LYLE CREEK BRIDGE NO. 6450
REPLACEMENT

GEOTECHNICAL INVESTIGATIONS SUMMARY
AND RECOMMENDATIONS
PROJECT # 23755-0000

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# GEOTECHNICAL INVESTIGATIONS SUMMARY AND RECOMMENDATIONS
## PROPOSED LYLE BRIDGE REPLACEMENT (STRUCTURE NO. 6450)

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1.0 INTRODUCTION

The Ministry of Transportation and Infrastructure (MOTI) plans to replace Lyle Bridge No. 6450, which is located along Highway 31A, approximately 2 km west of Kaslo, BC. In conjunction with replacement of the bridge superstructure, MOTI is also considering minor adjustments to the bridge approach and highway curvature, which will improve public safety on Highway 31A.

The MOTI Geotechnical and Material Engineering Group has completed a geotechnical investigation to facilitate planning and foundation design of the new structure. The field investigation program included a site reconnaissance with the design team on July 17, 2017, and mud rotary test hole drilling on September 18-22, 2014. Asphalt pavement auguring was also completed on July 15, 2016.

The factual results of the geotechnical investigations are summarized, and this data is used to develop the geotechnical recommendations for the design of the new bridge structure.

2.0 SCOPE OF WORK AND PROPOSED BRIDGE STRUCTURE

We understand that the new bridge crossing will be a single span, two-lane bridge, approximately 16 m long, over Lyle Creek. The proposed bridge deck elevation will be approximately 0.8 m higher than the existing bridge deck elevation and the centre line alignment will shift slightly south. It is anticipated that approach fills up to 10 m high will be required at both abutments. The bridge crosses Lyle Creek on Highway 31A approximately 22 km west of Kaslo BC.

The existing bridge was constructed in 1953 and a review of historic construction drawings indicates that the bridge abutments are founded on spread footings. The existing bridge span is approximately 6 m and the roadway width is approximately 7.3 m. A search for geotechnical files for this bridge, produced no additional information.

3.0 GEOTECHNICAL SITE INVESTIGATION

3.1 Site Description
Lyle Bridge is located on the east side of a mountainous pass separating New Denver and Kaslo BC. A broad valley that begins near Kaslo gains elevation rising to the pass; Hwy 31A traverses along the north side of this valley several metres above the valley floor and the Kaslo river. The gradient of the highway and Kaslo River around Lyle Creek Bridge is approximately 2% to 4%. Lyle Creek, which Lyle Creek Bridge Crosses, is a steep mountain creek fed by Glaciated terrain and is a tributary of the Kaslo River. The terrain upslope of the highway rises steadily to alpine peaks and the terrain between the existing embankments and the Kaslo River is generally flat and located within the flood plain of the Kaslo River. During the site reconnaissance the flood plain was noted to likely contain many areas with thick deposit of organic material estimated to be 1 m in thickness.

3.2 Geotechnical Investigation – Mud Rotary Drilling
The mud rotary geotechnical field investigation was completed between September 18-22, 2014, during which time four test holes were drilled to depths up to 17.4 m below the ground surface. Test holes TH14-01 and TH14-04 were drilled approximately 3 m south of the south abutment on the existing
highway in the northbound and southbound travel lanes respectively. Test holes 14-02 and 14-03 were drilled approximately 3 m north of the north abutment on the existing highway in the northbound and southbound travel lanes respectively. The test hole locations are shown on the site plan figure in Appendix A.

All test holes were drilled with a Mobile B53 truck-mounted drill rig supplied and operated by Sea to Sky Drilling of Coquitlam, BC. Standard Penetration Testing (SPT) was completed at 5 foot intervals within the test holes to determine the relative density of the materials encountered and to retrieve representative samples. Where difficult ground was encountered, the test holes were advanced with a tricone carbide drill bit. Within bedrock strata, continuous rock coring was completed using HQ triple tube coring equipment to obtain rock core samples.

The fieldwork was carried out under full time inspection by Mike Smallwood (Sea to Sky Drilling) who logged the soil conditions encountered in the test holes, and brought representative samples to the MOTI Nelson office for detailed examination and selective laboratory testing. Laboratory testing was completed by Walgren Soil Testing.

### 3.3 Pavement Coring

The pavement drilling field investigation was completed on July 15, 2016, during which time eleven auger holes were drilled to confirm the thickness of the asphalt pavement, and identification of the subgrade directly below the asphalt layer. The auger holes were put down to depths between 0.9 and 3.0 m below the existing road surface within the travelling lane and shoulder of the existing alignment. The auger holes were out down with a solid stem augers mounted on the Mobile B-53 truck-mounted drill rig identified above. The asphalt pavement auger hole locations are shown on the site plan figure in Appendix A.

### 3.4 Encountered Conditions

Detailed descriptions of the soil and groundwater conditions encountered within both the mud rotary test holes and auger holes are presented on the Test Hole logs within Appendix A and B, respectively, following the text of this report.

The generalized subsurface conditions can be summarized as follows:

- 12 to 14.5 m of Loose to Compact SAND and Gravel colluvium deposits. Like most colluvium deposits the encountered composition is variable and generally contain low proportions of silt and clay, as well as a large number of cobbles and boulders.
- Bedrock, identified as Phyllite, underlies the SAND and Gravel. The upper 1 to 2.5 m of the bedrock is considered to be weathered, as it was penetrated by the carbide and tri-cone drill bits. Based on visual examination of sampled rock cores and simple field methods of strength determination the estimated Unconfined Compressive Strength (UCS) is 20 MPa and the Rock Quality Designation (RQD) is 70%.

A summary of the encountered conditions is provided in Table 1. The exposed soils in the banks immediately adjacent to the creek were observed to be comprised of loose sand and gravels with cobbles and boulders. This appears consistent with the NTS 82K/03 MOE 1979 Soils and Landforms Geological map which indicates medium to course colluvium deposits (CE3).
Table 1: Summary of Encountered Conditions

<table>
<thead>
<tr>
<th>Test hole. (Ground Surface Elevation)</th>
<th>Stratigraphy – observed unit thickness provided (bottom elevation of unit indicated in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loose to Compact Sand and Gravel</td>
</tr>
<tr>
<td>TH14-01 (el. 960.2 m)</td>
<td>13.6 m GP/SB (el. 946.6 m)</td>
</tr>
<tr>
<td>TH14-02 (el. 960.1 m)</td>
<td>12.2 m GP/SB (el. 947.9 m)</td>
</tr>
<tr>
<td>TH14-03 (el. 960.0 m)</td>
<td>13.3 m GP/SB (el. 946.7 m)</td>
</tr>
<tr>
<td>TH14-04 (el. 960.1 m)</td>
<td>14.3 m GP/SB (el. 944.8 m)</td>
</tr>
</tbody>
</table>

The pavement auger holes put down on site indicate that the thickness of asphaltic concrete ranges from 50 mm to 250 mm along the existing alignment. The Travel Lanes range from 75 mm to 250 mm with a mean of 190 mm. The shoulders range from 50 mm to 200 mm with a mean of 100 mm. The existing road base encountered generally consists of compact sand and gravel to compact sand and gravel with some fines.

3.5 Laboratory Testing
Following a detailed examination of the samples collected from the field investigation program, routine laboratory testing was carried out in 2014 on selected samples recovered from the drilling program for the purposes of soil classification. A total of 12 gradation analysis, and 12 moisture content measurements were carried out on disturbed soil samples collected from the four test holes. The results are summarized in more detail on the test sheets provided in Appendix C. Table 3 below summarizes the location and results of the laboratory testing.

Table 2 summarizes the results of the pavement coring program.

4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 General
Based on the results of the investigation, the proposed Lyle Creek Bridge location, is underlain by loose to Compact sand and gravel colluvium deposits which overlies bedrock located at approximately 944.5 m to 947.0 m elevation. The upper 1 to 2.5 m of bedrock was observed to be weathered with more solid rock below. The sand and gravel deposits encountered are highly variable and contained some silt and clay as well as a large proportion of cobbles and boulders.
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Table 2: Summary of Pavement Coring holes

<table>
<thead>
<tr>
<th>Auger hole</th>
<th>Lane Dir.</th>
<th>Pavement Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lane</td>
</tr>
<tr>
<td>16-01</td>
<td>E</td>
<td>200</td>
</tr>
<tr>
<td>16-02</td>
<td>E</td>
<td>0</td>
</tr>
<tr>
<td>16-03</td>
<td>E</td>
<td>75</td>
</tr>
<tr>
<td>16-04</td>
<td>E</td>
<td>0</td>
</tr>
<tr>
<td>16-05</td>
<td>E</td>
<td>200</td>
</tr>
<tr>
<td>16-06</td>
<td>E</td>
<td>0</td>
</tr>
<tr>
<td>16-07</td>
<td>W</td>
<td>175</td>
</tr>
<tr>
<td>16-08</td>
<td>W</td>
<td>0</td>
</tr>
<tr>
<td>16-09</td>
<td>W</td>
<td>250</td>
</tr>
<tr>
<td>16-10</td>
<td>W</td>
<td>0</td>
</tr>
<tr>
<td>16-11</td>
<td>W</td>
<td>150</td>
</tr>
<tr>
<td>16-12</td>
<td>W</td>
<td>0</td>
</tr>
<tr>
<td>MIN</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>MAX</td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>MEAN</td>
<td></td>
<td>190</td>
</tr>
</tbody>
</table>

The natural sand and gravel deposits, and underlying bedrock strata would be considered suitable to support the proposed bridge structure and related road structure, provided that the recommendations below are followed.

4.2 Cut Slopes
Existing cut slopes within the vicinity of the project were noted to be composed of sand and gravel deposits with cobbles and boulders. The materials within these existing slopes are assumed to have little to no cohesion, and to be fully drained. These existing slopes are currently constructed at cut angles of approximately 1.5H:1V or steeper, and appear to be relatively stable.

At this time only nominal cut slopes are anticipated for this project. If cuts slopes are required they should be constructed at 2H:1V. Sliver cuts (i.e. less than 3 m horizontal thickness) should be avoided if the top of cut is 6 m or more above the existing highway elevation.

Cut slopes may be susceptible to erosion. To avoid stability problems, cut slopes should be hydroseeded as soon after construction as possible. A mix suitable to the soil conditions and climate zone should be used.

4.3 Embankment Slopes
Permanent embankment fill slopes are required primarily to provide widening for asphalt and gravel shoulder width. For embankment construction, a “Typical” consequence geotechnical factor has been assumed and because material will be inspected as it is placed, a high degree of understanding is
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assumed. As per the CHBDC S6-14 a geotechnical resistance factor of 0.7 is applied to embankment slopes.

Embankment slopes are recommended to be constructed of quality aggregate material approved by the ministry representative and meet the Ministry of Transportation and Infrastructure (MoTI) 2016 Standard Specifications for Highway Construction (Standard Specifications or SS) for earth embankments (SS201.37) and contain less than 10 percent fines. Earth embankments should be constructed no steeper than 1.75 horizontal to 1 vertical (1.75H:1V). If steeper slopes are required, rock fill embankment slopes can be constructed with a slope angle of 1.5 horizontal to 1 vertical (1.5H:1V). The Contractor shall supply and place material for rock embankments in accordance with SS 201.36.

In addition to SS 201.36, the material supplied for rock embankment construction shall be durable angular quarry rock that will not disintegrate on exposure to water or the atmosphere. Physical properties for rocks shall meet the requirements of SS 205.02.01. Rocks shall be well graded with a maximum size of 600 mm diameter. Placement and compaction of layers of rock is indicated in SS 201.36. End dumping of rocks will not be permitted under any circumstances. A minimum fill width of 3 m should be maintained through fill slopes to accommodate compaction equipment. Compaction should be completed with a minimum class 7 vibratory roller equipped with a grid drum. To provide a stable foundation, larger rock pieces may be used selectively along the base of the rock embankment as directed by the Ministry Representative.

Thick deposits of organic material were noted at the base of the existing highway embankment during the site reconnaissance between stations 201+10 to 201+60 and 202+10 to 202+65. Grubbing to remove organic material is estimated to be 1 m within the floodplain between these stations. Rock fill (as described above) should be used in the lower portion of embankments placed in these areas and brought to an elevation of 1.2 m above the floodplain.

Rocks shall be tested for Acid Rock Drainage (ARD) and Metal Leaching (ML) as required by the Ministry Representative. Testing and reporting shall meet the Ministry requirements outlined in the Ministry’s Technical Circular T04-13 and in the contract documents.

4.4 Type A Rock Excavation
Excavation into rock slopes should be avoided at this site due primarily to the high likelihood of Acid Rock Drainage (ARD) and Metal Leaching (ML) issues it could cause. A visual assessment by Ministry staff of existing rock outcrops concluded that the shale/siltstone rock contains many large pyrite crystals which are evidence that the rock is likely acid generating. No laboratory ARD or ML testing has been completed.

It is possible that some large boulders with a volume > 2 m³ may be encountered during excavation. These would classify as Type A excavation and a provision for type A excavation should be included in the contract.

4.5 Frost Penetration
The freezing index for the New Denver and Kaslo is obtained from Environment and Natural Resource Canada climate norms. Correlation of the freezing index with depth of frost penetration, as presented by Canadian Research Council (http://irc.nrc-cnrc.gc.ca), indicates a normal frost penetration of less than 1.5
m. however, the Lyle Bridge is located at a significantly higher elevation and the assumed frost penetration is 1.7 m at the proposed bridge replacement site.

4.6 Groundwater
Groundwater will likely be encountered in excavations that are below the creek water elevation. If surface or groundwater is encountered during construction, specific remedial measures should be carried out, such as lined drainage ditches, interceptor ditches, horizontal drains, filter cloth, etc. in order to prevent subgrade saturation.

4.7 Reuse or Excavated Materials
The majority of existing fill material can be reused as earth fill for this project as long as it is in accordance with the MoTI Standard Specifications (SS). This may require screening to remove oversized material.

Rock and aggregate types within the project area are likely to be variable, ranging from high to low quality, mostly in terms of durability and gradation. Before material is placed it should be checked for durability. It is recommended that any questionable material be tested by Micro Deval using a <= 30% as the maximum acceptable loss. The majority of excavated native sand and gravel can likely be used. However, it is likely that the excavated material will require screening to remove excess oversize particles.

4.8 Use of Reclaimed Asphalt Pavement
The use of reclaimed asphalt pavement should follow the recommendations of Technical Circular T-05/17.

4.8.1 Incorporating RAP into Pavement Structure Gravels for Base Strengthening
RAP contains roughly 6% AC and reduces permeability of any gravel it is blended with; the only suitable location for a RAP/gravel blend is at the top of the pavement structure. (i.e. in the base course layer directly beneath the asphalt pavement layer).

An efficient way to use RAP in a pavement structure through an in-situ process is by means of pulverizing. It is not anticipated that pulverizing will be considered for this project due to the pavement thickness and small quantities involved. RAP generated by milling may be stockpiled on or off site, then blended with base gravel and placed and compacted as the last base course lift immediately below the asphalt pavement layer. The mix of RAP and aggregates can vary between 1:3 and 3:1 proportions, with 1:1 being the most common.

RAP (either by itself or blended with aggregates) should never be inserted/placed anywhere else in the pavement structure where either vertical or lateral drainage will be compromised (ie. between the sub-base and base layers or other layers which would then reduce permeability of those layers).

4.8.2 Using RAP for Shoulder Build-Up or Shouldering
Straight RAP can be used directly for shoulder build-up beneath a new shoulder pavement if it is carefully placed and compacted and where it doesn't impede the lateral pavement structure drainage.

RAP blended with shoulder gravel can be used for shouldering after paving; typically this blend is much more stable (less prone to sloughing and erosion) than straight shoulder gravel.
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If RAP is not incorporated into the design then District Operations and Local Maintenance Contractors (MCs) are often eager to obtain RAP. District Operations staff and MCs in the vicinity of the project should be contacted to see if unwanted RAP can be used for other purposes such as blending with gravel for side road shouldering, surfacing, etc. A nearby stockpile site will usually be identified.

4.9 Pile Foundation Design
Details of Pile Foundation Design are addressed in a separate document titled Lyle Bridge (Structure No. 6450) Replacement Supplementary Foundation Design Memo – Piles. A summary of the results in that document are presented below.

Pile Analysis for the structure No. 6450 replacement used the following information provided by the MOTI Structures group:

- 100% Detailed design drawing package dated July 13, 2018
- Critical scour depth is 2.3 m below existing ground
- Load Cases provided by the Ministry Structures Group on May 4th, 2018

<table>
<thead>
<tr>
<th>Table 3: Summary Pile Loads Cases provided by MOTI Structures Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Load Case</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>ULS Load Case-1 (Normal)</td>
</tr>
<tr>
<td>ULS Load Case-3 (Wind+ temperature)</td>
</tr>
<tr>
<td>ULS Load Case-5 (seismic)</td>
</tr>
</tbody>
</table>

For analysis ULS Load Case 1 is used for axial pile analysis and ULS Load Cases 1, 3, and 5 are used for Later Load pile analysis. In both cases the piles are assumed fixed from rotation in both the longitudinal and transverse direction. It is anticipated that the fixed condition will be achieved with the reinforcement extending from the pile cap into the pile. This is a structural design consideration that will need to be evaluated by the MOTI Structures group. Although scour protection is provided by rip rap, this rip rap cannot be relied upon in accordance with the Ministry Supplement to S6-14 (Supplement).

The lateral analysis includes the 610 by 12.7 mm steel pipe, 2 m of concrete fill at the pile head and 610 by 15.9 mm steel pipe, 10 m of concrete fill at the pile head and no contribution of stiffness from the rebar.

The Lateral Pile analysis completed for the 610 mm/ 12.7 mm pipe pile calculates deflections at the pile head of 31.9 mm for load case 3. The analysis indicates that the maximum pile tip elevation of 946.5 m A.S.L is required at both the north and south abutment. The anticipated pile tip elevation is relative the bedrock surface. If deflections of less than 25.4 mm are required then 610 by 15.9 mm steel pipe, 10 m of concrete fill at the pile head are recommended.

<table>
<thead>
<tr>
<th>Location</th>
<th>Max Pile Tip Elevation</th>
<th>Anticipated Pile Tip Elevation</th>
</tr>
</thead>
</table>

Table 4: Maximum and Anticipated Pile Tip Elevations
The Pipe Piles are anticipated to be founded on/in the relatively shallow bedrock surface. This is required for vertical axial capacity and lateral fixity. Due to the ground conditions and depth of fixity being below the weathered bedrock surface in many locations and below the solid bedrock surface in several location it is assumed that piles will be installed by drilling to the maximum pile tip elevation and then driven to achieve vertical axial capacity. It is possible that the pile tip could be damaged during driving in the weathered and solid bedrock. For this reason it is recommended that a pile shoe be used during installation. The installation method used should minimize the disturbance outside of the pile to no more than 3 mm.

4.10 Site Preparation and Bearing Capacity for Abutment and Retaining Wall Design
If a spread footing is required at abutment walls is it recommended that the walls be founded in the Sand and Gravel unit. Footings should be founded a minimum of 1.7 m below the ground surface for frost protection. It is recommended that the foundations be supported on a minimum 1500 mm thickness of compacted Bridge End Fill. The allowable bear capacity for a footing placed on 1500 mm of structural fills compacted to 100 percent of standard proctor maximum dry density (SPMDD) supported by the native sand and gravel is 150 kPa.

It is anticipated that total settlements of the foundations prepared as described above will not exceed 25 mm with differential settlements less than approximately 12 mm. Settlements in the granular soils are expected to be small and occur essentially as the loads are placed. For the proposed 1500 mm subexcavation depth, the width of the excavation shall be a minimum of 1500 mm larger either side in order for the stress bulb to be distributed at a minimum angle of 1:1 through the fills.

It is anticipated that excavations can be carried out using conventional excavation equipment. Some disturbance of the subgrade may occur if cobble and boulder sized particles are encountered during excavation works. This may require further subexcavation or added compactive efforts to provide a suitable subgrade to support foundations. A nominal levelling layer (say a maximum 100 mm thickness and comprised of Bridge End Fill) placed on top of high points or exposed cobble and boulder sized particles, may be considered to assist with compaction of the subgrade.

To minimize the risk of disturbance, it is recommended that the site preparation be carried out during dry weather conditions. The subgrade shall be inspected and approved by a Geotechnical Engineer prior to placement of fills or other structural elements. The approved subgrade shall be compacted with a smooth drum roller prior to approval and excavators and other earth moving equipment should progressively
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retreat from the prepared subgrade areas. Construction equipment should not be permitted to operate on the approved final subgrade. The prepared subgrade should also be graded to provide gravity drainage away from the prepared area to a collector ditch or sump.

Any disturbed or softened subgrade soils resulting from exposure to inclement weather or construction traffic, should be completely subexcavated and removed down to the underlying undisturbed deposits.

Consideration should be given to the following drainage requirements for the abutment walls:

- 150mm diameter perforated PVC drain pipe encapsulated within 600 mm drain rock and fully wrapped with non-woven geotextile filter fabric (such as Nilex 4553, or approved equivalent) at the toe of the wall.

The final arrangement and drains used will be developed with input from the structural designer.

4.11 Temporary Excavations, Water Control and Backfill Requirements
Temporary open excavations within the existing fills and native granular deposits under dry conditions, may be developed using cut slopes no steeper than 1 horizontal to 1 vertical to a maximum height of 6 m. Flatter excavation slopes may be required if the work encounters loose conditions, or if groundwater seepage is encountered. All excavation slopes are to be maintained to meet the current Work Safe requirements.

Excavation to elevations below the creek for abutment wall construction may be difficult due to the free flowing and permeable nature of the upper sand and gravel unit. For this reason, groundwater control will be an important consideration that will need to be highlighted in the contract documents for the project.

After the subgrade has been exposed to the target elevation, it is recommended that a Geotechnical Engineer inspect the foundation as described above. Following inspection, Bridge End Fill shall be placed and compacted for the new foundation subgrade, behind the new abutments, and at the toe of the new abutments. Bridge End Fill is to be constructed in accordance with MoTI Standard Specification 202.23.

4.12 Seismic Design Considerations
Based on interpolated 2015 model seismic hazard values from Natural Resources Canada for this site and vicinity, the corresponding peak “firm ground” accelerations (Site Class “C”) for periods, T=0.2 seconds, 0.5 seconds, 1.0 seconds and 2.0 seconds are presented in Table 5 below. In accordance with Update No. 1 (April 2016) of the S6-14 Canadian Highway Bridge Design Code (CHBDC) Section 4.3.3.3, the “firm ground accelerations” presented in Table 5 need to be factored as a function of the “site class” and PGAref.

Lyle bridge site can be considered Site Class “D” and the factored spectral accelerations are provided below.

Loose granular soils were encountered in the test holes. A Cyclic Stress Ratio analysis indicates that the soils are unlikely to liquefy during the 1 in 275 design earthquake. However, due to the nature of
colluvium deposits minor settlement may be expected from liquefaction of local pockets of silty sand within the overall deposits under the design seismic event.

Table 5: Spectral Accelerations for Site Class “C” (Firm Ground) and Site Class “D” (Firm Soil)

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Sa(0.2)</th>
<th>Sa(0.5)</th>
<th>Sa(1.0)</th>
<th>Sa(2.0)</th>
<th>PGA (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Class “C” - 1 in 2475</td>
<td>0.142 g</td>
<td>0.107</td>
<td>0.071</td>
<td>0.043</td>
<td>0.062 g</td>
</tr>
<tr>
<td>F(a) – Site Class “D”</td>
<td>1.24</td>
<td>1.47</td>
<td>1.55</td>
<td>1.57</td>
<td>1.29</td>
</tr>
<tr>
<td>Site Class “D” – Design Accelerations</td>
<td>0.176 g</td>
<td>0.157</td>
<td>0.11</td>
<td>0.068</td>
<td>0.080 g</td>
</tr>
</tbody>
</table>

4.13 Lateral Loading for Abutment Walls

Static lateral earth pressures distributions for design of walls may be assumed to have a triangular distribution with the resulting force acting at 1/3H of the wall measured from the wall base. The following equations can be used to calculate this distribution for a ‘yielding’ or ‘non-yielding’ wall:

\[ Ps = 2.4 \times (0.8 + H)^2 \] (for vertical walls that are permitted to move at least 0.2% of the wall height)

\[ Ps = 3.8 \times (0.8 + H)^2 \] (for wall structures that are restrained from movement)

Where:

\[ Ps = \text{Lateral force due to static loading (kN/m); and,} \]
\[ H = \text{Wall backfill height (m).} \]

The above expression is based on the assumption that the wall is vertical, the backslope is horizontal with no surcharge loading, the wall backfill is fully drained, and the backfill comprises compacted Bridge End Fill assumed to have an effective angle of internal friction of 38 degrees, a unit weight of 20 kN/m³, and an effective angle of wall-soil friction of 20 degrees. As per section 6.12.5 of S6-14, a surcharge load equivalent to 0.8 m fill is included. Earth pressure distributions can also be calculated with the following earth pressure coefficients using the same assumptions described above: \( K_o = 0.38; K_a = 0.24; K_p = 4.2 \). However, in accordance with the Canadian Foundation Engineering Manual (4th Edition) Section 24.12.4.2 (stability against sliding) passive pressure cannot be considered to resist sliding within the frost penetration depth anticipated to be about 1.7m below the ground surface. A coefficient of friction of 0.5 may be used between the foundation base and the well compacted Bridge End Fills (BEF).

For seismic analysis, earthquake induced pressures can be calculated using the Mononobe-Okabe equations, in accordance with the CHBC S6-14. For this calculation, dimensionless horizontal ground acceleration (kh) of 0.040 can be assumed which is half of the site specific peak ground acceleration. Based on our calculations, and Sketch 2, it is recommended that a dynamic lateral earth pressure coefficient \( K_{ae} \) of 0.28 be used in design for the 2475-year design event for vertical walls that are permitted to move at least 0.2% of the wall height.
4.14 Aggregate Sources
Potential aggregate sources for road structure and borrow have not yet been identified. It is anticipated that no source close to the job site will be available, and material will need to be hauled from near Kaslo (approximately 26 km) or New Denver (approximately 16 km).

Potential Rockfill sources have been identified at Buchanan Pit and stockpiled material near Sandon. The Buchanan Pit is located 2 km west of Kaslo and the stockpiled material near Sandon is located at various locations along Hwy 31A. Both rock sources have been tested for ML/ARD and have been found to be at low risk of both ML and ARD. ML/ARD assessments are included in Appendix D. Durability testing has not yet been completed on either of the materials.

4.15 Pavement Design

4.15.1 General
It is recommended that existing asphalt pavement within the construction limits be removed and replaced with new asphalt pavement given the length of the project. The pavement substructure has performed reasonably well in the past and reshaping of the existing base to meet the new profile is acceptable.

Where the profile is required to be raised, existing asphalt should be removed and 25 mm WGB base material should be placed and compacted as per the 2016 MoTI Standard Specifications to raise the grade. Asphalt milling and overlay of the existing asphalt to reshape the profile is also acceptable.

4.15.2 Full Depth Pavement
The following pavement structure is recommended along Highway 3A:

- 50 mm Asphalt Pavement surface course 16mm Class 1 Medium Mix
- 50 mm Asphalt Pavement Base Course 16 or 19 mm Class 1 Medium Mix
- 300 mm 25 mm Well Graded Base (WGB)
- 300 mm Select Granular Sub-Base (SGSB)
The BCMoTI 2014 Technical Circular 01-04, Pavement Structure Design Guidelines was used to determine pavement structure for this project. Design Criteria is shown in Table 7.

The pavement auguring investigation conducted along short sections of the existing highway encountered asphalt thickness that varies from about 75 mm to 250 mm within the travel lanes and the paved shoulders. Materials encountered 300 mm below the asphalt pavement were general compact sand and gravel with some silt.

Granular and asphalt materials should be produced, placed and compacted as per the 2016 MoTI Standard Specifications. New pavement should be tapered at 4H:1V when joining existing asphalt pavement at the limits of construction.

Granular and asphalt materials should be produced, placed and compacted as per the 2012 Standard Specifications for Highway Construction. New pavement should be tapered at 4H:1V when joining existing asphalt pavement at the limits of construction.

### 5.0 CONCLUDING REMARKS

It has been concluded that the proposed site is suitable from a geotechnical perspective for the new two lane, single span bridge structure and it is envisaged that the proposed bridge structure will be founded on 610 mm pipe piles, driven open ended. Consideration should be given to a 12.7 mm (5/8”) pile wall thickness in order to limit the potential for damage from cobbles and boulders encountered in the subsurface during pile driving. Drilling of piles to the maximum pile tip elevation is likely to be required.

The anticipated pile tip elevation is relative to the bedrock surface and piles are anticipated to be driven 0.3 m to 1 m into solid bedrock. Pile Dynamic Analysis (PDA) testing may be carried out during installation if blow count criteria can not be achieved to confirm adequate pile resistance.
Table 6: Pavement design criteria.

<table>
<thead>
<tr>
<th>Design Factor</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Life (years):</td>
<td>20</td>
</tr>
<tr>
<td>AADT:</td>
<td>848</td>
</tr>
<tr>
<td>Directional Distribution:</td>
<td>0.5</td>
</tr>
<tr>
<td>Lane Distribution:</td>
<td>1</td>
</tr>
<tr>
<td>% Trucks:</td>
<td>0.15*</td>
</tr>
<tr>
<td>Growth Rate Factor:</td>
<td>24.3</td>
</tr>
<tr>
<td>Traffic Days:</td>
<td>365</td>
</tr>
<tr>
<td>Design ESAL's:</td>
<td>1,470,00</td>
</tr>
<tr>
<td>Pavement Design Type:</td>
<td>B</td>
</tr>
</tbody>
</table>

* no data available for traffic distribution. % trucks is assumed.

**CLOSURE:**

We trust that the information presented above is sufficient for your present needs. If we can be of further assistance on this or other related concerns, please feel free to give us a call.

Regards,

Reviewed by:

David Tracz, P.Eng.  
Geotechnical Engineer  
Geotechnical & Materials Engineering – Nelson

Tom Kneale P.Eng.  
Manager, Senior Geotechnical Engineer  
Geotechnical & Materials Engineering – Kamloops
Appendix A

Test Hole Location Figure
And Test Hole Logs (2014)
Legend:
Approximate Test Hole or Auger Hole Location
Note: Imagery obtained from Bing.
**SUMMARY LOG**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC

**Date(s) Drilled:** Sept 18-19, 2014  
**Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** Wash Rotary

---

**SOIL DESCRIPTION**

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>Sample Type</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>ASPHALT SAND and GRAVEL, some silt and clay, grey to black, dry, loose (Fill)</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>SAND and GRAVEL, some silt and clay, grey to black, wet, loose, contains cobbles and boulders.</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>GRAVEL and SAND, some silt and clay, grey to black, wet, loose to compact, contains cobbles and boulders.</td>
</tr>
</tbody>
</table>

Driller estimate of oversize material: 950mm at 9.6m.
GRAVEL and SAND, some silt and clay, grey to black, wet, loose to compact, contains cobbles and boulders.

(continued)

BEDROCK, weathered

End of Hole at 16.5m

Final Depth of Hole: 16.5 m
Depth to Top of Rock: 13.6 m
Project:  Lyle Creek Bridge #06450

Location:  Highway 31A, Retallack, BC

Datum:  Project Coordinates
Northing/Easting:  545589.664, 491213.895
Elevation:  960.1 m

Date(s) Drilled:  Sept 19, 2014
Company:  Sea to Sky Drilling
Driller:  Mike Smallwood
Drill Make/Model:  Mobile B53
Drilling Method:  Wash Rotary

Final Depth of Hole:  15.2 m
Depth to Top of Rock:  12.2 m
**SUMMARY LOG**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC  
**Datum:** Project Coordinates  
**Nothing/Easting:** 545589.664, 491213.895  
**Elevation:** 960.1 m  
**Date(s) Drilled:** Sept 19, 2014  
**Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** Wash Rotary  

**Drill Hole #:** TH14-02

**SOIL DESCRIPTION**

- SAND and GRAVEL, some silt and clay, grey to black, wet, compact, contains cobbles and boulders. *(continued)*

**CLASSIFICATION**

- (G:60 S:35 F:5)

**ELEVATION (m)**

- Final Depth of Hole: 15.2 m  
- Depth to Top of Rock: 12.2 m
### Project: Lyle Creek Bridge #06450

**Location:** Highway 31A, Retallack, BC

**Datum:** Project Coordinates: Northing/Easting: 545585.295, 491209.277

**Elevation:** 960.0 m

---

#### SUMMARY LOG

**Drill Hole #:** TH14-03

**Date(s) Drilled:** Sept 19-20, 2014

**Company:** Sea to Sky Drilling

**Driller:** Mike Smallwood

**Drill Make/Model:** Mobile B53

**Drilling Method:** Wash Rotary

---

#### DRILLING DETAILS

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>W%</th>
<th>W %</th>
<th>L%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.21m</td>
<td>ASPHALT</td>
<td>0.76m</td>
</tr>
<tr>
<td>3.66m</td>
<td>SAND and GRAVEL, some silt and clay, black, dry, loose (fill)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.60m</td>
<td>GRAVEL and SAND, some silt and clay, woody debris at 9m, grey to black, wet, loose, contains cobbles and boulders.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

#### SOIL DESCRIPTION

<table>
<thead>
<tr>
<th>Sample Type No.</th>
<th>Soil Symbol</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AP</td>
<td>ASPHALT</td>
</tr>
<tr>
<td>2</td>
<td>GM1</td>
<td>SAND and GRAVEL, some silt and clay, black, dry, loose (fill)</td>
</tr>
<tr>
<td>3</td>
<td>GP</td>
<td>SAND and GRAVEL, some silt and clay, black, dry, loose, contains cobbles and boulders.</td>
</tr>
<tr>
<td>4</td>
<td>GP</td>
<td>GRAVEL and SAND, some silt and clay, woody debris at 9m, grey to black, wet, loose, contains cobbles and boulders.</td>
</tr>
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#### CLASSIFICATION

<table>
<thead>
<tr>
<th>Driller's Estimate</th>
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<tbody>
<tr>
<td>[(G:70 S:30 F:0)]</td>
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<tr>
<td>[(G:70 S:25 F:5)]</td>
</tr>
<tr>
<td>[(G:75 S:20 F:5)]</td>
</tr>
<tr>
<td>[(G:65 S:30 F:5)]</td>
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---

#### FINAL DETAILS

**Datum:** Project Coordinates: Northing/Easting: 545585.295, 491209.277

**Elevation:** 960.0 m

**Depth to Top of Rock:** 13.3 m

**Final Depth of Hole:** 17.4 m

---

**Legends:**

- A-Auger
- B-Becker
- C-Core
- G-Grab
- V-Vane
- U-Lab
- S-Split
- O-Odex (air rotary)
- W-Wash (mud return)
- S-Shely (Spoon)
- T-Tube
SUMMARY LOG

Project: Lyle Creek Bridge #06450
Location: Highway 31A, Retallack, BC
Datum: Project Coordinates
Northing/Easting: 545585.295, 491209.277
Elevation: 956.0 m

Drill Hole #: TH14-03
Date(s) Drilled: Sept 19-20, 2014
Company: Sea to Sky Drilling
Driller: Mike Smallwood
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

Elevations:
- 13.29 m
- 15.85 m
- 17.37 m

SOIL DESCRIPTION

GRAVEL and SAND, some silt and clay, woody debris at 9m, grey to black, wet, loose, contains cobbles and boulders. (continued)

Driller estimate of oversize material: 250mm at 11.6m

Bedrock, weathered

Drillers Estimate
(G:70 S:25 F:5)

Bedrock

Sieve (Silt?)
G:18% S:69% F:13%

End of Hole at 17.4m

Depth to Top of Rock: 13.3 m
Final Depth of Hole: 17.4 m
**SUMMARY LOG**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC  
**Datum:** Project Coordinates  
**Northing/Easting:** 545595.844, 491201.282  
**Elevation:** 960.1 m  

**Date(s) Drilled:** Sept 20, 2014  
**Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** Wash Rotary  

---

**DEPT (m)**  
**DRILLING DETAILS**  
**SAMPLING DETAILS**  
**SOIL SYMBOL**  
**SOIL DESCRIPTION**  
**CLASSIFICATION**  
**COMMENTS TESTING**  
**ELEVATION (m)**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Sample No</th>
<th>Recovery (%)</th>
<th>Soil Symbol</th>
<th>Soil Description</th>
<th>Classification</th>
<th>Comments Testing</th>
<th>Testing</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>1</td>
<td>42</td>
<td>ASPHALT</td>
<td>0.21m</td>
<td>G:46% S:45% F:9%</td>
<td>Driller estimate of oversize material: 150mm at 2.3m, 200mm at 3.0m, 350mm at 10.6m</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>2</td>
<td>25</td>
<td>SAND and GRAVEL, some silt and clay, black, dry, loose (fill)</td>
<td>G:60 S:30 F:10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>3</td>
<td>25</td>
<td>SAND and GRAVEL, some silt and clay, grey to black, wet, loose Woody debris at 7.8m, contains cobbles and boulders.</td>
<td>G:70 S:15 F:15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>4</td>
<td>33</td>
<td>G:65 S:30 F:5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**FINAL DEPTH OF HOLE:** 16.9 m  
**DEPTH TO TOP OF ROCK:** 14.3 m  

---

**Legend**  
- A-Auger  
- B-Becker  
- C-Core  
- G-Grab  
- V-Vane  
- $\#$-Lab  
- S-Split  
- O-Odex  
- W-Wash  
- T-Shenby  
- Tube  

---

**Prepared by:** Ministry of Transportation & Infrastructure  
**Logged by:** MS  
**Reviewed by:** DT
SAND and GRAVEL, some silt and clay, grey to black, wet, loose, contains cobbles and boulders.

Driller estimate of oversize material: 200mm at 11.4m, 250mm at 12.2m

BEDROCK, weathered

End of Hole at 16.9m
Appendix B

Pavement Auger Hole Logs (2016)
**SUMMARY LOG**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Soil Symbol</th>
<th>Soil Description</th>
<th>Recovery (%)</th>
<th>Classification</th>
<th>Comments Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>G:40 S:60 F:0</td>
<td>AP</td>
<td>ASPHALT</td>
<td>0.2m</td>
<td></td>
<td>Driller's Estimate</td>
</tr>
<tr>
<td>0.61</td>
<td>G:25 S:75 F:0</td>
<td>SP</td>
<td>SAND and GRAVEL, grey brown, damp, compact</td>
<td>0.01m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.05</td>
<td>G:15 S:85 F:0</td>
<td>SP</td>
<td>SAND and GRAVEL, grey brown, damp, compact to dense</td>
<td>End of Hole at 3.0m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Drill Hole #: AH16-01**

- **Project:** Lyle Creek Bridge #06450
- **Location:** Highway 31A, Retallack, BC
- **Datum:** NAD83 UTM Zone 11
- **Northing/Easting:** 5542415, 491038
- **Drill Make/Model:** Mobile B53
- **Coordinates taken with GPS:** July 15, 2016
- **Date(s) Drilled:** July 15, 2016
- **Alignment:**
- **Driller:** Mike Smallwood
- **Logging:** MS
- **Reviewed by:** DT
- **Ministry of Transportation & Infrastructure**
- **Prepared by:**
- **Logged by:** MS
- **Reviewed by:** DT
- **Datum:** NAD83 UTM Zone 11
- **Elevation:** 966.0 m

**Drilling Details**

- **Drilling Method:** 6” Solid Stem Auger
- **Elevation:** 966.0 m
- **Final Depth of Hole:** 3.0 m
- **Depth to Top of Rock:**

---

**Legend**

- A-Auger
- C-Core
- G-Grab
- V-Vane
- S-Split
- O-Odex
- W-Wash
- T-Shelby Tube

**Coordinates taken with GPS:** July 15, 2016

**Drilling Company:** Sea to Sky Drilling
Project: Lyle Creek Bridge #06450

Date(s) Drilled: July 15, 2016
Drill Hole #: AH16-02

Location: Highway 31A, Retailack, BC
Datum: NAD83 UTM Zone 11
Northing/Easting: 5542416, 491039
Elevation: 966.0 m
Coordinates taken with GPS July 15, 2016

Drillers Estimate
(G % S % F %)

Drilling Company: Sea to Sky Drilling
Driller: Mike Smallwood
Drill Make/Model: Mobile B53
Drilling Method: 6" Solild Stem Auger

Location: Highway 31A, Retailack, BC
Date(s) Drilled: July 15, 2016
Drilling Method: 6" Solild Stem Auger
Coordinates taken with GPS July 15, 2016

Prepared by: Ministry of Transportation & Infrastructure
Logged by: MS Reviewed by: DT

SUMMARY LOG

End of Hole at 1.8m
Refusal on possible bedrock at 1.8m

SAND and GRAVEL, grey brown, damp, compact

ASPHALT

Ministry of Transportation & Infrastructure
Prepared by:
Logged by: MS Reviewed by: DT

Datum: NAD83 UTM Zone 11
Northing/Easting: 5542416, 491039
Elevation: 966.0 m
Coordinates taken with GPS July 15, 2016

Drilling Company: Sea to Sky Drilling
Driller: Mike Smallwood
Drill Make/Model: Mobile B53
Drilling Method: 6" Solild Stem Auger
**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retaillack, BC  
**Datum:** NAD83 UTM Zone 11  
**Northing/Easting:** 5542565, 490926  
**Elevation:** 970.0 m  
**Date(s) Drilled:** July 15, 2016  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger  
**Datum:** NAD83 UTM Zone 11  
**Alignement:**  
**Station/Offset:** Coordinates taken with GPS July 15, 2016  
**Project:** Lyle Creek Bridge #06450  
**Ministry of Transportation & Infrastructure**  
**Prepared by:**  
**Logged by:**  
**Reviewed by:**  
**Classifcation:**  
**Comments Testing:** Driller's Estimate (G % S % F %)  
**SOIL SYMBOL**  
**SOIL DESCRIPTION**  
**SOIL SAMPLE**  
<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DRILLING DETAILS</th>
<th>SOIL TYPE</th>
<th>SOIL DESCRIPTION</th>
<th>RECOVERY (%)</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 0.8 1.2 2.2 3.2</td>
<td>S-Pocket Penetrometer X Shear Strength (kPa)</td>
<td>1</td>
<td>ASPHALT</td>
<td>0%</td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>GRANUL, grey, damp, compact</td>
<td>30%</td>
<td>GP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>SAND and GRAVEL, grey, damp, very dense</td>
<td>60%</td>
<td>SP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>End of Hole at 2.3m</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**SUMMARY LOG**  
**Drill Hole #:** AH16-03  
**Coordinates:** Northing/Easting: 5542565, 490926  
**Final Depth of Hole:** 2.3 m  
**Depth to Top of Rock:**
**SUMMARY LOG**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC

Datum: NAD83 UTM Zone 11  
Northing/Easting: 5542566, 490927  
Elevation: 970.0 m  
Coordinates taken with GPS July 15, 2016

**Date(s) Drilled:** July 15, 2016  
**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger

**Drill Hole #:** AH16-04

**Datum:** NAD83 UTM Zone 11
**Alignment:**
**Station/Offset:**

---

**SOIL DESCRIPTION**

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<tr>
<th>Depth (m)</th>
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<th>Soil Description</th>
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</thead>
<tbody>
<tr>
<td>0.05m</td>
<td>SP</td>
<td>ASPHALT</td>
</tr>
<tr>
<td>0.91m</td>
<td>SP</td>
<td>SAND and GRAVEL, grey, damp, compact</td>
</tr>
<tr>
<td>1.83m</td>
<td>SP</td>
<td>SAND and GRAVEL, grey, damp, compact to dense</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Refusal on possible bedrock at 1.8m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End of Hole at 1.8m</td>
</tr>
</tbody>
</table>

---

**COORDINATES TAKEN WITH GPS JULY 15, 2016**

**ELEVATION (m)**

- 969
- 968
- 967
- 966
- 965

**DEPARTMENTS**

- **Prepared by:** Ministry of Transportation & Infrastructure
- **Logged by:** MS
- **Reviewed by:** DT

---

**FINAL DEPTH OF HOLE:** 1.8 m  
**DEPTH TO TOP OF ROCK:**

---

**Legend:**
- A-Auger
- C-Core
- G-Grab
- V-Vane
- L-Lab Sample
- S-Split
- O-Odex
- W-Wash
- T-Shelby
- P-Pocket Penetrometer
- Shear Strength (kPa)

---

**Final Depth of Hole:** 1.8 m  
**Depth to Top of Rock:**
### SUMMARY LOG

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC  
**Datum:** NAD83 UTM Zone 11  
**Station/Offset:** 5542751, 490691  
**Elevation:** 974.0 m  
**Date(s) Drilled:** July 15, 2016  
**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger  
**Coordinates taken with GPS July 15, 2016**

#### Soil Description

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Soil Type</th>
<th>Recovery (%)</th>
<th>Soil Symbol</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ASPHALT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2m</td>
<td>SAND and GRAVEL, brown grey, damp, compact</td>
<td>100%</td>
<td>SP</td>
<td></td>
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<td>0.46m</td>
<td>Silty SAND, brown, damp, compact</td>
<td>100%</td>
<td>SM</td>
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<tr>
<td>1.52m</td>
<td>Silty GRAVEL, grey brown, damp, compact to dense</td>
<td>100%</td>
<td>GM</td>
<td></td>
</tr>
<tr>
<td>2.0m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0m</td>
<td>End of Hole at 3.0m</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CLASSIFICATION**

- AP: Asphalt
- SP: Sand and Gravel
- SM: Silty Sand
- G: Gravel
- C: Core
- A: Auger
- G: Grab
- V: Vane
- T: Shelby

#### Soil Testing

- **SPT** (BLOWS/300 mm)
- **P-Pocket Penetrometer**
- **Shear Strength (kPa)**
- **SPT N*(N-values)**

---

**Alignment:**

- Northing/Easting: 5542751, 490691
- Final Depth of Hole: 3.0 m
- Depth to Top of Rock: 0.0 m

---

**Datum:** NAD83 UTM Zone 11

---

**Prepared by:** Ministry of Transportation & Infrastructure  
**Logged by:** MS  
**Reviewed by:** DT

---

**Project:** Lyle Creek Bridge #06450  
**Date:** July 15, 2016  
**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger  
**Coordinates taken with GPS July 15, 2016**
**SUMMARY LOG**

**Drill Hole #: AH16-06**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC

**Datum:** NAD83 UTM Zone 11  
**Northing/Easting:** 5542752, 590692  
**Elevation:** 974.0 m

**Date(s) Drilled:** July 15, 2016  
**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger

**Coordinates taken with GPS July 15, 2016**

**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood

**Location:** Highway 31A, Retallack, BC  
**Project:** Lyle Creek Bridge #06450

**Datum:** NAD83 UTM Zone 11  
**Northing/Easting:** 5542752, 590692

**Elevation:** 974.0 m

---

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DRILLING DETAILS</th>
<th>SOIL DESCRIPTION</th>
<th>SOIL SYMBOL</th>
<th>CLASSIFICATION</th>
<th>COMMENTS TESTING</th>
<th>ELEVATION (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>ASPHALTGRAVEL, grey brown, damp, compact</td>
<td>AP</td>
<td></td>
<td>[G:55 S:45 F:0]</td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td></td>
<td></td>
<td>GP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.46</td>
<td></td>
<td>SAND, grey brown, damp to dense</td>
<td>SP</td>
<td></td>
<td>[G:40 S:55 F:5]</td>
<td></td>
</tr>
<tr>
<td>1.52</td>
<td></td>
<td>Silty GRAVEL, grey brown, wet, compact to dense</td>
<td>GM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.08</td>
<td></td>
<td>Wet at 2.3m to 3.0m</td>
<td>SM</td>
<td></td>
<td>(G:45 S:45 F:10)</td>
<td></td>
</tr>
<tr>
<td>3.06</td>
<td></td>
<td>End of Hole at 3.0m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELEVATION (m):**

- 974.0 m
- 973 m
- 972 m
- 971 m
- 970 m

**Final Depth of Hole:** 3.0 m

**Depth to Top of Rock:**

---

**Legend:**

- L-Aug Sample  
- S-Split Spoon  
- D-Core  
- G-Grab  
- V-Vane  
- T-Shelby Tube

---

**Prepared by:** Ministry of Transportation & Infrastructure  
**Logged by:** MS  
**Reviewed by:** DT

**Prepared by:** Ministry of Transportation & Infrastructure  
**Logged by:** MS  
**Reviewed by:** DT
### SUMMARY LOG

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC  
**Datum:** NAD83 UTM Zone 11

**Date Drilled:** July 15, 2016  
**Drilling Company:** Sea to Sky Drilling  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger

**Drill Hole #: AH16-07**

**Coordinates taken with GPS July 15, 2016**

**Location:** Highway 31A, Retallack, BC

**Date(s) Drilled:** July 15, 2016

**Alignment:**

**Elevation:** 972.0 m

**Classification:**

**Comments Testing:**

**Final Depth of Hole:** 0.9 m

**Depth to Top of Rock:**

**Datum:** NAD83 UTM Zone 11

---

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DRILLING DETAILS</th>
<th>SOIL DESCRIPTION</th>
</tr>
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<tr>
<td>0</td>
<td></td>
<td>ASPHALT</td>
</tr>
<tr>
<td>0.18m</td>
<td></td>
<td>SAND and GRAVEL, brown, damp, compact</td>
</tr>
<tr>
<td>0.9m</td>
<td></td>
<td>End of Hole at 0.9m</td>
</tr>
</tbody>
</table>

**Sample Type:**

- S - Split Spoon
- SP - Odex (air rotary)
- G - Grab
- V - Vane
- A - Auger
- T - Shelby Tube

**Sample No:**

1

**SOIL SYMBOL:**

- AP
- SP

**SOIL SYMBOL:**

- [G:35 S:65 F:0]
SUMMARY LOG

Project: Lyle Creek Bridge #06450
Location: Highway 31A, Retallack, BC
Datum: NAD83 UTM Zone 11
Northing/Easting: 5542659, 490809
Elevation: 972.0 m
Coordinates taken with GPS July 15, 2016

Driller: Mike Smallwood
Drill Make/Model: Mobile B53
Drilling Method: 6" Solid Stem Auger

Date(s) Drilled: July 15, 2016

Drilling Company: Sea to Sky Drilling

Location: Highway 31A, Retallack, BC
Datum: NAD83 UTM Zone 11
Northing/Easting: 5542659, 490809
Elevation: 972.0 m
Coordinates taken with GPS July 15, 2016

Project: Lyle Creek Bridge #06450

SOIL DESCRIPTION

- **ASPHALT**, brown, damp, compact
- **SAND and GRAVEL**, brown, damp, compact
- **Silty SAND**, some gravel, brown, damp, compact
- **SAND and Silty SAND**, rusty brown, damp, compact to dense

End of Hole at 3.0m

CLASSIFICATION

- Drillers Estimate

ELEVATION (m)

Drill Hole #: AH16-08

Final Depth of Hole: 3.0 m
Depth to Top of Rock:

Final Depth of Hole: 3.0 m
Depth to Top of Rock:

Page 1 of 1
SUMMARY LOG

Project: Lyle Creek Bridge #06450
Location: Highway 31A, Retallack, BC
Datum: NAD83 UTM Zone 11
Northing/Easting: 5542532, 490945
Elevation: 970.0 m
Coordinates taken with GPS July 15, 2016

Driller: Mike Smallwood
Drilling Company: Sea to Sky Drilling
Drill Make/Model: Mobile B53
Drilling Method: 6" Solid Stem Auger

Date(s) Drilled: July 15, 2016
Project: Lyle Creek Bridge #06450
Datum: NAD83 UTM Zone 11
Northing/Easting: 5542532, 490945
Elevation: 970.0 m
Coordinates taken with GPS July 15, 2016

Driller: Mike Smallwood
Drilling Company: Sea to Sky Drilling
Drill Make/Model: Mobile B53
Drilling Method: 6" Solid Stem Auger

Drill Hole #: AH16-10

CLASSIFICATION
Drillers Estimate
(G % S % F %)

SOIL SYMBOLO

DEPTH (m) DRILLING DETAILS

SOIL DESCRIPTION

- ASPHALT
  GRAVEL and SAND, brown to grey, damp to saturated, compact

ELEVATION (m)

FINAL DEPTH OF HOLE: 3.0 m
DEPT TO TOP OF ROCK:

Page 1 of 1
**SUMMARY LOG**

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retallack, BC

**Datum:** NAD83 UTM Zone 11  
**North/Easting:** 5542308, 491143

**Elevation:** 963.0 m  
**Drill Hole #:** AH16-11

**Date(s) Drilled:** July 15, 2016  
**Driller:** Mike Smallwood

**Drilling Company:** Sea to Sky Drilling  
**Drill Make/Model:** Mobile B53

**Drilling Method:** 6" Solid Stem Auger  
**Datum:** NAD83 UTM Zone 11

---

**SOIL DESCRIPTION**

**Depth:** 0.0 m  
**Sample Type:** AP

**Soil Type:** Asphalt  
**Soil Description:** SAND and GRAVEL, brown grey, damp, compact

**Depth:** 1.37 m  
**Sample Type:** GP

**Soil Type:** Silty SAND, grey, damp to saturated, compact to loose

**Depth:** 3.05 m  
**Sample Type:** SP

**Soil Type:** End of Hole at 3.0m

---

**Drilling Details**

**Drillers Estimate**

**Soil Symbol**

---

**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger

---

**Legend**

- A-Auger
- C-Core
- G-Grab
- V-Vane
- L-Lab Sample
- S-Split
- O-Odex (air rotary)
- W-Wash
- T-Shelby Tube

---

**Remarks**

- **Sample Type:** L - Lab Sample  
- **W - Wash:** 20 40 60 80

- **P - P**
- **W%**
- **SPT "N" (BLOWS/300 mm)**  
- **Pocket Penetrometer**  
- **Shear Strength (kPa)**  
- **SPT**

---

**Elevation (m)**

- 963.0
- 962.0
- 961.0
- 960.0
- 959.0

---

**Final Depth of Hole:** 3.0 m  
**Depth to Top of Rock:**

---

**Prepared by:**  
**Logged by:**  
**Reviewed by:**
### SUMMARY LOG

**Project:** Lyle Creek Bridge #06450  
**Location:** Highway 31A, Retailack, BC  
**Datum:** NAD83 UTM Zone 11  
**North/Easting:** 5542307, 491143  
**Elevation:** 963.0 m  
**Coordinates taken with GPS July 15, 2016**

**Date(s) Drilled:** July 15, 2016  
**Driller:** Mike Smallwood  
**Drill Make/Model:** Mobile B53  
**Drilling Method:** 6" Solid Stem Auger  
**Drilling Company:** Sea to Sky Drilling  
**Project:** Lyle Creek Bridge #06450  
**Datum:** NAD83 UTM Zone 11  
**North/Easting:** 5542307, 491143  
**Elevation:** 963.0 m

#### DRILLING DETAILS

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>RECOVERY (%)</th>
<th>SAMPLE NO</th>
<th>SOIL SYMBOL</th>
<th>SOIL DESCRIPTION</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>ASPHALT</td>
<td>AP</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>SAND and GRAVEL, brown grey, damp, compact</td>
<td>(G:35 S:65 F:0)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
<td>Silty SAND, some organics, grey, damp to saturated, compact to loose</td>
<td>(G:30 S:70 F:0)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
<td>End of Hole at 3.0m</td>
<td>(G:0 S:85 F:15)</td>
</tr>
</tbody>
</table>

**SOIL SYMBOL**

- AP: Asphalt
- SP: Sand
- SM: Silty Mixture

**Sample Type:**
- S: Split
- O: Odex
- T: Shelby
- A: Auger
- C: Core
- G: Grab
- V: Vane
- W: Wash

**ELEVATION (m):**

- 963.0 m

**Coordinates taken with GPS July 15, 2016**

**Final Depth of Hole:** 3.0 m

**Depth to Top of Rock:**

---

**Legend:**
- A: Auger
- C: Core
- G: Grab
- V: Vane
- O: Odex
- W: Wash
- T: Shelby
- S: Split
- Spoon
- Lab Sample

**Prepared by:** Ministry of Transportation & Infrastructure  
**Logged by:** MS  
**Reviewed by:** DT

---

MOT-SOIL-REV2  LYLECREEK_2014TH_2016AH.GPJ  MOT-DRAFT-REV2.GDT  11-3-17

Page 1 of 1
Appendix C

2014 Laboratory Testing
### MOISTURE DETERMINATION

<table>
<thead>
<tr>
<th>Mass of Moist Sample (g)</th>
<th>956.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of Dry Sample (g)</td>
<td>805.8</td>
</tr>
<tr>
<td>Mass of Washed Sample (g)</td>
<td>150.9</td>
</tr>
</tbody>
</table>

### Loss of Moisture

| % Moisture | 4.7 g |

### Total Passing 0.075mm

| Mass Retained (g) | 16.3 |

### SIEVE ANALYSIS (WASH)

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Mass Retained (g)</th>
<th>% Retained</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.5</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>25.0</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>19.0</td>
<td>27.4</td>
<td>2.9</td>
<td>97.1</td>
</tr>
<tr>
<td>12.5</td>
<td>67.8</td>
<td>7.1</td>
<td>90.0</td>
</tr>
<tr>
<td>9.5</td>
<td>71.3</td>
<td>7.5</td>
<td>82.6</td>
</tr>
<tr>
<td>4.75</td>
<td>153.4</td>
<td>16.0</td>
<td>66.6</td>
</tr>
<tr>
<td>2.36</td>
<td>143.5</td>
<td>15.0</td>
<td>51.6</td>
</tr>
<tr>
<td>1.18</td>
<td>100.4</td>
<td>10.5</td>
<td>41.1</td>
</tr>
<tr>
<td>0.60</td>
<td>73.9</td>
<td>7.7</td>
<td>33.3</td>
</tr>
<tr>
<td>0.30</td>
<td>74.2</td>
<td>7.8</td>
<td>25.6</td>
</tr>
<tr>
<td>0.15</td>
<td>56.4</td>
<td>5.9</td>
<td>19.7</td>
</tr>
<tr>
<td>0.075</td>
<td>32.8</td>
<td>3.4</td>
<td>16.3</td>
</tr>
<tr>
<td>PAN</td>
<td>155.6</td>
<td>16.3</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>956.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Plot:**

- X-axis: GRAIN SIZE (mm)
- Y-axis: % PASSING (BY MASS)

**Graph:**

- Data points for % passing at various grain sizes are shown, indicating the percentage of material retained or passed through different sieve sizes.
## MOISTURE DETERMINATION

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Mass (g)</th>
<th>% Retained</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of Moist Sample</td>
<td>564.1</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>Mass of Dry Sample</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Loss of Moisture</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% Moisture</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

## WASH TEST

<table>
<thead>
<tr>
<th>Test Mass (g)</th>
<th>% Retained</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of dry sample</td>
<td>564.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Mass of Washed Sample</td>
<td>530.4</td>
<td>94.3</td>
</tr>
<tr>
<td>Mass Lost(Passing 0.075mm)</td>
<td>33.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Total Passing 0.075mm on Dry Sieve</td>
<td>35.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

### Sieve Analysis (Wash)

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Mass Retained (g)</th>
<th>% Retained</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.5</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>25.0</td>
<td>78.2</td>
<td>13.9</td>
<td>86.1</td>
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<tr>
<td>19.0</td>
<td>80.8</td>
<td>14.3</td>
<td>71.8</td>
</tr>
<tr>
<td>12.5</td>
<td>54</td>
<td>9.6</td>
<td>62.2</td>
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<tr>
<td>9.5</td>
<td>40.2</td>
<td>7.1</td>
<td>55.1</td>
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<tr>
<td>4.75</td>
<td>84.2</td>
<td>14.9</td>
<td>40.2</td>
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<tr>
<td>2.36</td>
<td>69.8</td>
<td>12.4</td>
<td>27.8</td>
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<tr>
<td>1.18</td>
<td>48</td>
<td>8.5</td>
<td>19.3</td>
</tr>
<tr>
<td>0.60</td>
<td>30.5</td>
<td>5.4</td>
<td>13.9</td>
</tr>
<tr>
<td>0.30</td>
<td>19.4</td>
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<td>10.5</td>
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<tr>
<td>0.15</td>
<td>14.3</td>
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<td>7.9</td>
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<tr>
<td>0.075</td>
<td>9.5</td>
<td>1.7</td>
<td>6.2</td>
</tr>
<tr>
<td>PAN</td>
<td>35.2</td>
<td>6.2</td>
<td>100.0</td>
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<tr>
<td>TOTAL</td>
<td>564.1</td>
<td>100.0</td>
<td>100.0</td>
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</tbody>
</table>
### Walgren Soils Testing

#### MECHANICAL ANALYSIS OF AGGREGATES

**Project:** Lyle Cr.  
**Contract No:** Test Hole 14 - 01  
**Pit Name:** Depth 4.3 - 4.9 m  
**Material:** Grab Sample Sample Sa # 4  
**Date Sampled:** Dec. 2014  
**Date Tested:** Feb. 2/16  
**By:** DY/DT  
**By:** WST

<table>
<thead>
<tr>
<th>MOISTURE DETERMINATION</th>
<th>WASH TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of Moist Sample g</td>
<td>Mass of dry sample 531.5 g</td>
</tr>
<tr>
<td>Mass of Dry Sample g</td>
<td>Mass of Washed Sample 503.8 g</td>
</tr>
<tr>
<td>Loss of Moisture g</td>
<td>Mass Lost(Passing 0.075mm) 27.7 g</td>
</tr>
<tr>
<td>% Moisture</td>
<td>Passing 0.075mm on Dry Siev 2.4 g</td>
</tr>
<tr>
<td></td>
<td>Total Passing 0.075mm 30.1 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.5</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>25.0</td>
<td>41.8</td>
<td>7.9</td>
<td>92.1</td>
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<tr>
<td>19.0</td>
<td>44.8</td>
<td>8.4</td>
<td>83.7</td>
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<td>12.5</td>
<td>63.3</td>
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<td>71.8</td>
</tr>
<tr>
<td>9.5</td>
<td>56.9</td>
<td>10.7</td>
<td>61.1</td>
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<tr>
<td>4.75</td>
<td>104.2</td>
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<td>41.5</td>
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<tr>
<td>2.36</td>
<td>70.8</td>
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<td>28.2</td>
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<td>11.1</td>
</tr>
<tr>
<td>0.15</td>
<td>17.4</td>
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<td>7.8</td>
</tr>
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<td>0.075</td>
<td>11.3</td>
<td>2.1</td>
<td>5.7</td>
</tr>
<tr>
<td>PAN</td>
<td>30.1</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>531.5</td>
</tr>
</tbody>
</table>

**Graph:**
- **X-axis:** GRAIN SIZE (mm)  
- **Y-axis:** % PASSING (BY MASS)  
- **Sieve Analysis (Wash):**
  - % Passing vs. Sieve Size
  - PAN 30.1
  - 0.075 5.7
## MECHANICAL ANALYSIS OF AGGREGATES

**Project**: Lyle Cr.  
**Contract No**: 14 - 01  
**Pit Name**:  
**Depth**: 11.9 - 12.5 m  
**Material**: Grab Sample  
**Sample**: Sa # 8  
**Date Sampled**: Dec. 2014  
**By**: DY/DT  
**Date Tested**: Feb. 2/16  
**By**: WST

### MOISTURE DETERMINATION

<table>
<thead>
<tr>
<th>Mass of Moist Sample</th>
<th>Mass of Dry Sample</th>
</tr>
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<tbody>
<tr>
<td>g</td>
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<table>
<thead>
<tr>
<th>Loss of Moisture</th>
<th>Mass Lost(Passing 0.075mm)</th>
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<tbody>
<tr>
<td>g</td>
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<table>
<thead>
<tr>
<th>% Moisture</th>
<th>Mass of Washed Sample</th>
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<tbody>
<tr>
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### WASH TEST

<table>
<thead>
<tr>
<th>Mass of dry sample</th>
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</table>

<table>
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<tr>
<th>Mass of Washed Sample</th>
<th>g</th>
</tr>
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</table>

<table>
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<tr>
<th>Mass Lost(Passing 0.075mm)</th>
<th>12 g</th>
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<table>
<thead>
<tr>
<th>Passing 0.075mm on Dry Siev</th>
<th>1.3 g</th>
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<table>
<thead>
<tr>
<th>Total Passing 0.075mm</th>
<th>13.3 g</th>
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### SIEVE ANALYSIS (WASH)

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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<tbody>
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<td>1.8</td>
<td>4.2</td>
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| PAN             | 13.3          | 1.8       | 4.2      |
| TOTAL           | 314.9         |           |         |

Total Passing 0.075mm: 57.73261 g
Total Passing 0.075mm: 38.0 g

![Graph showing % Passing vs Grain Size (mm)]
## MECHANICAL ANALYSIS OF AGGREGATES

**Project:** Lyle Cr.  
**Contract No:** Test Hole 14 - 02  
**Pit Name:** Depth 1.2 - 1.8 m  
**Material:** Grab Sample  
**Sample:** Sa # 1  
**Date Sampled:** Dec. 2014  
**By:** DY/DT  
**Date Tested:** Feb. 2/16  
**By:** WST

### MOISTURE DETERMINATION

<table>
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<tr>
<th>Mass of Moist Sample</th>
<th>Mass of Dry Sample</th>
<th>Loss of Moisture</th>
<th>% Moisture</th>
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</thead>
<tbody>
<tr>
<td>318 g</td>
<td>282.5 g</td>
<td>35.5 g</td>
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### WASH TEST

<table>
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<tr>
<th>Mass of Dry Sample</th>
<th>Mass of Washed Sample</th>
<th>Mass Lost(Passing 0.075mm)</th>
<th>Passing 0.075mm on Dry Siev</th>
<th>Total Passing 0.075mm</th>
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<tbody>
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<td>6 g</td>
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### GRAIN SIZE(mm)

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<th>%Retained</th>
<th>%Passing</th>
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### SIEVE ANALYSIS (WASH) -

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<th>% Passing (by Mass)</th>
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<td>100.0</td>
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**GRAIN SIZE(mm)**

**% Passing (by Mass)**

0.01 0.076 0.10 0.60 4.75 9.5 12.5 16.0 100.0

**GRAIN SIZE(mm)**

0 10 20 30 40 50 60 70 80 90 100
Walgren Soils Testing

MECHANICAL ANALYSIS OF AGGREGATES

Project Lyle Cr.
Contract No Test Hole 14 - 02
Pit Name Grab Sample Depth 2.7 - 3.4 m
Material Grab Sample Sample Sa # 2
Date Sampled Dec. 2014 By DY/DT
Date Tested Feb. 2/16 By WST

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<thead>
<tr>
<th>MOISTURE DETERMINATION</th>
<th>WASH TEST</th>
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<tr>
<td>Mass of Moist Sample</td>
<td>Mass of dry sample 370.2 g</td>
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<tr>
<td>Mass of Dry Sample</td>
<td>Mass of Washed Sample 344 g</td>
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<tr>
<td>Loss of Moisture</td>
<td>Mass Lost(Passing 0.075mm) 26.2 g</td>
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<tr>
<td>% Moisture</td>
<td>Passing 0.075mm on Dry Siev 1.4 g</td>
</tr>
<tr>
<td></td>
<td>Total Passing 0.075mm 27.6 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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GRAIN SIZE(mm) vs. % PASSING(BY MASS)
**MOISTURE DETERMINATION**

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<th>Material</th>
<th>Sample</th>
<th>Date Sampled</th>
<th>Date Tested</th>
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<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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<tr>
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**WASH TEST**

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<thead>
<tr>
<th>Mass of Moist Sample</th>
<th>Mass of Dry Sample</th>
<th>Mass of Washed Sample</th>
<th>Mass Lost(Passing 0.075mm)</th>
<th>Passing 0.075mm on Dry Siev</th>
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<tbody>
<tr>
<td>g</td>
<td>g</td>
<td>g</td>
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<table>
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<th>%Retained</th>
<th>%Passing</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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<td>100.0</td>
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</table>
**Walgren Soils Testing**

**MECHANICAL ANALYSIS OF AGGREGATES**

**Project**: Lyle Cr.  
**Contract No**: Test Hole 14 - 02  
**Pit Name**:  
**Depth**: 5.8 - 6.4 m  
**Material**: Grab Sample  
**Sample**: Sa # 4  
**Date Sampled**: Dec. 2014  
**By**: DY/DT  
**Date Tested**: Feb. 2/16  
**By**: WST

---

**MOISTURE DETERMINATION**

| Material | Sample | Date Sampled | Date Tested | Pit Name | Depth | Material | Sample | Date Sampled | Date Tested | Project | Contract No | Pit Name | Depth | Material | Sample | Date Sampled | Date Tested | Project | Contract No | Pit Name | Depth | Material | Sample | Date Sampled | Date Tested |
|----------|--------|--------------|-------------|----------|-------|----------|--------|--------------|-------------|----------|-------------|----------|-------|----------|--------|--------------|-------------|----------|-------------|----------|-------|----------|--------|--------------|-------------|----------|
| Moisture | % Moisture | Mass of Moist Sample | Mass of Dry Sample | Mass of Washed Sample | Loss of Moisture | Mass Lost(Passing 0.075mm) | Total Passing 0.075mm on Dry Siev | Total Passing 0.075mm | Total | 471.2 | 451.6 | 19.6 |

**SIEVE ANALYSIS (WASH)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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<tbody>
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**GRAIN SIZE(mm)**

**0.01 0.07 0.10 0.60 1.00 4.75 9.50 16.00 100.00**

**% PASSING(BY MASS)**

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### Walgren Soils Testing

**MECHANICAL ANALYSIS OF AGGREGATES**

**Project** Lyle Cr.  
**Contract No.** Test Hole 14 - 03  
**Pit Name** Grab Sample  
**Depth** 4.3 - 4.9 m  
**Material Sample** Sa # 3  
**Date Sampled** Dec. 2014  
**By** DY/DT  
**Date Tested** Feb. 2/16  
**By** WST

#### MOISTURE DETERMINATION
- **Mass of Moist Sample** 231.3 g
- **Mass of Dry Sample** 200.1 g
- **Loss of Moisture** 31.2 g
- **% Moisture** 2.4%

#### WASH TEST
- **Mass of dry sample** 231.3 g
- **Mass of Washed Sample** 200.1 g
- **Mass Lost(Passing 0.075mm)** 31.2 g
- **Passing 0.075mm on Dry Siev** 2.4 g
- **Total Passing 0.075mm** 33.6 g

#### SIEVE ANALYSIS (WASH)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Retained</th>
<th>%Retained</th>
<th>%Passing</th>
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**Graph**

![Graph showing grain size distribution](attachment:graph.png)
### MOISTURE DETERMINATION

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<td>Mass of Washed Sample</td>
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<td>Mass Lost(Passing 0.075mm)</td>
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<td>% Moisture</td>
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### WASH TEST

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**Total Passing 0.075mm on Dry Siev:** 57 g

**Total Passing 0.075mm:** 59.7 g

**Loss of Moisture:** 57 g

**% Moisture Passing 0.075mm on Dry Sieve:** 2.7%

**Total Mass Retained:** 18.49097 g

**PAN:** 68.8 g

**% Retained:** 12.7%
### MECHANICAL ANALYSIS OF AGGREGATES

**Walgren Soils Testing**

**Project**:
Lyle Cr.

**Contract No**:
Test Hole 14 - 04

**Pit Name**:
Grab Sample

**Material**:
Sample Sa # 1

**Date Sampled**:
Dec. 2014

**By**:
DY/DT

**Date Tested**:
Feb. 2/16

**By**:
WST

#### MOISTURE DETERMINATION

<table>
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<tr>
<th>Mass of Moist Sample g</th>
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<th>Mass of Washed Sample g</th>
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</thead>
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#### WASH TEST

- Mass of dry sample: 400.5 g
- Mass of Washed Sample: 367.2 g
- Mass Lost(Passing 0.075mm): 33.3 g
- Passing 0.075mm on Dry Siev: 2.1 g
- Total Passing 0.075mm: 35.4 g

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<th>% Passing</th>
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#### SIEVE ANALYSIS (WASH)

- PAN 46.39201
- 8.8

- GRAIN SIZE:mm
- % PASSING(100.0)
- 44.8

- GRAIN SIZE:mm
- % PASSING(100.0)
**Walgren Soils Testing**

### MECHANICAL ANALYSIS OF AGGREGATES

- **Project**: Lyle Cr.
- **Contract No**: Test Hole 14 - 04
- **Pit Name**: Depth 5.8 - 6.4 m
- **Material**: Grab Sample Sample Sa # 4
- **Date Sampled**: Dec. 2014 By DY/DT
- **Date Tested**: Feb. 2/16 By WST

#### MOISTURE DETERMINATION

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<th>Loss of Moisture</th>
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#### WASH TEST

- **Mass of dry sample**: 363 g
- **Mass of Washed Sample**: 348.8 g
- **Mass Lost(Passing 0.075mm)**: 14.2 g
- **Passing 0.075mm on Dry Siev**: 1.8 g
- **Total Passing 0.075mm**: 16 g

#### SIEVE ANALYSIS (WASH)

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*55.28926 40.3 4.4*
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<th>Wt. of Dry Sample + Tare</th>
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