, including excavation, regrading and removal of existing fuelling station facilities at the Compound, could expose potentially impacted soils. Additionally, potentially-impacted groundwater and vapour may be encountered during excavation activities and removal of the fuelling station facilities. Potential contaminants of concern that may be encountered include salt, petroleum hydrocarbons, and metals. Due to the potential for the exposure and handling of potentially-impacted soil and/or groundwater containing salt, petroleum hydrocarbons and/or metals during Project activities, soil, groundwater and vapour quality and groundwater will be carried forward as VCs through the effects assessment (Section 7).

Cultural Resources

The Project occurs in an area where historical activities associated with the Canadian Pacific Railway (CPR) and the construction of the TCH has occurred. Beginning in 1899 and expanding in the mid-1900s the two overlapping station sites of Rogers Pass Station 3 and 4 contained a five stall roundhouse, a railyard, a turn table, station building and numerous structures to support an active railyard and station, as well as surrounding businesses and residences (Perry 2016). The two areas that have been identified by Parks Canada are shown in Figure 3. Site 411T5 is the area where the third and fourth Rogers Pass CPR stations were located and site 1247T was a historical refuse deposit for the area (Perry 2016).

There is potential to disrupt the two identified historical resource sites during construction of the Project so the Cultural Resources VC will be carried forward in the effects analysis (Section 7).

Visitor Experience

Visitor experience has been considered in relation to the Project for the following indicators: traffic pattern changes, visitor safety, and visual aesthetics. Each of these indicators has some impact on visitor experience.

Traffic patterns on the TCH between Golden and Revelstoke are highly seasonal with monthly average daily traffic hitting a low of 2,813 vehicles in January and peaking in August at 11,682 vehicles (BC MOTI 2014). July and August receive significantly higher traffic volumes over the rest of the year. Monthly average weekday traffic (Monday to Thursday) versus monthly average weekend traffic (Friday to Sunday) alternates highs and lows through the year but generally remains closely equal except in July and August when average weekend traffic is higher by approximately 1,000 vehicles. Construction of the Project will require temporary traffic control for equipment maneuvering that may lead to disruptions in traffic flow and increase travel times through the Rogers Pass.

Natural aesthetics through sight-seeing is a major attraction to GNP with visitors seeking a wilderness experience (PCA 2008). Construction activities will include vegetation clearing and alteration, which will temporarily negatively impact sight-seeing opportunities within the Rogers Pass. Visitor experience has been selected to carry forward through the effects analysis (Section 7).

7. EFFECTS ANALYSIS

The effects analysis considers the possible interactions between the Project infrastructure components and activities and the VCs, within the identified spatial boundaries. Project interactions may be direct (e.g., as a result of vegetation clearing for the Project affecting a VC), or indirect (i.e., as a result of a change to one VC affecting another VC). Potential effects of the Project on the key indicators are determined by comparing the existing conditions to those that are expected to result from the introduction of the Project.

The interactions that have been identified are described in this effects analysis and mitigations are provided in Section 8. All relevant Project activities were analyzed individually to determine if there was a plausible mechanism for an effect on each VC during normal Project conditions. The analyses were based on professional judgment and experience of the BIA team in consultation with MRG FU with regard to the natural and cultural resources and their potential for interaction with the Project.

Potential direct and indirect effects of the Project on VC's are described in the paragraphs below and are summarized in Table 5.

Table 5 Potential Project Effects

Valued Components	Key Indicators	Project Phase	
		Construction	**Operation**
Air Quality	Particulate Matter	Change in air quality due to generation of dust from construction equipment	n/a
Aquatic Resources	Fish and Fish Habitat	Change in habitat quality and/or quantity due to alteration of instream fish habitat	n/a
		Change in fish behavior, physiological damage or mortality due to increase in suspended sediment	n/a
		Physical damage to fish during instream work	n/a
		Change in fish passage through the creation of a temporary upstream or downstream movement barrier when water is diverted around the isolated areas and culverts are being replaced	Change in fish passage through the creation of a migration barrier due to increase in water velocity if culvert inadequately sized
		Change in habitat quality and/or quantity due to increase in suspended sediment load and sediment deposition during instream work	Change in habitat quality due to change in suspended sediment load and sediment deposition from surface water run-off
	Surface Water Quality	Change in water quality due to encountering water that has elevated salts, metals or hydrocarbons during excavation of sewer lines or underground fuel tank at existing fuelling station at the Compound	n/a
		Potential change in water temperature from clearing of riparian vegetation or introduction of warmer water from stormwater detention facilities	Potential change in water temperature from being retained in stormwater detention facility
		Change in water quality due to deleterious substances (sediment, salts, hydrocarbons) from surface water run-off during construction	Change in water quality due to improvement through the removal of deleterious substances (sediment, salts, hydrocarbons) from surface water run-off
		Accidental spills or leaks.	Accidental spills or leaks.

Flora and Fauna	Invasive Plants Species	Introduction of Invasive plant species from construction equipment	n/a
	Riparian Vegetation	Change in riparian vegetation quantity or quality due to disturbance or removal during construction	Change in riparian vegetation quantity or quality due to disturbance or removal during operations
	American Pine Marten	Loss of dens due to tree clearing	n/a
		Indirect mortality associated with attraction to waste and work sites resulting in management actions to deter Martens.	Indirect mortality associated with attraction to waste resulting in management actions to deter Martens.
	Black Bear and Grizzly Bear	Indirect mortality associated with attraction to waste and work sites resulting in management actions to deter / remove bears.	n/a
	Western Toad	Increased mortality of western toads from use of detention ponds as breeding habitat. Increase mortality of western toad young-of-year due to increase activity in the Compound during migration periods.	Change in mortality of western toads from use of detention ponds as breeding habitat and increase in vehicle mortality
	Bats (i.e. Little Myotis, Northern Myotis)	Potential loss of maternity and/or day roosts and foraging habitat. Direct mortality or indirect mortality (sensory disturbance) associated with vegetation clearing.	n/a
	Olive-sided Flycatcher	Loss of breeding and foraging habitat from site clearing. High potential for sensory disturbance during construction. Direct mortality to hatchlings and early fledglings during vegetation clearing.	n/a
Soil and Landforms	Soil, Groundwater and Vapour Quality	Exposure of soil, groundwater and vapour containing elevated salinity, metals and/or hydrocarbons during excavation, stripping, handling or storage (stockpiling) of soil or groundwater.	n/a
	Soil, Groundwater and Vapour Quality	Accidental spills or leaks.	Accidental spills or leaks.
Cultural Resources	General	Interaction with historical resources during construction	n/a
Visitor Experience	General	Temporary traffic delays due to traffic control during construction. Loss of natural aesthetic appeal during construction.	n/a

Aquatic Resources

Fish and Fish Habitat

Bull Trout and Mountain Whitefish are present in Rogers Creek and Connaught Creek and although Project activities will occur near Rogers Creek, Connaught Creek could be affected by upstream influences. The discussion of fish and fish habitat relates to Bull Trout, Mountain Whitefish and their habitat.

Instream work will occur during the replacement of two existing culverts under access roads that cross Rogers Creek. The proposed length of the culverts is assumed 6 m long and a diameter of 2000 mm. The replacement culverts will have approximately the same instream footprint as the existing culverts (24 m^2) (one culvert is 5.9 m in length and the other is 5.8 m long). The replacement culverts will be open-bottom culverts and will have an increased diameter, compared to existing culverts, which will facilitate fish passage.

The open-bottom culverts also have potential to create a movement barrier to Bull Trout and Mountain Whitefish if not designed adequately and water velocities in the culverted area exceed the swimming ability of fish, or if no resting areas are provided in the stream bottom under the culvert. The potential creation of a movement barrier could limit migration of fish in Rogers Creek and limit access to habitat and resources within Rogers Creek.

During the removal of the existing culverts and the installation of the new culverts, there will be potential to mobilize sediment (TSS) within Rogers Creek that can migrate downstream to Connaught Creek. Elevated TSS has been shown to cause effects that range from behavioral avoidance to physiological effects (e.g., irritation of gill tissue) that can result in mortality in fish, as well as the suffocation of developing embryos in situ (Newcombe and Jensen 1996). The effects depend on the duration and intensity of exposure (Newcombe and Jensen 1996).

Dewatering during construction could also potentially result in direct harm to individual fish. Direct harm includes entrainment on dewatering screens, impingement within dewatering pumps, suffocation due to stranding in de-watered areas, or mechanical damage from equipment and instream implements. A temporary movement barrier is usually created during isolation of the work area (when water is pumped around).

The mobilization and deposition of sediment from instream activities could affect fish habitat through the covering of substrates that are used for spawning and food production (benthic invertebrates) which could limit the reproductive success of fish and possibly limit benthic invertebrate production that is vital in streams at high elevations with low levels of productivity. If a culvert is not installed appropriately, and disturbed riparian vegetation reclaimed, sediment could also be generated from erosion at the upstream or downstream ends of the culvert that will be installed, or from the road surfaces or ditches themselves.

Watercourse isolation during instream construction will require vegetation removal and will expose soils to wind and water erosion. Removal of riparian vegetation can also affect water quality by potentially causing an increase in water temperature.

Surface Water Quality

During the excavation and replacement of the existing sanitary sewer pipes and the removal of the existing fuelling station facilities at the Compound, there is potential to encounter groundwater. Due to historic sources of contamination from salts, hydrocarbons and/or metals on the west and east side of the TCH, there is potential for contaminated groundwater to be encountered during excavation. During dewatering of the excavated areas, there is potential for water containing suspended sediment, elevated salinities, hydrocarbons and/or metals to migrate off the disturbed footprint or into Rogers Creek causing a potential effect to the health of vegetation, wildlife and the aquatic environment.

During construction activities and operations of the Project, there is potential for surface run-off water from precipitation events or melt water to collect deleterious substances such as sediment, salts or hydrocarbons and transport these substances off the disturbed footprint of the Project. The surface water runoff would have potential to affect the health of vegetation, wildlife, and the aquatic environment.

The performance goal of the stormwater upgrades proposed in this Project is the removal of 80% of the annual TSS and 90 to 95% of the free oil and hydrocarbon loading that is transported in the run-off in the Project footprint. These reductions in TSS and hydrocarbons will be performed by a multi-stage sediment removal process involving concrete sediment chambers for gravel, oil/silt separators for the sand/silt and oil/fuel, and subsurface detention for flow attenuation. Proper functioning of the upgrades will reduce the concentration of TSS transported to Rogers Creek, and subsequently Connaught Creek upon completion of the Project (2017).

The stormwater infrastructure that will remove salt concentration from runoff water is proposed to contain the runoff from the vicinity of vehicle storage 1 and the abrasives storage buildings in separate localized bio-retention ponds that would be designed for high salt content water. Once salt is dissolved in runoff water it can be challenging to isolate so the proposed process of source control is most effective. It is challenging to quantify the surface water quality changes that will result from the introduction of the stormwater upgrades; however, the method of source control and collection of runoff water that has contacted salt is expected to result in improved surface water quality in Rogers Creek.

There is potential for water temperature increases in Rogers Creek as a result of additional sun exposure from the riparian vegetation clearing and paving of surfaces near the creek. The optimal water temperatures for Bull Trout and Mountain Whitefish egg incubation, rearing and spawning are similar and deviations in water temperature could cause reduced growth or mortality (BC MOE 2015). The vegetation clearing is proposed to occur on both sides of Rogers Creek where the existing culverts near the sewage treatment lagoon and snow research area are situated. It is assumed that 15 linear metres of riparian vegetation clearing on each side of the creek will be required for each culvert replacement, for an assumed total of 60 m^2 (0.006 ha). The second potential cause of the increase in water temperatures is during the release of treated water from the stormwater detention facilities into Rogers Creek. The water in the detention facilities could increase in temperature through sun exposure while in each detention facility. The water retained in the detention facilities will be retained for maximum of a day, which will likely not be sufficient time for a marked increase in water temperature. The stormwater detention facilities will only be open to sun exposure for one year before they will be covered with concrete in Phase II of the Project. Once covered, the detention facilities will be underground and are not expected to create a heat sink since they will be insulated by the ground and the concrete cover.

Accidental spills of salts or hydrocarbons could also occur during construction or operations within the Project area affecting changes in surface water quality.

Flora

Invasive Plant Species

Indirect effects on terrestrial vegetation communities are related to the encroachment of IAP species that have the potential to displace native plant species. IAP have the potential to be introduced to the Project footprint or the LSA from adjacent areas, or from construction equipment, vehicles, as well as the introduction of fill material from offsite that could introduce seeds or plant propagules from other work sites. Disturbance of terrestrial vegetation communities and the movements of equipment can facilitate proliferation and encroachment of IAP, which have the potential to displace native plant species. Bare soil, where reclamation has not been initiated or is unsuccessful, is particularly susceptible to encroachment by IAP. The presence of IAP species within the LSA documented in 2014 (Tannas 2014) suggests a potential for construction and operation of the Project to amplify these occurrences.

Riparian Vegetation

Riparian vegetation removal will occur during the two proposed culvert replacements on Rogers Creek. There is also potential for riparian vegetation to be disturbed on the east side of the operation compound through the operational activities such as snow storage and operation of machinery. The Project design includes the construction of a concrete containment wall during Phase II of the Project that will delineate the eastern and northern edge of the Compound adjacent to Rogers Creek. The concrete wall will also separate the fuel dispensing location from Detention Facility C (Appendix 1). The wall will be constructed out of concrete and will be approximately 4 m in height. The wall is expected to reduce disturbance to Rogers Creek and the riparian vegetation from snow storage activities during operations at the Compound. The primary activity that is expected to cause a change to riparian vegetation is riparian clearing during the culvert replacement near the sewage lagoon and at the snow research centre on Rogers Creek.

Fauna

Western Toad

Western toads may aggregate at any life stage, making them vulnerable to mortality such as roadkill (COSEWIC 2012) from late April through to October. The area around the Compound does support large areas of seasonally wet habitat for breeding, while the stormwater retention ponds that are part of the stormwater upgrades have potential to provide breeding habitat. The maximum retention time of the water in the detention facility is approximately one day. The stormwater detention ponds will be constructed and will remain uncovered during Phase I of the Project but will be covered by concrete during Phase II of the Project, which will deter the use of these structures by toads. The covering of the detention ponds will remove a source of attraction of the western toad and will conversely reduce the likelihood of mortality from vehicle traffic to existing conditions. A temporary period (approximately one year) during Phase I of the Project may expose the western toads to an increased source of mortality if they are concentrated through the use of the stormwater detention ponds as breeding habitat, which would be located very close to Compound vehicle traffic.

American Pine Martens

Clearing of 1,200 m² of mature coniferous trees is required to facilitate the construction of stormwater detention facility E as well as the swale that is proposed to be constructed west of the Compound (Appendix 1).

Martens have been observed around the Project in high numbers (Boyle, Ecologist Team Leader, Parks Canada, 2016, *pers. comm.*) (Figure 2) and dens in the adjacent undisturbed forests may be encountered during tree clearing. Additionally, Martens have potential to be attracted to food or garbage facilities during construction and operations at the RPDC area and Compound.

Black Bear and Grizzly Bear

The Project will have minimal direct impacts on black bear or grizzly bear habitat; however, considering bears are opportunistic by nature, activities associated with construction and operation of the Project (e.g., waste generation) have the potential of attracting bears to the Project area. Black bears and grizzly bears that become conditioned to human foods or that persist in areas where humans frequent may have to be destroyed.

Bats – Little Myotis and Northern Myotis

The clearing of larger diameter trees and snags for stormwater detention facilities and swales may remove maternity and/or day roost sites for bats and may result in the direct or indirect mortality (sensory disturbance associated with the vegetation clearing.

Olive-sided Flycatcher

Vegetation clearing will result in the direct loss of nesting and foraging habitat for the Olive-sided flycatcher. There is also a high potential for sensory disturbance which may lead to displacement from suitable habitat during construction. Direct mortality to hatchlings and early fledglings may also occur if clearing were to occur during the nesting period typically April 1 to August 31.

Soil and Landforms

Soil, Groundwater and Vapour Quality

Based on environmental investigations conducted to date (Golder, 2016), and with respect to the Project footprint, the following comments are provided regarding the extent of potentially-impacted soil and groundwater.

- Petroleum hydrocarbon- and metals- impacted soil, groundwater and/or vapour have been identified west of the TCH, between the three buildings located in the RPDC area and the THC. Petroleum hydrocarbons- and metals-impacted soil and hydrocarbon-impacted vapour may be encountered during proposed trenches/excavations west of the THC and potentially beneath the THC.

Groundwater may be encountered in these areas, and depending on the depths of the proposed facilities, dewatering may be required to control the flow of water into the trenches/excavations.

- Hydrocarbons- and metals- impacted soil and groundwater has been identified at the east end of the Compound, specifically, south of Vehicle Storage Building 2 and at the northeast corner of Vehicle Storage Building 2. Hydrocarbons- and metals- impacted soil may be encountered during proposed stormwater upgrades in these areas. Groundwater may be encountered, and depending on the depths of the proposed facilities, dewatering may be required to control the flow of water into trenches/excavations.

Little to no information is available regarding soil or groundwater quality in the area of the water treatment facility, west of the THC (i.e., between the Rogers Pass Inn and the water treatment facility); or between the THC and Vehicle Storage Building 2, at the Compound. There is a potential for impacted soil to be encountered during excavations or ground disturbance. Groundwater may be encountered in these areas, and depending on the depths of the proposed facilities, dewatering may be required to control the flow of water.

Salt was not assessed in soils at the Compound; however, the storage and transportation of salt in the vicinity of the vehicle storage 1 and the abrasives storage buildings creates potential for introduction of salts into the soils in the Project footprint and to a lesser extent the LSA.

During construction activities at the RPDC area, Compound and beneath the THC, potentially-impacted soil, groundwater and/or vapour could be exposed. During construction activities and throughout future operations, specifically at the Compound, there is the possibility for the occurrence of accidental spills or leaks or salts or hydrocarbons. Spills could occur during refueling of machinery, transportation of fuel or from leaks or spills from machinery or fuel containment tanks.

Cultural Resources

Two historically sensitive areas have been identified by Parks Canada within the LSA of the Project (Perry 2016). Historically sensitive area 1247T is located on the western perimeter of where a stormwater swale will be constructed (Figure 3; Appendix 1). The construction activities in this area will create potential for the interaction with historical resources.

Visitor Experience

Effects to visitor experience during Project construction are expected through temporary traffic delays and loss of natural aesthetic appeal of the Project area. Construction of the Project will require maneuvering construction equipment and vehicles at various times to facilitate work, and owing to the proximity to the TCH and in some cases of machinery crossing the TCH, will require traffic to be stopped. Traffic delays add travel time to trips through the park and limits time spent out of the vehicle experiencing the park. Traffic delays are expected to be of short duration and would not require complete closure of the highway.

Construction equipment, cleared vegetation, and exposed soil are not characteristic sights of the valley within the park. The alteration of viewscapes and traffic delays due to Project construction will temporarily reduce visitor experience.

8. MITIGATION MEASURES

Staff and contractors will understand and comply with all National Park regulations. Pre-work briefings/meetings will be held to address environmental sensitivities within the Project Site, such as potential to harm vegetation, wildlife interactions, and equipment spills or leaks.

An Environmental Protection Plan (EPP), which includes an Erosion and Sedimentation Control Plan and a Soil and Groundwater Management Plan will be prepared in accordance with Parks Canada Environmental Procedures, submitted and approved 2 weeks prior to initiation of the work and be available to all staff during project activites. Prior to the commencement of construction the Contractor selected to perform construction will prepare the following documents to accompany the EPP:

- Include an access plan with access routes, traffic safety, type of equipment used for various construction phases and lay down areas that aim to prevent/minimize disturbance to vegetation and soils. Lay down areas will occur on paved and/or hardened surfaces, where possible. Any new laydown areas will require approval from the assigned MRG FU Environmental Surveillance Officer (ESO);
- Include soil and groundwater management, and sediment and erosion control planning;
- Contain spill response procedures, with appropriate containment, storage, security, handling, and transportation of applicable materials/substances, spill kit requirements, and emergency response contacts. The Material Safety Data Sheets (MSDS) for all chemicals used will be made available on-site;
- Include an Emergency Response Plan (ERP) that outlines procedures to follow in case of emergency (e.g., wildlife encounter, spill; equipment malfunction/failure, fire, avalanche);
- Include details of environmental monitoring and rehabilitation;
- Include a traffic safety or management plan;
- Supply a description of the equipment that will be used at various construction stages (Clearing, grubbing, stripping and stockpiling). The contractor will supply the equipment list to Parks prior to the commencement of construction. This list should be appended to the EPP, and the EPP modified accordingly to match equipment specifications;
- Include details on how the work limits will be marked and what procedures will be employed to ensure trespasses or impacts outside these limits will not occur and to ensure that the environment is not impacted or damaged by workers or construction equipment beyond the work limits;
- Details on how the work limits will be marked and what procedures will be employed to ensure trespasses or impacts outside these limits will not occur and to ensure that the environment is not impacted or damaged by workers or construction equipment beyond the work limits;
- A Spill Response Plan will be prepared and will detail the containment and storage, security, handling, use and disposal of empty containers, surplus fuels or other hydrocarbon products to the satisfaction of the ESO and in accordance with all applicable federal and provincial legislation. The contractor will be required to submit to Parks Canada a list of products and materials to be used or brought to the work site that are considered or defined as hazardous or toxic to the environment. This list should be appended to the EPP. Such products may include but are not limited to fuels and

lubricants. The Material Safety Data Sheets (MSDS) for all chemicals used will be made available on-site. Appropriately sized and stocked spill kits will be on site capable of dealing with 110% of the largest potential spill. All Contractors' staff must be aware of their location(s) on site and must be trained on spill response procedures; and,

- A Fire Prevention Plan that describes the fire prevention equipment (e.g., fire extinguishers) and procedures on-site in the event of a fire. Should a fire occur, Jasper Dispatch and the Fire Duty Officer must be notified immediately.

In addition, further details will be required in the EPP depending on final Project design. The MRG FU will be consulted throughout the Project and given the opportunity to comment on the design phase of the project and on the development of the EPP.

All staff employed at the construction sites shall be instructed by the ESO, assigned by MRG FU, during an environmental briefing regarding their individual and collective responsibilities to ensure that avoidable adverse environmental impacts do not arise from their activities and/or personal decisions. The ESO will be contacted two weeks prior to work commencing in order to schedule this briefing. The ESO will conduct periodic visits (i.e., surveillance) to ensure Project operations are being conducted in accordance with identified environmental protection measures. The ESO maintains the right to halt work, if required.

Mitigation measures specific to VCs, in addition to the general mitigations that will be outlined in the EPP, can be applied by adhering to operational protocols or through Project design alterations to reduce potential adverse effects.

General Mitigation Measures

In general, the Parks Canada National Best Management Practices: Roadway, Highway, Parkway and Related Infrastructure BMP (PCA 2015b) will be applied.

1. It is the responsibility of the Contractor to ensure that all Project works are conducted in accordance with all applicable regulations and approvals including the SARA and Canada National Parks Act.
2. The ESO (or Departmental Representative) will provide periodic and unscheduled site visits to ensure that Project operations are conducted in accordance with all identified environmental protection measures (including but not limited to those within this document, applicable legislation and construction Best Management Practices). The ESO will prepare follow up reports such that criteria in Parks Canada's Approvals and the EPP are being adhered to, including any non-compliance and corrective actions recommended/taken. The ESO will report to the Project Manager and MRG FU for non- compliance.
3. It is the responsibility of the Contractor's Project Manager to provide Parks Canada staff with advanced notifications of Project activities and direct that this information be included in local media announcements, if required.
4. All site workers are required to wear the appropriate Personal Protective Equipment (PPE) and be trained to standards that comply with both WorkSafe BC Act and Worker's Compensation Board rules and regulations.
5. Firearms and pets are prohibited on-site.

6. Fishing in rivers and streams in Glacier National Park is prohibited.
7. Park campgrounds will not be used for staff accommodation for the Contractor.
8. The Contractor assumes any risk to public safety as a result of Project activities.
9. The Contractor will ensure that works are completely contained such that deleterious substances (e.g., highly turbid runoff, dewatering, spills or leaks, etc.) will not be released into the environment.
10. Prior to use on-site, equipment will be cleaned of soil, plant propagules, or any substance that could introduce invasive plants species.
11. Where impediments to traffic are expected along TCH for transportation of equipment and personnel, appropriate traffic mitigation strategies will be in place, which may include lowering of speed limits, check-ins with the MRG FU to determine reports of wildlife on the highway, distracted driving policies, and encouragement of carpooling.

Spill and Leaks Mitigation

1. Prior to use on-site, equipment will be inspected for fluid leaks of any kind. Any detected leaks from equipment on-site will be addressed immediately and absorbent pads will be used under equipment with chronic leaks. Inspections should be done daily and recorded. Equipment stored overnight will be stored on tarps with appropriate containment if required.
2. Respond to all spills (e.g., hydraulic fluids) immediately according to the Mount Revelstoke-Glacier Spill Response Plan. In the event of any fluid spills or leaks exceeding 5 L, or any spill quantity in or near water, the Spill Response Plan must be followed including immediate containment, cleanup/mitigation, and immediate reporting to Jasper Dispatch and the ESO. Any absorbent materials used in the clean-up or soils contaminated by the spill will be disposed of in the appropriate facilities and transported in accordance with the Transportation of Dangerous Goods Regulations. All spills, regardless of size or location, will be reported to the ESO.
3. Prevent deleterious materials from entering drainages, wetlands, or Rogers Creek that would result in damage to aquatic and riparian habitat. Hazardous or toxic products (fuels, lubricants, etc.) shall be stored no closer than 30 m from any watercourse. The Contractor shall develop a response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit on site.
4. Conduct all vehicle, machinery and equipment fueling and maintenance at locations approved by Parks Canada. Waste products (oil filters, used containers, etc.) shall be secured in spill-proof containers and properly recycled or disposed of at an approved facility.
5. Follow existing MRG Spill Response protocols for all spills, regardless of volume, and report to the Jasper Dispatch and the ESO the same day as the spill. Appropriately stocked spill kits must be available during stockpiling operations and all machinery in use shall be in good working order.
6. Spill kits will be available on site and with all equipment. Spills kits must be able to contain 110% of the largest possible anticipated spill.

7. To avoid accidental spills and potential subsequent uptake into vegetation, all fuels, gases, or harmful substances will be contained within the appropriate and approved containers, and transported according to the Transportation of Dangerous Goods Regulations. If spills or leaks occur, the Spill Emergency Response Plan will be carried out.

8. All stationary operating equipment with fuel tanks or hydraulic systems (e.g., pumps), or stores of liquid hazardous materials (e.g., fuel) will be located within an impervious secondary containment area capable of holding 110% of the contents of the largest container within the area

Air Quality

1. Dust generated by Project activities, both on Project Sites and the TCH, will be controlled as necessary by covering debris, soils etc., and/or ongoing cleanup/maintenance.

2. To reduce noise and air pollution, construction equipment will be turned off when not in use, equipment and vehicles will be operated at optimal efficiency and performance (polluting vehicles or equipment is to be removed from Site), and carpooling of personnel to staging areas and Project area will be encouraged.

Aquatic Resources

1. Instream work will only occur between June 1 to August 31

2. All equipment, waders, boots that will be instream should follow strict disinfection procedure to prevent the spread of didymo and chytrid fungus between aquatic sites. The disinfection should occur greater than 30 m out of the riprain zone and should consist of removal of mud and plant material from weuipment, waders and boots and spraying all surfaces unitl soaked with a 5% bleach solution. Removal of mud and plant material should occur between boot cleats

3. Ensuring downstream connectivity and fish passage through the culverts to be replaced in Rogers Creek is mandatory; therefore, the culvert shall be open bottom and sized appropriately to accommodate flow in Rogers Creek

4. The section of creek shall be isolated from flows using a bypass of pumping flow around the work zone to ensure downstream habitat is not dewatered. Pumping will require a Restricted Activity Permit (RAP) from Parks Canada. Screen any water intakes to prevent entrainment or impingement of fish.

5. Screened intakes must meet the requirements of the Department of Fisheries and Oceans (DFO) (DFO 1995) in order to eliminate potential entrainment and harm to fish.

6. Removal and installation of the culverts shall be performed in isolated conditions only after a fish salvage has been completed by the QEP (QEP will be hired specifically to coordinate, conduct and monitor in-stream works) in the instream work area. The site shall be isolated from flows by pumping flow around the work zone to ensure downstream habitat is not dewatered. The QEP and associated work will be suppoted by the MRG ESO.

7. Once installed, the velocity of water passing through the culvert should not exceed the average velocity of water upstream and downstream of the culvert to ensure fish passage is maintained. Native substrate, consisting of boulders and cobbles, shall be placed into the culvert bottom to emulate the natural stream bed and provide resting areas for fish.

8. The Contractor shall develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the project. Appropriate erosion control measures will be designed and constructed to avoid vertical or lateral scour of watercourses near the outlet of modified culverts. The plan should include:

    a. Installation of appropriate erosion and sediment control methods before starting work to protect sensitive aquatic habitats and wetland areas;

    b. Use of sediment fencing and/or other appropriate erosion control materials to prevent sediment transport to mitigate the migration of sediment-laden water into Rogers Creek. The intended end result is to avoid the release of sediments into any watercourse in levels that may cause harm to fish. The target is 0 mg/L of TSS over background levels, with a maximum allowable instantaneous increase of 25 mg/L (8 NTUs) over background levels when background levels are <250 mg/L or a maximum allowable instantaneous increase of 10% over background levels where background levels are >250 mg/L (80 NTUs)(CCME 2002);

    c. Maintain erosion and sediment control measures until all disturbed ground has been stabilized, suspended sediment has resettled to the bed of the waterbody or settling basin and runoff water is clear; and,

    d. Temporarily diverted water should be returned to the same water feature downstream of construction activities and water flow maintained at all times. Management of water flowing onto the site, as well as water being pumped/diverted from the site must be treated such that sediment is filtered out prior to the water entering a watercourse. For example, pumping/diversion of water to a vegetated area, construction of a settling basin or other filtration system.

9. Stockpiling of construction materials will not occur beyond work limits to avoid sedimentation resulting from overland flows, heavy rain/snow events, and spring melt. Appropriate use of erosion and sediment control measures will be implemented.

10. Restore bed and banks of the waterbody to their original substrate composition, contour and gradient; if the original gradient cannot be restored due to instability, a stable gradient that does not obstruct fish passage should be restored.

11. MRG FU will be consulted during the development of designs for culvert replacement, to ensure that plans are developed to maintain or improve appropriate connectivity (i.e., of aquatic, hydrologic and wildlife resources). Open bottom culverts should be considered for fish bearing streams.

12. Work limits and setbacks from wetlands, watercourses, and drainages will be clearly marked. This plan is to ensure that the environment is not impacted or damaged by workers or construction equipment.

13. Activities modifying water features should not occur during high flows, either due to snowmelt or rainfall events. High flows are typical in May and June during snowmelt runoff, and in response to fall and summer rainfall events.

14. Cleaning out of stormwater components such as oil separators and sediment traps should be done annually (or more frequently if required). Cleaning of the oil separator should be performed with a vacuum truck and the removed material disposed at an appropriate facility.

Flora

1. Clearing of riparian vegetation should be kept to a minimum: use existing trails, roads or cut lines wherever possible to avoid disturbance to the riparian vegetation and prevent soil compaction. When practicable, prune or top the vegetation instead of grubbing/uprooting

2. All vegetation clearing will occur according to the Parks Canada National Best Management Practices: Roadway, Highway and Parkway Infrastructure (PCA 2015b) and Parks Canada Vegetation Clearing Best Mangement Practices (PCA 2015c). Any variance for vegetation removal must be obtained from the Field Unit Superintendent in advance of works

3. Restore riparian vegetation where removed or disturbed

4. Apply appropriately selected MRG native seed mix on slopes and on top of stockpiles to create vegetated surfaces

5. Control/restrict the spread of IAP within the Project footprint. Measures to reduce the potential for establishment of IAP within the Project Area and adjacent riparian areas include:

    a. The construction area will be surveyed prior to construction to determine sites in need of treatment. IAP infestations will be treated prior to the start of construction in collaboration with the ESO and MRG FU staff. Appropriate control measures will be identified and implemented in cooperation with the ESO (the contractor may be required to address weed control at site). The site will be monitored annually for invasive plants (this may need to continue for up to five years until vegetation has reestablished) in collaboration with ESO.

    b. The Contractor is responsible for all construction equipment that could transport IAPs into the Project zone. Vehicles must be thoroughly cleaned and free of soil and weed seeds prior to arrival on site. Contractor's equipment should be cleaned regularly, with additional attention to movement between sites to minimize spread of invasive plants. Contractor's equipment and vehicles should avoid staging, parking and turning around at sites where invasive plant infestations exist.

    c. To prevent the spread of IAP, the contractor will ensure that soils, seeds, and debris attached to clothing, footwear and construction equipment to be used on the Project Sites have been removed outside GNP, prior to arrival on the work site, and before leaving the area. Footwear, undercarriages, wheels, and blades/buckets will receive special attention.MRG FU staff shall monitor sensitive sites and riparian areas adjacent to project works for potential invasive plant spread. Where found, the MRG FU will control weeds appropriately according to site restrictions (i.e., mechanical control/ hand-pulling in wetland areas). All control will be consistent with Integrated Pest Management Regulations under the BC Integrated Pest Management Act.

d. Staging equipment, parking for vehicles, materials, etc. must be kept to existing hardened surfaces.

e. The Contractor is responsible for seeding all disturbed areas and exposed soils with MRG approved native seed mix to help prevent invasive plant infestations. Seeds must be worked into the soil to improve germination. Native shrub staking may be required at disturbed riparian sites where shrub establishment is required to accelerate re-vegetation and reclamation to prevent invasive plant establishment, as determined by the MRG ESO. Restoration will be implemented in collaboration with the ESO.

6. Hydroseeding or mechanical seeding of disturbed areas that will not be covered with infrastructure or asphalt (i.e., riparian areas, swales) should be completed as soon as possible in order to preclude establishment of invasive plants.

7. Effects to vegetation outside of the proposed Project footprint area should be avoided. Should impacts be anticipated, the ESO will be contacted immediately.

8. Where riparian vegetation is removed for the two culvert replacements, it is recommended that an appropriate plan for the replanting/restoration of native riparian vegetation be developed prior to completion of this phase of the project. The species and locations of riparian planting will be planned in consultation with the ESO and MRG ecologists. Experienced restoration contractors should be used to carry out this work.

9. The Contractor will develop a Fire Prevention Plan to protect vegetation and buildings. The fire prevention plan will comply with applicable Parks Canada fire prevention policies.

Fauna

1. Sequence Project tasks for most efficient completion to minimize disturbance to wildlife, including sensory impacts and human presence.

2. The Contractor shall make every effort to prevent wheel ruts or other depressions within work areas to reduce the potential to collect and store water in order to avoid possible western toad breeding.

3. If a toadlet migration is observed, construction work will temporarily be stopped and the ESO will be contacted immediately.

4. Tree and riparian vegetation clearing work should occur outside the key breeding, activity and migration periods for amphibians (typically April to October). A pre-disturbance survey should be conducted by a Qualified Environmental Professional to identify potential habitat and/or species presence within the Project areas if construction will occur during the key amphibian periods.

5. Avoid artificial lighting, increased noise and increased activity near dead and dying trees that are potential bat roost trees (PCA 2015c).

6. Remove vegetation prior to the MRG FU specific Bird Period (April 1 - August 31). Where removal of vegetation cannot occur outside of this period, approval must be obtained from the MRG FU and a pre-clearance nest surveys should be conducted by a Qualified Environmental Professional with an appropriate level of experience identifying birds and conducting nest sweeps. Should active nests be detected during surveys, consultation will occur with MRG FU staff to determine the appropriate

course of action. Most migratory birds, their nests and eggs are protected under the Migratory Birds Convention Act, 1994 (MBCA) (GoC 1994).

7. Fencing will be placed around the sewage lagoon in early August to ensure that any western toadlets that might emerge from the lagoon are directed towards the forest rather than the compound. Contractors will be briefed on western toadlet migration activities and will stop work and contact the ESO should an emergence event be observed.

Human-Wildlife Interactions

Provisions to reduce human-wildlife interactions will include but are not limited to the following.

- Notify the ESO immediately of any dens, litters, nests, carcasses (road kills or other), wildlife encounters (for species of interest as directed by the ESO), or carnivore (bears, wolves or cougars) observations on or around the worksite.
- If wildlife is observed at or near the work site, allow the animal(s) the opportunity to leave the work area to the surrounding habitat and away from areas of potential conflict.
- Parks Canada will be notified in the event of human-wildlife interactions, or activity or encounters with bears, American Pine Martens, Lynx, Wolves, Cougars, Wolverines, Porcupine, any species at risk, dens and/or nests. The following should be reported immediately to Jasper dispatch (877-852-3100), and the ESO:

  (i) aggressive encounters involving any species;

  (ii) sightings of large carnivores; or,

  (iii) observations of carcasses.

- Reports of other species or features of particular management interest (e.g., cultural resources) must be reported as soon as possible to the ESO. SARA listed species could potentially be observed at or near the Project location. Should this occur, operations in the immediate vicinity of the species should be halted and should re-commence only when the species has left the immediate area. The ESO or Resource Conservation staff will be notified immediately via Jasper Dispatch (877-852-3100). If a toad migration, snake hibernacula or a bird nest are identified, work should stop until the ESO can evaluate the situation. Work would resume once a determination is made and it is safe or appropriate to proceed.
- The contractor will ensure that all workers receive a wildlife awareness briefing, including the use of bear spray. Bear spray will be mandatory on site.
- Secure all materials that might attract wildlife (e.g. petroleum products, human food, recyclable food and drink containers and garbage).
- No feeding, baiting or luring of any wildlife (including bears, small mammals, birds); do not approach or harass wildlife in any way. Notify the ESO immediately if wildlife obtain garbage or human food. If wildlife get into attractants that have been intentionally or accidentally left out, individuals or the contractor could be charged under the *Canada National Parks Act* Regulations.

8. The Contractor shall prepare and include a plan to minimize disturbance to wildlife, including timing of work, and potentially stopping all activities while potentially dangerous and/or sensitive wildlife is in the immediate vicinity. Consultation with the MRG FU will take place prior to work commencement to determine whether there are reports of wildlife in the immediate vicinity while work is occurring.

9. Feeding, harassment or destruction of any wildlife is strictly prohibited. Wildlife encountered at or near Project locations will be allowed to passively disperse without undue harassment. Nuisance wildlife and/or any incidents involving wildlife getting into garbage or attractants will be immediately reported to Jasper dispatch (1- 877-852-3100).

10. Wildlife will be prevented from obtaining food, garbage or other domestic wastes by the Contractor and contract staff while undertaking work in National Parks. Such wildlife attractants will not be stored at the work site overnight. Lunches, coolers and food products, including waste food products, will be securely stored away from access by animals. Daily removal from the Park and off-site disposal of food scraps, food wrappers, pop cans, domestic waste, and other potential wildlife attractants is mandatory. Existing Parks Canada waste receptacles will not be used for disposal of such wastes without prior arrangement with PCA. Incidents involving wildlife accessing garbage or attractants will be reported immediately to the ESO or Resource Conservation staff.

Soil, Groundwater and Vapour Quality

1. A soil and groundwater management plan should be prepared in conjunction with the EPP. The soil and groundwater management plan should include management (i.e., soil segregation, stockpiling, and drainage control) and disposal procedures for potentially-impacted soils that may be encountered during excavation or ground disturbance activities; and, management of potentially-impacted groundwater that may need to be recovered, treated or appropriately disposed to facilitate Project activities.

2. Prevent contact of runoff water with material or soil stockpile areas. This will also act to prevent ponding and potential subsequent use of pools/vegetated depressions by amphibians over time in locations subject to continued impacts and/or of limited habitat value.

3. The worksite will be winterized using appropriate erosion and sediment control measures to ensure that sediment does not run into Rogers Creek during spring run off. Details of winterization will be provided in the EPP.

4. A Health and Safety Plan should be developed for workers that may encounter petroleum hydrocarbon contaminated soils and/or vapour in trenches or excavations (through direct contact and inhalation). Potential risks can be managed through use of PPE and proper ventilation of trenches.

5. Construction of a new fuel storage and dispensing system will occur during Phase I of the Project and will incorporate the following design features to mitigate release of fuel (Stantec 2016).

    a. All new tanks will be double walled above ground steel tanks with a vacuum monitor, level monitor and level gauge.

    b. Each tank will be equipped with an overfill valve, spill box and overfill alarm to prevent any overfill of the tank systems.

c. Each dispenser is equipped with an emergency stop button both at the dispenser and at a safe distance away. This is to shut down flow in the event of a dispenser malfunction.

d. The dispensing area and product transfer area are the same area located in front of the tanks. There is a concrete pad sloped to a drain that collects into an oil water separator.

e. The oil water separator is monitored for oil levels and will alarm should the oil levels rise above the set point. This will prevent any oil from exiting the oil water separator.

f. The installation complies with SOR 2008-197, CCME Code of Practice, and the National Fire Code 2010.

g. The installation will be completed by licensed tank installer in BC.

h. The installation commissioning will be witnessed by the Departmental Representative of Parks Canada.

Cultural Resources

1. When performing construction activities near cultural resources Site 411T5 or Site 1247T (Figure 3) a Professional Archaeologist is required to perform monitoring.
2. Clearly mark areas for clearing and remain within clearing boundaries.
3. If a cultural or historical resource is encountered or suspected to be encountered, whether an archaeologist is on site or not, work will cease immediately and ESO and MRG FU will then contact Parks Canada Terrestrial Archeology Section to determine the appropriate mitigation and protocols. Artifacts should be lift in place until Parks Canada Archeologist has been consulted.
4. If an artifacts is discovered, documentation should include what was seen, the location, description of the surrounding soil, depth from ground surface. The artifacts should also be photgraphed. This information should be submitted to MRG FU who will disseminate the information to Parks Canada Terrestrial Archeology Section.

Visitor Experience

1. The MRG FU will be kept apprised of timelines, work periods, and construction activities so that their staff (e.g., Visitor Centre and media) can provide information to the public to prevent additional safety risks for recreational users in the vicinity of the Project during construction.
2. Work spaces will be maintained in a tidy and well-kept manner and appearance.
3. The contractor is responsible for posting road signage (e.g., trucks turning, reduced speed) to ensure public safety.
4. To reduce noise and air pollution, construction equipment will be turned off when not in use, equipment and vehicles will be operated at optimal efficiency and performance, and carpooling of personnel to staging areas and the Project area will be encouraged.

5. Aesthetically displeasing visual impacts of construction can be reduced by minimizing clearing of vegetation.

6. Construction activities will take place within the designated hours which will be determined in consultation with Parks Canada.

9. PUBLIC/STAKEHOLDER ENGAGEMENT & ABORIGINAL CONSULTATION

9 a) Indicate whether public/stakeholder engagement was undertaken in relation to potential adverse effects of the proposed project:

☐☒ No

☐ Yes (describe the process to involve relevant parties and indicate how comments were taken into consideration).

9 b) Indicate whether Aboriginal consultation was undertaken in relation to potential adverse effects of the proposed project:

☐☒ No

☐ Yes (describe the process to involve relevant parties and how the results were taken into consideration).

10. SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

Residual adverse effects are defined as effects remaining after the mitigation measures are applied. In determining significance, the following criteria were considered:

- Direction;
- Magnitude;
- Geographic Extent
- Duration/Reversibility;
- Frequency; and,
- Probability.

Project impacts that can be avoided or completely mitigated are not considered to have a residual impact, and therefore, have not been rated or incorporated into the Signification of Residual Adverse Effects Table (Table 7) below.

Table 6 Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components or Key Indicators

Criteria	Definition	Natural Resources Description	Cultural Resources Description
Direction	Direction relates to the value of the effect in relation to the environment.	• Positive – net gain or benefit; effect is desirable	• Positive – an improvement over existing values or conditions
		• Neutral – no change compared with existing conditions and trends	• Neutral – no change compared with existing conditions and trends
		• Negative – net loss or adverse effect; effect is undesirable	• Negative – a less favourable change relative to existing values or conditions
Magnitude	Magnitude is the intensity of the effect, or a measure of the degree of change from existing (baseline) conditions.	• Negligible – no detectable change is expected from existing values	• Negligible – no detectable change is expected from existing values
		• Low – effect occurs that might be detectable, but is expected to be within the range of existing or guideline values, or within the range of natural variability	• Low – the change has no effect on the cultural resources setting beyond that of a nuisance (annoyance) value
		• Moderate – effect is expected to be at or to slightly exceed the limits of existing or guideline values – clearly an effect, but unlikely to be a management concern(a)	• Moderate – the change modifies the cultural resources setting, but there is no change in the system
		• High – effect is expected to exceed the limits of existing or guideline values – the effect can pose a serious risk and represents a management concern(a)	• High – the change is large enough to result in a change of cultural resources

Criteria	Definition	Natural Resources Description	Cultural Resources Description
Geographic Extent	Geographic extent refers to the spatial extent over which an environmental or socio-economic effect will occur.	• Local – the effect is confined to the Local Study Area	• Local – the effect is confined to the LSA
		• Regional – the effect extends beyond the LSA but is confined within the region (i.e, Glacier National Park)	• Regional – the effect extends to users throughout Glacier National Park
		• Beyond regional – the effect extends beyond Glacier National Park	• Beyond regional – the effect extends beyond Glacier National Park
Duration/reversibility	Duration is the period of time over which the natural or cultural resource effect will be present. The amount of time between the start and end of a Project activity or stressor, plus the time required for the effect to be reversed. Duration and reversibility are functions of the length of time the valued component (VC)/key indicator are exposed to Project activities.	• Short-term – the effect occurs during construction or during operation as a result of maintenance activities, and is reversible before or during operation	• Short-term – the effect occurs during construction or during operation as a result of maintenance activities, and is reversible before or during operation
	Reversibility is an indication of the potential for recovery of the VC/key indicator from the Project effect. Reversible implies that the effect will not result in a permanent change of state of the VC/key indicator compared to similar environments not influenced by the Project (similar being an environment of the same type, region and time period). For effects that are permanent, the effect is determined to be irreversible.	• Medium-term – the effect occurs during construction or operation and is reversible at abandonment	• Medium-term – the effect occurs during construction or operation and is reversible at abandonment
		• Long-term – the effect occurs during construction or operation and persists beyond abandonment, but is reversible	• Long-term – the effect occurs beyond the operational life of the Project, but is reversible
		• Permanent – the effect occurs during construction or operation and is irreversible	• Permanent – the effect occurs during construction or operation and is irreversible

Criteria	Definition	Natural Resources Description	Cultural Resources Description
Frequency	Frequency refers to the occurrence regularity of the effect over the duration of the Project.	• Infrequent – the effect is expected to occur rarely	• Infrequent – the effect is expected to occur rarely
	Discussions on seasonal considerations are made when they are important in the evaluation of the effect.	• Frequent – the effect is expected to occur intermittently	• Frequent – the effect is expected to occur intermittently
		• Continuous – the effect is expected to occur continually	• Continuous – the effect is expected to occur continually
Probability	Probability of occurrence is a measure of the likelihood that a Project activity will result in an effect.	• Unlikely – the effect is not likely to occur	• Unlikely – the effect is not likely to occur
		• Possible – the effect may occur, but is not likely	• Possible – the effect may occur, but is not likely
		• Probable – the effect is likely to occur	• Probable – the effect is likely to occur
		• Certain – the effect will occur	• Certain – the effect will to occur

(a) Effects that pose a management concern can require actions such as research, monitoring or recovery initiatives.

Table 7 Signification of Residual Adverse Effects

Valued Component	Key Indicator	Potential Effects Considered to be Residual	Residual Impact Criteria Rating						Significance
			Direction	Mag-nitude	Geo-graphic Extent	Duration/ Reversibility	Frequency	Probability	
Air Quality	Particulate Matter	Change in particulate matter in air during construction	Negative	Low	Local	Short-term	Frequent	Certain	Not Significant
Aquatic Resources	Fish and Fish Habitat	Change in fish behaviour, physiological damage or mortality due to increase in suspended sediment	Negative	Low	Local	Short-term	Infrequent	Possible	Not Significant
		Change in habitat quality or quantity due to increase in suspended sediment load and sediment deposition during instream work	Negative	Low	Local	Short-term	Infrequent	Possible	Not Significant

Valued Component	Key Indicator	Potential Effects Considered to be Residual	Residual Impact Criteria Rating						Significance
			Direction	Mag-nitude	Geo-graphic Extent	Duration/ Reversibility	Frequency	Probability	
Aquatic Resources	Fish and Fish Habitat	Change in habitat quality or quantity, or harm to fish due to suspended sediment load and sediment deposition from surface water run-off	Positive	Moderate	Local	Long-term	Continuous	Certain	Significant
	Surface Water Quality	Change in water quality due to deleterious substances (sediment, salts, hydrocarbons) from surface water run-off	Positive	Moderate	Local	Long-term	Continuous	Certain	Significant

Valued Component	Key Indicator	Potential Effects Considered to be Residual	Residual Impact Criteria Rating						Significance
			Direction	Mag-nitude	Geo-graphic Extent	Duration/ Reversibility	Frequency	Probability	
Flora	Invasive Plants Species	Alteration of native species composition on the Project footprint	Negative	Low to Moderate	Local	Long term	Infrequent	Possible	Not Significant
	Riparian Vegetation	Change in riparian vegetation quantity or quality due to disturbance or removal	Negative	Low	Local	Medium-term	Frequent	Certain	Not Significant
Fauna	American Pine Marten	Change in suitable habitat due to vegetation clearing	Negative	Negligible	Local	Short-term	Infrequent	Possible	Not Significant
	Black Bear and Grizzly Bear	Change in wildlife abundance due to human encounters	Negative	Low	Local	Short-term	Infrequent	Possible	Not Significant

Valued Component	Key Indicator	Potential Effects Considered to be Residual	Residual Impact Criteria Rating						Significance
			Direction	Mag-nitude	Geo-graphic Extent	Duration/ Reversibility	Frequency	Probability	
SARA Species	Western Toad	Change in wildlife abundance due to mortality from equipment	Negative	Low	Local	Short-term	Infrequent	Possible	Not Significant
	Bats (Little Myotis, Northern Myotis)	Change in suitable habitat due to vegetation clearing	Negative	Negligible	Local	Long-term	Infrequent	Possible	Not Significant
	Olive-sided Flycatcher	Change in suitable habitat due to vegetation clearing	Negative	Negligible	Local	Long-term	Infrequent	Possible	Not Significant
	Soil Groundwater and Vapour Quality	Change in soil, groundwater and vapour quality from accidental spills	Negative	Low to Moderate	Local	Long Term	Infrequent	Possible	Not Significant
Visitor Experience	General	Alteration of viewscapes and traffic delays	Negative	Low	Local	Short-term	Continuous	Certain	Not Significant

Air Quality

Particulate Matter

The operation of construction equipment during construction activities associated with excavation, soil stripping, tree clearing, and machinery emissions is anticipated to generate particulate matter from construction equipment. These effects are predicted to be negative, low in magnitude, local in geographic extent, short-term, certain, and not significant.

Aquatic Resources

Fish and Fish Habitat

There are several potential effects that could occur as a result of increased suspended sediment in Rogers Creek and Connaught Creek. During instream work associated with the replacement of the two culverts, sediment may be mobilized that will elevate TSS concentration in Rogers Creek. The effects of elevated TSS would have a negative effect on fish behaviour but is unlikely to be present in such high concentration as to cause physiological damage or mortality in Bull Trout and Mountain Whitefish. The successful implementation of mitigation measures to monitor TSS and isolate the instream work spaces will reduce the intensity and duration of elevated TSS. The effect of suspended sediment on fish behaviour, physiological damage or mortality is expected to be local, short term, and not significant during construction.

Increased suspended sediment in Rogers Creek is also predicted to cause a residual effect of the change in fish habitat quality or quantity due to the increase in suspended sediment during instream work. The isolation of the instream work area and the TSS monitoring that will occur during instream work is predicted to mitigate the intensity and duration of increased TSS, and conversely the effects of TSS on fish habitat. Assuming the successful implementation of mitigation measures, the magnitude of this change is expected to be low, local in geographic extent, short term, infrequent, and not significant.

Project activities could also affect concentrations of suspended sediment, salts, and hydrocarbons entering Rogers Creek from surface water run-off from the Project area. The stormwater upgrades associated with the Project are expected to reduce the concentration of suspended sediment entering Rogers Creek by approximately 80% and as well as reduce between 90% to 95% of the free oil and hydrocarbon loading. In Phase II of the Project a concrete containment wall will be constructed around the eastern and northern edges of the Compound that will mitigate migration of runoff and contaminants outside of the footprint of the Compound. The reduction in suspended sediment is expected to create a positive change in the quality and quantity of fish habitat as well as a positive change in water quality from the reduction of deleterious substances entering Rogers Creek. The magnitude of this positive change on habitat quality and quantity and water quality is expected to be moderate with a local geographic extent over a long-term duration with a continuous frequency and a certain probability for both positive residual effects.

No residual adverse effects on aquatic resources are predicted as effective implementation of appropriate mitigation is expected to reduce or eliminate the following potential effects:

- Change in the quality or quantity of fish habitat due to alteration of instream habitat. The existing instream footprint of the culverts is nearly identical to the footprint of the proposed culverts, and the increase in culvert diameter and installation of open-bottom replacement culvert will provide enhanced fish passage than existed within the smaller diameter culverts that are currently in place;

- Change in water temperature as a result of vegetation clearing and retention of water in the stormwater detention ponds being released into Rogers Creek.
- Change in water quality due to the potential release of deleterious substances from dewatering watering that may be encountered during sanitary sewer excavation of removal of the existing underground fuel tank; and,
- Physical damage to fish during instream work.

Flora

Invasive Plant Species (IAP)

A possible residual effect may occur to vegetation composition resulting from the potential introduction of IAP. Several mitigation measures have been recommended in Section 8 and will serve to reduce impacts from IAP during construction. However, operations of the Project will require continuous monitoring and management of these species indefinitely. The ability of IAP to colonize quickly and proficiently adjacent to areas of disturbance is very efficient, and controlling these species can take substantial effort and cost to effectively control them. During the operation of the Project, a low to moderate magnitude effect is expected because 90% of the Project will occur on a previously disturbed footprint. The effect is predicted to be local, long-term, infrequent, possible, and not-significant.

Riparian Vegetation

The residual effect of clearing riparian vegetation will change the quantity of riparian vegetation as a result of Project activities. This residual effect is described as negative, low in magnitude, and local in geographic extent because the clearing will only occur in the Project footprint. The effect is considered to be of medium-term duration because the riparian zones will be re-vegetated as soon as practical following construction, however, there will be a time delay before the riparian vegetation is functioning and able to provide value to the aquatic ecosystem. The effect is determined to be not significant based on the mitigation measures in place including limiting the footprint of the clearing area and the re-vegetation of the area after construction.

Fauna

American Pine Marten

A predicted residual effect is expected for a change in suitable habitat due to vegetation clearing. Pine Martens are commonly associated with mature coniferous forest and the clearing of 1.2 ha of mature coniferous trees could have potential to remove Pine Marten habitat. The relative small size of the Project footprint and the mobility of pine martens to use alternate forested areas determined the effect to be negligible and not significant.

Department/Agency/Institution: **Parks Canada Agency**	Date of Request: 2016-03-15
Expert's Name & Contact Information: Bryan Chruszcz, M.Sc., Mount Revelstoke and Glacier National Parks, Box 350 301 W. 3rd Street, Revelstoke, BC V0E2S0 Telephone 250-837-7560, Facsimile 250-837-7536 Bryan.Chruszcz@pc.gc.ca mailto:alexandra.taylor@pc.gc.camailto:alexandra.taylor@pc.gc.ca	Title: Ecologist Team Leader
Expertise Requested: BIA review and data provision	
Response: Provided feedback for BIA and data for inclusion	

15. DECISION

Taking into account implementation of mitigation measures outlined in the analysis, the Project is:

☒ not likely to cause significant adverse environmental effects.

☐ likely to cause significant adverse environmental effects.

NOTE: If the Project is identified as likely to cause significant adverse effects, CEAA 2012 prohibits approval of the Project unless the Governor in Council (Cabinet) determines that the effects are justified in the circumstances. A finding of significant effects therefore means the Project CANNOT go ahead as proposed.

FOR SARA REQUIREMENTS:

☒ There are no residual adverse effects to species at risk and therefore the SARA-Compliant Authorization Decision Tool was not required

OR, the SARA-Compliant Authorization Decision Tool was used and determined:

☐ There is no contravention of SARA prohibitions

☐ Project activities contravene a SARA prohibition and CAN be authorized under SARA

☐ Project activities contravene a SARA prohibition and CANNOT be authorized

16. RECOMMENDATION AND APPROVAL

Prepared by: EIA author (name & position): Golder Associates Ltd. Bobby Bedingfield, Fisheries Biologist Panagiota Athanasopoulos, Senior Hydrogeologist BIA Reviewers: Darryl Arsenault, Senior Fisheries Biologist	Date: 2016-04-05
Recommended by: Bruno Delesalle, Resource Conservation Manager	Date: APRIL 06/2016.
Recommended by: Functional manager of the Project (name): Ron Larsen FOR	Date: APRIL 6 2016
Approved by: Name & position: (*Field Unit Superintendent, Director of a Waterway)*: Nicholas Irving, Field Unit Superintendent	Date: APRIL 6 2016
Signature: FOR	

18. NATIONAL IMPACT ASSESSMENT TRACKING SYSTEM

☐ Project registered in tracking system

☒ Not yet registered *(CEAA 2012 requires PCA submit a report to Parliament annually. EIAs must be entered in the tracking system* ***by the end of April*** *to enable reporting.*

*****Ensure that all required mitigation measures and conditions (e.g. follow-up monitoring requirements) are included in project permits and authorizations*****

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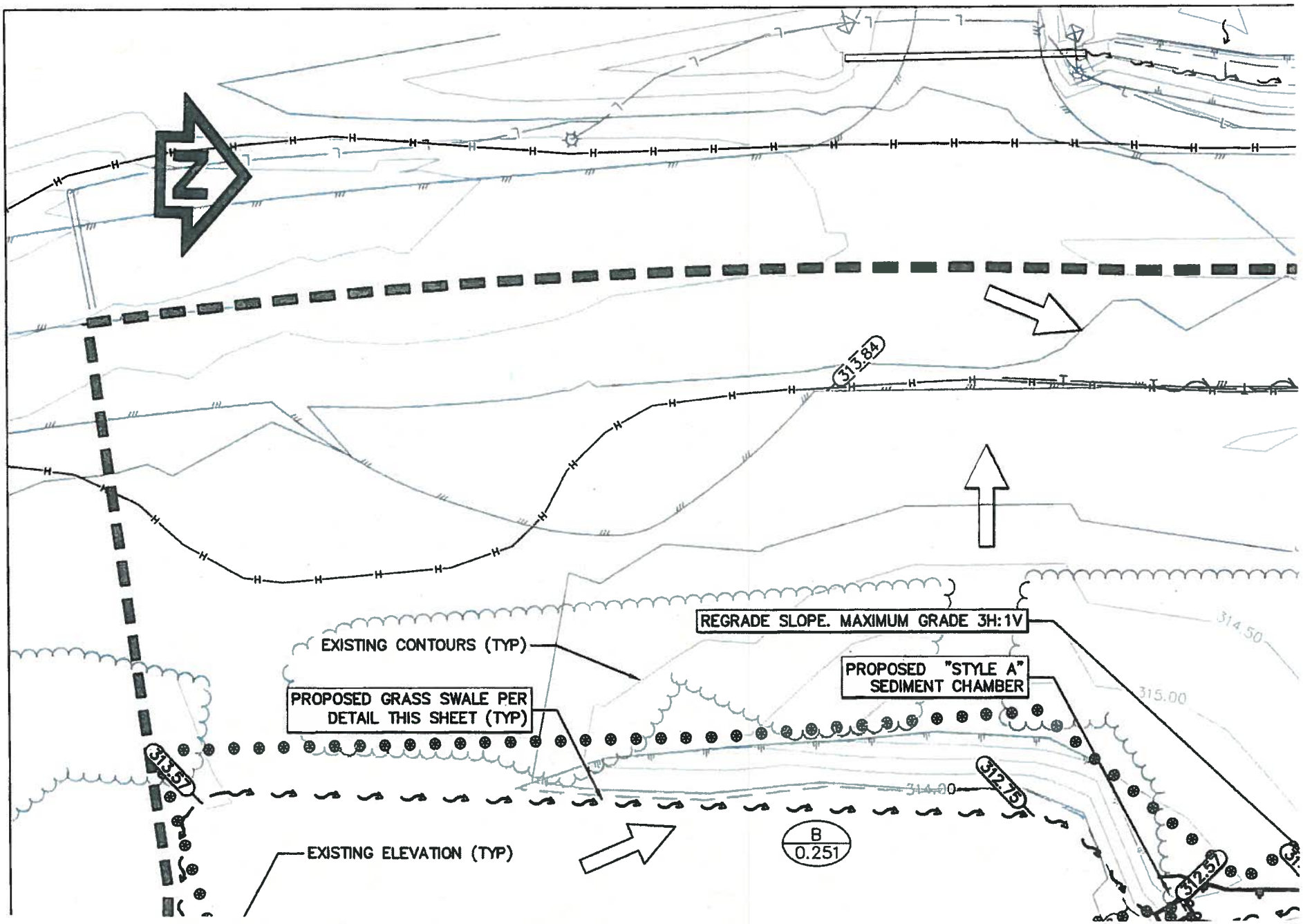
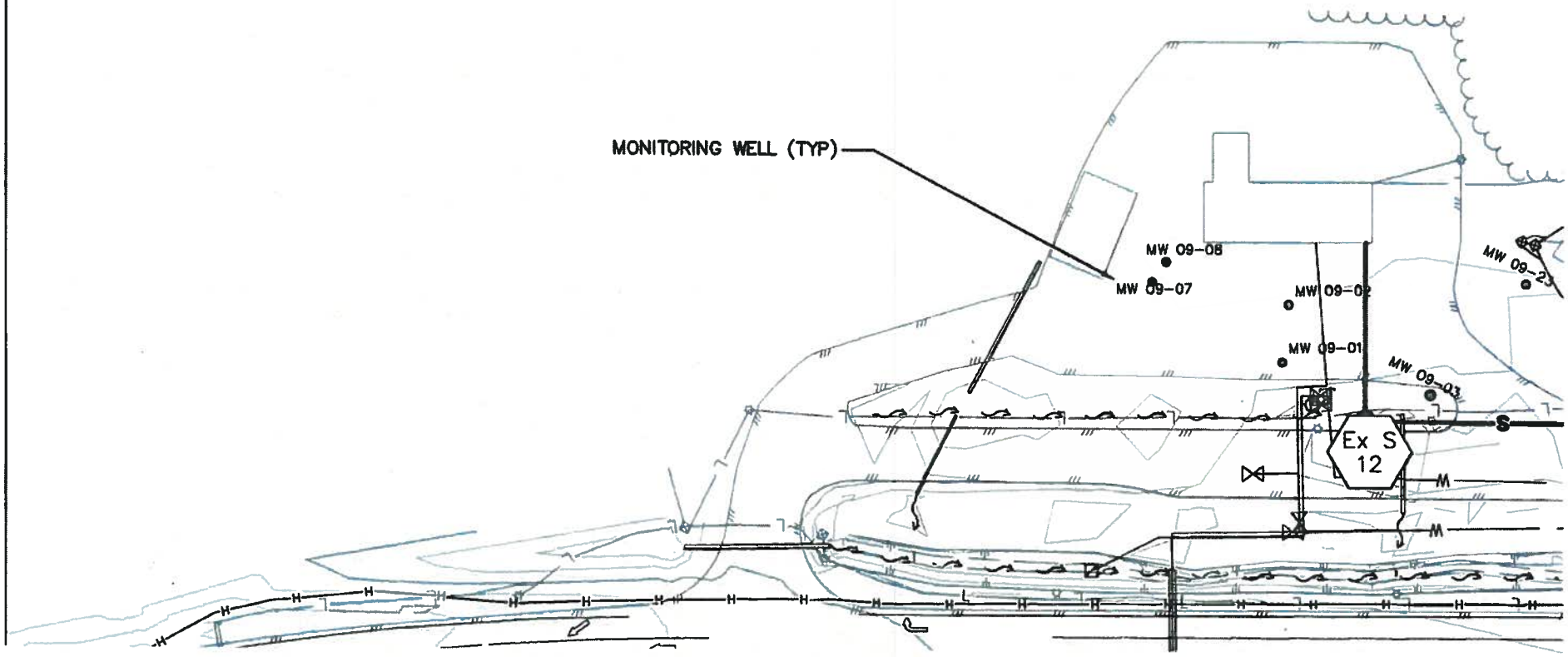
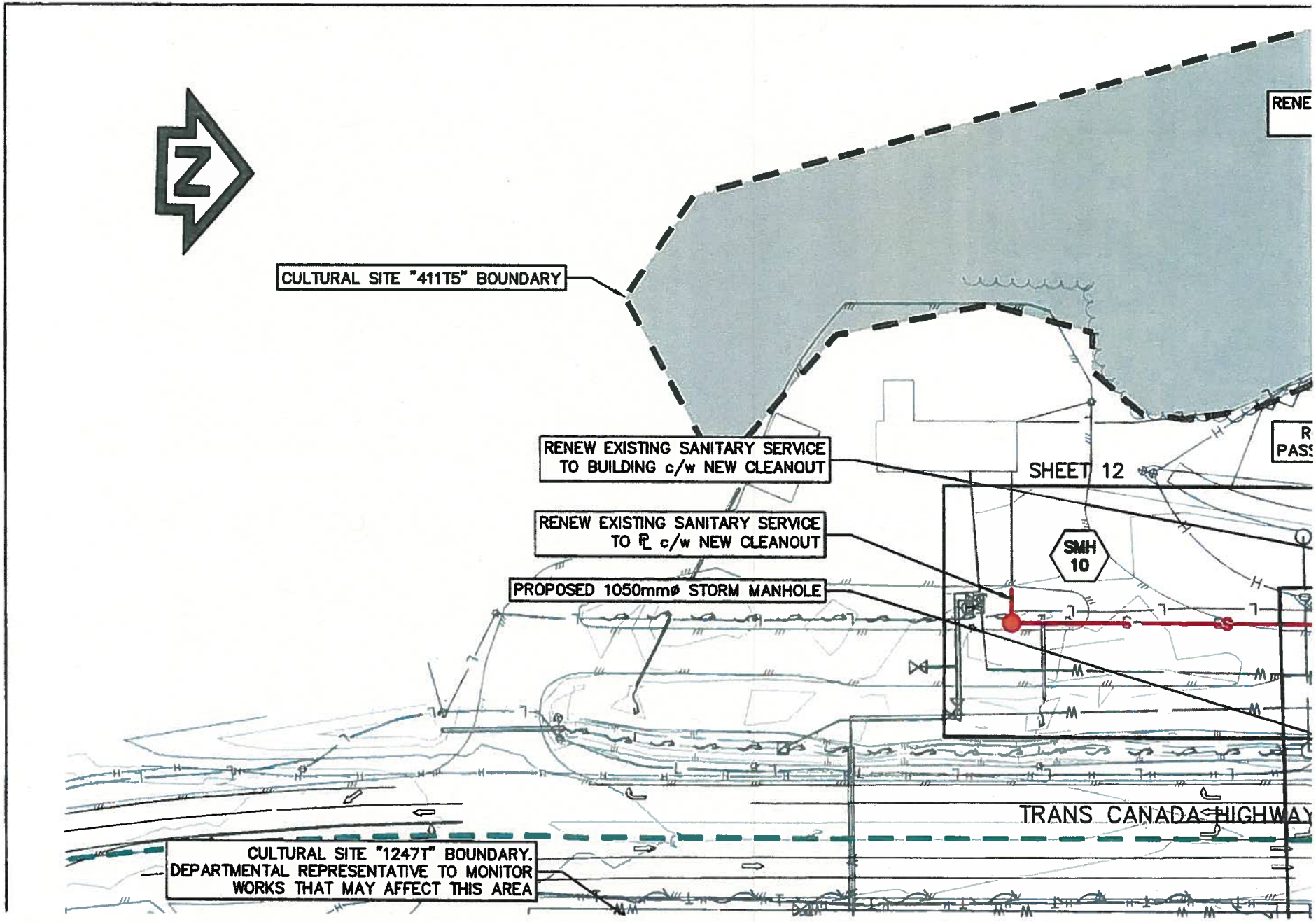
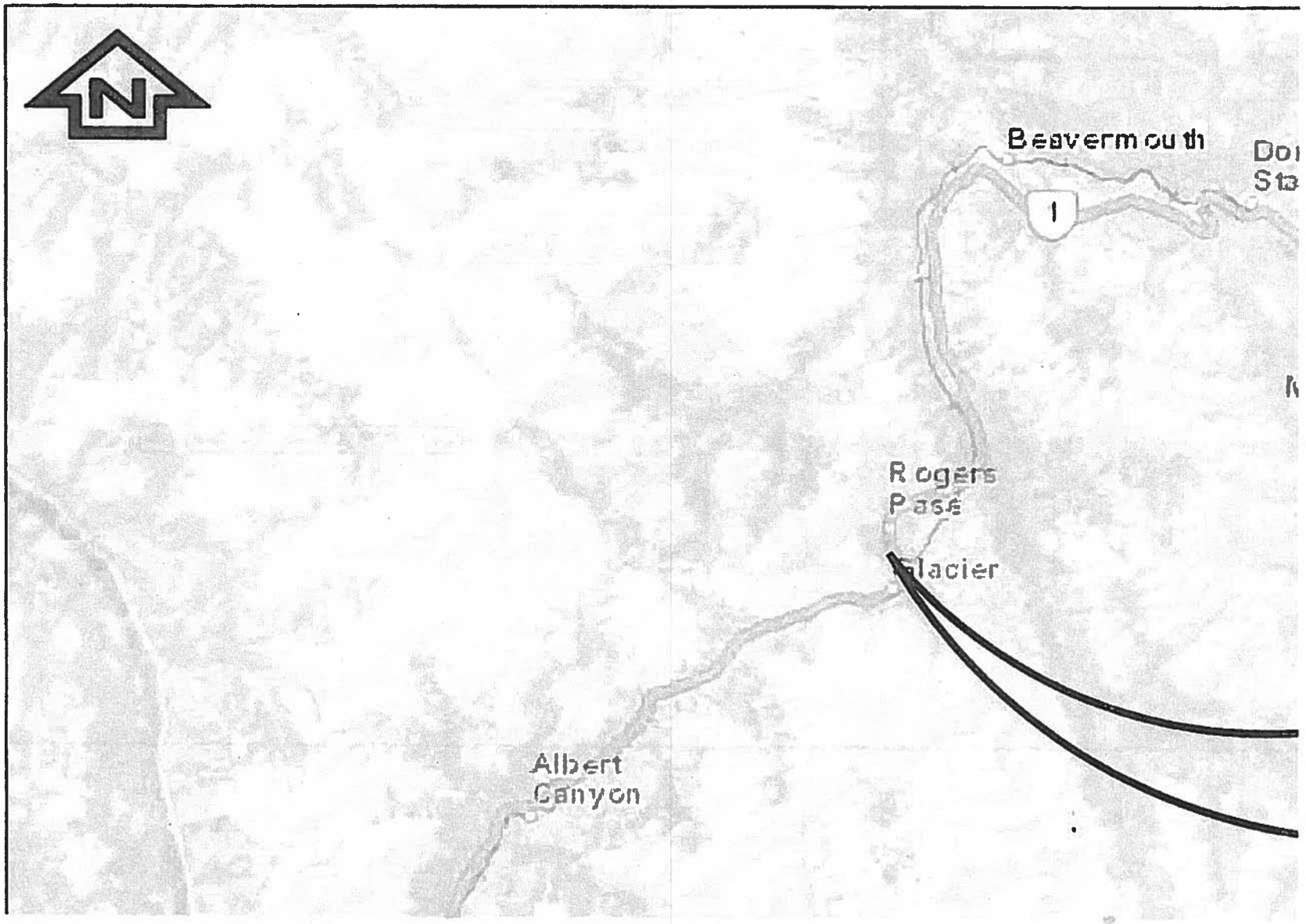

313.84
REGRADE SLOPE. MAXIMUM GRADE 3H:1V
EXISTING CONTOURS (TYP)
PROPOSED "STYLE A" SEDIMENT CHAMBER
PROPOSED GRASS SWALE PER DETAIL THIS SHEET (TYP)
314.50
315.00
313.57
314.00
312.75
B
0.251
EXISTING ELEVATION (TYP)
312.5

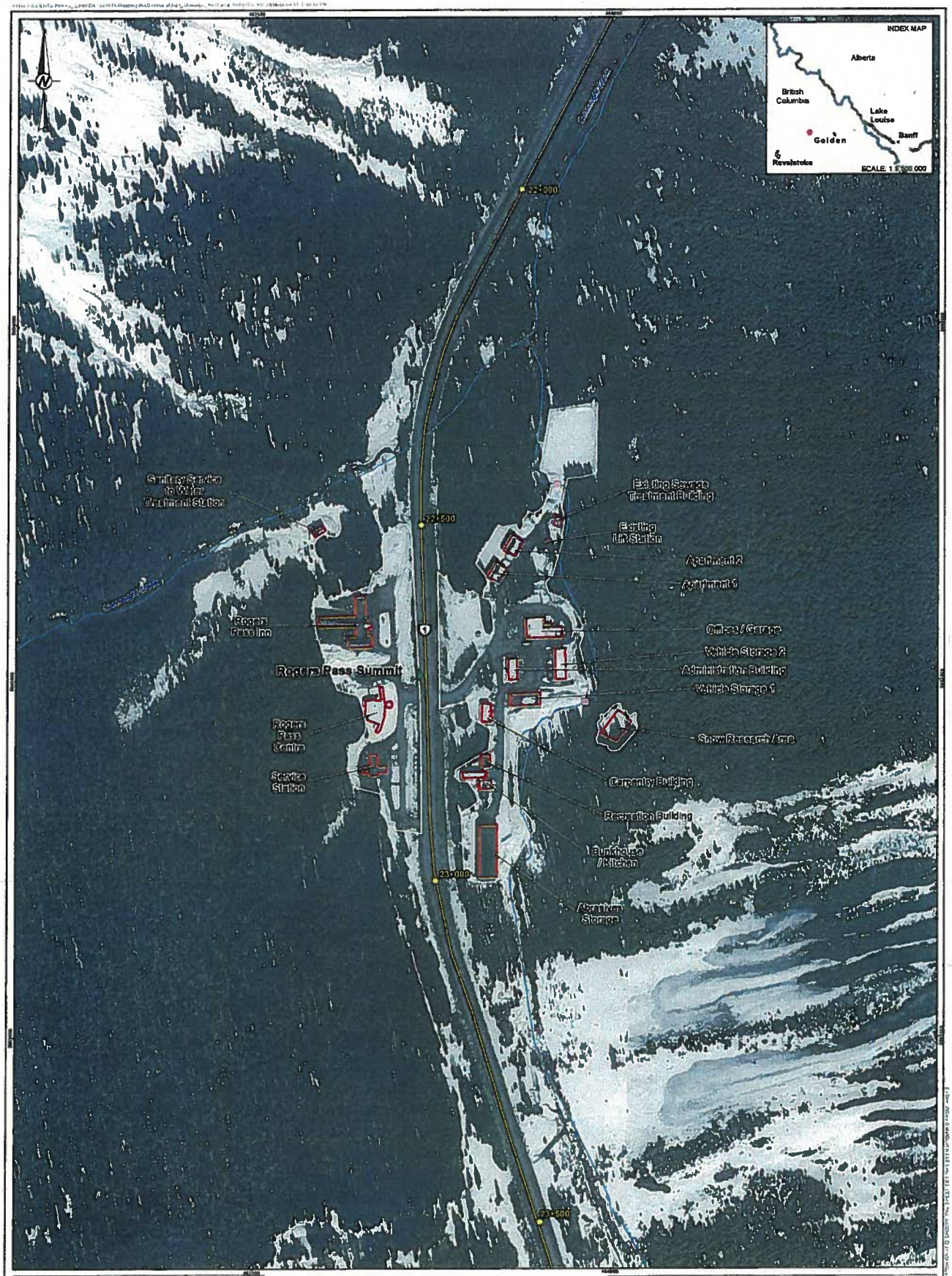
CRUSH AND/OF
ALL EXISTING
SERVICES WEST
MANHOLES AN




CULTURAL SITE "411T5" BOUNDARY
RENE
RENEW EXISTING SANITARY SERVICE TO BUILDING c/w NEW CLEANOUT
SHEET 12
RENEW EXISTING SANITARY SERVICE TO ℄ c/w NEW CLEANOUT
SMH 10
PROPOSED 1050mmø STORM MANHOLE
TRANS CANADA HIGHWAY
CULTURAL SITE "1247T" BOUNDARY. DEPARTMENTAL REPRESENTATIVE TO MONITOR WORKS THAT MAY AFFECT THIS AREA


N
Beavermouth
1
Rogers
Pass
Albert
Canyon

APPENDICES



LEGEND

- CULVERT
- ROGERS PASS SUMMIT
- TRANS-CANADA HIGHWAY KILOMETRE POST WITHIN GLACIER NATIONAL PARK
- TRANS-CANADA HIGHWAY (TCH)
- WATERCOURSE
- BUILDING INFRASTRUCTURE
- EXISTING FOOTPRINT

0 200 400

1:5 000 METRES

REFERENCE(S)

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4. CULVERTS DIGITIZED BY GOLDER ASSOCIATES LTD.

DATUM NAD 83 PROJECTION UTM ZONE 11

CLIENT
PARKS CANADA

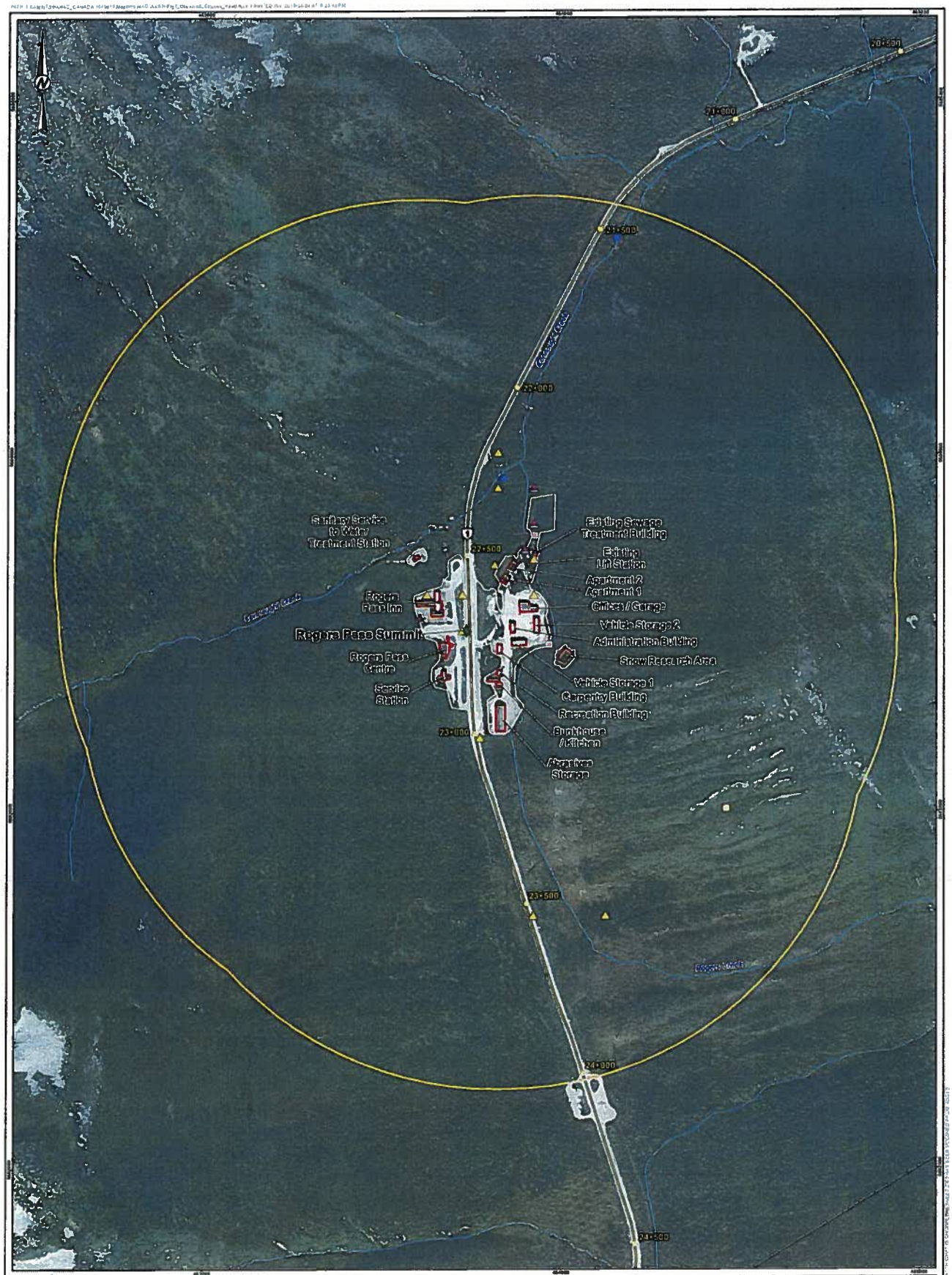
PROJECT
ROGERS PASS STORM WATER AND GRADING UPGRADES

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-04-04
DESIGNED	BB
PREPARED	CH
REVIEWED	DJA
APPROVED	DJA

TITLE
OVERVIEW

PROJECT NO	CONTROL	REV	FIGURE
1649619	1000	0	1



LEGEND

- CULVERT
- ROGERS PASS SUMMIT
- TRANS-CANADA HIGHWAY KILOMETRE POST WITHIN GLACIER NATIONAL PARK

OBSERVED SPECIES

- AMERICAN PINE MARTEN
- BULL TROUT
- WESTERN ST JOHNS-WORT
- WESTERN TOAD

- CANADIAN PACIFIC RAILWAY
- TRANS-CANADA HIGHWAY (TCH)
- WATERCOURSE
- BUILDING INFRASTRUCTURE
- EXISTING FOOTPRINT
- LOCAL STUDY AREA (1 km RADIUS)

0 400 800

1:10 000 METRES

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DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
PARKS CANADA

PROJECT
ROGERS PASS STORM WATER AND GRADING UPGRADES

CONSULTANT
Golder Associates

YYYY-MM-DD	2018-04-04
DESIGNED	SB
PREPARED	SG
REVIEWED	DJA
APPROVED	DJA

TITLE
OBSERVED SPECIES WITHIN 1 KILOMETRE OF PROJECT LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
1849619	1000	0	2

LEGEND

- CULVERT
- ROGERS PASS SUMMIT
- TRANS-CANADA HIGHWAY KILOMETRE POST WITHIN GLACIER NATIONAL PARK
- CANADIAN PACIFIC RAILWAY
- TRANS-CANADA HIGHWAY (TCH)
- WATERCOURSE
- CULTURAL RESOURCE SITE
- BUILDING INFRASTRUCTURE
- EXISTING FOOTPRINT
- LOCAL STUDY AREA (1 km RADIUS)

0 400 800

1:10 000 METRES

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DATUM NAD 83 PROJECTION UTM ZONE 11

CLIENT
PARKS CANADA

PROJECT
ROGERS PASS STORM WATER AND GRADING UPGRADES

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-04-04
DESIGNED	BB
PREPARED	CH
REVIEWED	DJA
APPROVED	DJA

TITLE
CULTURAL SITES WITHIN PROJECT LOCATION

PROJECT NO	CONTROL	REV	FIGURE
1546618	1000	0	3

APPENDICES

Public Works and Government Services Canada | Travaux publics et Services gouvernementaux Canada

PRELIMINARY HAZARD ASSESSMENT FORM

Project Number:	**R. 076550.001**
Location:	**Rogers Pass Maintenance Compound Rogers Pass, BC**
Date:	October 18, 2016
Name of PWGSC Departmental Representative and Senior Project Manager:	Tom Dunphy PH (604) 775 6822
Name of Client:	Parks Canada
Name of Client Project Co-ordinator	Ron Larsen

Site Specific Orientation Provided at Project Location Yes ● No ○

Notice of Project Required Yes ● No ○

NOTE:
PWGSC REQUIRES A Notice of Project FOR ALL CONSTRUCTION WORK RELATED ACTIVITIES

NOTE:
OHS law is made up of many municipal, provincial, and federal acts, regulations, bylaws and codes. There are also many other pieces of legislation in British Columbia that impose OHS obligations.

Important Notice: This hazard assessment has been prepared by PWGSC for its own project planning process, and to inform the service provider of actual and potential hazards that may be encountered in performance of the work. PWGSC does not warrant the completeness or adequacy of this hazard assessment for the project and the paramount responsibility for project hazard assessment rests with the service provider.

TYPES OF HAZARDS TO CONSIDER	Potential Risk for:				COMMENTS
Examples: Chemical, Biological, Natural, Physical, and Ergonomic	PWGSC, OGD's, or tenants		General Public or other contractors		Note: When thinking about this pre-construction hazard assessment, remember a **hazard** is anything that may cause harm, such as chemicals, electricity, working from heights, etc; the **risk** is the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious the harm could be.
Listed below are common construction related hazards. Your project may include pre-existing hazards that are not listed. Contact the Regional Construction Safety Coordinator for assistance should this issue arise.	**Yes**	**No**	**Yes**	**No**	

Canada

Typical Construction Hazards					
Concealed/Buried Services (electrical, gas, water, sewer etc)	Yes		Yes		
Slip Hazards or Unsound Footing	Yes		Yes		
Working at Heights		No		No	
Working Over or Around Water	Yes		Yes		
Heavy overhead lifting operations, mobile cranes etc.	Yes		Yes		
Marine and/or Vehicular Traffic (site vehicles, public vehicles, etc.	Yes		Yes		
Fire and Explosion Hazards	Yes		Yes		
High Noise Levels	Yes		Yes		
Excavations	Yes		Yes		
Blasting		No		No	
Construction Equipment	Yes		Yes		
Pedestrian Traffic (site personnel, tenants, visitors, public)	Yes		Yes		
Multiple Employer Worksite	Yes		Yes		Example: Contractor working in an occupied Federal Employee space.
Electrical Hazards					**Comments**
Contact With Overhead Wires	Yes		Yes		
Live Electrical Systems or Equipment	Yes		Yes		
Other:					
Physical Hazards					
Equipment Slippage Due To Slopes/Ground Conditions	Yes		Yes		
Earthquake		No		No	
Tsunami		No		No	
Avalanche	Yes		Yes		
Forest Fires	Yes		Yes		
Fire and Explosion Hazards	Yes		Yes		
Working in Isolation		No		No	
Working Alone		No		No	
Violence in the Workplace	Yes		Yes		
High Noise Levels	Yes		Yes		
Inclement weather	Yes		Yes		
High Pressure Systems					TBD
Other:					
Hazardous Work Environments					
Confined Spaces / Restricted Spaces					Review and provide confined space assessment(s) from PWGSC or client confined space inventories. Refer to PWGSC Standard on Entry into Confined Spaces. Contact the Regional Construction Safety Coordinator.
Suspended / Mobile Work Platforms		No		No	
Other:					

Biological Hazards					
Mould Proliferations		No		No	
Accumulation of Bird or Bat Guano	Yes		Yes		
Bacteria / Legionella in Cooling Towers / Process Water		No		No	
Rodent / Insect Infestation		No		No	
Poisonous Plants					TBD
Sharp or Potentially Infectious Objects in Wastes	Yes		Yes		
Wildlife	Yes		Yes		
Chemical Hazards					
Asbestos Materials on Site		No		No	
Designated Substance Present		No		No	
Chemicals Used in work	Yes		Yes		
Lead in paint					TBD
Mercury in Thermostats or Switches					TBD
Application of Chemicals or Pesticides		No		No	
PCB Liquids in Electrical Equipment		No		No	
Radioactive Materials in Equipment	Yes			No	Nuclear Densometer
Other:					
Contaminated Sites Hazards					
Hazardous Waste					TBD
Hydrocarbons	Yes		Yes		
Metals	Yes		Yes		
Other:					

Security Hazards					**Comments**
Risk of Assault		No		No	
Other:					
Other Hazards					

Other Compliance and Permit Requirements[1]	YES	NO	Notes / Comments[2]
Is a Building Permit required?		No	
Is an Electrical permit required?			TBD
Is a Plumbing Permit required?			TBD
Is a Sewage Permit required?		No	
Is a Dumping Permit required?			TBD (Materials to be disposed at an offsite disposal facility)
Is a Hot Work Permit required?			TBD
Is a Permit to Work required?	Yes		
Is a Confined Space Entry Permit required?			TBD
Is a Confined Space Entry Log required			TBD
Discharge Approval for treated water required			TBD

Notes:

(1) Does not relieve Service Provider from complying with all applicable federal, provincial, and municipal laws and regulations.

(2) TBD means To Be Determined by Service Provider.

Service Provider Acknowledgement: We confirm receipt and review of this Pre-Project Hazard Assessment and acknowledge our responsibility for conducting our own assessment of project hazards, and taking all necessary protective measures (which may exceed those cited herein) for performance of the work.			
Service Provider Name			
Signatory for Service Provider		**Date Signed**	
RETURN EXECUTED DOCUMENT TO PWGSC DEPARTMENTAL REPRESENTATIVE PRIOR TO ANY WORK COMMENCING			

WEDLER ENGINEERING

Date 24-Mar-17
Estimator SBR
Checked ARG

Wedler Project No. V15-0218/C
PWGSC Project No.: R.076550.001

PWGSC - Class 'A' Cost Estimate
Maintenance Compound Infrastructure Improvements - Phase 2
Rogers Pass, Glacier National Park, BC

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
Site Mobilization & Demobilization	l.sum	1	$250,000.00	$250,000
Clearing & Grubbing				
Swale ROW	ha.	0.11	$20,000.00	$2,200
Asphalt Resurfacing				
Excavation - Off-site Crushing & Disposal (300mm thick)	sq.m	16800	$22.50	$378,000
Place Subgrade Materials	cu.m.	2400	$25.00	$60,000
Granular Base	sq.m	22000	$20.00	$440,000
Tie Asphalt to Existing	ea	1	$1,500.00	$1,500
100mm Asphalt Paving	sq.m.	22000	$57.00	$1,254,000
Stormwater Management				
Hydro Seeding	sq.m	1200	$2.25	$2,700
Proposed Concrete Lined Swales (8mm)	lin.m.	30	$800.00	$24,000
Excavation - Offsite Disposal	cu.m	100	$16.00	$1,600
600mm Catch Basin	each	6	$4,000.00	$24,000
200mm PVC Service Leads	l.m	100	$200.00	$20,000
450mm HDPE Culvert	l.m	75	$350.00	$26,250
1000mm HDPE Culvert	l.m	100	$300.00	$30,000
Concrete Headwall - Inlet	each	2	$6,000.00	$12,000
Concrete Headwall - Outlet	each	1	$4,500.00	$4,500
Rip Rap Armouring Class 10kg	cu.m	20	$50.00	$1,000
Drain Rock (cobble)	cu.m	795	$75.00	$59,625
Imported granular fill	cu.m	3410	$20.00	$68,200
Stormceptor 750	each	4	$24,000.00	$96,000
3152 Style Precast Chambers	each	1	$9,000.00	$9,000
5212 Style Precast Chambers	each	13	$17,500.00	$227,500
Trench Drain	l.m	40	$125.00	$5,000
Temporary Sediment Control	l.s	1	$25,000.00	$25,000
Contaminated Soil	cu.m	100	$75.00	$7,500
Sanitary Replacement				
100mm Sanitary Services	l.m	60	$200.00	$12,000
200mm PVC	l.m	230	$325.00	$74,750
1050 Manholes	each	3	$7,500.00	$22,500
Temporary Paving	sq.m	240	$55.00	$13,200
Contaminated Soil	cm	100	$75.00	$7,500
Snow Barrier Fence				
Reinforced Concrete Panel Fence - 4m high				
W360x110 HDG Post (supply)	ea.	58	$3,000.00	$174,000
W360x110 HDG Post (install)	ea.	58	$1,000.00	$58,000
3.65x2.00m Reinfocred Concrete Panels (supply)	ea.	110	$1,500.00	$165,000
3.65x2.00m Reinfocred Concrete Panels (install)	ea.	110	$600.00	$66,000
Reinforced Concrete Alfabloc Fence - 4m high	l.m	125	$2,725.00	$340,625
Misc.				
Concrete Vehicle Barrier	l.m	75	$150.00	$11,250
Adjust Montoring Well Elevations	l.s	1	$5,000.00	$5,000
Reinforced Concrete Pad - Abrasive & Garage	cu.m	90	$900.00	$81,000
Water Stand-pipe	l.s	1	$7,500.00	$7,500
Maintenance Compound Improvements Works Sub-total				**$4,067,900**
Add 10% Contingency				**$406,790**
Maintenance Compound Improvements Works Total				**$4,474,690**

WEDLER ENGINEERING

Date	24-Mar-17
Estimator	SBR
Checked	ARG
Wedler Project No.	V15-0218/C
PWGSC Project No.:	R.076550.001

PWGSC - Class 'A' Cost Estimate
Maintenance Compound Infrastructure Improvements - Phase 2
Rogers Pass, Glacier National Park, BC

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE

Notes & Assumptions

- Taxes are not included.
- Price shown is for construction labour and materials.
- Fueling DEF system not included.
- Construction works proceed during summer months.
- Minimal deliterious material shall be encountered during earthworks.
- Excavated native material can be re-used for all other utility trenches.

27 March 2017