GEOTECHNICAL ENGINEERING REPORT

Statler Bridge Replacement
Okanogan County, Washington

Prepared for: Nicholls Kovich Engineering, PLLC.

Project No. 180593 • July 2, 2019 Final

Aspect CONSULTING

earth + water

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Aspect Consulting, LLC

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1 Introduction and Project Description

This report presents the results of a geotechnical engineering study performed by Aspect Consulting, LLC (Aspect) for the Statler Bridge Replacement (Project). The Project is led by structural and hydraulics engineer, Nicholls Kovich Engineering, PLLC (Nicholls Kovich), and Okanogan County Public Works (County).

The Project generally consists of removal and replacement of the existing Statler Bridge (existing bridge) with a new bridge located along Salmon Creek Road (road) and spanning over Salmon Creek (creek) in Okanogan County, Washington (Site). The Site location is shown on Figure 1.

The existing bridge consists of a 14-foot-long, single-span bridge with a concrete deck and shallow foundation abutments constructed over 50 years ago. The creek flows from west to east below the existing bridge. Localized scour of the soil beside and beneath the existing bridge abutments has occurred.

The new bridge is proposed to be constructed just east of the existing bridge location with a total span of 68 feet. It is proposed to be single-span with concrete shallow foundation abutments. A combination of wing walls and modular block retaining walls will be used to retain road approach/embankment fill. The creek channel is also planned to be widened beneath the bridge. A preliminary plan showing current Site topography, the existing bridge, road alignment, and the approximate proposed location of the new bridge and proposed channel alignment are shown on Figure 2.

We understand the new bridge will be designed in general accordance with the current American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications (AASHTO, 2017) and Washington State Department of Transportation (WSDOT) guidance.

This geotechnical engineering report summarizes the results of the completed field explorations and provides our geotechnical engineering conclusions and design and construction recommendations for the Project.

2 Site Conditions

2.1 General Geology

The Site is mapped as being underlain by glacial drift (map unit Qgd; Gulick et al, 1990). Based on subsurface explorations for this Project, fill soils from the existing bridge and road construction are present at the Site. Although not mapped, localized surficial alluvium or colluvium were observed during our Site reconnaissance on January 2, 2019.

2.2 Surface

Site surface conditions generally consist of a paved road with gravel shoulders, road embankment side slopes, the existing bridge, the creek channel, and relatively steep ravine slopes created by creek incision. Site topography is shown on Figure 2 and best depicts the variability of slope heights and angles present at the Site.

The depth of flow in the creek was about 1.5 feet at the time of our explorations.

Of note, an approximately 12-foot-tall, 70-foot-long gabion basket wall exists about 30 feet to the south of the proposed bridge along the west shoulder of the road (Figure 2). We did not observe the gabion basket wall to be noticeably leaning or overturning. In our opinion, it is likely providing face control of cuts made for road construction and catchment of debris that could occasionally ravel downslope.

2.3 Field and Laboratory Investigations

2.3.1 Test Pits

We completed a field exploration program consisting of five test pits (designated TP-1 through TP-5) on January 2, 2019. The test pits were completed near the proposed location of the new bridge abutments at the locations shown on Figure 2.

The test pits were advanced to depths between about 7 and 16 feet below ground surface (bgs) using a Cat 325C tracked-excavator with a toothed bucket by Cates & Erb under subcontract to Aspect.

An Aspect geotechnical engineer was present throughout the field exploration program to observe the test pits, collect soil samples, and prepare descriptive logs of the explorations. Soils were identified in general accordance with ASTM International (ASTM) D2488, *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure; ASTM, 2018). Soil density in the test pits were qualitatively assessed based on our observations of excavation efforts and hand probing.

Descriptions of the soils encountered in the test pits, as well as the depths where characteristics of the soils changed, are indicated on the exploration logs presented in Appendix A of this report. Definitions of the terminology and symbols used on the logs are included in the Exploration Log Key.

2.3.2 Laboratory Testing

Select soil samples collected from the test pits were submitted for laboratory testing to determine engineering and index properties, including moisture content and grain-size distribution. Laboratory test results are shown in Appendix B.

2.4 Stratigraphy

We interpret the Site stratigraphy to generally consist of glacial drift deposits overlain by fill near the existing bridge and roadway, and a localized layer of surficial alluvium and colluvium near the creek channel and toe of bank slopes.

We interpret that the alluvium and colluvium were deposited by creek flow and incision of the bank slopes. Alluvium and colluvium materials were observed during our Site reconnaissance, but not in the test pit explorations completed further away from the creek channel and toe of banks slopes (above ordinary high water mark [OHWM] elevation). The localized alluvium and colluvium materials are of similar gradation/composition to the glacial drift deposits.

Details of the soil units encountered in the test pits are described below, in order of shallowest to deepest. The test pits were excavated into the sloping ground of the creek banks, and the descriptions presented below are based on the soils observed in the uphill sidewall of each test pit excavation.

2.4.1 North Creek Bank/Abutment Stratigraphy

Fill

At the ground surface in TP-4 and TP-5, we encountered fill that extended to a depth of about 1.5 and 3.0 feet bgs, respectively. The fill typically consisted of silty GRAVEL with sand (GM); loose, slightly moist, dark brown, with an estimated 20 to 40 percent cobbles and boulders by volume. Boulders were observed up to 2 feet in diameter.

The fill was placed as part of previous road and bridge construction and overlies native glacial drift on the north bank of the creek.

Glacial Drift

Below the fill in TP-4 and TP-5, we encountered glacial drift that extended to the bottom of test pit excavations (16 and 12 feet bgs, respectively). The glacial drift typically consisted of SAND with silt (SP-SM); medium dense, moist, brown, with occasional lenses of GRAVEL with silt and sand (GP-GM) observed near the top of the stratum.

2.4.2 South Creek Bank/Abutment Stratigraphy

Fill

At the ground surface in TP-1 through TP-3, we encountered fill that extended to depths between about 3.0 and 4.0 feet bgs. The fill typically consisted of silty GRAVEL with sand (GM); loose, slightly moist, dark brown, with an estimated 40 to 60 percent cobbles and boulders by volume. Boulders were observed up to 4 feet in diameter. The fill was placed as part of previous road and bridge construction and overlies native glacial drift on the south bank of the creek.

Glacial Drift

Below the fill, we encountered glacial drift that extended to the bottom of the test pits (about 7, 10.5, and 16 feet bgs in TP-1 TP-2, and TP-3, respectively). The glacial drift in TP-1, TP-2, and the upper portion of TP-3 typically consisted of GRAVEL with silt and sand (GP-GM); medium dense, slightly moist, brown, with an estimated 60 to 80 percent cobbles and boulders by volume that were up to 7 feet in diameter. In TP-3, the GP-GM was underlain by SAND with silt (SP-SM); medium dense slightly moist, brown.

2.4.3 Localized Alluvium and Colluvium

Although not observed in the test pit explorations, we observed surficial soils near the creek channel and base of bank slopes to consist of alluvium and colluvium materials of similar gradation and composition to the glacial drift deposits described as GRAVEL with silt and sand (GP-GM); brown; with abundant cobble and boulder content. Because the alluvium and colluvium are surficial in nature (likely a few feet thick) we expect they will be largely be removed from the area of the proposed new bridge footprint to expose glacial drift soils below.

2.5 Groundwater

At the time of our explorations, the water in the creek was approximately 1.5 feet deep. While the ground surface at each test pit was located above the OHWM, the test pits extended to depths of 1 to 11 feet below the creek thalweg. Groundwater or indications of groundwater such as seepage or wet soils were not encountered in the test pits, but is expected to vary with location at the Site and seasonal factors, and could be affected by weather, snowmelt, and the water level in the creek.

Based on logs of water wells completed near the Site, we estimate the static groundwater level is on the order of 30 to 50 feet bgs (Ecology, 2019).

3 Conclusions and Recommendations

3.1 Summary

From a geotechnical perspective, the new bridge can be grade-supported on conventional spread footings founded below the design scour level (determined by Nicholls Kovich). A summary of key Project geotechnical conclusions and recommendations are listed below and described in more detail in the following sections.

- The granular, medium dense glacial drift Site soils will provide suitable bearing support for bridge foundations with relatively low elastic settlement potential.
- The foundations should be constructed directly atop a 12-inch-thick fill pad consisting of compacted crushed rock overlying the existing granular glacial drift Site soils. The crushed rock fill pad is intended to provide relatively uniform support directly beneath the foundations that will be constructed over subgrade soils that are expected to contain variable amounts of cobble and boulders (boulders on the order of 7 feet in diameter could be encountered, based on test pit observations).
- Excavations below creek level during periods of very low creek flow, or with a creek diversion through the Site in place, are not expected to encounter a static groundwater table or high seepage inflows. If encountered, seepage inflows can likely be handled by the Contractor with sumps and pumps.
- A portion of the on-Site soil volume anticipated to be excavated for the Project is suitable for reuse as structural fill for the new bridge approach embankments.

3.2 Earthquake Engineering

Seismic design of the proposed bridge will be in accordance with AASHTO LRFD. An assessment of the seismic hazards at the Site and design recommendations for the proposed bridge are presented below.

3.2.1 Seismic Hazards

3.2.1.1 Surficial Fault Rupture

There are no mapped faults within about 100 miles of the Site (USGS, 2019). In our opinion, the relative risk of fault rupture at the surface of the Site is very low and is not a design consideration.

3.2.1.2 Soil Liquefaction

Liquefaction occurs when loose, saturated, and relatively cohesionless soil deposits temporarily lose strength as a result of earthquake shaking.

Considering the Site groundwater conditions, low seismicity, and the composition and relative density of the soils, we conclude that the potential of liquefaction triggering at the Site is very low and is not a design consideration.

3.2.2 Seismic Design Parameters

The AASHTO LRFD Bridge Design Specifications specify seismic design based on a seismic event with 7 percent probability of exceedance in 75 years (approximately 975-year recurrence interval). Amplification of bedrock ground motions is affected by Site-specific soil conditions, which are expressed in terms of "Site Class." Our recommended seismic design parameters, based on Site location and soil conditions, are shown in Table 1 below with values taken AASHTO LRFD Bridge Design Specifications (AASHTO, 2017).

Table 1. Recommended Seismic Design Parameters

AASHTO Parameter[1]	Recommended Value
Site Class	**D**
Short Period Spectral Acceleration, S_s (g)	0.33
1-Second Period Spectral Acceleration, S_1 (g)	0.10
Site Coefficient (F_a)	1.54
Site Coefficient (F_v)	2.39
Design Short Period Spectral Acceleration, S_{DS} (g)	0.51
Design 1-Second Period Spectral Acceleration, S_{D1} (g)	0.25
Site-Adjusted Peak Ground Acceleration (PGA_M) (g)	0.22

Notes:
1. Based on the latitude and longitude of the Site: 48.386782°N, 119.598761°W

3.3 Abutment and Wingwall Design

3.3.1 Foundation Bearing Subgrade and Narrative

We recommend constructing the bridge abutment and wingwall foundations atop a 12-inch-thick crushed rock fill pad (fill pad) comprised of Crushed Surfacing Base Course (CSBC) per WSDOT Standard Specification 9-03.9(3) (WSDOT, 2018). The compacted CSBC pad should be placed over undisturbed glacial drift materials.

The fill pad will provide relatively uniform subgrade conditions directly beneath the foundations and "bridge" potential hard spots below foundations caused by the edges/points of larger cobbles and boulders in the native glacial drift subgrade (if present). The 12-inch-thick fill pad should extend at least 12 inches in all directions beyond the edges of the foundations.

Prior to placing the fill pad, the subgrade should be prepared to a relatively firm and level condition that is generally free of protruding cobbles and boulders edges/points, which might require some target rock chipping or removal of the cobble/boulder. Voids created from cobble/boulder chipping or removal should be backfilled with compacted CSBC structural fill. An Aspect geotechnical engineer or geologist should evaluate the foundation subgrade prior to placement of the fill pad and the foundations to verify conditions.

All foundations should bear at least 2 feet bgs for frost protection.

3.3.2 Foundation Bearing Resistance

The bearing resistance values presented below assume all foundations are built atop subgrade materials prepared in accordance with Section 3.3.1 above.

- Figure 3 presents the Nominal (unfactored) Bearing Resistances for use in design of 4- to 10-foot-wide foundations. These values assume foundations are embedded at least 2 feet below the design scour level and the foundation subgrade soils are periodically submerged by high creek water levels.
- The recommended LRFD resistance factors required to calculate Strength and Extreme Limit State Bearing Resistances from the provided Nominal Bearing Resistances (shown on Figure 3) are provided in Table 2 below.
- Service Limit State Bearing Resistances corresponding to total foundation settlements estimates of 1.0 or 1.5 inches to design 4- to 10-foot-wide (effective width) foundations are presented on Figure 3. Differential settlement over the foundation length are estimated to be about half the total settlement. Settlement is anticipated to occur as loads are applied during construction.

Table 2. LRFD Resistance Factors for Shallow Foundations

Limit State	Bearing Resistance, ϕ_b	Shear Resistance to Sliding, ϕ_τ[1]	Passive Pressure Resistance to Sliding, ϕ_{ep}
Strength	0.45	0.8 / 0.9	0.5
Extreme	0.9	0.9	0.9

Notes:
1. Value of 0.8 for cast-in-place concrete foundations, or 0.9 for precast concrete foundations.

3.3.3 Lateral Earth Pressures

The lateral earth pressures acting on the abutment and wing walls for active, at-rest, and seismic conditions are shown below in Table 3. These values assume properly compacted structural fill (as described in Section 3.8 below) and/or undisturbed native soils are present around abutments and wing walls.

To invoke active earth pressure conditions, a wall must be capable of yielding laterally at least 0.001 to 0.002H, where H is the exposed height of the wall; otherwise, at-rest conditions should be assumed.

Table 3. Lateral Earth Pressure Parameters

Earth Pressure Condition	Backslope Condition	Earth Pressure Coefficient	Equivalent Fluid Density[3] (pcf)[1]	Uniform Lateral Surcharge Pressure[4] (psf)[1]
Active[2]	Level	0.26	32	0.26S
	3H:1V	0.32	40	0.32S
	2H:1V	0.37	46	0.37S
At-Rest	Level	0.41	51	0.41S
	3H:1V	0.54	67	0.54S
	2H:1V	0.60	75	0.60S
Active Seismic	Level	-	-	5H
At-Rest Seismic	Level	-	-	9H
Passive[5]	Level	3.50	440	-

Notes:

1. psf = pounds per square foot; pcf = pounds per cubic foot.
2. To invoke active earth pressure condition, the wall must be capable of yielding laterally at least 0.001 to 0.002H, where H is the exposed height of the wall.
3. The equivalent fluid densities provided above are distributed triangularly along the exposed height of the wall. The uniform lateral surcharge pressures are distributed uniformly (rectangularly) along the exposed height of the wall.
4. S is the vertical surcharge pressure at the ground surface immediately above/behind the wall. The vertical surcharge pressure causes a lateral earth pressure to act on the wall, which is calculated as the product of S and the appropriate lateral earth pressure coefficient. We recommend a traffic live load surcharge of 250 psf be utilized for abutment wall design. The resultant uniform rectangular lateral pressure should be applied to the full height of the abutment wall.
5. Ultimate passive pressures are presented; a Strength Limit State resistance factor (ϕ_{ep}) of 0.50 should be applied for design. Passive resistance within a depth of 2 feet of the ground surface in front of the walls, or within scour depth in front of the walls, should be ignored (whichever is depth is greater).
6. Linear interpolation may be utilized to calculate earth pressures for backslope angles that fall between those shown above.

3.3.4 Sliding Resistance

Sliding resistance is developed from the friction occurring between the bottom of the foundation and the subgrade soil, and the passive resistance developed from the soil around the foundation. The frictional and passive resistance values presented assume the foundations bear on the materials described in Section 3.3.1.

For passive resistance against the sides of foundations, the nominal passive values provided in Table 3 above may be utilized for design. For frictional resistance along the bottoms of footings, an unfactored coefficient of 0.6 may be utilized. LRFD Resistance Factors for determining limit state sliding and passive resistance are provided in Table 2 above.

3.3.5 Global Stability

We used limit equilibrium methods within Slide (Rocscience, 2018) to evaluate global stability of the abutment wall. Based the analyses results, we conclude that for an abutment wall on the order of 15 feet tall, with foundations embedded a minimum of 2 feet below the design scour level, the minimum factor of safety (FOS) for potential failure surfaces extending through the approach embankment and beneath the abutment will be at least 1.5 and 1.1, under static and seismic loading conditions, respectively.

Consistent with WSDOT guidance, approach embankment side slopes not supporting foundations should be designed for a minimum static factor of safety of 1.3. Based on limit equilibrium slope stability analysis, a FOS of greater than 1.3 can be achieved if the approach embankment sideslopes are:

- Graded to a final configuration of 2H:1V or flatter.
- Constructed from properly compacted on-Site gravel fill material or imported Gravel Borrow meeting WSDOT Standard Specifications Section 9-03.14(1) (WSDOT, 2018); these materials are discussed further in Section 3.8.
- Terraced atop/into existing ground surface (if fill) as described in WSDOT Standard Specifications Section 2-03.3(14) and keyed in to the existing ground surface by a minimum of 18 inches at the toe.

3.4 Drainage

Surface runoff from the paved roadway surface should be diverted or sloped away from abutments and wingwalls to the extent possible. We recommend that structural fill directly behind abutments and walls consist of at least a 12-inch-thick (measured laterally from back of abutment/wall) gravel curtain drain to convey water down to the relatively permeable foundation subgrade stratum below. The curtain drain material should meet the requirements of Gravel Backfill for Walls, WSDOT Standard Specifications 9.03.12(2) (WSDOT, 2018).

3.5 Earthwork

Based on the materials encountered in the explorations, and our understanding of the Project, we anticipate Site earthwork can be completed with standard construction equipment such as tracked excavators, dozers, and mobile cranes. The equipment should

be capable of performing relatively deep excavation and selective chipping and/or rock breaking in cobble- and boulder-laden materials. Based on our test pit explorations, boulders up to 7 feet in diameter (or larger) could be encountered and might require removal by selective rock chipping and/or breaking methods.

Appropriate erosion and sedimentation control measures should be in accordance with the local best management practices (BMPs) and should be installed prior to beginning earthwork activities.

3.5.1 Temporary Excavation Slopes and Shoring

3.5.1.1 General

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the Contractor. All temporary cuts in excess of 4 feet in height that are not protected by trench boxes or otherwise shored, should be sloped in accordance with Part N of Washington Administrative Code (WAC) 296-155 for worker safety (WAC, 2016). For planning purposes and using guidance provided by the WAC and our Site observations, we classify the Site soils as Type C with a maximum allowable temporary slope inclination of 1.5H:1V.

We expect temporary slopes may need to be flatter than 1.5H:1V in Site soils with particularly high cobble and boulder content. Selective removal of precariously lodged cobble and boulders in the excavation sidewall should be completed by the Contractor to establish safe working conditions.

With time and the presence of seepage and/or precipitation, the stability of temporary unsupported cut slopes can be significantly reduced. Therefore, all temporary slopes should be protected from erosion by installing a surface water diversion ditch or berm at the top of the slope if precipitation is expected.

In addition, the Contractor should monitor the stability of the temporary cut slopes and adjust the construction schedule and slope inclination accordingly. Vibrations created by traffic and construction equipment may cause caving and raveling of the temporary slopes. In such an event, lateral support for the temporary slopes should be provided by the Contractor.

3.5.1.2 South Abutment Special Considerations

We understand the planned foundation subgrade elevation at the south abutment is Elevation 1266.5 feet. The existing ground surface at the south abutment location is approximately Elevation 1282 feet. With this, a temporary excavation of approximately 16 feet in depth will be needed to reach foundation subgrade elevation at the south abutment. By inspection, a temporary excavation sloped at 1.5H:1V could extend to or relatively close to the base of the existing gabion basket wall.

We evaluated the temporary slope stability of an approximately 16-foot-deep temporary excavation and the nearby gabion basket wall using limit equilibrium methods within Slide. Based on the analysis results and our engineering judgement, we conclude the crest of the temporary 1.5H:1V excavation should be at least 8 feet away from the base of the gabion basket wall.

Considering this requirement or space constraint, we anticipate temporary shoring on the order 4 feet in height (with temporary slopes above) may be needed at the base of the west portion of the south abutment excavation to facilitate foundation construction. We consider steel boxes and/or steel sheets with lateral bracing to be practical/feasible shoring methods to be designed and implemented by the Contractor.

3.5.2 Dewatering

Based on the completed test pits, we do not anticipate excavations will extend below a continuous, static groundwater table at the Site.

We understand a relatively low flow rate of about 8 cubic feet per second (cfs) will be maintained in the creek during construction by the Okanogan Irrigation District for reasons related to local fisheries. We understand the Project contract documents will require a diversion/containment of the 8 cfs flow through the Site by a culvert pipe or similar means.

Excavations could encounter zones of seepage emanating from high-permeability layers of soil. In our opinion, this seepage can likely be managed with sumps and pumps with the creek diversion/containment in place.

3.6 Modular Block Retaining Wall Design

We understand from Nicholls Kovich that modular block retaining walls (block walls) abutting the abutment wing walls will be used to retain road approach/embankment fill. We understand the block walls will be designed by others. For design of block walls, we provide the following recommendations:

- The block walls should be designed using the soil parameters provided in Table 3. Passive resistance within 12 inches of the ground surface in front of the block walls should be ignored for design.
- The block walls should be constructed directly atop a 6-inch-thick (minimum) crushed rock leveling pad consisting of CSBC per WSDOT Standard Specification 9-03.9(3) (WSDOT, 2018). The leveling pad should be placed over relatively firm and unyielding granular native or structural fill subgrade soils.
- The block walls should be embedded at least 2 feet below the ground surface in front of the base block.
- For block wall foundations (i.e., base blocks) measuring between 2 and 5 feet wide, Strength and Service Limit State bearing resistances of 3 kips per square foot (ksf) may be assumed for design. These values assume the block walls are constructed atop the materials described above, are embedded least 2 feet below the ground surface in front of the base block, and can tolerate total settlement of up to 1 inch and 0.5-inch differential settlement over the length of the wall.
- A 12-inch-thick curtain of WSDOT Gravel Backfill for Walls should be placed directly behind the block walls as described in Section 3.4.

3.7 Embankment and Pavement Design

Approach embankments should consist of compacted structural fill materials detailed below in Section 3.8 with side slopes not exceeding those presented in Section 3.3.5. Final grades are not yet known at this time, but we expect fill placement in some locations will be required to raise grades. We expect embankment soil settlement will occur as structural fill is being placed with no appreciable long-term settlement expected.

Pavement subgrade will consist of compacted structural fill to reconstruct the roadway embankments utilizing the materials and construction requirements detailed in Section 3.8 below. We recommend proof rolling all pavement subgrade areas with heavy, pneumatic-tired construction equipment such as a loaded dump truck or front-end loader to identify apparent loose, soft or pumping areas prior to placing pavement sections.

Pavement sections should not be placed on frozen subgrade.

3.8 Structural Fill

3.8.1 Beneath Foundations and Behind Walls

Structural fill placed beneath foundations and walls should consist of materials described in Sections 3.3.1 and 3.6. Structural fill placed directly behind walls should consist of materials described in Sections 3.4.

3.8.2 Approach Embankments and Use of On-Site Soils

We provide the recommendations below for structural fill used to construct approach embankments, which will likely consist mostly of on-Site borrow soils:

- Structural fill for approach embankments, if on-Site materials are used, should generally meet the requirements for Common Borrow, WSDOT Standard Specification 9-03.14(3). If imported materials are utilized, they should meet the requirements for Gravel Borrow, WSDOT Standard Specification 9-03.14(1) (WSDOT, 2018).
- The majority of on-Site fill (GM) and glacial drift (GP-GM and SP-SM) materials generally meet the Common Borrow criteria and are suitable use as structural fill for approach embankments, with some exceptions. If present, organics or other deleterious materials should be removed from the on-Site material before being used as structural fill.
- We recommend limiting the maximum particle size of the on-Site materials to 12 inches for use as structural fill for approach embankments. The uppermost 6 inches of the approach embankment fill (just below the base course and pavement section) should consist of imported or on-Site crushed rock, gravel, or other free-draining material that does not exceed 3 inches in diameter.
- We recommend constructing the outermost 3 feet of approach embankment slopes using the on-Site gravel materials or imported gravel materials. We do not recommend using the on-Site glacial drift [sand with silt (SP-SM)] or imported materials comprised mostly of sand within the outer 3 feet of embankment slopes

due to the material gradation and its potential to deform and easily erode/rill outwards towards the face of the embankment.

- We recommend overbuilding the outer edge of approach embankment slopes by at least 2 feet prior to regrading them to their final configuration. This will ensure the outer face of the approach embankment slopes are adequately compacted and reduce the potential for deformation and erosion.
- Placement and compaction of structural fill for approach embankments during the dry summer months is preferred because the structural fill materials may contain enough fines (silt and clay) to be moisture-sensitive in wet weather, especially the on-Site materials.

3.8.3 Compaction Criteria

Soils placed beneath or around the bridge structure/foundations, the roadway embankment, and below paved areas should be considered as structural fill and placed and compacted in general accordance with the methods described in WSDOT Standard Specifications 2-03.3(14) C, Method C (WSDOT, 2018), except those materials/applications described in Section 3.8.2 (approach embankments).

It should be noted that nuclear densometer testing of materials containing more than 25 percent or more (by volume) of gravel or particles greater than 4 inches in diameter – such as the screened on-Site material – will not give accurate results. This condition may apply to the on-Site fill and gravel glacial drift. In this case, we recommend compacting the material as described by WSDOT Standard Specifications for Rock Embankment Construction, Section 2-03.3(14)A (WSDOT, 2018).

3.8.4 Placement and Compaction on Slopes

Based preliminary grading plans by Nicholls Kovich, we understand grading and placement of structural fill is planned on slopes and provide the following recommendations:

- The existing slopes should be cleared and grubbed of organic and deleterious material prior to fill placement.
- The existing slopes should be terraced prior to fill placement as described in WSDOT Standard Specifications Section 2-03.3(14) (WSDOT, 2018). The toe of the fill should be keyed in to the existing slope ground surface by a minimum of 18 inches (depth below existing ground surface).
- Fill placed on existing slopes should meet the material and compaction specifications provided in Section 3.8.2 and 3.8.3, respectively.
- The outer edge of fill slopes should be ‘overbuilt’ as described in Section 3.8.2.

4 Recommendations for Continuing Geotechnical Services

4.1 Continuing Contracted Design and Consultation Services

Per our scope of work and as part of the design phase process, we recommend that Aspect attend design team meetings by telephone as design progresses, on an as-needed basis as determined by Nicholls Kovich.

4.2 Additional Services During Construction

We are available to provide geotechnical engineering and monitoring services during construction. The integrity of the geotechnical elements depends on proper Site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

During the construction phase of the Project, we recommend that Aspect be retained to perform the following tasks:

- Review applicable submittals for geotechnical materials
- Observe and evaluate subgrade for all foundations, walls, and pavements
- Observe temporary excavations and structural fill placement
- Attend meetings by telephone or on-Site, as needed
- Other geotechnical engineering considerations that may arise during the course of construction

The purpose of our observations is to verify compliance with design concepts and recommendations, and to allow design changes or evaluation of appropriate construction methods in the event that subsurface conditions differ from those anticipated prior to the start of construction.

5 References

ASTM International (ASTM), 2018, 2018 Annual Book of ASTM Standards, West Conshohocken, Pennsylvania.

American Association of State Highway and Transportation Officials (AASHTO), 2017, Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Customary U.S. Units.

Gulick, C.W., and Korosec, M.A., 1990, Geologic map of the Omak 1:100,000 quadrangle, Washington: Washington Division of Geology and Earth Resources, Open File Report 90-12, scale 1:100,000.

Rocscience, 2018, Slide, version 108 8.022.

U.S. Geological Survey (USGS), 2017, U.S. Seismic Design Maps: https://earthquake.usgs.gov/designmaps/us/application.php.

U.S. Geological Survey (USGS), 2019, Quaternary Fault and Fold Database of the United States, https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

Washington Administrative Code (WAC), Chapter 296-155, Part N - Excavation, Trenching, and Shoring, April 19, 2016.

Washington State Department of Ecology (Ecology), 2019, Washington State Well Log Viewer, Website accessed February 2019. https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/.

Washington State Department of Transportation (WSDOT), 2018, Standard Specifications for Road, Bridge and Municipal Construction, Document M 41-10.

6 Limitations

Work for this project was performed for Nicholls Kovich Engineering, PLLC. (Client), and this report was prepared consistent with recognized standards of professionals in the same locality and involving similar conditions, at the time the work was performed. No other warranty, expressed or implied, is made by Aspect Consulting, LLC (Aspect).

Recommendations presented herein are based on our interpretation of site conditions, geotechnical engineering calculations, and judgment in accordance with our mutually agreed-upon scope of work. Our recommendations are unique and specific to the project, site, and Client. Application of this report for any purpose other than the project should be done only after consultation with Aspect.

Variations may exist between the soil and groundwater conditions reported and those actually underlying the site. The nature and extent of such soil variations may change over time and may not be evident before construction begins. If any soil conditions are encountered at the site that are different from those described in this report, Aspect should be notified immediately to review the applicability of our recommendations.

Risks are inherent with any site involving slopes and no recommendations, geologic analysis, or engineering design can assure slope stability. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the Client.

It is the Client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, and agents, are made aware of this report in its entirety. At the time of this report, design plans and construction methods have not been finalized, and the recommendations presented herein are based on preliminary project information. If project developments result in changes from the preliminary project information, Aspect should be contacted to determine if our recommendations contained in this report should be revised and/or expanded upon.

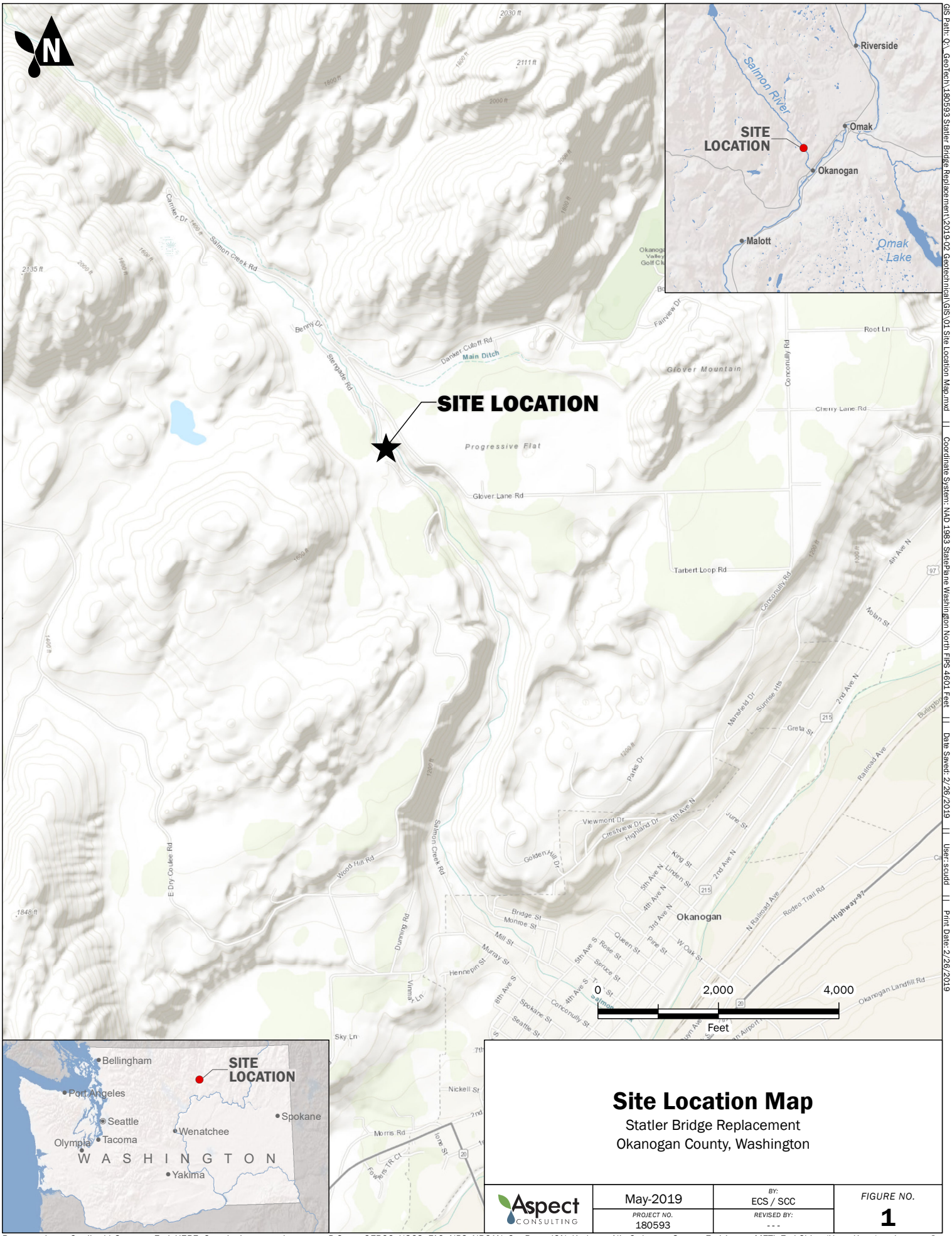
The scope of work does not include services related to construction safety precautions. Site safety is typically the responsibility of the contractor, and our recommendations are not intended to direct the contractor’s site safety methods, techniques, sequences, or procedures. The scope of our work also does not include the assessment of environmental characteristics, particularly those involving potentially hazardous substances in soil or groundwater.

All reports prepared by Aspect for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect. Aspect’s original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Please refer to Appendix C titled “Report Limitations and Guidelines for Use” for additional information governing the use of this report.

We appreciate the opportunity to perform these services. If you have any questions please call Nick Szot, Senior Project Geotechnical Engineer, at (509) 888-7218.

FIGURES



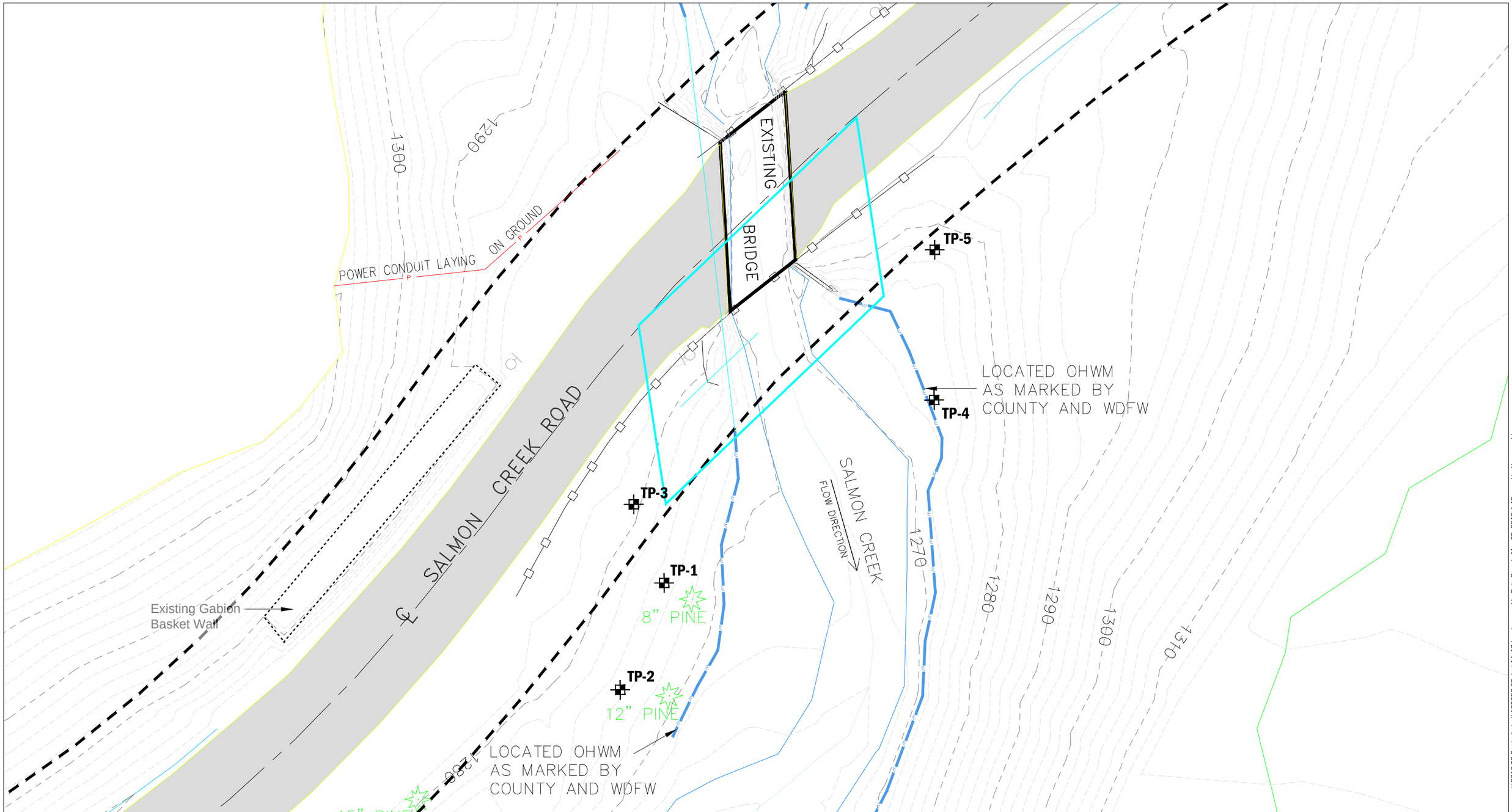
Site Location Map

Statler Bridge Replacement
Okanogan County, Washington

Aspect CONSULTING	May-2019	BY: ECS / SCC	FIGURE NO.
	PROJECT NO. 180593	REVISED BY: - - -	1

Basemap Layer Credits || Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
Copyright:© 2014 Esri

GIS Path: Q:_GeoTech\180593 Statler Bridge Replacement\2019-02 Geotechnical\GIS\01 Site Location Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 2/26/2019 || User: scudd || Print Date: 2/26/2019



Source: Base map provided by NCW Land Surveying, LLC, Okanogan, Washington, 12-20-2018.

Legend

- Test Pit Location
- Approximate Location of New Bridge

N

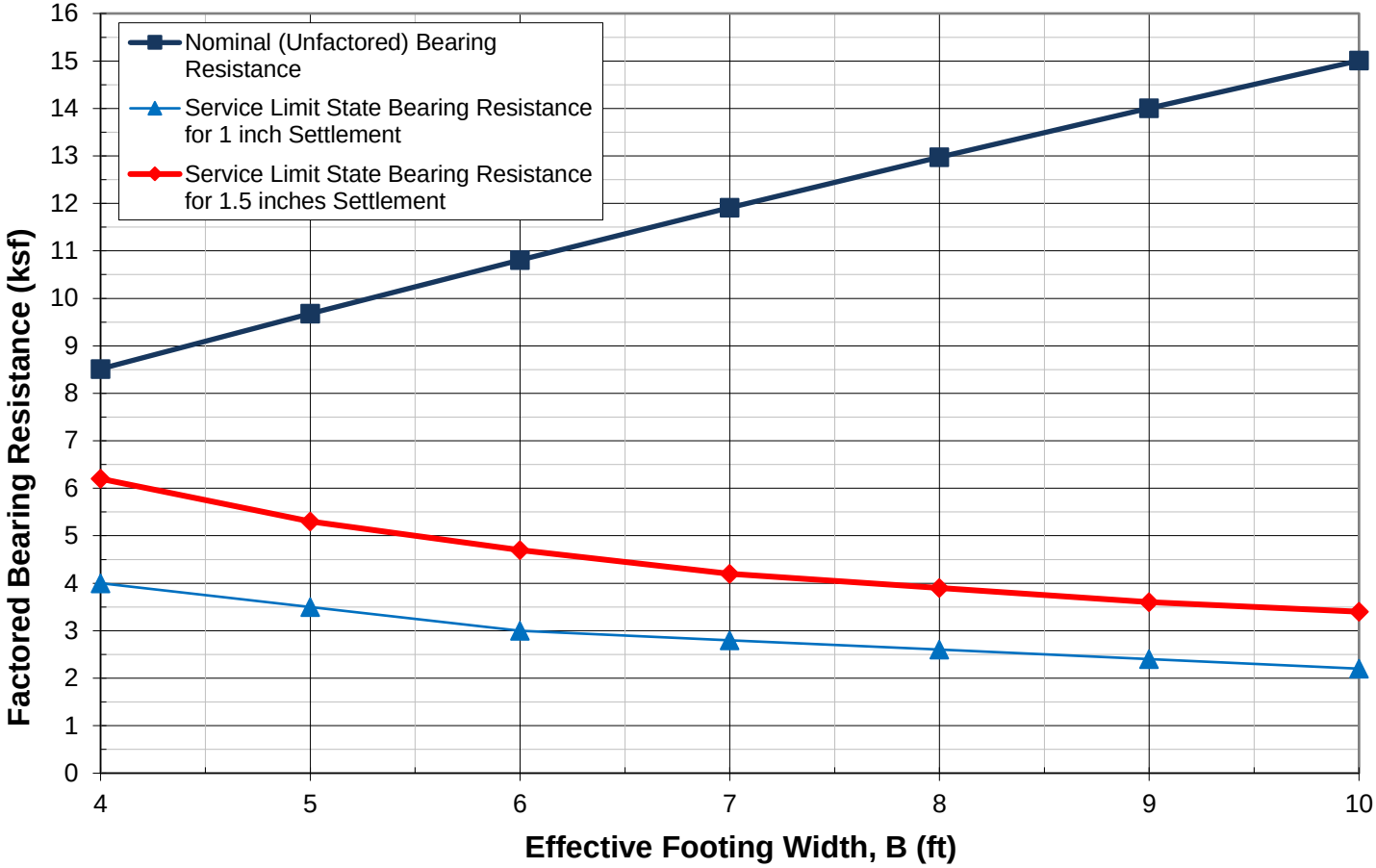
0 20 40 Feet

Site Exploration Map

Statler Bridge Replacement
Okanogan County, Washington

Aspect CONSULTING	May-2019	BY: ECS/SCC	FIGURE NO.
	PROJECT NO. 180593	REVISED BY: -	2

CAD Path: Q:_GeoTech\180593 Statler Bridge Replacement\2019-02 Geotechnical\180593-02.dwg 11x17 Landscape || Date Saved: May 08, 2019 4:45pm || User: scudd



Notes:
1. Assumes foundation embedment depth of at least 2 feet below design scour elevation.
2. Apply Resistance Factors shown in Table 2 to Nominal (Unfactored) Bearing Resistance to calculate Strength and Extreme Limit State Bearing Resistances.

Foundation Bearing Resistance

Statler Bridge Replacement
Okanogan County, Washington

180593

May-19

Figure
3

Aspect CONSULTING

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines	GW	Well-graded GRAVEL Well-graded GRAVEL WITH SAND
			GP	Poorly-graded GRAVEL Poorly-graded GRAVEL WITH SAND
		≥15% Fines	GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
			GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines	SW	Well-graded SAND Well-graded SAND WITH GRAVEL
			SP	Poorly-graded SAND Poorly-graded SAND WITH GRAVEL
		≥15% Fines	SM	SILTY SAND SILTY SAND WITH GRAVEL
			SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50%		ML	SILT SANDY or GRAVELLY SILT SILT WITH SAND SILT WITH GRAVEL
			CL	LEAN CLAY SANDY or GRAVELLY LEAN CLAY LEAN CLAY WITH SAND LEAN CLAY WITH GRAVEL
			OL	ORGANIC SILT SANDY or GRAVELLY ORGANIC SILT ORGANIC SILT WITH SAND ORGANIC SILT WITH GRAVEL
	Silts and Clays Liquid Limit 50% or More		MH	ELASTIC SILT SANDY or GRAVELLY ELASTIC SILT ELASTIC SILT WITH SAND ELASTIC SILT WITH GRAVEL
			CH	FAT CLAY SANDY or GRAVELLY FAT CLAY FAT CLAY WITH SAND FAT CLAY WITH GRAVEL
			OH	ORGANIC CLAY SANDY or GRAVELLY ORGANIC CLAY ORGANIC CLAY WITH SAND ORGANIC CLAY WITH GRAVEL
Highly Organic Soils			PT	PEAT and other mostly organic soils

"WITH SILT" or "WITH CLAY" means 5 to 15% silt and clay, denoted by a "-" in the group name; e.g., SP-SM • "SILTY" or "CLAYEY" means >15% silt and clay • "WITH SAND" or "WITH GRAVEL" means 15 to 30% sand and gravel. • "SANDY" or "GRAVELLY" means >30% sand and gravel. • "Well-graded" means approximately equal amounts of fine to coarse grain sizes • "Poorly graded" means unequal amounts of grain sizes • Group names separated by "/" means soil contains layers of the two soil types; e.g., SM/ML.

Soils were described and identified in the field in general accordance with the methods described in ASTM D2488. Where indicated in the log, soils were classified using ASTM D2487 or other laboratory tests as appropriate. Refer to the report accompanying these exploration logs for details.

1. Estimated or measured percentage by dry weight
2. (SPT) Standard Penetration Test (ASTM D1586)
3. Determined by SPT, DCPT (ASTM STP399) or other field methods. See report text for details.

GEOTECHNICAL LAB TESTS

MC	=	Natural Moisture Content
GS	=	Grain Size Distribution
FC	=	Fines Content (% < 0.075 mm)
GH	=	Hydrometer Test
AL	=	Atterberg Limits
C	=	Consolidation Test
Str	=	Strength Test
OC	=	Organic Content (% Loss by Ignition)
Comp	=	Proctor Test
K	=	Hydraulic Conductivity Test
SG	=	Specific Gravity Test

CHEMICAL LAB TESTS

Organic Chemicals

BTEX	=	Benzene, Toluene, Ethylbenzene, Xylenes
TPH-Dx	=	Diesel and Oil-Range Petroleum Hydrocarbons
TPH-G	=	Gasoline-Range Petroleum Hydrocarbons
VOCs	=	Volatile Organic Compounds
SVOCs	=	Semi-Volatile Organic Compounds
PAHs	=	Polycyclic Aromatic Hydrocarbon Compounds
PCBs	=	Polychlorinated Biphenyls

Metals

RCRA8	=	As, Ba, Cd, Cr, Pb, Hg, Se, Ag, (d = dissolved, t = total)
MTCA5	=	As, Cd, Cr, Hg, Pb (d = dissolved, t = total)
PP-13	=	Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, Zn (d=dissolved, t=total)

FIELD TESTS

PID	=	Photoionization Detector
Sheen	=	Oil Sheen Test
SPT[2]	=	Standard Penetration Test
NSPT	=	Non-Standard Penetration Test
DCPT	=	Dynamic Cone Penetration Test

COMPONENT DEFINITIONS

Descriptive Term		*Size Range and Sieve Number*
Boulders	=	Larger than 12 inches
Cobbles	=	3 inches to 12 inches
Coarse Gravel	=	3 inches to 3/4 inches
Fine Gravel	=	3/4 inches to No. 4 (4.75 mm)
Coarse Sand	=	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	=	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	=	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	=	Smaller than No. 200 (0.075 mm)

ESTIMATED[1] PERCENTAGE

% by Weight		*Modifier*	*% by Weight*		*Modifier*
<1	=	Subtrace	15 to 25	=	Little
1 to <5	=	Trace	30 to 45	=	Some
5 to 10	=	Few	>50	=	Mostly

MOISTURE CONTENT

Dry	=	Absence of moisture, dusty, dry to the touch
Slightly Moist	=	Perceptible moisture
Moist	=	Damp but no visible water
Very Moist	=	Water visible but not free draining
Wet	=	Visible free water, usually from below water table

RELATIVE DENSITY

Non-Cohesive or Coarse-Grained Soils

Density[3]		*SPT[2] Blows/Foot*	*Penetration with 1/2" Diameter Rod*
Very Loose	=	0 to 4	≥ 2'
Loose	=	5 to 10	1' to 2'
Medium Dense	=	11 to 30	3" to 1'
Dense	=	31 to 50	1" to 3"
Very Dense	=	> 50	< 1"

CONSISTENCY

Cohesive or Fine-Grained Soils

Consistency[3]		*SPT[2] Blows/Foot*	*Manual Test*
Very Soft	=	0 to 1	Penetrated >1" easily by thumb. Extrudes between thumb & fingers.
Soft	=	2 to 4	Penetrated 1/4" to 1" easily by thumb. Easily molded.
Medium Stiff	=	5 to 8	Penetrated >1/4" with effort by thumb. Molded with strong pressure.
Stiff	=	9 to 15	Indented ~1/4" with effort by thumb.
Very Stiff	=	16 to 30	Indented easily by thumbnail.
Hard	=	> 30	Indented with difficulty by thumbnail.

GEOLOGIC CONTACTS

Observed and Distinct — Observed and Gradual — Inferred

Aspect CONSULTING

Exploration Log Key

AI Path: Q:_ACAD Standards\FIELD REFERENCE\MASTERS\Exploration Log Key-2018.ai // user: jinman // last saved: 09/26/2018

Aspect CONSULTING	Statler Bridge Replacement - 180593			Geotechnical Exploration Log	
	Project Address & Site Specific Location			*Coordinates*	*Exploration Number*
	Salmon Creek Rd, South bank of Salmon Creek; see Figure 2			NA	**TP-1**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	
Cates & Erb	Cat 325C with 42" toothed bucket	Grab		1274'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Bill	Test Pit	1/2/2019		NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil.						**FILL** SILTY GRAVEL WITH SAND (GM); Loose, slightly moist, dark brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 60 percent cobbles and boulders by volume and up to 3 feet in diameter; trace roots.	
	1270							**GLACIAL DRIFT** GRAVEL WITH SILT AND SAND (GP-GM); Medium dense, slightly moist, brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 80 percent cobbles and boulders by volume and up to about 4 feet in diameter.	
5									5
								Bottom of exploration at 7 ft. bgs. Note: Minor caving of test pit sidewalls observed. Test pit terminated upon practical digging refusal on boulder (estimated to be 5 to 7 feet in diameter).	
	1265								
10									10
	1260								
15									15
	1255								

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ECS
Approved by: NCS

Exploration Log TP-1

Sheet 1 of 1

NEW STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\STATLER BRIDGE OKANOGAN COUNTY - 180593.GPJ March 1, 2019

Review Stage:DRAFT Rev.2

Aspect CONSULTING	Statler Bridge Replacement - 180593		Geotechnical Exploration Log	
	Project Address & Site Specific Location Salmon Creek Rd, South bank of Salmon Creek; see Figure 2		*Coordinates* NA	*Exploration Number* **TP-2**
Contractor Cates & Erb	*Equipment* Cat 325C with 42" toothed bucket	*Sampling Method* Grab	*Ground Surface (GS) Elev. (NAVD88)* 1275'	
Operator Bill	*Exploration Method(s)* Test Pit	*Work Start/Completion Dates* 1/2/2019	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil.						**FILL** SILTY GRAVEL WITH SAND (GM); Loose, slightly moist, dark brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 60 percent cobbles and boulders by volume and up to 3 feet in diameter; trace roots.	
		Sample obtained from downslope wall of test pit.	S-1					**GLACIAL DRIFT** GRAVEL WITH SILT AND SAND (GP-GM); Medium dense, slightly moist, brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 80 percent cobbles and boulders by volume and up to about 6 feet in diameter. 5.5 to 6-foot diameter boulder encountered.	
5	1270								5
10	1265								10
								Bottom of exploration at 10.5 ft. bgs. Note: Minor caving of test pit sidewalls observed.	
15	1260								15

Legend

Sample Type: Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ECS
Approved by: NCS

Exploration Log TP-2

Sheet 1 of 1

NEW STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\STATLER BRIDGE OKANOGAN COUNTY - 180593.GPJ March 1, 2019

Review Stage:DRAFT Rev.2

Aspect CONSULTING	Statler Bridge Replacement - 180593		Geotechnical Exploration Log	
	Project Address & Site Specific Location Salmon Creek Rd, South bank of Salmon Creek; see Figure 2		*Coordinates* NA	*Exploration Number* **TP-3**
Contractor Cates & Erb	*Equipment* Cat 325C with 42" toothed bucket	*Sampling Method* Grab	*Ground Surface (GS) Elev. (NAVD88)* 1280'	
Operator Bill	*Exploration Method(s)* Test Pit	*Work Start/Completion Dates* 1/2/2019	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil.						**FILL** SILTY GRAVEL WITH SAND (GM); Loose, slightly moist, dark brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 40 percent cobbles by volume and up to 3 feet in diameter.	
5	1275							**GLACIAL DRIFT** GRAVEL WITH SILT AND SAND (GP-GM); Medium dense, slightly moist, brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 60 percent cobbles and boulders and up to 2.5 feet in diameter.	5
								Decrease in boulder content observed.	
10	1270	Sample obtained from upslope wall of test pit.	S-1					SAND WITH SILT (SP-SM); Medium dense, slightly moist, brown; fine to medium sand; trace fine to coarse, subrounded to rounded gravel; horizontally bedded.	10
15	1265								15
								Bottom of exploration at 16 ft. bgs. Note: Minor caving of test pit sidewalls within upper fill and alluvium observed.	

Legend

Sample Type: Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ECS
Approved by: NCS

Exploration Log TP-3

Sheet 1 of 1

NEW STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\STATLER BRIDGE OKANOGAN COUNTY - 180593.GPJ March 1, 2019

Review Stage:DRAFT Rev.2

Aspect CONSULTING	Statler Bridge Replacement - 180593		Geotechnical Exploration Log	
	Project Address & Site Specific Location Salmon Creek Rd, North bank of Salmon Creek; see Figure 2		*Coordinates* NA	*Exploration Number* **TP-4**
Contractor Cates & Erb	*Equipment* Cat 325C with 42" toothed bucket	*Sampling Method* Grab	*Ground Surface (GS) Elev. (NAVD88)* 1273'	
Operator Bill	*Exploration Method(s)* Test Pit	*Work Start/Completion Dates* 1/2/2019	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil.						**FILL** SILTY GRAVEL WITH SAND (GM); Loose, moist, dark brown;fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 20 percent cobbles and boulders by volume and up to 2 feet in diameter; trace roots.	
	1270							**GLACIAL DRIFT** GRAVEL WITH SILT AND SAND (GP-GM); Medium dense, slightly moist, brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel.	
								SAND WITH SILT (SP-SM); Medium dense, slightly moist, brown; fine to medium sand; trace fine to coarse, subrounded to rounded gravel; occasional cobble; horizontally bedded.	
5						Hand Probe =8 inches			5
	1265								
		Sample obtained from upslope wall of test pit.	S-1	●		PS FC=8% D50=0.24mm			
10									10
								Becomes moist	
	1260								
15									15
								Bottom of exploration at 16 ft. bgs. Note: Test pit sidewalls remained vertical.	
	1255								

Legend

Sample Type: Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ECS
Approved by: NCS

Exploration Log TP-4

Sheet 1 of 1

NEW STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\STATLER BRIDGE OKANOGAN COUNTY - 180593.GPJ March 1, 2019

Review Stage:DRAFT Rev.2

Aspect CONSULTING	Statler Bridge Replacement - 180593		Geotechnical Exploration Log	
	Project Address & Site Specific Location Salmon Creek Rd, North bank of Salmon Creek; see Figure 2		*Coordinates* NA	*Exploration Number* **TP-5**
Contractor Cates & Erb	*Equipment* Cat 325C with 42" toothed bucket	*Sampling Method* Grab	*Ground Surface (GS) Elev. (NAVD88)* 1278'	
Operator Bill	*Exploration Method(s)* Test Pit	*Work Start/Completion Dates* 1/2/2019	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil.						**FILL** SILTY GRAVEL WITH SAND (GM); Loose, moist, dark brown; fine to coarse sand; fine to coarse, subrounded to rounded gravel; estimated 40 percent cobbles and boulders by volume and up to 2 feet in diameter.	
	1275							**GLACIAL DRIFT** SAND WITH SILT (SP-SM); Medium dense, slightly moist, brown; fine to medium sand; lenses of fine to coarse, subrounded to rounded gravel to 5.5 feet.	
5						Hand Probe =8 inches			5
	1270								
10									10
	1265							Bottom of exploration at 12 ft. bgs. Note: Test pit sidewalls remained vertical.	
15									15
	1260								

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ECS
Approved by: NCS

Exploration Log TP-5

Sheet 1 of 1

NEW STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\STATLER BRIDGE OKANOGAN COUNTY - 180593.GPJ March 1, 2019

Review Stage:DRAFT Rev.2

APPENDIX B

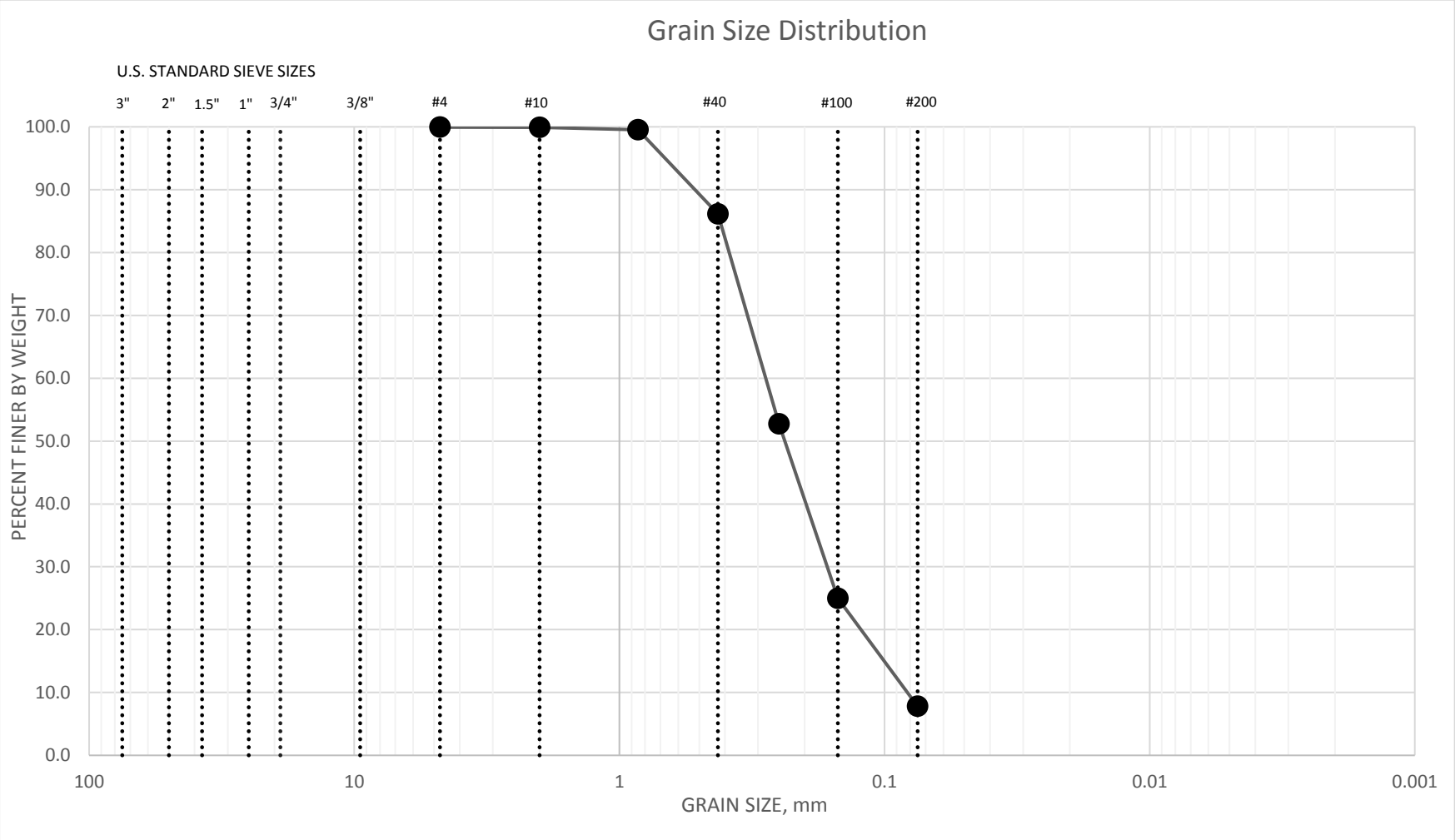
Geotechnical Laboratory Testing Results

B.1 Geotechnical Laboratory Testing

Geotechnical laboratory tests were conducted on selected creek bank/channel sample collected from TP-4 during the field exploration program for determination of moisture content and grain size distribution:

- Moisture content was determined by ASTM International (ASTM) D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- Grain size analysis was conducted in accordance with ASTM D6913, Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis.

The results of the tests are provided in the attached data sheets.



Symbol	Exploration, Sample, Depth	Moisture Content (%)	Silt/Clay Content (%)	Sand Content (%)	Gravel Content (%)	USCS	D_{90} (mm)	D_{60} (mm)	D_{50} (mm)	D_{30} (mm)	D_{10} (mm)
●	TP-4, S-1, 9'	4	8.0	100.0	0.0	SP-SM	0.55	0.29	0.24	0.17	0.08
■											
▲											

*The sample(s) tested may not include oversized particles and may only be representative of a portion of the sample/site soil conditions.

Project Name: **Okanogan County Statler Bridge Replacement**
Project Number: 180593
K:\Projects\Okanogan County Statler Bridge Replacement\Data\Analyses\Lab Testing\Lab Testing.xlsx

APPENDIX C

Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

This Report and Project-Specific Factors

Aspect Consulting, LLC (Aspect) considered a number of unique, project-specific factors when establishing the Scope of Work for this project and report. You should not rely on this report if it was:

- Not prepared for you
- Not prepared for the specific purpose identified in the Agreement
- Not prepared for the specific real property assessed
- Completed before important changes occurred concerning the subject property, project or governmental regulatory actions

Geoscience Interpretations

The geoscience practices (geotechnical engineering, geology, and environmental science) require interpretation of spatial information that can make them less exact than other engineering and natural science disciplines. It is important to recognize this limitation in evaluating the content of the report. If you are unclear how these "Report Limitations and Use Guidelines" apply to your project or site, you should contact Aspect.

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against liability claims by third parties with whom there would otherwise be no contractual limitations. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with our Agreement with the Client and recognized geoscience practices in the same locality and involving similar conditions at the time this report was prepared

Property Conditions Change Over Time

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by events such as a change in property use or occupancy, or by natural events, such as floods, earthquakes, slope instability, or groundwater fluctuations. If any of the described events may have occurred following the issuance of the report, you should contact Aspect so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Discipline-Specific Reports Are Not Interchangeable

The equipment, techniques, and personnel used to perform a geotechnical or geologic study differ significantly from those used to perform an environmental study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually address any environmental findings, conclusions, or recommendations (e.g., about the likelihood of encountering underground storage tanks or regulated contaminants). Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding the subject property.

We appreciate the opportunity to perform these services. If you have any questions please contact the Aspect Project Manager for this project.