July 23, 2021

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Report of Geotechnical Services
White Creek Bridge
Yakima County, Washington
Project No. 20-002-1

INTRODUCTION AND PROJECT DESCRIPTION

Geotechnics LLC is pleased to submit this geotechnical report to support design and construction of a road bridge within forested lands of the Yakama Nation. The bridge will carry traffic across a small stream - White Creek.

White Creek is a southward-flowing tributary of the Klickitat River, located approximately 20 miles east of Mt. Adams as shown on the Vicinity Map, Figure 1. The intermittent stream currently flows through an earth embankment within three parallel steel culverts. The culverts will be replaced with a bridge crossing to eliminate the fish passage restriction. The single-span bridge will be approximately 29 feet in length and 16½ feet in width. The project administrator is the Yakama Nation and the designer is Waterways Consulting, Inc.

The following report provides our geological and geotechnical assessment of the site as well as our geotechnical engineering recommendations. Our work was completed in general accordance with our contract with Waterways Consulting dated June 4, 2021.

SCOPE OF SERVICES

The purpose of our services is to evaluate soil and groundwater conditions as a basis for developing geotechnical design and construction recommendations. We completed the following specific services:

- Reviewed existing available subsurface soil and groundwater information, geologic maps, and other information pertinent to the site.
- Performed a geologic reconnaissance to observe existing surficial slope, soil, ground, and surface water conditions.
- Explored subsurface soil and groundwater conditions by completing three test pits.
- Obtained samples at representative intervals from the explorations, observed soil and groundwater conditions, and maintained detailed logs. Performed laboratory tests on selected soil samples.

- Performed geotechnical evaluations and prepared the design recommendations presented in this geotechnical report.

SITE AND PROJECT DESCRIPTION

The top of the stream banks and the fill embankment road surface are at about Elev. 2,657 feet and the base of the channel is approximately Elev. 2,647 feet. The side slopes of the fill embankment are inclined approximately 1.1H:1V to 1.5H:1V (Horizontal:Vertical). Figure 2 shows the existing embankment and 2-ft topographic contours, as well as locations of the three existing culverts. The culverts are ovaloid (8'W x 6'H) and approximately 55 feet in length. The easternmost culvert has a higher invert elevation than the other two, as illustrated on the Profile, Figure 3.

The culverts are corrugated steel. The majority of current flow is through the westernmost culvert. The others likely receive flow during high-flow events. The easternmost culvert is filled with sediment, approximately 12 inches thick and there is a small tree growing within it, near the outlet. Below are two photos facing the embankment at the westernmost culvert under different stream flow conditions.

The Yakama Nation plans to remove the earth embankment and construct a road bridge spanning the width of the channel. The current design calls for a clear span of 24 feet with an overall bridge length of 29 feet. Current design includes concrete abutment walls and wing walls as shown on Figure 2. The new thalweg will be located between the current locations of the westerly and central culverts. Downstream and upstream improvements will include grading stream banks to 2H:1V, including downwards from the wingwalls. We assume the bridge must be designed to accommodate HS-20 live loads from trucks.

GEOLOGIC MAPPING

To research the geology and geologic setting of the site, we reviewed the following two publications:

- *Stratigraphy and Structure of the Yakima Indian Reservation, with emphasis on the Columbia River Basalt Group* (Bentley et al, 1980).
- *Geologic map of the Simcoe Mountains volcanic field, main central segment, Yakama Nation, Washington* (Hildreth and Fierstein, 2015).

The first is a smaller scale map with much less detail, with mapped near-surface rocks identified as the Yakima Basalt subgroup of the Columbia River Basalt (CRB). The more detailed mapping by Hildreth and Fierstein identifies the many basalt units that make up the Simcoe Mountains volcanic field. As explained, the volcanic field is largely from cinder cones that blanket the underlying and much older CRB. The first reference just describes all younger lava flows as a single entity without the detailed description that Hildreth and Fierstein added to make up for that lack of local mapping. Our further discussion is based on the second reference.

The site is within the central portion of the Simcoe Mountains volcanic field which is bounded structurally by two east-west trending anticlines, the Simcoe Mountains Anticline on the south and the Toppenish Ridge Anticline on the north. These anticlines are a feature of the more regional Yakima Fold Belt, of which the Simcoe Mountains field makes up the SW portion. The site is about 20 miles to the east-southeast of Mt. Adams.

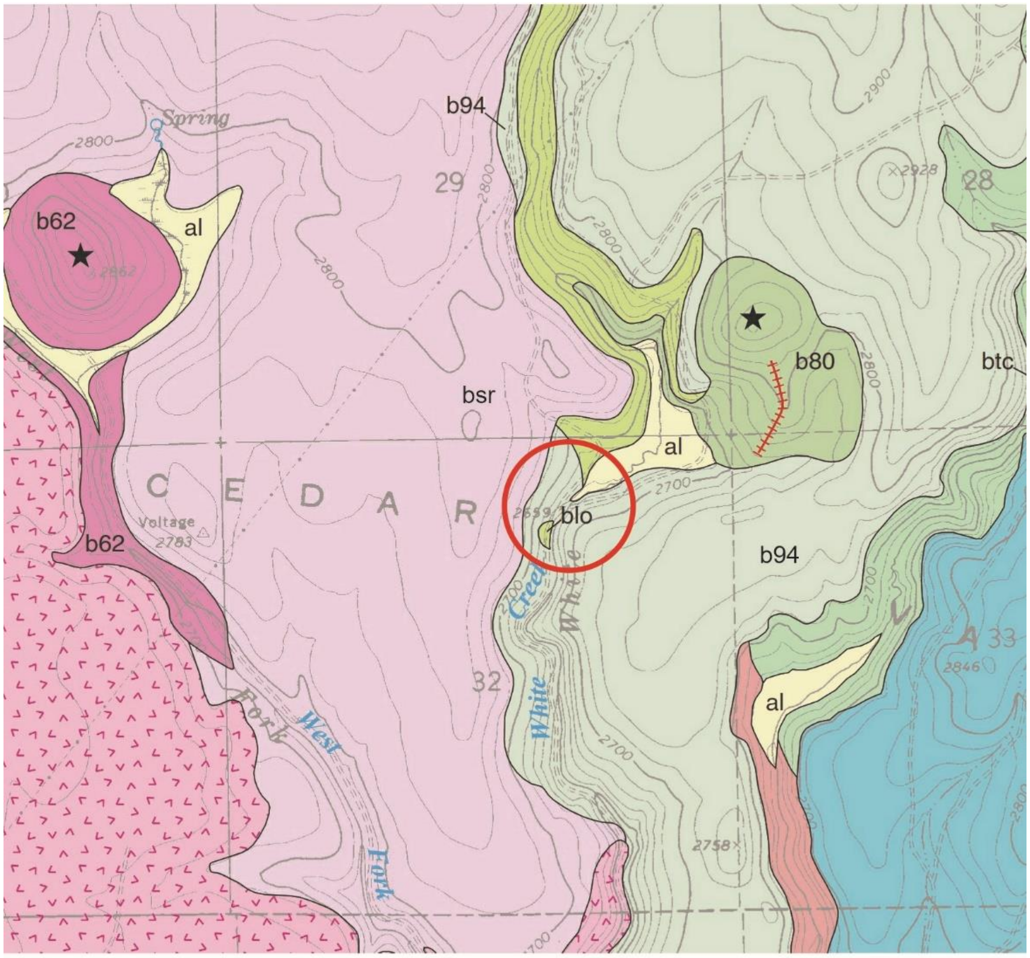
The following page contains a blown-up portion of the Hildreth & Fierstein map, along with abbreviated legend showing relative age of basalts. As noted, the majority of basalts at or near our site are early Pleistocene, generally aged 1.5 to 2 million years. Exceptions are basalt units *blo* and *b80* which are Pliocene and aged about 3.3 million years. All of these basalts result from extinct cinder cones and are much younger than the underlying Miocene-age CRB. The star symbols on the map represent cinder cone locations.

Due to the bedrock's relatively young age and the geomorphic setting, soil cover is limited in most areas. This is described nicely in the second reference along with a description of the typical underlying basalt units:

> *"Lava flows of the Simcoe Mountains volcanic field are generally covered by several feet of silty soil (loess), much of which was blown here by winds from barren areas of the Cascade Range during the ice ages (Pleistocene). Beneath such soils, however, tops of most flows are rubbly and porous, and interior parts typically contain abundant fractures. These properties make the Simcoe Mountains lava flows highly permeable, promoting infiltration of rainfall and snowmelt and favoring rapid lateral transport of groundwater."*

While the soil blanket may be thin in most areas, thicker soil deposits can be anticipated in areas mapped as alluvium, and of course in areas of manmade fill such as stream-crossing embankments. The pervasive shallow bedrock would suggest that existing fill embankments that have been sourced from nearby excavations will contain significant quantities of rock in varying sizes, most likely including cobble and boulder sizes.

White Creek geology detail (Hildreth and Fierstein, 2015):



al	**Alluvium and silt deposits (Holocene)**
blo	**Basalt of Lost Springs (Pliocene)**
bsr	**Trachybasalt of Shamrock Spring (early Pleistocene)**
b80	**Trachybasalt of Cone 2880 (Pliocene)**
b94	**Basalt of Cone 3294 (early Pleistocene)**

EXPLORATIONS AND TESTING

We completed field explorations on June 25, 2021 consisting of three test pits (TP-1 through TP-3) at the approximate locations shown on Figure 2. The test pits were excavated with a Hitachi 40u trackhoe by Dan Fischer Excavating of Forest Grove, Oregon. Completion depths varied from 4½ to 7 ft below ground surface (bgs). Detailed logs of the test pits are included as Figures A1 through A3.

Samples were collected from the test pits and returned to our soils laboratory for further examination and testing. Testing included Moisture Content (ASTM D2216) and Grain Size Distribution (ASTM D6913). Laboratory test results are provided on the individual test pit logs and on Figure A4.

In agreement with the geologic mapping described above, we encountered basalt at relatively shallow depth. The encountered soil units are described separately below and Figure 3 illustrates our findings in a profile taken through the creek, downstream from the crossing.

Fill and Organic Topsoil

Embankment fill was encountered in TP-3, and TP-2 also had minimal fill associated with the original stream crossing construction. TP-2 fill soils extended to 2 ft depth and were likely placed to build-up the stream bank, downstream of the culverts. This soil was gravelly sand and silt, with many boulders mantling the surface in this area. Between 2 ft and 3 ft in TP-2, we also encountered a layer of highly organic topsoil, generally soft silt. This material may be the original surficial layer but may also be a layer of fill.

In TP-3, excavated within the embankment between two culverts, fill soils were generally a matrix of silt with abundant gravel and cobbles, and some boulders. Boulders mantle the slope surfaces above and around the culverts. These soils were relatively dry.

Colluvium

At the base of the easterly slope above the stream, TP-1 revealed a thin layer of colluvium (slope wash) material mantling the underlying soils. This soil consists of gravelly silt.

Alluvium

Soils from stream deposition were encountered in both the downstream test pits. Alluvium is generally thicker to the west, indicating past eastward migration of the stream. Alluvial soils vary from gravel to silty gravel and are generally well graded with abundant sand and cobble fractions. These soils are generally medium dense.

Basalt

We encountered weathered residual basalt bedrock beneath the alluvium. Basalt encountered consisted of a highly weathered rock classifying as a soil - silty gravel. This material was easily excavated with the trackhoe bucket in the locations encountered.

Groundwater

Groundwater inflow in TP-1 was more rapid and at a higher level than in TP-2 (see Figure 3). Subsurface flow within colluvium from the eastern hillside may be perched above the lower-permeability basalt, accumulating in the alluvium at this time of year. Lower groundwater levels should be anticipated in the later summer months.

TP-1, Excavating below groundwater, cobbly, wet.

TP-1, First seepage at 4.5 feet.

TP-2, Removing surficial boulders, looking SW.

TP-2, Excavating, looking NW.

Field Photos – Test Pits TP-1 and TP-2

TP-2, Top of organic topsoil at 2 feet.

TP-2, Cobbly alluvium at 4 feet.

TP-2, Seepage at 5 feet.

TP-3, Angular cobbles and boulders in fill soil.

Field Photos – Test Pits TP-2 and TP-3

SEISMIC EVALUATION

EARTHQUAKE FAULTS

The USGS online Fault and Fold database (USGS, 2021) shows no known active or potentially active faults passing through the sites. No indications of the presence of faulting were noted during our field investigation. We consider the possibility of fault rupture and displacement to be remote.

GROUND SHAKING

Ground shaking is responsible for generating high inertial forces and excessive dynamic movements that can impart unacceptable damage to structures. Ground shaking should be mitigated by using the design ground motions and site classification given below.

LIQUEFACTION/LATERAL SPREADING

Liquefaction is a phenomenon caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils, which rely on interparticle friction for strength, are susceptible to liquefaction until the excess pore pressures can dissipate. The alluvial materials, when saturated, may be liquefaction susceptible. However, based on their very limited thickness in the saturated zone, we consider the potential for liquefaction and lateral spreading at this site to be minimal to none.

DESIGN GROUND MOTIONS AND SITE CLASSIFICATION

We have developed appropriate seismic parameters for AASHTO level seismic design (AASHTO, 2020). We developed ground motion parameters for the 1,000 year "no-collapse" event. The seismic design parameters are summarized in the following table.

Seismic Design Parameters	
Soil Profile Site Class	D
Peak Ground Acceleration, PGA	0.15g
Spectral Response Acceleration S_s	0.36g
Spectral Response Acceleration S_1	0.13g
Site Coefficient, F_{pga}	1.49
Site Coefficient, F_a	1.51
Site Coefficient, F_v	2.27
Factored Peak Ground Acceleration	0.23g
Spectral Response Acceleration (Short Period), S_{DS}	0.54g
Spectral Response Acceleration (1-Second Period), S_{D1}	0.30g

Notes:

1. g = acceleration due to gravity
2. AASHTO seismic parameters are based upon an expected peak bedrock acceleration having a 7 percent probability of exceedance in 75 years, representing an approximately 1,000-year return period.

Seismic earth pressures acting on abutment and wing walls were calculated and are included below in the report section titled *Retaining Walls and Abutments*.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION SUMMARY

Based on our explorations, testing, and analyses, it is our opinion that the site is suitable for the proposed development provided the recommendations in the following sections are included in design and construction. We offer the following summary of conclusions:

- Appropriate bearing for shallow foundations is alluvium or residual basalt. The other soil units encountered (fill, topsoil, and colluvium) are unsuitable for foundation support of abutments and walls. As illustrated on the Figure 3 profile, the projection of proposed footings does land within these layers. However, this profile is a projection and may change in the upstream direction and at wingwall locations. Geotechnical construction monitoring is recommended to confirm appropriate foundation bearing material.
- Although bedrock was encountered, the basalt is likely to be very weathered and highly fractured. The necessity of blasting is unlikely.
- No elevated seismic hazards have been identified, as summarized above.
- Significant groundwater could be encountered within excavations for wingwalls and abutments. For this reason, we recommend scheduling the work for dry-season construction.

RETAINING WALLS AND ABUTMENTS

Foundation Support

The bridge abutments will likely require wing walls in addition to the abutment walls. Appropriate abutment and wingwall types include cast-in-place concrete and modular block walls such as Ultrablock.

All foundations can be supported on spread footings bearing on the medium dense alluvium or the basalt. Foundations should not bear on fill soils. Minimum foundation depth below lowest adjacent final grade should be 2 feet for wingwall footings and 3 feet for bridge abutments. However, bridge abutments will likely be deeper than 3 feet to reach the native bearing soils. The slope-side bottom edge of abutment footings should have a minimum horizontal offset of 5 feet from the slope face.

For use in design of abutment and wingwall footings, an allowable bearing pressure of 4,000 psf is recommended. We expect that spread foundations designed and constructed as recommended will experience settlements of less than 1 inch. Differential settlements of up to one-half of the total settlement magnitude can be expected. The majority of these settlements should occur during construction.

If soft or loose soils, or large boulders, are encountered at foundation subgrade elevation, the materials should be removed and replaced with compacted crushed rock as described below in the report section *Fill Materials and Compaction*. Similarly, if water infiltrates and pools in the excavation, the water, along with any disturbed soil should be removed and replaced with a thin layer of crushed rock. We recommend that Geotechnics observe the base of prepared foundation excavations before placing any concrete forms and reinforcing steel. We will evaluate whether the bearing surface has been adequately prepared and that the soil conditions are consistent with those observed during our explorations.

Lateral Loading and Resistance

<u>Lateral Loading:</u>

Retaining walls should be designed to resist lateral pressures from soil, surcharge, and seismic loading.

Retaining structures free to rotate slightly around the base should be designed for active earth pressures using an equivalent fluid unit weight of 40 pcf. If retaining walls are restrained against rotation during backfilling, they should be designed for an at-rest equivalent fluid unit weight of 60 pcf. Surcharge loads applied closer than one-half of the wall height should be considered as uniformly distributed horizontal pressures equal to one-third of the distributed vertical surcharge pressure. The above load assumes a level backslope.

We evaluated seismic loads on retaining walls using Mononabe-Okabe methods and a peak acceleration of 0.23g. This corresponds to a seismic event with a roughly 1,000-year return period. Seismic incremental loading of $5H^2$ lb per foot of wall should be added to the static active earth pressure, with its resultant acting at a point 0.33H from the bottom of the wall (Sitar et al., 2012). This loading assumes a level backslope.

The above loads assume adequate drainage behind the wall to prevent the buildup of hydrostatic pressure. At a minimum, this should consist of drain rock extending from the base to within one foot of the top of wall, and extending at least 18 inches behind the wall. Drain rock material is discussed below in the report section *Fill Materials and Compaction*. The wall drainage system should be connected at its low point to the creek or other suitable outlet.

<u>Lateral Resistance:</u>

Lateral loads on retaining wall footings can be resisted by passive earth pressure on the sides of footings and by friction on the bearing surface. Passive earth pressures for retaining structures should be calculated using an equivalent unit weight of 350 pounds per cubic foot (pcf). Passive resistance should be reduced by the following factors on the downslope side based on slope inclination:

- 2H:1V: 60%
- 3H:1V: 44%
- 4H:1V: 35%

We recommend using a friction coefficient of 0.45 between the base of the footing and the native granular soil. The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The passive earth pressures and friction coefficient do not include a factor of safety.

EARTHWORK RECOMMENDATIONS

Dewatering and Dry Weather Construction

Groundwater is likely to occur within the depths of expected excavations, probably even during the dry season. Excavations that extend into saturated soils should be dewatered. Provided work is performed in the dry season, sump pumps placed in the excavations will likely be sufficient for dewatering. Although the need for dewatering wells and/or wellpoints is unlikely at that time of year, the contractor should plan on dealing with groundwater to allow foundation construction to occur in the dry. To limit the amount of required pumping, we recommend earthwork be scheduled for the dry summer months.

Graded Permanent Slopes

Permanent cut and fill slopes should not exceed 2H:1V. If existing site slopes cannot be graded to 2H:1V or flatter, retaining walls should be designed and constructed. Constructed slopes should be planted with appropriate vegetation as soon as possible after grading to provide protection against erosion. When fill is placed on sloping ground, the ground should be benched and keyed such that soils are placed on a level surface.

Fill Materials and Compaction

Structural fill materials will be required to construct slopes and to reconstruct portions of the earth embankment. Some crushed rock may be needed if foundation overexcavation is necessary (see *Foundation Support* above).

Crushed Rock: If foundation excavations require overexcavation, the imported replacement material should consist of clean, durable, crushed angular rock. Such rock should be well-graded and have a maximum particle size of 2½ inches, and less than 9 percent passing the U.S. No. 200 Sieve. The material should conform to WSDOT Specification 9-03.9(1), *Ballast* (WSDOT, 2021).

Drain Rock for Walls: Within 18 inches of the back face of retaining walls, select drain rock should consist of WSDOT Specification 9-03.12(2), *Gravel Backfill for Walls* (WSDOT, 2021).

General Structural Fill: Material for use in constructing graded slopes should be placed and compacted as structural fill. On-site soils, placed during dry weather, may be suitable for use as structural fill provided debris, organics, and oversized particles are removed, as described below.

Structural fill soils should be free of debris, roots, organic matter, frozen soil, man-made contaminants, particles with greatest dimension exceeding 4 inches, and other deleterious materials. For existing site materials, the contractor should be prepared to sort and remove oversize cobbles and boulders. The suitability of soil for use as structural fill will also depend on the gradation and moisture content of the soil. As the amount of fines in the soil matrix increases, the soil becomes increasingly more sensitive to small changes in moisture content and achieving the required degree of compaction becomes more difficult or impossible. If the soil is too wet to achieve satisfactory compaction, moisture conditioning such as disking or tilling will be required. If the material cannot be properly moisture conditioned, we recommend using imported material for structural fill.

Select imported granular material may be used as general structural fill. The imported material should consist of pit or quarry run rock, crushed rock or crushed gravel and sand that is fairly well graded between coarse and fine sizes. The material should have less than 15 percent passing the U.S. No. 200 Sieve, but during dry weather the fines content can be increased to a maximum of 25 percent. The material should have a maximum particle size of 4 inches.

Other Soil and Rock Materials: Other materials such as rip-rap or quarry spalls may be required for scour protection, to be designed by others.

Compaction: Structural fill material should be placed and compacted to a minimum of 95 percent of maximum dry density, as determined by ASTM D698. Fill should also be placed and compacted in accordance with the following:

- Place all fill and backfill on a prepared subgrade that consists of firm, inorganic native soils or approved structural fill. When placed on sloping ground, the ground should be benched and keyed such that soils are placed on a level surface.
- Place all fill or backfill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Unless otherwise directed by the geotechnical engineer, maximum thickness of loose lifts shall be 8 inches.
- Place fill at a moisture content within about 3 percent of optimum as determined in accordance with ASTM Test Method D698. Moisture condition fill soil to achieve a uniform moisture content within the specified range before compacting.
- Do not place, spread or compact fill soils during freezing or unfavorable weather conditions. Frozen or disturbed lifts should be removed or properly recompacted prior to placement of subsequent lifts of fill soils.
- Do not place fill and backfill until tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.
- Grade the surface of the fill at the end of each working shift so that surface water can drain readily.
- During fill placement and compaction, a sufficient number of in-place density tests should be completed to verify that the specified degree of compaction is being achieved. As an alternative to testing, the geotechnical engineer may elect to use the observational method, consisting of a method specification to achieve a level of compaction considered equivalent to 95% of ASTM D698.

Surface Drainage and Erosion Control

Surface runoff can be controlled during construction by careful grading practices. Typically, these include the construction of shallow, upgrade perimeter ditches or low earthen berms and the use of temporary sumps to collect runoff and prevent water from damaging exposed subgrades. Also, measures should be taken to avoid ponding of surface water during construction.

Some site soils may present a moderate erosion hazard. In our opinion, erosion at the site during construction can be minimized by judicious use of straw bales, silt fences and plastic sheets. The erosion control devices should be in place and remain in place throughout site preparation and construction. Maintaining appropriate erosion control is the responsibility of the contractor and should be carried out in accordance with the project plans and specifications and applicable regulations.

DOCUMENT REVIEW AND CONSTRUCTION SUPPORT

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the exploration program. Recognition of changed conditions often requires experience; therefore, the project geotechnical engineer or their representative should visit the site with sufficient frequency to detect whether conditions differ significantly from those anticipated. In particular, foundation excavations should be observed by Geotechnics prior to pouring bridge abutments and wingwalls. If observational-method compaction verification is selected, Geotechnics personnel should be on-site during all compaction activities.

Geotechnics should also review the final plans and specifications to verify that the recommendations presented herein have been interpreted as intended.

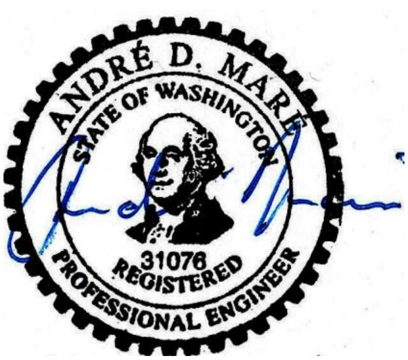
LIMITATIONS

We have prepared this report for the exclusive use of Waterways Consulting, The Yakama Nation, and the design team for this project. Our report is intended to provide our opinion of geotechnical parameters for design and construction of the proposed project based on exploration locations that are believed to be representative of site conditions. However, conditions can vary significantly between exploration locations and our conclusions should not be construed as a warranty or guarantee of subsurface conditions or future site performance. If soil conditions are encountered during construction that differ from those described herein, we should be notified immediately to assess the implications and provide any necessary design supplements or modifications. If the scope of proposed construction changes from that described herein, our recommendations should also be reviewed.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty, expressed or implied, should be understood.

We appreciate the opportunity to submit this report. Please contact us if you have any questions or need additional information.

Sincerely,



André D. Maré, P.E., G.E.
Geotechnical Engineer

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Attachments:

Figure 1:	Vicinity Map
Figure 2:	Site and Exploration Plan
Figure 3:	Profile A-A’
Key to Log Symbols and Terms	
Figures A1 - A3:	Test Pit Logs
Figure A4:	Grain Size Distribution

REFERENCES

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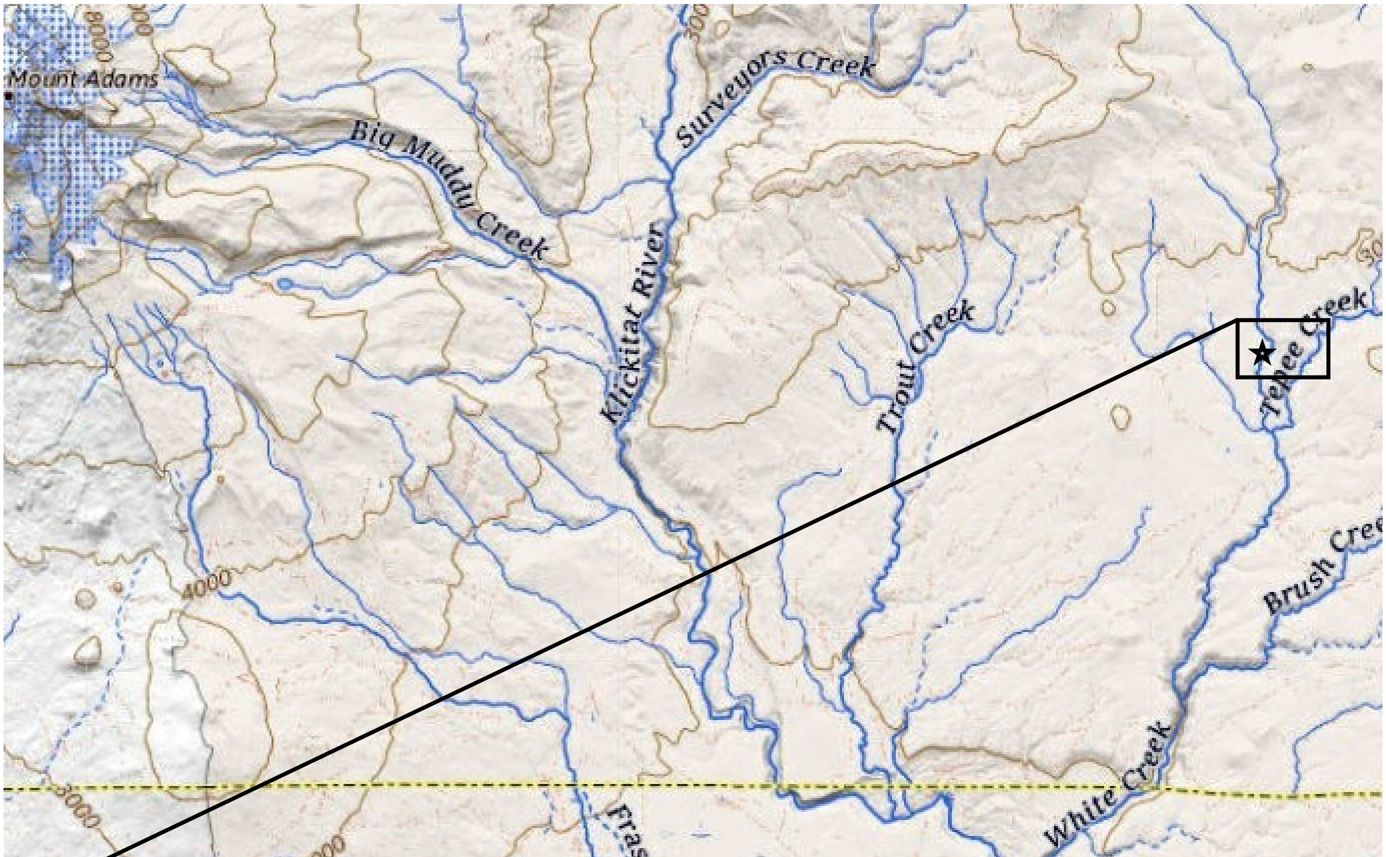

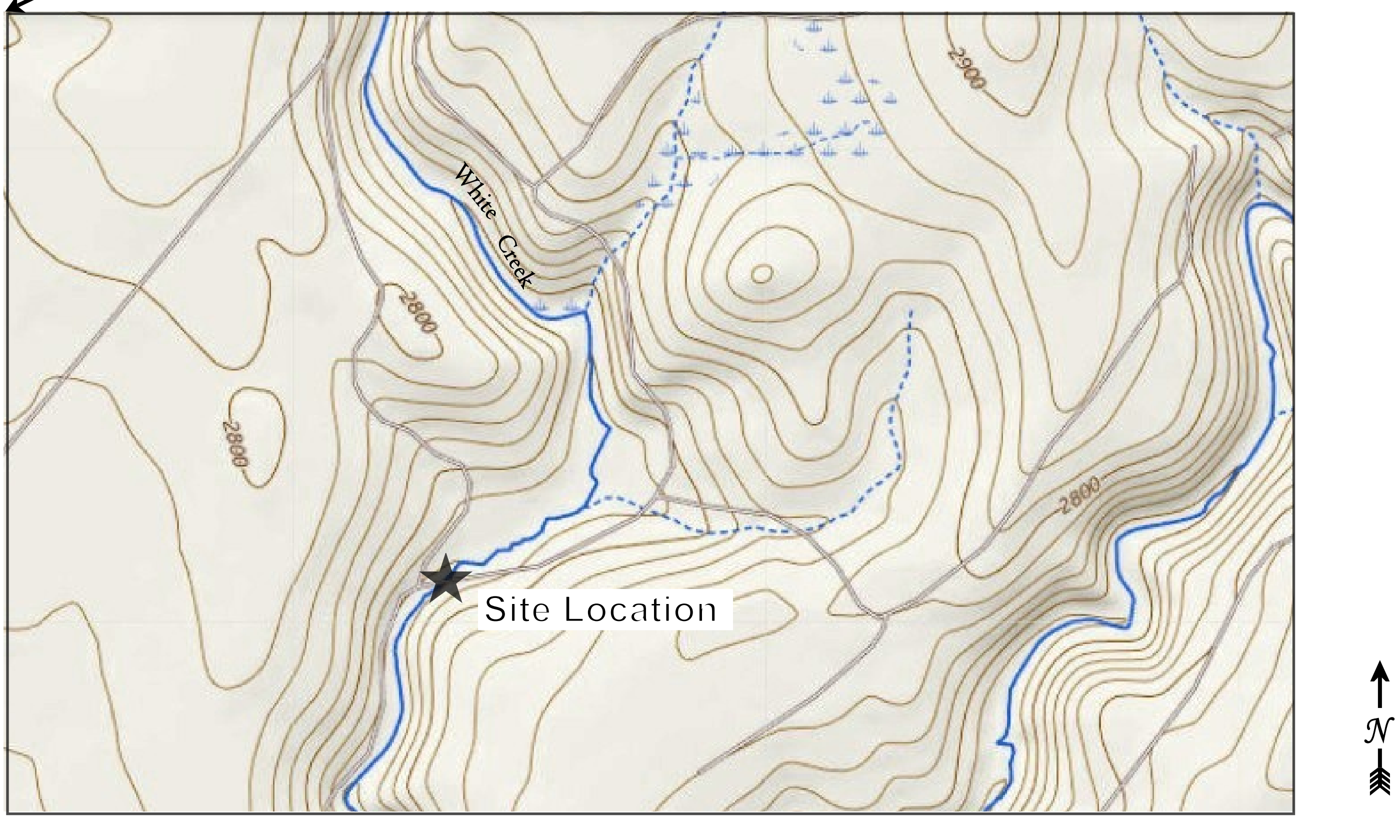

VICINITY MAP

White Creek Bridge
Yakima County, Washington

Project No. 20-002-2

Figure 1

Graded Permanent Slopes

Permanent cut and fill slopes should not exceed 2H:1V. If existing site slopes cannot be graded to 2H:1V or flatter, retaining walls should be designed and constructed. Constructed slopes should be planted with appropriate vegetation as soon as possible after grading to provide protection against erosion. When fill is placed on sloping ground, the ground should be benched and keyed such that soils are placed on a level surface.

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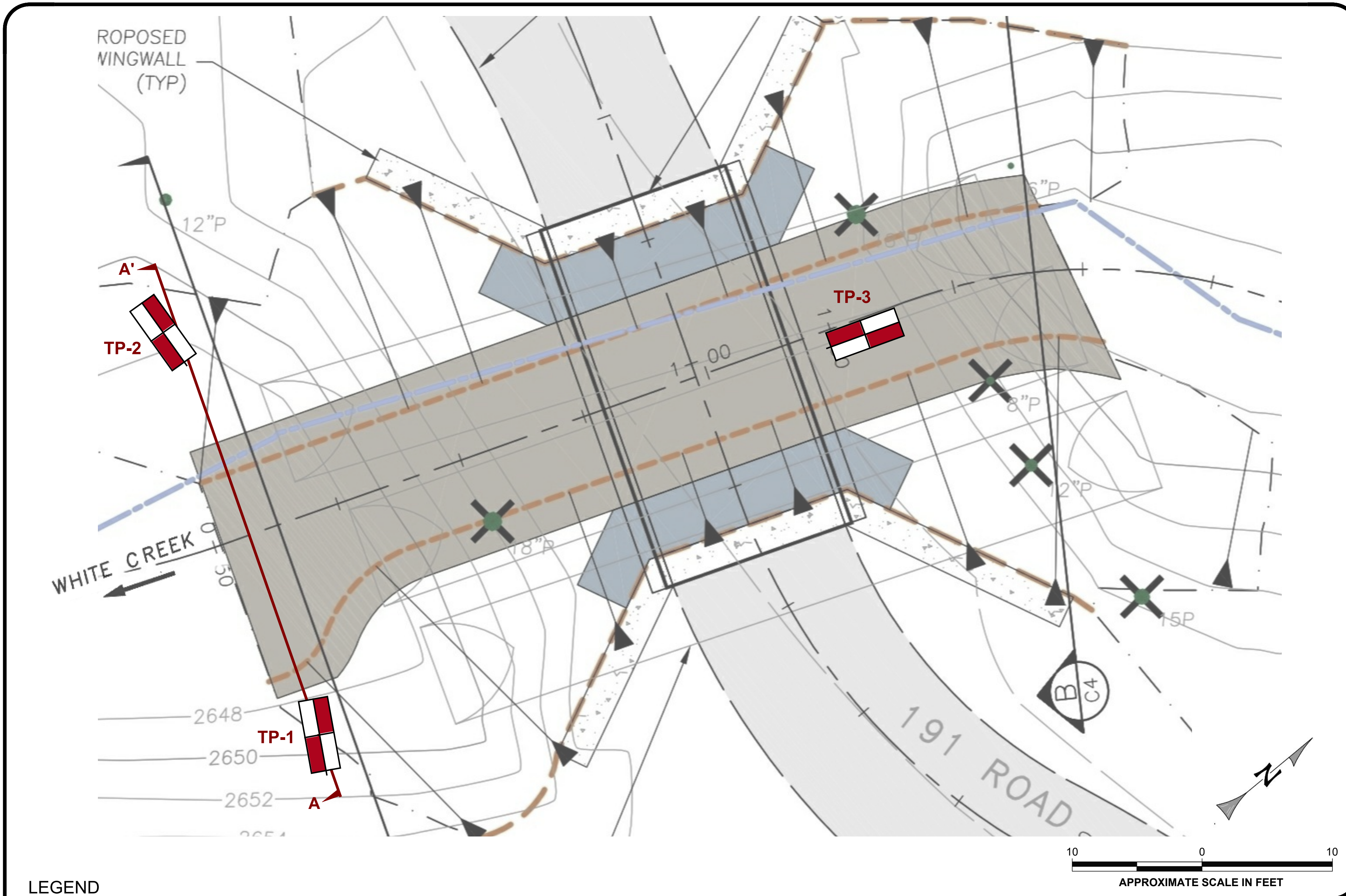


LEGEND

TP-3 Test Pit Location and Designation

A A' Cross Section Location

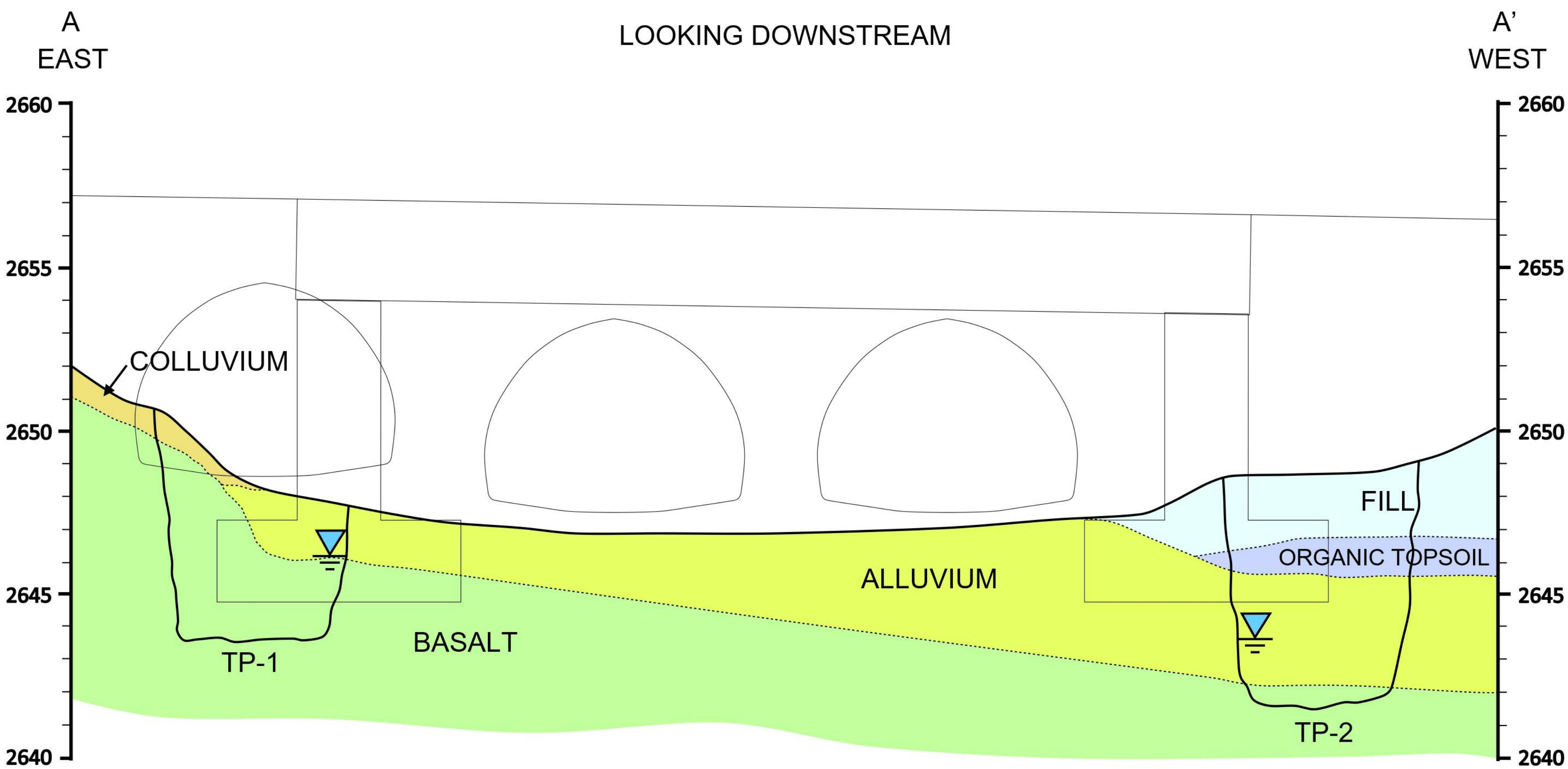
GEOTECHNICS

SITE AND EXPLORATION PLAN

White Creek Bridge
Yakima County, Washington

Project No. 20-002-2

Figure 2



Fill - Silty SAND with gravel, cobbles, and boulders.

Organic Topsoil - Gray, soft, SILT with organics.

Colluvium - Slopewash - Gravelly SILT.

Alluvium - Poorly Graded GRAVEL with silt.

Basalt - Highly weathered bedrock. Breaking into gravel and cobble-sized fragments. Silty GRAVEL.

Seepage level, June 25, 2021

5 0 5
APPROXIMATE SCALE IN FEET

GEOTECHNICS

PROFILE A-A'

White Creek Bridge
Yakima County, Washington

Project No. 20-002-2

Figure 3

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density (%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 to 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 to 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 to 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 to 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 to 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils More than 50% Retained on No. 200 Sieve Size	**Gravel and Gravelly Soils** More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
		Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
	Sand and Sandy Soils 50% or More of Coarse Fraction Passing No. 4 Sieve	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
		Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils 50% or More Passing No. 200 Sieve Size	**Silt and Clay**	Liquid Limit Less than 50%	ML	SILT
			ML	Sandy SILT
			CL	Lean CLAY
			CL	Sandy CLAY
	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to 5 mm
Coarse Gravel	3 in to ³⁄ in
Fine Gravel	³⁄ in to 5 mm
Sand	5 mm to 200 0.0 5 mm
Coarse Sand	5 mm to 10 2 mm
Medium Sand	10 2 mm to 0 0. mm
Fine Sand	0 0. mm to 200 0.0 5 mm
Silt and Clay	Smaller than 200 0.0 5 mm

ABBREVIATIONS

Laboratory Tests

AL	Atterberg Limits
PL	Plastic Limit
LL	Li uid Limit
F	Fines Content
GSD	Grain Size Distribution
DD	Dry Density
MD	Moisture Density Relationship
-S	Standard Proctor ASTM D-69
-M	Modified Proctor ASTM D-155
SG	Specific Gravity
CBR	California Bearing Ratio
RM	Resilient Modulus
	Permeability
CN	Consolidation
DS	Direct Shear
T	Tria ial Shear
-	nconsolidated ndrained
-C	Consolidated ndrained

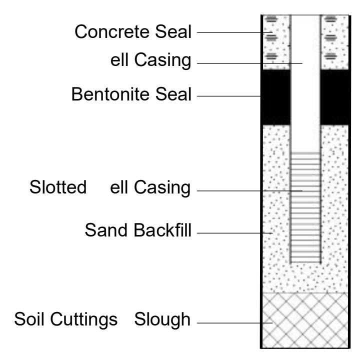
Field Tests

PP	Pocket Penetrometer
TV	Torvane

Sample Type

SPT	Standard Penetration Test 2.0 OD
D M	Ring Sampler 3.25 OD
C-MOD	California Modified Sampler 3.0 OD
SH	Thin- alled Shelby Tube 3.0 OD
GRAB	Disturbed Sample collected from auger cuttings or test pit

WELL DETAIL



NOTES

Soil descriptions are based on the general approach presented in ASTM D-2 Visual-Manual Procedure . here laboratory data are available, soil classifications are in accordance with ASTM D-2 .

Solid lines between soil unit descriptions indicate change in interpreted geologic unit. Dashed lines indicate stratigraphic change within the geologic unit.

Blowcount N is recorded for driven samplers as the number of blows re uired to advance sampler 12 inches or distance noted per ASTM D-15 6. See e ploration log for hammer weight and drop.

Please also refer to the discussion in the report for a general description of subsurface conditions.

GEOTECHNICS

KEY TO LOG SYMBOLS AND TERMS

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	06-25-21
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,650.6
EQUIPMENT:	Hitachi 40u	STATE PLANE EAST:	1,494,071
LOGGED BY:	ADM	STATE PLANE NORTH:	295,447

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	POCKET PENETROM (tsf)	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
S-1	Grab	■	15.6		0–1.5		Grayish brown, Gravelly SILT (ML), slightly moist, medium stiff. Coarse sand and fine gravel in silt matrix. Roots and rootlets. (COLLUVIUM)	
					1.5–4.5		Brown, Poorly Graded GRAVEL with Silt and Sand (GP-GM), moist, medium dense. Predominantly ½" to 2" gravel, with minor cobbles. Sand is fine to coarse. (ALLUVIUM) @3', angular flat boulder to 27" max dimension. @4.5', groundwater seepage, moderate rate.	
S-2	Grab	■	16.0					GSD, %F=7.0
					4.5–7		Brown mottled orangish brown, Silty GRAVEL with Sand (GM), very moist, very dense. Highly weathered bedrock. (RESIDUAL BASALT)	
S-3	Grab	■	21.8					GSD, %F=23.0
S-4	Grab	■	26.5					GSD, %F=24.1
					7		Total Depth = 7 feet. Groundwater at 4.5 feet. Minor Caving.	

Depth scale (FT): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

NOTES:

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GEOTECHNICS

TEST PIT TP-1

White Creek Bridge
Yakima County, Washington

Project Number 20-002-2

Figure A1

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	06-25-21
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,648.7
EQUIPMENT:	Hitachi 40u	STATE PLANE EAST:	1,494,039
LOGGED BY:	ADM	STATE PLANE NORTH:	295,458

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	POCKET PENETROM (tsf)	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0–1		Brown, Silty SAND with Gravel (SM), moist, loose to medium dense. Angular and rounded gravel with minor cobbles. Boulders at ground surface. (FILL)	
S-1	Grab	■	19.5					
S-2	Grab	■			1–2		Brown to reddish brown, Sandy SILT with Gravel (ML), moist, loose to medium dense. Minor wood - small sticks.	
S-3	Grab	■	32.6		2–3		Dark gray, SILT (ML), moist, soft. Few gravel, minor sand. With organics - sticks and decaying wood chunks, strong organic odor. (TOPSOIL AND/OR FILL)	
S-4	Grab	■			3–5.5		Brown, Poorly Graded GRAVEL with Sand (GP), moist, medium dense. Predominantly coarse gravel, with some cobbles. Sand is medium to coarse. (ALLUVIUM) @5', groundwater seepage, slow	
S-5	Grab	■	19.1		5.5–6.5		Brown, Silty GRAVEL (GM), moist, medium dense.	GSD, %F=14.1
					6.5–7		Reddish brown mottled gray and dark brown, Silty GRAVEL with Sand (GM), moist, very dense. Highly weathered bedrock. Breaking off easily in gravel and cobble-sized pieces. (RESIDUAL BASALT)	
							Total Depth = 7 feet. Groundwater at 5 feet. Minor Caving.	

NOTES:

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GEOTECHNICS

TEST PIT TP-2

White Creek Bridge
Yakima County, Washington

Project Number 20-002-2

Figure A2

COMPANY:	Dan Fischer Excavating, Inc.	DATE:	06-25-21
METHOD:	Trackhoe w/ 2-ft bucket	ELEVATION (FT):	2,657.0
EQUIPMENT:	Hitachi 40u	STATE PLANE EAST:	1,494,074
LOGGED BY:	ADM	STATE PLANE NORTH:	295,497

SAMPLE ID	SAMPLE TYPE	SAMPLE	MOISTURE CONTENT (%)	POCKET PENETROM (tsf)	DEPTH (FT)	GRAPHIC SYMBOL	MATERIAL DESCRIPTION	OTHER TESTS & NOTES
					0		Light brown, Gravelly SILT with Sand (ML), slightly moist, loose to medium dense. Abundant gravel and cobbles, predominantly 1" to 4". Some boulders.	
					1		(FILL)	
S-1	Grab	■	18.1					
					2			
							below 2.5', fewer boulders, scattered cobbles.	
					3			
S-2	Grab	■	13.7					
					4			
					5		Total Depth = 4.5 feet. No Groundwater Encountered. Minor Caving.	
					6			
					7			
					8			
					9			
					10			
					11			
					12			
					13			
					14			

NOTES:

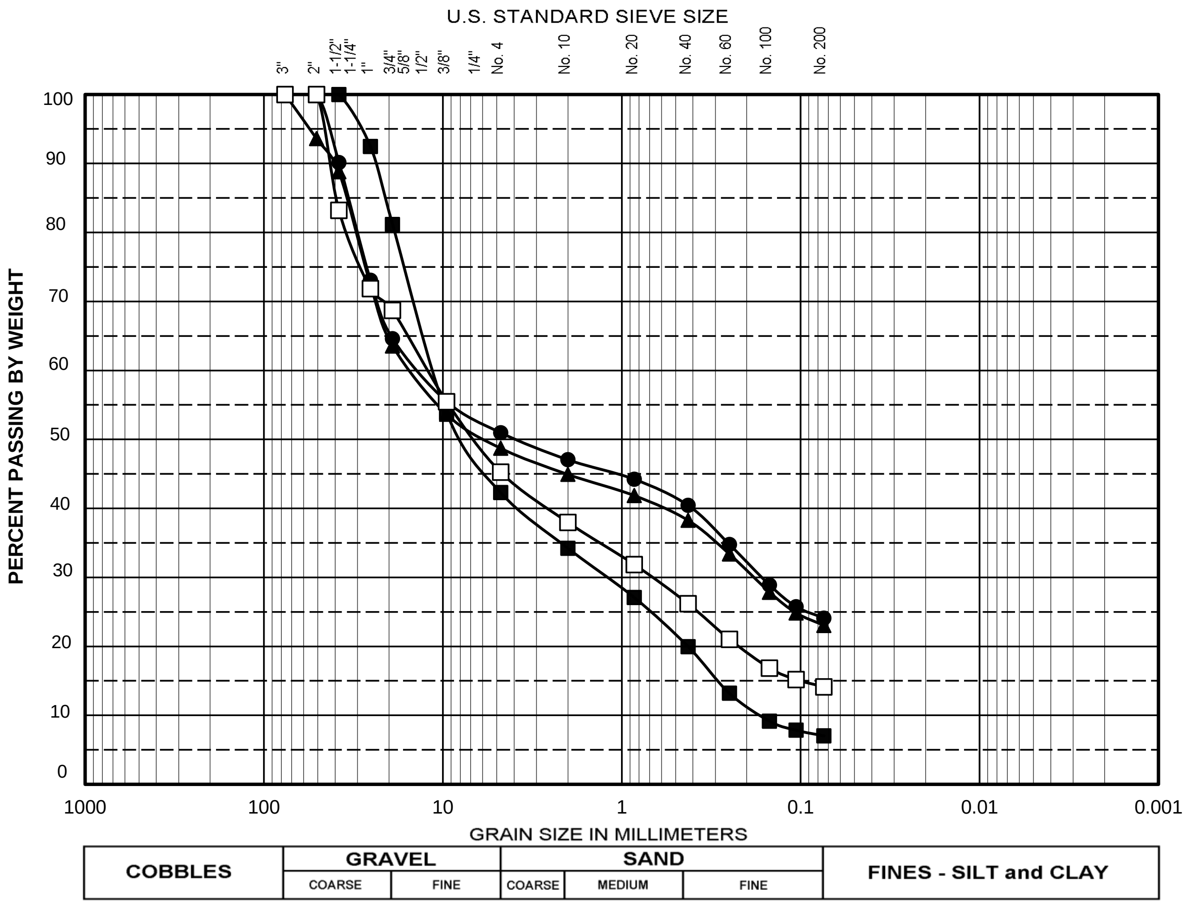
GEOTECHNICS

TEST PIT TP-3

White Creek Bridge
Yakima County, Washington

Project Number 20-002-2

Figure A3



Symbol	Sample Location	% MC	% Gravel	% Sand	%Fines	Classification
■	TP-1 ; @ 3.5 - 4.0ft	16.0	57.7	35.2	7.0	Poorly Graded GRAVEL with Silt and Sand (GP-GM) *Alluvium*
▲	TP-1 ; @ 5.0 - 5.5ft	21.8	51.3	25.7	23.0	Silty GRAVEL with Sand (GM) *Weathered Basalt Bedrock*
●	TP-1 ; @ 6.5 - 7.0ft	26.5	49.0	26.9	24.1	Silty GRAVEL with Sand (GM) *Weathered Basalt Bedrock*
□	TP-2 ; @ 5.5 - 6.0ft	19.1	54.8	31.1	14.1	Silty GRAVEL (GM) *Alluvium*

Grain Size Distribution determined in accordance with ASTM D-6913

GEOTECHNICS

GRAIN SIZE DISTRIBUTION

White Creek Bridge
Yakima County, Washington

Project No. 20-002-2

Figure A4