GEOTECHNICAL ENGINEERING REPORT

SKY VALLEY SWITCHING STATION
19622 Tjerne Place Southeast
Monroe, Washington

Project No. 2326.01
14 December 2020

Prepared for:
Snohomish County PUD No. 1

Prepared by:
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Project No. 2326.01
14 December 2020

Snohomish County PUD No. 1
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Attention: Mr. Will Blanchard, PE, Professional Engineer

Subject: Geotechnical Engineering Report
Sky Valley Switching Station
19622 Tjerne Place Southeast
Monroe, Washington

Dear Mr. Blanchard:

In accordance with your request, Zipper Geo Associates, LLC (ZGA) has completed the subsurface exploration and geotechnical engineering evaluation for the proposed Sky Valley Switching Station. This report presents the findings of the subsurface exploration and geotechnical recommendations for the project. Our work was completed in general accordance with the scope of services described in Contract No. CW2240216. Written authorization to proceed was provided by the District on 3 April 2020. We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further assistance, please contact us.

Sincerely,
Zipper Geo Associates LLC

Signed 12.14.20

David C. Williams, LG, LEG
Principal Engineering Geologist

Robert A. Ross, PE
Managing Principal

Distribution: Addressee (1 electronic)

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INTRODUCTION

The geotechnical engineering exploration and analysis have been completed for the proposed Sky Valley Switching Station in Monroe, Washington. Six borings (B-1 through B-6) and 18 test pit explorations (TP-1 through TP-18) were completed by ZGA to depths ranging from approximately 2-1/2 feet to 31.5 feet below the existing ground surface to evaluate subsurface conditions. Three borings and 36 test pit explorations were previously completed by GeoEngineers and Terra Associates, Inc. to depths ranging from approximately 4-1/2 feet to 26-1/2 feet below the existing ground surface, between June 1999 and June 2012; we reviewed the reports containing logs of these explorations as part of our evaluation. We also reviewed a ZZA-Terracon report from 2008 that included the logs of borings advanced on the eastern portion of the site. Descriptive logs of ZGA explorations are included in Appendix A; Appendix B contains a summary of ZGA laboratory testing procedures and results; and Appendix C contains selected ZZA-Terracon boring logs. Appendix D contains selected exhibits from a 2015 GeoEngineers report prepared for the City of Monroe.

PROJECT INFORMATION

Site Location
The project property comprises a former gravel pit known as Chain Lake Pit No. 4 in Monroe, Washington. The property consists of a 6.43-acre parcel that is largely located north of the Tjerne Place SE and Woods Creek Road intersection. The parcel is irregularly shaped and the southwestern 0.43 acres is separated from the main portion of the property by Tjerne Place SE. The site is bordered by commercial properties to the west, Tjerne Place SE at the south, by Woods Creek Road to the east, and by a wooded hillside to the north. The subject property is illustrated on the Site and Exploration Plan, Figure 1.

Project Description
Plans available at the time this report was prepared indicate that a switching station will be constructed in the primary site area north of Tjerne Place SE (hereinafter referred to as the “site”) where grades are relatively level resulting from historical site use as a gravel pit and abandoned former pre-development grading activity. Access to the substation will be provided by a paved driveway extension from Tjerne Place SE. Site improvements are expected to include:

- Dead end towers (termination structures) in the middle to eastern portions of the yard.
• Circuit switchers, disconnect switches, neutral reactors, termination structures, and bus supports.

• Two slab-supported switchgear enclosures.

• Two slab-supported transformers.

• Below-grade conduits and pre-cast concrete vaults in the yard.

• Storm sewer piping and structures, including components of an on-site stormwater infiltration system.

• Cuts up to about 16 feet and fills up to about 10 feet (the deeper fill is at the location of an existing below-grade stormwater vault that will be removed).

• Improvements on the 0.43-acre portion of the property to the southwest of Tjerne Place SE include new below-grade vaults.

• Two transmission poles are planned for construction at the east side of the property and along Woods Creek Road. Geotechnical evaluation of these poles was not included in our authorized scope of services.

SITE HISTORY

According to documents accessed from the City and those provided by the District for our review, and our review of historical aerial imagery, surface mining of sand and gravel took place on the property between about 1991 and 1996. Prior to mining, the property was largely forested and a single-family residence and driveway were located in the eastern portion of the site.

The gravel pit was designed to include 2H:1V (Horizontal:Vertical) cuts along the northern and eastern site areas, with the deepest cuts of approximately 50 feet occurring at the east. The gravel pit floor was designed to include cuts of approximately 5 to 35 feet, and 1 to 2 percent gradients toward the southwest where surface runoff would discharge into an infiltration and settlement pond.

Sparse vegetation continued to grow across the site once mining ceased. Review of the mine plan documents and readily available aerial photographs suggests that past operations included mining and screening, but apparently not washing of mined materials. Obvious wash sediment ponds were not identified in the aerial photographs that we reviewed. Based on historical aerial imagery, a concrete stormwater vault was constructed in the western site area circa 2005; we understand that subsequent commercial development plans were abandoned.
The District purchased the property in 2013. Based on the records we reviewed, the District completed some grading and a small landslide occurred in the southeastern portion of the site between 2013 and 2017. The approximately limits of the landslide are shown on Figure 1.

Tjerne Place SE was constructed along the south side of the site in 2015. This included grading of the cut slope immediately south of the switching station property. The City of Monroe constructed a cantilever soldier pile retaining wall along the east property boundary and adjacent to Woods Creek Road in 2016.

SITE CONDITIONS

Surface Conditions
The central portion of the site which will support the new switching station has somewhat irregular topography that reflects previous mining and grading and ground surface elevations generally ranging from about 122 to 126 feet. There is an old fill mound that extends into the northeast portion of the future switching station yard that rises to approximately 136 feet. The future access drive extends across a previously graded area (containing a buried concrete stormwater detention vault) with elevations ranging from about 116 to 122 feet. There is a relatively level depression in the far northwest corner of the site with elevations ranging from about 110 to 112 feet.

The future yard is bordered by slopes to the north, east, and south. The ascending slopes to the north and northeast are inclined on the order of 45 percent. The small fill mound near the base of the northeast slope that extends into the yard footprint has a maximum inclination of approximately 38 percent but is largely less than 30 percent. The southeast-facing slope descending to Woods Creek Road has a maximum inclination of about 70 percent. The descending slope at the south, which abuts Tjerne Place SE, was graded to an inclination of 50 percent when constructed in 2015. The slope rising above the low area in the northwest portion of the site is relatively steep at about 78 percent near the toe.

Surface conditions in the southeastern portion of the site reflect previous landsliding. Figure 1 illustrates the approximate location of a landslide located on both the District property and the adjacent City of Monroe property. The main scarp is approximately 120 feet wide. The slope area disturbed by the landslide is characterized by a serious of scarps with heights ranging from approximately 1 to 8 feet with intermediate horizontal to near-horizontal benches. The presence of concrete clasts and boulders suggest that fill material had been pushed over the slope at some time in the past, and the topography in the middle to lower portion of the slope suggests that this area had been graded at some time in the past as well. We observed accumulations of soil displaced by landsliding on the upslope side of older trees (both fill and native soils) in the area impacted by landslide and also adjacent to it. Old and young trees on the slope are characterized by a variety of growth inclinations manifested as straight trunks and substantially curved or pistol-butted trunks. We observed groundwater seepage in a narrow bench at approximately elevation 100 feet in the approximate middle of the landslide feature.
The east-facing slope to the north of the area impacted by the landslide appears to have been graded in the past given the uniformity of slope segments. Tree trunk curvature in this area suggests shallow downslope soil creep, or solifluction, is taking place although surface conditions do not suggest the presence of shallow or deep-seated instability, in our opinion. The south-facing slope at the north of the site is mantled largely by blackberry, grasses, and weeds. The constructed south-facing slope adjacent to Tjerne Place SE is mantled with grasses and weeds as well as crushed rock in the lower elevations.

Subsurface Conditions

Local Geologic Conditions

The publication *Geologic Map of the Monroe Quadrangle, Snohomish County, Washington* (USGS, 2011) indicates that the site has been mapped as containing normally consolidated granular outwash deposits, containing fluvial outwash (Qgof) in the northern site area and deltaic outwash (Qgod) across the majority of the site, hereafter referred to as recessional outwash (Qvr). The surficial outwash soils are mapped as being underlain by fine-grained Whidbey Formation soils (Qcws) hereafter referred to as Whidbey soils. The surficial outwash soils consist of moderately to well stratified cobbly, gravelly sand and was the target material extracted during previous mining. The outwash soils generally have a low fines content (the soil fraction passing the US No. 200 sieve) overall, although discrete silt and silty sand horizons are common, and the facies with a low fines content may have a moderate to high permeability. The underlying Whidbey Formation soils consist of sand and silt with some clay, peat, and gravel interbeds. The Whidbey soils are characterized by a relatively high density and low permeability, and it is not uncommon to observe groundwater within the outwash material perched above the less permeable Whidbey soils.

Subsurface conditions disclosed by the borings and test pits advanced by ZGA and others are consistent with the published mapping. Explorations also disclosed undocumented fill material above the native soils at the substation site.

Soil Conditions

The soil descriptions presented below have been generalized for ease of report interpretation. Please refer to the exploration logs for detailed soil descriptions at the exploration locations. Variations in subsurface conditions may exist between the exploration locations and the nature and extent of variations between the explorations may not become evident until additional explorations are completed or until construction. Undocumented fill material is present and it should be recognized that the nature and depth of undocumented fill material is such that its composition and depth may vary over relatively short distances. Subsurface conditions at specific locations are summarized below.

Subsurface conditions were evaluated by advancing borings B-1 through B-6 in the future switching station yard and near previously proposed transmission pole locations. We also observed subsurface
conditions by excavating 18 test pits in the future yard as well as peripheral areas, including three test pits in the small portion of the property located southwest of Tjerne Place SE. Approximate exploration locations, as well as pertinent surface features, are shown on Figure 1. Observed soil conditions are summarized below.

**Fill**

Fill material associated with previous mining and development activity was observed at each of the boring locations and at all of the test pit locations other than test pit TP-17. The fill was largely composed of loose to medium dense sand with a variable silt, gravel, and cobble content. Quarry spalls and concrete clasts were observed on the ground surface near the southern site entrance as well. The fill locally contained some wood debris, organics, and relatively scarce brick, metal pipe, and plastic debris. Stockpiled boulders were observed along the base of the ascending slope to the north of the proposed yard location, along the southern margin of the site, and also on the slope descending toward the Tjerne Place SE and Woods Creek Road intersection at the southeast.

The fill in the yard extended to depths of approximately 1 to 9 feet, while the fill observed in the mound feature that extends into the northeast portion of the yard exceeded approximately 11.5 to 12 feet at the test pit TP-7 and TP-9 locations where the fill depth exceeded the test pits’ depth. The fill extended to a depth of approximately 7 feet at the test pit TP-8 location at the toe of the mound. Possible fill observed in test pits excavated west of the yard had a maximum depth of approximately 2-1/2 feet. The fill observed at the location of test pit TP-16, excavated on the slope above the low spot in the northwestern portion of the site, exceeded a depth of 8 feet, the maximum test pit depth. The fill extended to depths of approximately 1.3 to 8 feet at the locations of test pits TP-13, TP-14, and TP-15, excavated in the small portion of the property located on the south side of Tjerne Place SE.

**Recessional Outwash**

The fill was largely underlain by recessional outwash consisting of medium dense sand and silty sand with a relatively low gravel content. The soils were generally in a moist to wet condition. The outwash soils were most commonly observed below the fill in the middle to northern portions of the site.

**Whidbey Formation**

We observed Whidbey Formation soils beneath the fill in the middle to southern portions of yard and perimeter road areas. The Whidbey Formation soils generally consisted of stiff to hard, moist to wet, silt, sandy silt, fine sand, silty sand, clay, and silty clay. Although not observed at our exploration locations, logs of deeper explorations completed by others near the site describe some of the Whidbey soils as containing fractures and slickensides.
Groundwater

Groundwater seepage was observed while excavating five of the test pits and at one of the boring locations. Groundwater perched within fill material at a depth of approximately 2 feet was observed at the locations of test pits TP-10 and TP-12 in the yard area, and at depths of approximately 2 to 3.5 feet at the locations of test pits TP-3, TP-4, and TP-5 in the low area in the northwest portion of the site. We observed groundwater at a depth of approximately 16 feet while advancing boring B-3. A small occurrence of groundwater seepage was observed near a contact between the granular recessional outwash and the underlying Whidbey soils in the landslide feature in the southeastern portion of the site.

It should be noted that groundwater conditions will likely vary seasonally and in response to precipitation events, land use, and other factors, and its occurrence will be influenced by the composition and density/consistency of the fill material and the relatively low permeability of the finer-grained fractions of the Whidbey Formation soils, in particular.

Generalized subsurface conditions are summarized below in Tables 1 through 4.

<table>
<thead>
<tr>
<th>ZGA Exploration No.</th>
<th>Approximate Ground Surface Elevation (feet)</th>
<th>Approximate Fill Material Depth (feet)</th>
<th>Approximate Groundwater Depth (feet)</th>
<th>Native Soil Below Fill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NE (not encountered)</td>
<td>NE (not encountered)</td>
<td></td>
</tr>
<tr>
<td>TP-2</td>
<td>123</td>
<td>2.5</td>
<td>NE</td>
<td>Not applicable: TP-2 excavated above vault lid</td>
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<tr>
<td>TP-6</td>
<td>128</td>
<td>9</td>
<td>NE</td>
<td>Qvr</td>
</tr>
<tr>
<td>TP-7</td>
<td>132</td>
<td>12+</td>
<td>NE</td>
<td>Wf</td>
</tr>
<tr>
<td>TP-8</td>
<td>127</td>
<td>7</td>
<td>NE</td>
<td>Qvr</td>
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<tr>
<td>TP-9</td>
<td>140</td>
<td>11.5+</td>
<td>NE</td>
<td>Wf</td>
</tr>
<tr>
<td>TP-10</td>
<td>130</td>
<td>6</td>
<td>2 (perched in fill)</td>
<td>Qvr</td>
</tr>
<tr>
<td>TP-11</td>
<td>128</td>
<td>1</td>
<td>NE</td>
<td>Wf</td>
</tr>
<tr>
<td>TP-12</td>
<td>126</td>
<td>4</td>
<td>2 (perched in fill)</td>
<td>Wf</td>
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<td>TP-18</td>
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<td>2</td>
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<td>Wf</td>
</tr>
<tr>
<td>B-2</td>
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<td>7.5</td>
<td>NE</td>
<td>Qvr</td>
</tr>
<tr>
<td>B-3</td>
<td>127</td>
<td>5</td>
<td>16</td>
<td>Qvr / Wf</td>
</tr>
<tr>
<td>B-4</td>
<td>126</td>
<td>1</td>
<td>NE</td>
<td>Wf</td>
</tr>
<tr>
<td>B-6</td>
<td>126</td>
<td>1.5</td>
<td>NE</td>
<td>Qvr / Wf</td>
</tr>
</tbody>
</table>
Table 2: Subsurface Conditions Summary: 
Area West of Switching Station Access Road

<table>
<thead>
<tr>
<th>ZGA Exploration No.</th>
<th>Approximate Ground Surface Elevation (feet)</th>
<th>Approximate Fill Material Depth (feet) NE (not encountered)</th>
<th>Approximate Groundwater Depth (feet) NE (not encountered)</th>
<th>Native Soil Below Fill Q_{vr}: Recessional Outwash W_{r}: Whidbey Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-1</td>
<td>123</td>
<td>2.5</td>
<td>NE</td>
<td>Not applicable: TP-1 excavated above vault lid</td>
</tr>
<tr>
<td>TP-3</td>
<td>114</td>
<td>2.5</td>
<td>3</td>
<td>W_{r}</td>
</tr>
<tr>
<td>TP-4</td>
<td>116</td>
<td>2.5</td>
<td>3.5</td>
<td>W_{r}</td>
</tr>
<tr>
<td>TP-5</td>
<td>115</td>
<td>1</td>
<td>2</td>
<td>W_{r}</td>
</tr>
<tr>
<td>TP-16</td>
<td>138</td>
<td>8+</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>TP-17</td>
<td>129</td>
<td>NE</td>
<td>NE</td>
<td>W_{r}</td>
</tr>
</tbody>
</table>

Table 3: Subsurface Conditions Summary: 
Southwest Portion of Property Southwest of Tjerne Place SE

<table>
<thead>
<tr>
<th>ZGA Exploration No.</th>
<th>Approximate Ground Surface Elevation (feet)</th>
<th>Approximate Fill Material Depth (feet) and Composition</th>
<th>Approximate Groundwater Depth (feet) NE (not encountered)</th>
<th>Native Soil Below Fill Q_{vr}: Recessional Outwash W_{r}: Whidbey Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-13</td>
<td>121</td>
<td>8</td>
<td>NE</td>
<td>Q_{vr}</td>
</tr>
<tr>
<td>TP-14</td>
<td>121</td>
<td>1.3</td>
<td>NE</td>
<td>Q_{vr}</td>
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<tr>
<td>TP-15</td>
<td>121</td>
<td>4</td>
<td>NE</td>
<td>W_{r}</td>
</tr>
</tbody>
</table>

CONCLUSIONS AND RECOMMENDATIONS

General Geotechnical Considerations

Based on information gathered during the field exploration, laboratory testing, and analysis, we conclude that construction of the proposed improvements is feasible from the geotechnical perspective provided that the recommendations presented herein are followed during design and construction. Selected aspects of the site conditions that should be considered during design and construction are summarized below.

- The floor of the former surface mine, which includes the proposed switching station location, is mantled with a variable thickness of fill material likely associated with remnant mining, abandoned development, and District grading. The fill observed at the exploration locations consisted primarily of sand with a variable gravel and silt content and limited deleterious debris.
Native soil below the fill consisted of sand with a variable gravel and silt content (recessional outwash) and fine-grained Whidbey Formation soils. Overall, these soil conditions are considered favorable from the geotechnical perspective.

- A small landslide in the eastern portion of the site may be mitigated by grading. Otherwise, a 50-foot buffer from the feature (as shown on current plans) will be required per the Monroe Municipal Code.

- The granular nature of the shallow to moderately deep soils across the site is favorable from the stormwater infiltration perspective.

- Re-use of much of the existing soil during grading will be feasible provided that the soil moisture content can be adequately controlled.

Geotechnical engineering recommendations for site grading, drainage, foundations, and other geotechnically-related aspects of the project are presented in the following sections. The recommendations contained in this report are based upon the results of our field exploration, laboratory testing, engineering analyses, review of historical documents, and current understanding of the proposed project design. ASTM and WSDOT specification codes cited herein refer to the current manual published by the American Society for Testing & Materials and the current edition of the WSDOT Standard Specifications for Road, Bridge, and Municipal Construction (Publication M41-10).

Geologically Hazardous Areas
Chapter 22.80.130 of the Monroe Municipal Code (MMC) defines regulated geologically hazardous areas as follows in italics, and our conclusions regarding such areas are presented in regular text:

(1) Geologically Hazardous Areas. Geologically hazardous areas include areas susceptible to erosion, sliding, earthquake, or other geological events. They pose a threat to the health and safety of citizens when incompatible development is sited in areas of significant hazard. Such incompatible development may not only place itself at risk, but may also increase the hazard to surrounding development and uses. Areas susceptible to one or more of the following types of hazards shall be designated as a geologically hazardous area:
   1. Erosion hazard;
   2. Landslide hazard;
   3. Seismic hazard; and
   4. Other geological events including tsunami, mass wasting, debris flows, rock falls, and differential settlement.

(2) Erosion Hazard Areas. Erosion hazard areas are at least those areas identified by the U.S. Department of Agriculture’s Natural Resources Conservation Service as having “severe” or “very severe” rill and inter-rill erosion hazard.
Virtually all of the slopes on the site were created in association with previous grading activity and are consistent with the prescriptive definition of an erosion hazard, in our opinion. The slopes were created during mining and post-mining development activity and have since been effectively re-vegetated. However, some of the soils are relatively steep and largely consist of easily eroded granular soils which, when disturbed, would pose a severe or very severe risk of erosion. The only significant slope grading associated with the proposed construction is at the toe of the slope extending above the northeast side of the switching station at the location of a large fill mound. Less extensive grading consisting of a cut of about 8 feet to remove a small ridge-like feature is proposed for the southeast portion of the yard. Provided that the work is accomplished in accordance with a temporary erosion and sedimentation control plan approved by the City, and provided that the slopes are re-vegetated following grading, it is our opinion that the proposed grading is feasible from the geotechnical perspective relative to erosion.

(3) Landslide Hazard Areas. Landslide hazard areas are areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to, the following:

a. Areas of historic failure, such as:
   i. Those areas delineated by the U.S. Department of Agriculture’s Natural Resources Conservation Service as having a “severe” limitation for building site development; or
   ii. Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the U.S. Geological Survey or Department of Natural Resources;

b. Areas with all three of the following characteristics:
   i. Slopes steeper than fifteen percent; and
   ii. Hillsides intersecting geologic contacts with a relatively permeable sediment overlaying a relatively impermeable sediment or bedrock; and
   iii. Springs or groundwater seepage;

c. Areas that have shown movement during the Holocene epoch (from ten thousand years ago to the present) or that are underlain or covered by mass wastage debris of that epoch;

d. Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and faults) in subsurface materials;

e. Slopes having a gradient steeper than eighty percent subject to rock fall during seismic shaking;

f. Areas potentially unstable because of rapid stream incision, stream bank erosion, and undercutting by wave action;

g. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and

h. Any area with a slope of forty percent or steeper and with a vertical relief of ten or more feet except areas composed of consolidated rock. A slope delineated by establishing its toe and top and measured by averaging the inclination over at least ten feet of vertical relief.
The slopes inclined at 40 percent or steeper and with at least 10 feet of relief meet the MMC definition of a landslide hazard by virtue of the slope height and inclination criteria. This includes the slopes to the north and northwest of the future yard, some of the slope segments to the northeast of the yard, and the south and southeast slopes adjacent to Tjerne Place SE and above the intersection with Woods Creek Road.

Virtually all of the slopes on the site were created during or following permitted and legal mining development-related grading activity, as is the graded slope along the north side of Tjerne Place SE that adjoins the south side of the site. The slopes have been effectively re-vegetated, and in the case of the lower portion of the cut slope along Tjerne Place SE, mantled with crushed rock. With the exception of a small landslide feature at the southeast (discussed in more detail below), the balance of the slopes on and adjacent to the site lack surficial evidence of previous or ongoing instability. Based on our review of the current site plans, the proposed switching station construction will only encroach into a regulated steep slope segment north of the northeast portion of the yard. In this area the existing mound that extends into the yard footprint will be graded such that the resultant slope matches the currently stable slopes on either side that were created during previous legal grading.

MMC 22.80.130(H)(b) calls for a minimum buffer equal to the height of the slope or fifty feet, whichever is greater, from landslide hazard areas. Reduction of the standard buffer to 10 feet may be granted by the City if it approves a supporting geotechnical report. Alteration of a landslide or erosion hazard area or their associated buffers is only permitted when supporting geotechnical analysis indicates that the development will not increase surface water discharge to adjacent properties beyond the predeveloped condition, the development will not decrease slope stability on adjacent properties, and such alterations will not adversely impact other critical areas.

Current plans call for on-site storm water infiltration, the condition that currently exists on site. Site grading will be completed in such a fashion as to contain stormwater on site. Consequently, stormwater discharge to adjacent properties will not increase beyond existing conditions.

In our opinion, the planned site improvements will not decrease slope stability on adjacent properties. The only grading planned for a significantly sloping portion of the site is the removal of a fill mound (comprised primarily of fill) from the northeast portion of the switching station yard at the toe of the adjacent slope. The resultant slope will be inclined at approximately 50 percent to match the grade of the adjacent slope created through previous legal grading. This existing southwest-facing slope in the site-characteristic recessional outwash soils lacks surface features indicating that it has been subject to downslope displacement since it was created. The slope also lacks groundwater seepage. It is our opinion that a toe-of-slope buffer of 10 feet is adequate. Current plans indicate that no structures are proposed near the slope toe.
Appendix D includes GeoEngineers’ log of boring B-3 and Cross Section A-A’, the approximate locations of which are shown on Figure 1, and graphics illustrating the slope stability analysis demonstrating that the existing cut slope along the north side of Tjerne Place SE and immediately adjacent to the switching station site meets adequate factors of safety under both static and seismic loading conditions. This 2H:1V cut slope meets the MMC criteria for a landslide hazard. However, given the slope stability analysis that was completed on behalf of the City and described in the GeoEngineers’ report, it is our opinion that the MMC-specified minimum 10-foot buffer from the cut slope is appropriate. Current plans indicate that no structures are planned near the top of the slope. The proposed excavation of a small ridge-like feature at the southeast portion of the switching station yard and above the Tjerne Place SE cut slope will remove soil from above the slope and will not have an adverse impact on the slope, in our opinion.

In 2007, ZZA-Terracon advanced a number of borings along the slope above Woods Creek Road as part of assessing the feasibility of constructing retaining walls related to planned frontage improvements (sidewalks and curbs). ZZA-Terracon borings B-1, B-2, and B-3, approximately located on Figure 1, were advanced on what is now the switching station site. Logs of these borings are provided in Appendix C. The 5 September 2008 Geotechnical Engineering Report, West Alignment Retaining Wall Alternatives Evaluation, Woods Creek Road Improvements Phase 1, Oaks Street to Country Crescent Road (Project No. 81075061) prepared for the City of Monroe included the results of slope stability analysis of the hillside above Woods Creek Road. Based on the slope stability analysis, ZZA-Terracon recommended that permanent cut slope inclinations be no steeper than 3H:1V. It appears that it will be feasible to pull back the soils in the upper portion of the slope within the limits of the landslide and areas to the east to a 3H:1V inclination. Provided that this is accomplished, it is our opinion that the MMC-specified 10-foot buffer will be adequate. If the east slope is not regraded, we recommend establishing the 50-foot MMC-specified landslide hazard area buffer. Current plans indicate that only the small ridge-like feature at the top of the slope at the southeast portion of the yard will be graded. However, an effective buffer of approximately 50 feet between the top of the slope and the nearest structure is planned.

(4) **Seismic Hazard Areas.** Seismic hazard areas are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface failure. The strength of ground shaking is primarily affected by:

- **a. The magnitude of an earthquake;**
- **b. The distance from the source of an earthquake;**
- **c. The type and thickness of geologic materials at the surface; and**
- **d. The type of subsurface geological structure.**

Settlement and soil liquefaction-conducive conditions are common in areas underlain by cohesionless, loose or soft, saturated soils of low density, typically in association with a shallow groundwater table. Based upon the observed soil conditions at the proposed switching station site, it is our opinion that the site does not meet the MMC criteria for a seismic hazard. The site is underlain at shallow depths by
glacially consolidated soils and laterally discontinuous perched groundwater. Consequently, the risk of significant liquefaction occurring at the substation site is low, in our opinion.

The stability analyses completed by GeoEngineers and ZZA-Terracon for slopes adjoining the proposed switching station addressed slope stability under both static and seismic (dynamic) loading conditions. The slope adjacent to Tjerne Place SE was graded to an inclination found to be stable under the design seismic event loading, and ZZA-Terracon’s recommendation for permanent cut slopes no steeper than 3H:1V above Woods Creek Road reflects similar analysis. Rather than regrading the eastern slope to a shallower inclination, the District plans to construct improvements at least 50 feet from the top of the eastern slope.

(4) Other Hazard Areas. Geologically hazardous areas shall also include areas determined by the city to be susceptible to other geological events including tsunami, mass wasting, debris flows, rock falls, and differential settlement.

Site conditions are such that the risk of tsunami, mass wasting debris flows, and rock falls affecting the site is negligible, in our opinion. The existing uncontrolled fill material on the pit floor presents a risk of differential settlement, but this can be mitigated through appropriate grading and foundation and slab construction methods. Such methods would typically include excavation of loose uncontrolled fill material and replacing it with adequately compacted structural fill, procedures discussed in subsequent sections of this report.

Earthwork
The following sections present recommendations for site preparation, subgrade preparation and placement of engineered fills on the project. The recommendations presented in this report for design and construction of foundations and slabs are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by a ZGA representative. Evaluation of earthwork should include observation and testing of structural fill, subgrade preparation, foundation bearing soils, deep foundations, and subsurface drainage installations.

Site Preparation
Stripping: In preparation for grading we recommend removal of all existing surficial vegetation and deleterious debris, such as wood waste, concrete clasts, and boulders (unless used for landscaping purposes). These materials should be wasted away from the substation and access road areas.

Existing Fill Removal: Site preparation is recommended to include selective removal of existing undocumented fill material containing substantial organics or deleterious debris and any relic organic
topsoil below the fill at proposed structure locations or along the access road alignment due to the risk of future settlement if these materials are left in place.

Variation in the fill depth and composition, and the depth of organics possibly below the fill, should be expected. These materials should be evaluated during construction and removed as necessary under the observation of a ZGA representative. Our representative will identify unsuitable materials that should be removed and those that may be re-used as structural fill. The resulting excavations should be backfilled in accordance with the subsequent recommendations for structural fill placement and compaction. Specific recommendations regarding removal of existing fill material at foundation and slab locations are provided subsequently in association with foundation design and construction recommendations.

The existing undocumented fill in the open areas of the yard (not below foundations or slabs) and with no more than about 3 percent organic material and lacking deleterious material may be left in place. Existing fill that is excavated as part of construction activity may be re-used as structural fill provided that at the time of placement and compaction it is at a moisture content that allows its compaction to the required density, has no more than about 3 percent organics, and lacks deleterious debris.

**Site Preparation Scheduling:** We recommend that site preparation activities take place in the drier summer months if possible. Completion of site preparation and grading under dry site and weather conditions will reduce the potential for disturbance of some of the moisture-sensitive soils and reduce the likelihood of subgrade disturbance and the need to replace disturbed soils with other granular fill material.

**Structural Fill Placement and Compaction**

Establishing a yard elevation of about 126 feet, which is at or very near existing grade in most of the switching station yard area, will require placing some structural fill. Structural fill will also be placed for conduit and vault installations, storm drainage piping and structures, and adjacent to new shallow foundations. All fill material should be placed in accordance with the recommendations herein for structural fill. Prior to placement, the surfaces to receive structural fill should be observed by a ZGA representative in order to verify that at least medium dense properly prepared fill or native soil is present. In the event that soft or loose soils are present at the subgrade elevation, and we expect that this will locally be the case given the nature of undocumented fill material, the soils should be compacted to a firm and non-yielding condition and to at least 95 percent of the modified Proctor maximum dry density (ASTM D 1557) prior to placing structural fill. This may require partial to complete removal of existing fill material and replacing it as compacted structural fill. In the event that the soils cannot be adequately compacted, they should be removed as necessary and replaced with other granular fill material at a moisture content that allows its compaction to the recommended density.

The suitability of soils for use as structural fill depends primarily on the gradation and moisture content of the soil when it is placed. As the amount of fines (that soil fraction passing the US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate
Compaction becomes more difficult, or impossible, to achieve. Generally, soils containing more than about 5 percent fines by weight (based on that soil fraction passing the US No. 4 sieve) cannot be compacted to a firm, non-yielding condition when the moisture content is more than a few percent from optimum. The optimum moisture content is that which yields the greatest soil density under a given compactive effort.

**Re-use of On-site Soils:** Soil expected to be encountered in excavations include both native soil and existing fill material typically consisting of sand and gravel with a variable silt content. We anticipate that it will be feasible to re-use the soils with a lower fines content under a relatively wide variety of weather conditions, but use of soils with more than about 5 percent fines will depend on the weather conditions at the time of placement and compaction. Grain size analysis of samples collected within a depth of about 11 feet of existing grade had fines contents ranging from approximately 9 to 59 percent. The native recessional outwash, and the cleaner fill materials, are well-suited for use as structural fill. Please note that some of the fill material and the deeper native soil (Whidbey Formation) contain a relatively high silt content. Using these materials as structural fill could be difficult due to the high fines content and moisture sensitivity.

**Imported Structural Fill:** We recommend that imported structural fill consist of a well-graded sand and gravel with a low fines content, such as the District’s standard substation fill, the gradation of which is presented in the table below.

| Table 4: Snohomish County PUD No. 1 Substation Import Granular Fill Gradation |
|-----------------------------------------------|-------------------------------|
| US Standard Sieve Size | Percent Passing by Dry Weight Basis |
| 2 inch | 100 |
| ½ inch | 56 - 100 |
| ¼ inch | 40 - 78 |
| No. 10 | 22 - 57 |
| No. 40 | 8 - 32 |
| No. 200 | < 5 |

This material may be considered slightly to moderately moisture-sensitive relative to placement and compaction. A means of reducing the moisture sensitivity of the imported fill would be to base the fines content to less than 5 percent based on the soil fraction passing the ½ inch sieve. It would be feasible to use other granular soils with a higher fines content as structural fill, but it should be recognized that soils with a higher fines content will be more moisture-sensitive and this may limit their use during wet weather or wet site conditions. Another advantage of using granular fill with a relatively low fines content is that it will drain better than fill with a higher fines content. The use of other fill types should be reviewed and approved by ZGA prior to their use on site.
It has been our experience that the District may specify the use of Crushed Surfacing, Base Course Gradation [WSDOT Specification 9-03.9(3)] as structural fill. It should be noted that the gradational criteria for crushed surfacing base course allows up to 7.5 percent fines for 1.5-inch minus material. Crushed surfacing base course with a fines content near the permissible upper limit should not be considered select all-weather fill. Imported fill that is less moisture-sensitive could be achieved by specifying that the material have no more than 5 percent fines based on the soil fraction passing the 1/2-inch sieve.

**Compaction Recommendations:** Structural fill should be placed in horizontal lifts and compacted to a firm and non-yielding condition using equipment and procedures that will produce the recommended moisture content and densities throughout the fill. Fill lifts should generally not exceed 10 inches in loose thickness, although the nature of the compaction equipment in use and its effectiveness will influence functional fill lift thicknesses. Recommended compaction criteria for structural fill materials, including trench backfill, are as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Percent Compaction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below foundations and slabs</td>
<td>95</td>
</tr>
<tr>
<td>Yard area and extending 5 feet beyond the fence</td>
<td>95</td>
</tr>
<tr>
<td>Under driveways, roadways, and sidewalks</td>
<td>95</td>
</tr>
<tr>
<td>Fill sections and berms in other areas of the site</td>
<td>90 – 95 (refer to report text)</td>
</tr>
<tr>
<td>Trenches, foundation, slab, and retaining wall backfill</td>
<td>95</td>
</tr>
<tr>
<td>All other areas</td>
<td>90</td>
</tr>
</tbody>
</table>

* ASTM D 1557 Modified Proctor Maximum Dry Density

Earthwork may be difficult or impossible during periods of elevated soil moisture and wet weather. If soils are stockpiled for future use and wet weather is anticipated, the stockpile should be protected with plastic sheeting that is securely anchored.

Subgrade soils that become disturbed due to elevated moisture conditions should be overexcavated to expose firm, non-yielding, non-organic soils and backfilled with compacted structural fill. We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through June) it will be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork may require additional mitigative measures beyond that which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water. Once subgrades are established, it will be necessary to protect the exposed subgrade soils from construction traffic during wet weather. Placing quarry spalls or crushed recycled concrete over these areas would further protect the soils from construction traffic.
If earthwork takes place during freezing conditions, we recommend allowing the exposed subgrade to thaw and then recompacting the subgrade prior to placing subsequent lifts of engineered fill. Frozen soil should not be used as structural fill.

**Sidehill Fill Placement:** In cases where the slope upon which structural fill is to be placed is inclined at 20 percent or steeper, the receiving surface should be benched such that the structural fill is placed on a horizontal surface. Each bench should be on the order of 6 to 8 feet wide and no less than 2 feet high. The toe of the fill embankment should incorporate a key trench with a minimum width of about 8 feet and a depth of 3 feet.

All of the fill material comprising the embankment should be compacted to at least 95 percent density per ASTM D 1557, including the embankment face. The face may be compacted incrementally as the embankment is constructed, or the embankment may be overbuilt and then the face cut back to the compacted core.

We recommend constructing permanent fill slopes at a 2H:1V inclination or flatter. It is our opinion that such slopes, constructed in accordance with the recommendations presented herein, will be adequately stable. However, please note that slopes 40 percent or steeper and with 10 or more feet of relief will be regulated as landslide hazards per the MMC and the City may require a minimum 10-foot buffer from such slopes. All permanent cut and fill slopes should be adequately protected from erosion both temporarily and permanently. If the slopes are exposed to prolonged rainfall before vegetation becomes established, the surficial soils will be prone to erosion and possible shallow sloughing. We recommend covering permanent slopes with a rolled erosion protection product, such as Curlex II (manufactured by American Excelsior Company), or equivalent, if vegetation has not been established by the start of the wet season (typically November through May).

We recommend that a ZGA representative be present during the construction phase of the project to observe earthwork operations and to perform necessary tests and observations during subgrade preparation, placement and compaction of structural fill, backfilling of excavations, and prior to construction of foundations and slabs.

**Drainage:** Positive drainage should be provided during construction and maintained throughout the life of the project. Uncontrolled movement of water into trenches or foundation and slab excavations during construction should be prevented.

**Additional Considerations:** It is anticipated that excavations for the proposed improvements can be accomplished with conventional earthmoving equipment.

**Excavation Quantities:** It has been our experience that grading calculations need to accommodate a “shrink or swell” factor when comparing in-place soil volumes to truck volumes. We recommend
considering that the in-place volume of soil removed from excavations will increase by approximately 25 to 40 percent when measured on a loose cubic yards basis (truck yards). Likewise, loose truck yards delivered to the site will shrink on the order of 25 to 30 percent when compared to the in-place compacted volume of the soil. Truck yards are also subject to other discrepancies when correlating to bank yards, including “rounding errors” that can be significant.

Utility Installation Recommendations
Below-grade utilities are expected to include conduits and storm drain piping and structures. We recommend that utility trenching conform to all applicable federal, state, and local regulations, such as OSHA and WISHA, for open excavations. The existing shallow native and fill soils in the substation footprint are generally expected to be adequate for support of utilities.

All trenches should be wide enough to allow for compaction around the haunches of the pipe. If water is encountered in the excavations, it should be removed prior to fill placement. Materials, placement and compaction of utility trench backfill exclusive of CDF should be in accordance with the recommendations presented in the Structural Fill section of this report. In our opinion, the initial lift thickness should not exceed 1 foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand operated compaction equipment may be utilized directly above utilities if damage resulting from heavier compaction equipment is of concern.

Dewatering: Depending upon the time of year that the work takes place and the depth of the utilities, excavations may encounter perched water. The contractor should be prepared to pump water from excavations as necessary to maintain a relatively dry trench condition. We anticipate that the likelihood of encountering water in excavations will be highest in areas containing fill with a high fines content and during the wetter times of year.

Temporary Excavation Slopes: We recommend that utility trenching, installation, and backfilling conform to all applicable Federal, State, and local regulations such as WISHA and OSHA regulations for open excavations. In order to maintain the function of any existing utilities that may be located near excavations, we recommend that temporary excavations not encroach upon the bearing splay of existing utilities, foundations, or slabs. The bearing splay of structures and utilities should be considered to begin at the edge of the utility, foundation, or slab and extend downward at a 1H:1V (Horizontal:Vertical) slope. If, due to space constraints, an open excavation cannot be completed without encroaching on a utility, we recommend shoring the new utility excavation with a slip box or other suitable means that provide for protection of workers and that maintain excavation sidewall integrity to the depth of the excavation.

Temporary slope stability is a function of many factors, including the following:

- The presence and abundance of groundwater;
• The type and density of the various soil strata;

• The depth of cut;

• Surcharge loadings adjacent to the excavation;

• The length of time the excavation remains open.

It is difficult to pre-establish a safe and “maintenance-free” temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. It may be necessary to drape temporary slopes with plastic or to otherwise protect the slopes from the elements and minimize sloughing and erosion. We do not recommend vertical slopes or cuts deeper than 4 feet if worker access is necessary. The cuts should be adequately sloped or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable Federal, State, and local regulations.

Based upon our review of WAC Chapter 296-155-66401 (Appendix A – Soil Classification), we have interpreted the existing granular fill and native outwash soils disclosed by the explorations and likely to be present in most excavations as consistent with the Type C definition. The contractor should be responsible for determining soil types in all excavations at the time of construction and should be prepared to adequately shore or slope all excavations. Please note that some of the granular soils have a low fines content and that unsupported excavation sidewalls in these soils may slough or cave readily.

Below-grade Vault Recommendations

Bearing Conditions: Below-grade conduit vaults will be installed as part of the project. Based upon our experience with other District facilities, and depending on the orientation of the new conduit sweeps, the vault bases may be up to approximately 7 feet below grade. Based upon conditions disclosed by the explorations, we anticipate that vault subgrades will generally consist of loose to medium dense granular soils (both native and fill). Some variation in soil type and density at vault subgrade locations should be expected given the presence of undocumented fill. In the event that accumulations of organic materials or deleterious debris are present at vault subgrade elevations, we recommend removing them and replacing them with structural fill compacted to at least 95 percent density per ASTM D 1557 prior to setting the vaults.

The vaults will exert a relatively low bearing pressure. We recommend placing a minimum 6-inch compacted thickness of crushed rock below the vaults as a leveling course. The crushed rock should conform to the quality and gradation requirements for Crushing Surfacing – Base Course Gradation of the WSDOT Standard Specifications [Specification 9-03.9(3)].
Buoyancy Considerations: It is unlikely that the vaults will be subject to buoyant forces given the observed groundwater and soil conditions. Where observed, groundwater was well below the maximum anticipated vault depth.

Foundations
We anticipate that most of the new structures will be supported by drilled pier foundations. However, we have included recommendations for shallow foundations in the event that they are employed to support some of the lighter elements, such as switches or neutral reactors. The foundation net vertical bearing pressures are expected to be relatively low, and the foundations are typically about 4 feet deep, based upon our experience with other District facilities. The native granular soils, existing fill soils with no more than about 3 percent organics and lacking deleterious debris, that are at least medium dense, and properly compacted structural fill are adequate for support of shallow foundations.

Based on conditions observed at the locations of borings and test pits completed at or near the proposed slab locations, we anticipate that foundation subgrade soils will largely consist of medium dense sand with a variable silt content (existing fill and native soils). However, in the event that loose soils or soils containing organics material or deleterious debris are encountered at foundation subgrade elevation, we recommend removing the organics and deleterious debris and compacting loose soils to a firm and non-yielding condition and to at least 95 percent density per ASTM D 1557. Overexcavation of inadequate soils below footings should extend laterally beyond all edges of the footings a distance of 2 feet per 3 feet of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with the excavated material or other granular material placed in lifts of 10 inches or less in loose thickness and compacted to at least 95 percent of the material's modified Proctor maximum dry density (ASTM D 1557). If excavations are backfilled with lean mix concrete or CDF, we recommend the material have a minimum compressive strength of 125 psi. When using CDF, the overexcavation need only be 1 foot wider than the foundation on all sides.

Shallow Foundation Design Recommendations
It will be feasible to use conventional shallow foundations for the lightly-loaded structures located in the yard that bear upon at least medium dense native soil, existing medium dense fill material lacking debris and more than about 3 percent organics, and new structural fill placed and compacted in accordance with the recommendations presented in this report. Recommended criteria for shallow foundations are summarized below.

Net allowable bearing pressure: 2,500 psf for at least medium dense soils. This value incorporates a factor of safety of 3. A one-third increase may be applied for short-term wind or seismic loading.

Minimum dimensions: 15 inches

Minimum embedment for frost protection: 18 inches
Estimated total settlement: ¾ inch

Estimated differential settlement: One half of total settlement

Ultimate passive resistance: 425 psf. This value assumes that foundations are backfilled with granular backfill compacted to 95 percent density and does not include a factor of safety. Neglect the upper 18 inches of embedment when calculating passive resistance.

Ultimate coefficient of base friction: 0.45

Shallow Foundation Construction Considerations
The base of all foundation excavations should be free of water, loose soil, or debris prior to placing concrete, and should be compacted as recommended in this report. Concrete should be placed soon after excavating and compaction to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. A 6-inch thick lift of compacted crushed rock should be placed over the bearing soils if the excavations must remain open for an extended period of time. It is recommended that a ZGA representative evaluate foundation subgrades prior to placing the crushed rock and prior to form and reinforcing steel placement.

If unsuitable bearing soils are encountered in footing excavations, the excavations should be extended deeper to suitable soils. The footings could bear directly on suitable soils at the lower level, on lean concrete or CDF backfill placed in the excavations, or as discussed previously, the footings for lightly-loaded yard structures may bear on properly compacted backfill extending down to the suitable soils.

Seismic Design Parameters

<table>
<thead>
<tr>
<th>Table 6: Substation Site Seismic Design Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
</tr>
<tr>
<td>2012/2015 International Building Code (IBC) 1</td>
</tr>
<tr>
<td>S₁, Spectral Acceleration for a Short Period</td>
</tr>
<tr>
<td>S₂, Spectral Acceleration for a 1-Second Period</td>
</tr>
<tr>
<td>S₁M, Spectral Acceleration for a Short Period</td>
</tr>
<tr>
<td>S₂M, Spectral Acceleration for a 1-Second Period</td>
</tr>
</tbody>
</table>

1. In general accordance with ASCE 7, Table 20.3-1.
2. The 2012/2015 International Building Code, and by reference ASCE 7, considers a site soil profile determination extending a depth of 100 feet for seismic site classification. The current authorized scope did not include the required 100-foot soil profile determination. The borings advanced as
part of our evaluation extended to a maximum depth of approximately 31-1/2 feet and this seismic site class definition considers that medium dense to dense and stiff soils as noted on the published geologic mapping exist below the maximum depth of the subsurface exploration. Additional exploration to greater depths could be considered to confirm the conditions below the current depth of exploration, if necessary.

**Drilled Pier Foundation / Direct Burial Recommendations**

We anticipate that some of the structures in the switching station, including the dead end structures, will be supported by drilled pier foundations, although the dead end structures may be installed via direct burial. Based upon conditions observed at the locations of the exploratory borings and test pits, site conditions are generally favorable for support of drilled pier foundations or direct burial. The presence of uncontrolled fill material and the potential for its composition, density, and depth to vary across the site should be considered in the design.

We understand that the District will complete the foundation designs in house. The tables below provide recommended soil values for incorporation into the District’s Caisson design program. We have not incorporated factors of safety into the listed values. **The depth intervals referenced in the tables are relative to the existing ground surface elevation at the specific boring locations.** Cohesion values are provided only for plastic fine-grained soils. The pressuremeter elastic modulus values are based upon correlations with Standard Penetration Test values (N) published in “Estimating Foundation Settlements in Residual Soils”, Journal of the Geotechnical Engineering Division, Vol. 103, No. 3, March 1977.
### Table 7A: Recommended Soil Parameters Based on ZGA Boring B-1

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Average Standard Penetration Resistance (N)</th>
<th>Correlated Pressuremeter Elastic Modulus (kips/in²)¹</th>
<th>Soil Wet Density (pcf)</th>
<th>Cohesion (kips/ft²)</th>
<th>Internal Friction Angle (Ø, in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>Very loose – med. dense silty SAND with gravel</td>
<td>8</td>
<td>1.2</td>
<td>110</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>10 – 14.5</td>
<td>Stiff sandy SILT, trace clay, gravel</td>
<td>9</td>
<td>1.3</td>
<td>110</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>14.5 – 17.5</td>
<td>Very stiff CLAY</td>
<td>22</td>
<td>2.65</td>
<td>130</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>17.5 – 25</td>
<td>Hard sandy SILT with silty sand</td>
<td>37</td>
<td>3.25</td>
<td>140</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>25 – 31.5</td>
<td>Very dense silty SAND</td>
<td>53</td>
<td>4.11</td>
<td>145</td>
<td>0</td>
<td>41</td>
</tr>
</tbody>
</table>

¹. The pressuremeter modulus values are based upon published correlations between Standard Penetration Test values (N) and the pressuremeter modulus; a factor of safety does not apply.

### Table 7B: Recommended Soil Parameters Based on ZGA Boring B-1

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (D, as percent)</th>
<th>Ultimate Friction Factor¹</th>
<th>Ultimate Friction Factor²</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>Very loose – med. dense silty SAND with gravel</td>
<td>30</td>
<td>0.5</td>
<td>0.3</td>
<td>18</td>
<td>0.35 / 2.88</td>
</tr>
<tr>
<td>10 – 14.5</td>
<td>Stiff sandy SILT, trace clay, gravel</td>
<td>30</td>
<td>0.33</td>
<td>0.2</td>
<td>23</td>
<td>0.35 / 2.88</td>
</tr>
<tr>
<td>14.5 – 17.5</td>
<td>Very stiff CLAY</td>
<td>NA</td>
<td>0.45</td>
<td>0.2</td>
<td>34</td>
<td>0.29 / 3.39</td>
</tr>
<tr>
<td>17.5 – 25</td>
<td>Hard sandy SILT with silty sand</td>
<td>70</td>
<td>0.33</td>
<td>0.2</td>
<td>19</td>
<td>0.25 / 4.02</td>
</tr>
<tr>
<td>25 – 31.5</td>
<td>Very dense silty SAND</td>
<td>90</td>
<td>0.4</td>
<td>0.3</td>
<td>5</td>
<td>0.21 / 4.81</td>
</tr>
</tbody>
</table>

¹. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.

². The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.

³. Passive resistance in the upper 1.5 feet should be neglected entirely.
<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (D_r as percent)</th>
<th>Ultimate Friction Factor¹</th>
<th>Ultimate Friction Factor²</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 7.5</td>
<td>Med. dense to dense SAND and sandy GRAVEL, variable silt</td>
<td>60</td>
<td>0.57</td>
<td>0.4</td>
<td>11</td>
<td>0.27 / 3.69</td>
</tr>
<tr>
<td>7.5 – 14.5</td>
<td>Med. dense SAND with silt</td>
<td>42</td>
<td>0.5</td>
<td>0.3</td>
<td>20</td>
<td>0.31 / 3.25</td>
</tr>
<tr>
<td>14.5 – 25</td>
<td>Dense to very dense SAND with variable gravel and silt</td>
<td>77</td>
<td>0.5</td>
<td>0.3</td>
<td>24</td>
<td>0.23 / 4.4</td>
</tr>
<tr>
<td>25 – 31.5</td>
<td>Hard SILT, trace sand</td>
<td>73</td>
<td>0.33</td>
<td>0.2</td>
<td>25</td>
<td>0.24 / 4.2</td>
</tr>
</tbody>
</table>

1. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.
2. The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.
3. Passive resistance in the upper 1.5 feet should be neglected entirely.
### Table 9A: Recommended Soil Parameters Based on ZGA Boring B-3

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Average Standard Penetration Resistance (N)</th>
<th>Correlated Elastic Pressuremeter Modulus (kips/in²)¹</th>
<th>Soil Wet Density (pcf)</th>
<th>Internal Friction Angle (Ø, in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>Med. dense silty SAND with organics, roots, wood debris</td>
<td>20</td>
<td>2.18</td>
<td>125</td>
<td>33</td>
</tr>
<tr>
<td>5 - 10</td>
<td>Dense SAND with variable silt, gravel</td>
<td>33</td>
<td>3.02</td>
<td>135</td>
<td>36</td>
</tr>
<tr>
<td>10 – 17.5</td>
<td>Stiff sandy SILT, trace clay</td>
<td>13</td>
<td>1.65</td>
<td>120</td>
<td>31</td>
</tr>
<tr>
<td>17.5 – 27.5</td>
<td>Med. dense to very dense SAND and GRAVEL, variable silt</td>
<td>63</td>
<td>4.59</td>
<td>145</td>
<td>43</td>
</tr>
<tr>
<td>27.5 – 31.5</td>
<td>Hard SILT, trace sand</td>
<td>79</td>
<td>5.32</td>
<td>140</td>
<td>44</td>
</tr>
</tbody>
</table>

1. The pressuremeter modulus values are based upon published correlations between Standard Penetration Test values (N) and the pressuremeter modulus; a factor of safety does not apply.

### Table 9B: Recommended Soil Parameters Based on ZGA Boring B-3

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (Dr as percent)</th>
<th>Ultimate Friction Factor¹</th>
<th>Ultimate Friction Factor²</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>Med. dense silty SAND with organics, roots, wood debris</td>
<td>50</td>
<td>0.4</td>
<td>0.3</td>
<td>19</td>
<td>0.3 / 3.39</td>
</tr>
<tr>
<td>5 – 10</td>
<td>Dense SAND with variable silt, gravel</td>
<td>67</td>
<td>0.5</td>
<td>0.4</td>
<td>8</td>
<td>0.26 / 3.85</td>
</tr>
<tr>
<td>10 – 17.5</td>
<td>Stiff sandy SILT, trace clay</td>
<td>40</td>
<td>0.33</td>
<td>0.2</td>
<td>30</td>
<td>0.32 / 3.12</td>
</tr>
<tr>
<td>17.5 – 27.5</td>
<td>Med. dense to very dense SAND and GRAVEL, variable silt</td>
<td>90</td>
<td>0.5</td>
<td>0.3</td>
<td>14</td>
<td>0.19 / 5.29</td>
</tr>
<tr>
<td>27.5 – 31.5</td>
<td>Hard SILT, trace sand</td>
<td>95</td>
<td>0.33</td>
<td>0.2</td>
<td>19</td>
<td>0.18 / 5.55</td>
</tr>
</tbody>
</table>

1. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.
2. The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.
3. Passive resistance in the upper 1.5 feet should be neglected entirely.

### Table 10A: Recommended Soil Parameters Based on ZGA Boring B-4

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Average Standard Penetration Resistance (N)</th>
<th>Correlated Elastic Pressuremeter Modulus (kips/in²)¹</th>
<th>Soil Wet Density (pcf)</th>
<th>Internal Friction Angle (Ø, in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4.5</td>
<td>Dense silty SAND with sandy silt</td>
<td>32</td>
<td>2.96</td>
<td>135</td>
<td>36</td>
</tr>
<tr>
<td>4.5 – 14.5</td>
<td>Hard sandy SILT</td>
<td>37</td>
<td>3.25</td>
<td>130</td>
<td>38</td>
</tr>
<tr>
<td>14.5 – 22.5</td>
<td>Very stiff SILT, trace to some fine sand</td>
<td>24</td>
<td>2.45</td>
<td>125</td>
<td>34</td>
</tr>
<tr>
<td>22.5 – 31.5</td>
<td>Dense to very dense silty SAND</td>
<td>60</td>
<td>4.45</td>
<td>145</td>
<td>43</td>
</tr>
</tbody>
</table>

1. The pressuremeter modulus values are based upon published correlations between Standard Penetration Test values (N) and the pressuremeter modulus; a factor of safety does not apply.

### Table 10B: Recommended Soil Parameters Based on ZGA Boring B-4

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (Dₙ as percent)</th>
<th>Ultimate Friction Factor¹</th>
<th>Ultimate Friction Factor²</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4.5</td>
<td>Dense silty SAND with sandy silt</td>
<td>67</td>
<td>0.4</td>
<td>0.3</td>
<td>19</td>
<td>0.26 / 3.85</td>
</tr>
<tr>
<td>4.5 – 14.5</td>
<td>Hard sandy SILT</td>
<td>72</td>
<td>0.33</td>
<td>0.2</td>
<td>24</td>
<td>0.24 / 4.2</td>
</tr>
<tr>
<td>14.5 – 22.5</td>
<td>Very stiff SILT, trace to some fine sand</td>
<td>55</td>
<td>0.33</td>
<td>0.2</td>
<td>30</td>
<td>0.28 / 3.54</td>
</tr>
<tr>
<td>22.5 – 31.5</td>
<td>Dense to very dense silty SAND</td>
<td>90</td>
<td>0.4</td>
<td>0.3</td>
<td>21</td>
<td>0.19 / 5.29</td>
</tr>
</tbody>
</table>

1. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.
2. The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.
3. Passive resistance in the upper 1.5 feet should be neglected entirely.
## Table 11A: Recommended Soil Parameters Based on ZGA Boring B-5

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Average Standard Penetration Resistance (N)</th>
<th>Correlated Pressuremeter Elastic Modulus (kips/in²)¹</th>
<th>Soil Wet Density (pcf)</th>
<th>Cohesion (kips/ft²)</th>
<th>Internal Friction Angle (Ø, in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1.5</td>
<td>Med. dense silty SAND, trace gravel and roots</td>
<td>15</td>
<td>1.81</td>
<td>115</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>1.5 – 4.5</td>
<td>Dense silty fine SAND</td>
<td>45</td>
<td>3.69</td>
<td>140</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>4.5 – 12.5</td>
<td>Interbedded dense silty fine SAND and hard sandy SILT</td>
<td>31</td>
<td>2.9</td>
<td>125</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>12.5 – 17.5</td>
<td>Hard SILT, trace to some clay, sandy interbeds</td>
<td>58</td>
<td>4.35</td>
<td>135</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td>17.5 – 25</td>
<td>Very stiff CLAY with fine sand laminae</td>
<td>25</td>
<td>2.52</td>
<td>130</td>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>25 – 31.5</td>
<td>Dense to very dense silty fine SAND</td>
<td>50</td>
<td>3.95</td>
<td>145</td>
<td>0</td>
<td>41</td>
</tr>
</tbody>
</table>

1. The pressuremeter modulus values are based upon published correlations between Standard Penetration Test values (N) and the pressuremeter modulus; a factor of safety does not apply.
Table 11B: Recommended Soil Parameters Based on ZGA Boring B-5

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (Dₚ as percent)</th>
<th>Ultimate Friction Factor¹</th>
<th>Ultimate Friction Factor²</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1.5</td>
<td>Med. dense silty SAND, trace gravel and roots</td>
<td>42</td>
<td>0.4</td>
<td>0.3</td>
<td>23</td>
<td>0.31 / 3.25</td>
</tr>
<tr>
<td>1.5 – 4.5</td>
<td>Dense silty fine SAND</td>
<td>71</td>
<td>0.4</td>
<td>0.3</td>
<td>16</td>
<td>0.22 / 4.6</td>
</tr>
<tr>
<td>4.5 – 12.5</td>
<td>Interbedded dense silty fine SAND and hard sandy SILT</td>
<td>65</td>
<td>0.33</td>
<td>0.2</td>
<td>21</td>
<td>0.26 / 3.85</td>
</tr>
<tr>
<td>12.5 – 17.5</td>
<td>Hard SILT, trace to some clay, sandy interbeds</td>
<td>90</td>
<td>0.33</td>
<td>0.2</td>
<td>24</td>
<td>0.2 / 5.04</td>
</tr>
<tr>
<td>17.5 – 25</td>
<td>Very stiff CLAY with fine sand laminae</td>
<td>NA</td>
<td>0.33</td>
<td>0.2</td>
<td>30</td>
<td>0.27 / 3.69</td>
</tr>
<tr>
<td>25 – 31.5</td>
<td>Dense to very dense silty fine SAND</td>
<td>145</td>
<td>0.4</td>
<td>0.3</td>
<td>17</td>
<td>0.21 4.81</td>
</tr>
</tbody>
</table>

1. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.
2. The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.
3. Passive resistance in the upper 1.5 feet should be neglected entirely.
### Table 12A: Recommended Soil Parameters Based on ZGA Boring B-6

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Average Standard Penetration Resistance (N)</th>
<th>Correlated Elastic Pressuremeter Modulus (kips/in$^2$)$^1$</th>
<th>Soil Wet Density (pcf)</th>
<th>Internal Friction Angle ($\varphi$, in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4.5</td>
<td>Med. dense SAND and GRAVEL with variable silt, roots</td>
<td>29</td>
<td>2.77</td>
<td>135</td>
<td>36</td>
</tr>
<tr>
<td>4.5 – 9.5</td>
<td>Stiff to very stiff SILT, sandy SILT</td>
<td>15</td>
<td>1.81</td>
<td>125</td>
<td>32</td>
</tr>
<tr>
<td>9.5 – 27.5</td>
<td>Very stiff to hard SILT, trace clay and trace to some fine sand</td>
<td>30</td>
<td>2.84</td>
<td>135</td>
<td>36</td>
</tr>
<tr>
<td>27.5 – 31.5</td>
<td>Hard fine sandy SILT</td>
<td>53</td>
<td>4.11</td>
<td>140</td>
<td>41</td>
</tr>
</tbody>
</table>

1. The pressuremeter modulus values are based upon published correlations between Standard Penetration Test values (N) and the pressuremeter modulus; a factor of safety does not apply.

### Table 12B: Recommended Soil Parameters Based on ZGA Boring B-6

<table>
<thead>
<tr>
<th>Depth interval in feet below existing grade</th>
<th>Soil Condition</th>
<th>Relative Density (D as percent)</th>
<th>Ultimate Friction Factor$^1$</th>
<th>Ultimate Friction Factor$^2$</th>
<th>Moisture Content (percent by dry weight basis)</th>
<th>Rankine Coefficient Active / Passive$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4.5</td>
<td>Med. dense SAND and GRAVEL with variable silt, roots</td>
<td>65</td>
<td>0.5</td>
<td>0.3</td>
<td>12</td>
<td>0.26 / 3.85</td>
</tr>
<tr>
<td>4.5 – 9.5</td>
<td>Stiff to very stiff SILT, sandy SILT</td>
<td>45</td>
<td>0.33</td>
<td>0.2</td>
<td>20</td>
<td>0.31 / 3.25</td>
</tr>
<tr>
<td>9.5 – 27.5</td>
<td>Very stiff to hard SILT, trace clay and trace to some fine sand</td>
<td>65</td>
<td>0.33</td>
<td>0.2</td>
<td>24</td>
<td>0.26 / 3.85</td>
</tr>
<tr>
<td>27.5 – 31.5</td>
<td>Hard fine sandy SILT</td>
<td>90</td>
<td>0.33</td>
<td>0.2</td>
<td>27</td>
<td>0.21 / 4.81</td>
</tr>
</tbody>
</table>

1. The ultimate friction factors are based upon published values for adhesion between concrete and the applicable soil type.
2. The ultimate friction factors are based upon published values for adhesion between steel and the applicable soil type.
3. Passive resistance in the upper 1.5 feet should be neglected entirely.
Drilled Pier End Bearing Considerations: When calculating drilled pier end bearing values, it will be necessary to consider the density of the soils to a depth below the shaft that is a function of the shaft diameter. We can provide specific end bearing capacity recommendations once preliminary design efforts for the drilled pier foundations have identified likely drilled pier diameters and depths.

Open Shaft Construction Considerations
Given the soil conditions encountered at the exploration locations, we anticipate that construction of the shafts can be accomplished with standard drilling equipment. The contractor should be prepared to deal with the presence of cobbles and boulders over the drilled depth interval, as well as oversize obstructions within the existing fill material. It should be noted that boulders several feet in diameter are scattered about the site, remnants from past mining. It is possible that large boulders may be encountered during drilled pier construction and that excavation of the boulders, or core drilling, may be necessary to construct the shafts to the design depth.

We recommend that the contractor be required to have on site sufficient material to case the entire drilled depth of the drilled pier foundations if necessary to reduce sidewall sloughing. We recommend that the drilling contractor have a cleanout bucket on site to remove loose soils from the bottom of the borings.

We recommend that the shaft concrete be tremied from the bottom of the hole to displace accumulated water and to reduce the risk of contaminating or segregating the concrete mix should any accumulate in the shafts. A minimum 5-foot head of concrete should be maintained above the tremie. The Drilled Shaft Manual published by the Federal Highway Administration recommends that concrete be placed by tremie methods if more than 3 inches of water has accumulated in the excavation. The discharge end of the tremie tube on the concrete pump should include a device to seal out water while the tube is first filled with concrete. Alternatively, the contractor may consider using a plug that is inserted at the hopper of the concrete pump and travels through the tremie to keep the concrete separated from the water.

IBC Non-constrained Pole Design Recommendations
Section 1805.7.2.1 of the 2003 the International Building Code (IBC) describes the methodology for determining a drilled pier foundation or pole depth of embedment in cases where no constraint is provided at the surface to resist lateral forces. As per your request, we have evaluated the equivalent passive soil pressure per foot of depth for use in the IBC method. Recommended lateral bearing pressures as a function of pole depth are listed below in Table 8. We recommend neglecting resistance in the upper 1.5 feet of embedment. Please note that the values listed below are relative to the ground surface elevation at the boring locations.
### Table 13: IBC Non-constrained Pole Lateral Bearing Pressure

<table>
<thead>
<tr>
<th>ZGA Boring</th>
<th>Recommended Lateral Bearing Pressure (lbs/ft²/ft) of Embedment Depth$^{1,2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B-1</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 10 feet: 125</td>
<td></td>
</tr>
<tr>
<td>10 to 14.5 feet: 125</td>
<td></td>
</tr>
<tr>
<td>14.5 to 17.5 feet: 175</td>
<td></td>
</tr>
<tr>
<td>17.5 to 25 feet: 225</td>
<td></td>
</tr>
<tr>
<td>25 to 31.5 feet: 280</td>
<td></td>
</tr>
<tr>
<td><strong>B-2</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 7.5 feet: 190</td>
<td></td>
</tr>
<tr>
<td>7.5 to 14.5 feet: 155</td>
<td></td>
</tr>
<tr>
<td>14.5 to 25 feet: 245</td>
<td></td>
</tr>
<tr>
<td>25 to 31.5 feet: 235</td>
<td></td>
</tr>
<tr>
<td><strong>B-3</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 5 feet: 170</td>
<td></td>
</tr>
<tr>
<td>5 to 10 feet: 210</td>
<td></td>
</tr>
<tr>
<td>10 to 17.5 feet: 150</td>
<td></td>
</tr>
<tr>
<td>17.5 to 27.5 feet: 305</td>
<td></td>
</tr>
<tr>
<td>27.5 to 31.5 feet: 310</td>
<td></td>
</tr>
<tr>
<td><strong>B-4</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 4.5 feet: 210</td>
<td></td>
</tr>
<tr>
<td>4.5 to 14.5 feet: 220</td>
<td></td>
</tr>
<tr>
<td>14.5 to 22.5 feet: 175</td>
<td></td>
</tr>
<tr>
<td>22.5 to 31.5 feet: 305</td>
<td></td>
</tr>
<tr>
<td><strong>B-5</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 4.5 feet: 260</td>
<td></td>
</tr>
<tr>
<td>4.5 to 12.5 feet: 190</td>
<td></td>
</tr>
<tr>
<td>12.5 to 17.5 feet: 270</td>
<td></td>
</tr>
<tr>
<td>17.5 to 25 feet: 190</td>
<td></td>
</tr>
<tr>
<td>25 to 31.5 feet: 280</td>
<td></td>
</tr>
<tr>
<td><strong>B-6</strong></td>
<td></td>
</tr>
<tr>
<td>1.5 to 4.5 feet: 210</td>
<td></td>
</tr>
<tr>
<td>4.5 to 9.5 feet: 160</td>
<td></td>
</tr>
<tr>
<td>9.5 to 27.5 feet: 210</td>
<td></td>
</tr>
<tr>
<td>27.5 to 31.5 feet: 270</td>
<td></td>
</tr>
</tbody>
</table>

1. Values incorporate a factor of safety = 2.5  
2. Neglect upper 1.5 feet

In the event that structural fill compacted to 95 percent density per ASTM D 1557 is placed to raise grade at drilled pier locations, we recommend using a lateral bearing pressure of 200 lbs/ft²/ft of embedment depth for compacted fill that extends below a depth of 1.5 feet. This value incorporates a factor of safety of 2.5. The upper 1.5 feet of embedment should be neglected.

**Concrete Slab Subgrade Preparation Recommendations**

The transformers and switchgear enclosures will be supported by reinforced concrete slabs, and oil containment slabs will surround the transformer slabs. Our previous recommendations regarding
selective excavation and compaction of existing loose fill soils, and removal of organic materials and deleterious debris, should they be observed at the time of construction, are applicable to slab subgrades. Based on conditions observed at the locations of borings and test pits completed at or near the proposed slab locations, we anticipate that slab subgrade soils will largely consist of medium dense sand with a variable silt content (existing fill and native soils). We recommend compacting the slab subgrades to a firm and non-yielding condition and to at least 95 percent of the modified Proctor maximum dry density prior to placing a crushed rock leveling course for the slabs. Provided that the slab subgrades are prepared as described herein, we anticipate that total settlement will be less than ½ inch.

**Stormwater Management Analysis Considerations**

We understand that stormwater will be directed toward perforated pipes installed around the yard perimeter or in other applicable locations to allow infiltration. Conclusions regarding stormwater infiltration feasibility can be drawn from subsurface conditions disclosed by the subsurface explorations and laboratory testing completed to date.

We understand that stormwater management improvements will be designed in accordance with the Washington State Department of Ecology 2014 *Stormwater Management Manual for Western Washington* (*Manual*). The *Manual* requires modeling site soils per the *Western Washington Hydrology Model 2012 User Manual*, and the soil saturated hydraulic conductivity (effectively the infiltration rate) is one of the required criteria. We collected representative samples of shallow soils and completed mechanical grain size tests as part of assessing the soils’ saturated hydraulic conductivity, as summarized below.

**Saturated Hydraulic Conductivity**

The *Manual* allows a determination of soil saturated hydraulic conductivity to be estimated based on grain size distribution characteristics in accordance with the following formula:

$$\log_{10}(K_{sat, \text{initial}}) = -1.57 + 1.9D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{\text{fines}}$$

where:

- $K_{sat, \text{initial}} = \text{initial saturated hydraulic conductivity in centimeters/second prior to the application of correction factors}$
- $D_{10} = \text{grain size diameter (mm) for which 10 percent of the sample by weight is finer}$
- $D_{60} = \text{grain size diameter (mm) for which 60 percent of the sample by weight is finer}$
- $D_{90} = \text{grain size diameter (mm) for which 90 percent of the sample by weight is finer}$
- $f_{\text{fines}} = \text{fraction of the sample by weight that passes the US No. 200 sieve}$
The calculated hydraulic conductivity values for representative soils that we tested are listed in the table below. Grain size distribution curves for the samples are presented in Appendix B.

<table>
<thead>
<tr>
<th>Exploration / Sample</th>
<th>Approximate sample depth (feet)</th>
<th>Unfactored Saturated Hydraulic Conductivity (inches per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-2 / S-3</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>B-3 / S-4</td>
<td>7.5</td>
<td>34.3</td>
</tr>
<tr>
<td>TP-6 / S-2</td>
<td>8</td>
<td>20.6</td>
</tr>
<tr>
<td>TP-11 / S-2</td>
<td>4.5</td>
<td>9.6</td>
</tr>
<tr>
<td>TP-12 / S-2</td>
<td>5</td>
<td>4.1</td>
</tr>
<tr>
<td>TP-18 / S-3</td>
<td>6</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Design Infiltration Rate**

The manual requires applying correction factors to the baseline infiltration rate. Table 3.3.1 *Correction Factors to be Used with In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates* of the manual calls for 40 percent reduction of the baseline rate. Table 3.3.1 also requires applying correction factors for site variability and number of locations tested (CF<sub>v</sub>) and the degree of influent control to prevent siltation and bio-buildup (CF<sub>i</sub>). Based upon the site conditions, testing, and our experience with projects of a similar nature, we applied values of 0.4, 0.4, and 0.9 for CF<sub>v</sub>, CF<sub>i</sub>, and CF<sub>m</sub>, respectively. We recommend using a factored infiltration rate of 1 inch/hour when designing the infiltration system.

**Infiltration Trench Location**

We recommending constructing the infiltration trench section of the stormwater system in the northwestern portion of the site, rather than the southern or eastern portions of the site, in order to provide lateral separation from the descending slopes to the east and south.

**Soil Type**

The *Western Washington Hydrology Model 2012 User Manual* specifies pertinent soil, vegetation/surface, slope criteria as follows:

Soil groups are based on hydrogeologic characteristics:
- A – very well-drained, high infiltration soil
- B – well-drained soil, high infiltration soil
C – moderately drained, medium infiltration soil
D – poorly drained, low infiltration soil
Saturated – poorly drained, limited to no infiltration soil

Vegetation/Surface:
Forest – 2nd growth Douglas Fir
Pasture – non forested natural areas, scrub, and shrub rural vegetation
Lawn – Sod lawn, grass, landscape areas

Slopes:
Flat – 0 to 5 percent slopes
Moderate – 5 to 15 percent slopes
Steep – greater than 15 percent slopes

Considering the above criteria, we reviewed soil mapping accessed from the NRCS web site to determine soil groups and pertinent characteristics. The NRCS has mapped the site soils as consisting of Alderwood-Everett gravelly sandy loams and Everett very gravelly sandy loams. These soils include hydrogeologic ratings of A/B. Based on the vegetation criteria, the site would likely fall under the “pasture” characterization, in our opinion. As such, the site includes PERLND No. 4 where site slopes are 0 – 5 percent, 5 where site slopes are 5 – 15 percent, and 6 where site slopes are greater than 15 percent.

Groundwater Considerations

Groundwater as observed at the boring B-3 location was 16 feet at the time of exploration. Groundwater conditions may be considered favorable from the infiltration perspective.

Storage Considerations

In the event that it becomes necessary to provide some storage capacity to the yard, it would be feasible to include a layer of imported crushed rock with a high void ratio below the yard rock. In the past the District has had laboratory testing completed on crushed surfacing base course sourced from the Iron Mountain Quarry in Granite Falls, Washington. Samples of this material have been shown to have a permeability of 130 inches/hour and void ratio of over 40 percent. The Iron Mountain Quarry products are 100 percent crushed rock and no naturally occurring sand is blended with crushed rock to produce the finished product. Consequently, the crushed products from Iron Mountain Quarry tend to have a high permeability and void ratio compared to other vendor products that combine crushed rock and naturally occurring sand. Other suppliers may have similar products, and we recommend testing alternatives prior to construction in order to verify adequacy.
Perimeter Access Road Recommendations
The perimeter access road and portion of dead-end access road to the north of the yard will be unpaved and are expected to accommodate light to moderate service vehicle loading although occasional heavier loads may be present during future maintenance and construction activity. The District typically requires that the paved substation driveways be able to accommodate H20 loading, and we have assumed the same for the unpaved segments.

Explorations completed along and near the access road segments disclosed generally favorable conditions overall in that sand with a variable gravel and fines content is present. These soils can be expected to drain moderately well and are considered to have good support characteristics. Based upon existing conditions and anticipated access road usage, we recommend that the unpaved section consist of 5 inches of compacted crushed surfacing top course above 8 inches of compacted crushed surfacing base course. We recommend that the crushed surfacing conform to criteria described in Section 9-03.9(3) of the WSDOT Standard Specifications. The access road subgrade should be prepared in accordance with the recommendations presented in the Subgrade Preparation section of this report. We recommend compacting the subgrade soils to a depth of 12 inches to at least 95 percent of the modified Proctor maximum dry density along with the crushed surfacing.

We recommend sloping the access road so that surface water drains to a ditch or other appropriate drainage feature.

Vault Area Access Road Subgrade Preparation Recommendations
Some of the western portion of the access road will be above the existing below-grade concrete stormwater detention vault. It is our understanding that the District intends to demolish the vault. In consideration of this, we recommend demolishing all of the concrete vault components and removing them from the site. The resultant excavation should be prepared and backfilled with structural fill in accordance with our previous recommendations.

Driveway Flexible Pavement Section Recommendations
We have provided the recommendations below in the event that the District elects to pave the driveway. The District typically requires that the pavement section be able to accommodate H20 loading.

Pavement Life and Maintenance: It should be realized that asphaltic pavements such as hot mix asphalt (HMA) are not maintenance-free. The following pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially. Conversely, thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.
Soil Design Values: Pavement subgrade soils are anticipated to consist of sand with a variable silt and gravel content. Our analysis assumes the pavement section subgrade will have a minimum California Bearing Ratio (CBR) value of 10.

Recommended Pavement Section: We recommend that the pavement section, at a minimum, consist of 3 inches of asphalt concrete over 2 inches (compacted thickness) of crushed surfacing top course over either 8 inches of crushed surfacing base course or 4 inches of Asphalt Treated Base (ATB).

We recommend the following regarding flexible pavement materials and pavement construction.

Subgrade Preparation and Compaction: The subgrade should be prepared in accordance with the recommendations presented in the Subgrade Preparation section of this report, and all fill should be compacted in accordance with the recommendations presented in the Structural Fill section of this report.

HMA: We recommend that the HMA conform to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the WSDOT Standard Specifications. We also recommend that the gradation of the HMA aggregate conform to the aggregate gradation control points for ½-inch mixes as presented in Section 9-03.8(6), HMA Proportions of Materials.

Base Course: We recommend that the crushed surfacing base course conform to Section 9-03.9(3) of the WSDOT Standard Specifications.

Compaction and Paving: We recommend compacting the HMA to a minimum of 91 or 92 percent of the Rice (theoretical maximum) density, depending upon which version of the WSDOT Standard Specifications is in effect. Placement and compaction of HMA should conform to requirements of Section 5-04 of the Standard Specifications.

Erosion Control
Construction phase erosion control activities are recommended to include measures intended to reduce erosion and subsequent sediment transport. We recommend that the project incorporate the following erosion and sedimentation control measures during construction:

- Capturing water from low permeability surfaces and directing it away from bare soil exposures.

- Erosion control BMP inspection and maintenance: The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.
• Undertake site preparation, excavation, and filling during periods of little or no rainfall.

• Cover excavation surfaces with anchored plastic sheeting if surfaces will be left exposed during wet weather.

• Cover soil stockpiles with anchored plastic sheeting.

• Provide an all-weather quarry spall construction site entrance.

• Provide for street cleaning on an as-needed basis.

• Protect exposed soil surfaces that will be subject to vehicle traffic with crushed rock or crushed recycled concrete to reduce the likelihood of subgrade disturbance and sediment generation during wet weather or wet site conditions.

• Install siltation control fencing on the lower perimeter of work areas.

• If grounding wells are installed, containment of the cuttings produced during the drilling process will reduce the likelihood of off-site sediment migration. Cuttings with a high fines content should be removed from the site following completion of drilling.

• We recommend mantling the planned graded slopes with a rolled erosion control product (RECP), such as Curlex II manufactured by American Excelsior Company, or equivalent, as a means of reducing erosion of the graded slopes and to help speed revegetation. Seed or hydroseed should be applied to the slope prior to installation of the RECP.

**East Slope Tree Removal Considerations**

We understand that the District plans to remove trees from the eastern portion of the site to provide clearance for new transmission lines. Two cottonwood trees are also planned for removal at the southeast portion of the yard. As mentioned previously, much of the east facing slope above Woods Creek Road meets the MMC criteria for a landslide hazard area based on the slope height and inclination and at the southeast due to recent landsliding.

Based on our site observations, it is our opinion that the middle to northern portion of the slope east of the yard and above Woods Creek Road is characterized by slow downslope soil creep, or solifluction. This condition is reflected in the abundance of young and mature trees with curving trunks. However, we did not observe current site conditions that are indicative of currently ongoing slope instability or widespread erosion in the middle to northern portions of the east slope area where vegetation management (tree cutting) is proposed. As previously discussed, there is a small landslide in the southern portion of the slope.
Although we did not observe evidence of gross slope instability of the middle to northern portion of the slope that would be impacted by tree cutting, it is clear that the slope is subject to slow downslope creep. The soil creep combined with the effects of episodic severe rainstorms will result in lateral migration of the slope over time. This is the long-term effect of natural mass wasting events. It should be recognized that the replanting proposed for the site following tree cutting and trimming may attenuate, but will not eliminate, the natural mass wasting processes that affects the slopes, in our opinion. Removal of two cottonwood trees and the planned regarding at the top of the slope in the area of the small landslide shown on Figure 1 is not expected to have an adverse impact on slope stability, in our opinion.

It will not be necessary to grade or otherwise alter the slope in order to install the new transmission lines. It is our opinion that cutting and trimming existing trees will likely not have a significant adverse impact on slope stability provided that the recommendations presented below are followed and provided that a robust replanting effort is completed after the tree cutting and trimming. However, it should be recognized that future shallow slope instability may result from the long-term degradation of existing tree root systems even with an effective replanting effort and we consider this an unquantifiable risk. Treefall due to wind exposure following cutting and trimming may also decrease shallow slope stability. Removal of the trees offers a potential benefit in terms of eliminating the soil disturbance that can result from tree root mass movement during high winds.

**Tree Cutting**

- The stumps and root mass of all trees that are cut should be left in place. The root mass will help to maintain stability of shallow soils on the slopes for a period of time, even in those cases where the trees die following cutting or trimming.

- Tree cutting should be accomplished in a manner that eliminates or reduces damage to trees that are not slated for cutting or trimming.

- Wood debris that are to be removed from the site should not be yarded up or down the steep slopes by dragging. The wood debris should either be removed by full-suspension techniques that will eliminate the risk of dragging either butts or crowns of logs along the steep slope. Dragging wood debris along the slopes will disturb the shallow soils and increase the risk of erosion and shallow slope instability, in our opinion.

- Mechanized equipment should not be operated on the eastern slope as a means of reducing the likelihood of erosion or sediment transport.

**Wood Disposal**
• We do not recommend disposing of wood debris on the east slope in a random or haphazard manner. Improper placement of wood debris on the slope has the potential to alter surface water drainage patterns, increase the risk of erosion, and add weight to the surficial soils that are currently subject to downslope creep. Accumulations of wood debris can also create a long-term hazard of rapid downslope displacement that would disturb the shallow soils, increasing the risk of erosion.

• We recommend orienting cut logs on the slopes either parallel to the fall line or close enough to it so that the logs will not roll down the slopes.

• We do not recommend placing accumulations of trimmings on the slopes or establishing slash piles on the slopes. Trimmings left on the slopes should be distributed widely to avoid smothering existing vegetation and creating heavy accumulations of organic matter. The presence of trimmings piles would also make it more difficult to effectively replant the slopes.

Planting

• We recommend that the replanting effort be developed by a qualified arborist with steep slope planting experience.

• We recommend planting trees and shrubs that have a high root-to-shoot ratio. A healthy and robust root mass will provide reinforcement of shallow soils and increase the soil shear strength, helping to reduce soil erosion and shallow slope instability.

• The effectiveness of root mass reinforcement of the shallow soils will decrease in the cases where existing trees are killed by the cutting or trimming. Although leaving stumps and the root mass intact after cutting or trimming will be beneficial, decay of root matter over time will reduce the ability of the roots to provide soil reinforcement as the root material degrades and weaken. Research indicates that the benefit of the root mass may only last three to nine years. Therefore, it will be critical to initiate the replanting as soon as possible after the cutting and trimming take place so that the new root growth can compensate for the degradation of the root mass of trees that are killed as a result of the cutting or trimming.

• We recommend planting a combination of trees and shrubs. The trees should be varieties that have a relatively low height potential.

CLOSURE

The analysis and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, location, and depth of the explorations were completed within
the constraints of budget and site access so as to yield the information to formulate our recommendations. Project plans were in the preliminary stage at the time this report was prepared. We therefore recommend we be provided an opportunity to review the final plans and specifications when they become available in order to assess that the recommendations and design considerations presented in this report have been properly interpreted and implemented into the project design.

The performance of earthwork, structural fill, foundations, and slabs depends greatly on proper site preparation and construction procedures. We recommend that Zipper Geo Associates, LLC be retained to provide geotechnical engineering services during the earthwork-related construction phases of the project. If variations in subsurface conditions are observed at that time, a qualified geotechnical engineer could provide additional geotechnical recommendations to the contractor and design team in a timely manner as the project construction progresses.

This report has been prepared for the exclusive use of Snohomish County PUD No. 1, and its agents, for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless ZGA reviews the changes and either verifies or modifies the conclusions of this report in writing.
APPENDIX A
FIELD EXPLORATION AND TESTING PROCEDURES AND LOGS
FIELD EXPLORATION AND TESTING PROCEDURES AND LOGS

Our field exploration program for this project included completing a visual reconnaissance of the site, advancing five borings (B-1 through B-5) and excavating 18 test pits (TP-1 through TP-18). The approximate exploration locations are presented on Figure 1, the Site and Exploration Plan. Exploration locations were determined in the field using steel and fiberglas tape by measuring distances from existing site features shown on the Conceptual Site Plan, Drawing S-131-P25.1, dated July 2020, provided by the District. The ground surface elevation at each exploration location was interpolated from the topography shown on the reference drawing. As such, the exploration locations should be considered accurate to the degree implied by the measurement method. The following sections describe our procedures associated with the explorations. Descriptive logs of the explorations are enclosed in this appendix.

Boring Procedures
The borings were advanced using a track-mounted drill rig operated by an independent drilling company (Boretec1) working under subcontract to ZGA. The borings were advanced using hollow stem auger drilling methods. An engineering geologist from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further evaluation and testing. Samples were generally obtained by means of the Standard Penetration Test at 2.5-foot to 5-foot intervals throughout the drilling operation.

The Standard Penetration Test (ASTM D 1586) procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “blow count” (N value). If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boring. If groundwater was encountered in a borehole, the approximate groundwater depth and date of observation are depicted on the log.

Test Pit Procedures
An independent contractor (Northwest Excavation & Trucking) working under subcontract to ZGA excavated the test pits through the use of a tracked excavator. An engineering geologist from ZGA continuously observed the test pit excavations, logged the subsurface conditions, and obtained
representative soil samples. The samples were stored in moisture tight containers and transported to our laboratory for further visual classification and testing.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based primarily on our field classifications and supported by our subsequent laboratory testing. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of *in situ* soils by means of the excavation characteristics and by the sidewall stability. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits, as well as all sample numbers and sampling locations.

**Sample Screening**

The boring and selected test pit logs also include the results of sample container headspace measurements taken with a RAE Systems photoionization detector (PID). The measurements indicate the relative concentration of petroleum hydrocarbons in the headspace air, but do not identify the type of hydrocarbon. The sample headspace readings, recorded as hydrocarbon concentration in parts per million (ppm) are presented on the logs in this appendix. The sample screening did not detect hydrocarbon levels of concern.
### Sample Number

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Sample Recovery (Inches)</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td>18</td>
<td>12 &lt;1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-2</td>
<td>0</td>
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<tr>
<td>10</td>
<td>S-4</td>
<td>18</td>
<td>4 &lt;1.0</td>
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<td>10</td>
<td>S-5</td>
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<tr>
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<td>S-7</td>
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<td>22 &lt;1.0</td>
</tr>
<tr>
<td>20</td>
<td>S-8</td>
<td>18</td>
<td>37 &lt;1.0</td>
</tr>
</tbody>
</table>

### Soil Description

- **1 to 2-inches grass and weeds over medium dense, wet, brown, silty sandy GRAVEL, some roots and woody debris (Fill)**
- **No recovery, assumed loose GRAVEL based on drill action (Fill)**
- **Loose, wet, brown-tan, SAND with interbedded silt lenses, trace gravel (Fill)**
- **Very loose, moist, brown, silty SAND, interbedded silt, some soil mottling (Fill)**
- **Stiff, wet, brown, sandy SILT, trace gravel**
- **Stiff, wet, gray, sandy SILT, trace clay, interbedded sand lenses, trace fine roots**
- **Very stiff, wet, gray, CLAY**
- **PP = 5.0 tsf**
- **Hard, wet, brown, sandy SILT/silty SAND, slight mottling**

### Testing Key

- **SAMPLE LEGEND**
  - 2-inch O.D. split spoon sample
  - 3-inch I.D. Shelby tube sample

- **GROUNDWATER LEGEND**
  - Clean Sand
  - Bentonite
  - Grout/Concrete
  - Screened Casing
  - Blank Casing
  - Groundwater level at time of drilling (ATD) or on date of measurement.

- **PROJECT LEGEND**
  - % Fines (<0.075 mm)
  - % Water (Moisture) Content
  - Plastic Limit
  - Liquid Limit
  - Natural Water Content

---

**Sky Valley Switching Station**

**19622 Tjerne Place SE**

**Monroe, WA**

---

**Project No.: 2326.01**

**BORING LOG:**

**B-1**
### B-1

**Boring Location:** Sky Valley Switching Station  
19622 Tjerne Place SE  
Monroe, WA

**Date Drilled:** 5/21/2020

---

**SOIL DESCRIPTION**

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

---

**Sample Number**  
**Depth (ft)**  
**Depth**  
**Recovery (Inches)**  
**Blowcount**  
**PID**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Depth</th>
<th>Recovery (Inches)</th>
<th>Blowcount</th>
<th>PID</th>
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Very dense, wet to damp, silty SAND and SAND with trace silt

Boring completed at approximately 31.5 feet. No groundwater observed at time of drilling.

---

**SAMPLE LEGEND**

2-inch O.D. split spoon sample  
3-inch I.D. Shelby tube sample

**GROUNDWATER LEGEND**

- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- Groundwater level at time of drilling (ATD) or on date of measurement.

**TESTING KEY**

- GSA = Grain Size Analysis  
- 200W = 200 Wash Analysis  
- Consol. = Consolidation Test  
- Att. = Atterberg Limits

---

**GROUNDWATER LEVEL**

Groundwater level at time of drilling (ATD) or on date of measurement.

---

**Boring Company:** Boretec 1  
**Bore Hole Dia.:** 6 in.  
**Drilling Method:** Hollow Stem Auger  
**Drill Rig:** Track  
**Logged by:** BGF

---

**Additional Information:**

See Figure 1, Site and Exploration Plan

---

**Data:**

- Very dense, wet to damp, silty SAND and SAND with trace silt
- Boring completed at approximately 31.5 feet.
- No groundwater observed at time of drilling.
**SOIL DESCRIPTION**

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Recovery (Inches)</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td>1</td>
<td>Groundwater Blowcount: 25 &lt;1.0</td>
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<td>S-6</td>
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<td>-35</td>
<td>S-8</td>
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</table>

**GROUNDWATER LEGEND**

- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

**SAMPLE LEGEND**

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

**TESTING KEY**

- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

**Boring Location:** See Figure 1, Site and Exploration Plan

**Date Drilled:** 5/21/2020

**Drilling Company:** Boretec

**Drilling Method:** Hollow Stem Auger

**Borehole Dia.:** 6 in.

**Hammer Type:** Cathead

**Logged by:** BF

**Drill Rig:** Track

**Boring Log:** B-2

**Project No.:** 2326.01

**Sky Valley Switching Station**

19622 Tjerne Place SE

Monroe, WA

**Zipper Geo Associates**

19019 36th Ave. W, Suite E

Lynnwood, WA

**Page 1 of 2**
**SOIL DESCRIPTION**

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
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<tr>
<td>-25</td>
<td>S-9</td>
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<td>-30</td>
<td>S-10</td>
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<td>35 &lt;1.0</td>
</tr>
</tbody>
</table>

Hard, wet, gray, SILT with fine sand

PP = 5.0 tsf

Boring completed at approximately 31.5 feet. No groundwater observed at time of drilling.
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
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<th>Depth (ft)</th>
<th>Sample Number</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td>Groundwater 20 1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-2</td>
<td>Groundwater 48 1.6</td>
</tr>
<tr>
<td>0</td>
<td>S-3</td>
<td>Groundwater 32 1.4</td>
</tr>
<tr>
<td>0</td>
<td>S-4</td>
<td>Groundwater 34 1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-5</td>
<td>Groundwater 14 1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-6</td>
<td>Groundwater 13 1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-7</td>
<td>Groundwater 11 1.0</td>
</tr>
<tr>
<td>0</td>
<td>S-8</td>
<td>Groundwater 25 1.0</td>
</tr>
</tbody>
</table>

- 1 to 2-inches grass and weeds over medium dense, moist to wet, dark brown, silty SAND, some roots and woody debris (Fill)
- Medium dense, wet, brown, silty SAND with abundant organics, wood fibers, and roots (blowcount overstated) (Fill)
- Dense, moist, brown to dark gray, gravelly SAND, trace to some silt, gravel content decreases with depth
- Stiff, wet, brown-tan, sandy SILT/silty SAND
- Medium dense, wet, brown-tan, silty SAND
- Stiff, wet, brown-tan, sandy SILT, trace clay
- Medium dense, saturated, gray, medium to coarse SAND, trace fine gravel
- Harder drilling

**GROUNDWATER LEGEND**
- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit

**SAMPLE LEGEND**
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

**TESTING KEY**
- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

Sky Valley Switching Station
19622 Tjerne Place SE
Monroe, WA

Zipper Geo Associates
19019 36th Ave. W, Suite E
Lynnwood, WA

Project No.: 2326.01
BORING LOG: B-3
### Boring Location:
See Figure 1, Site and Exploration Plan

### Elevation:
127 feet

### Date Drilled:
5/21/2020

### Drilling Company:
Boretec 1

### Drill Rig:
Track

### Logged by:
BF

### Bore Hole Dia.:
6 in.

### Drilling Method:
Hollow Stem Auger

### Hammer Type:
Cathead

---

#### Soil Description

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Recovery (Inches)</th>
<th>Penetration Resistance (blows/foot)</th>
<th>Groundwater</th>
<th>Blowcount</th>
<th>PID</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>S-9</td>
<td>12</td>
<td>▲ 50/6&quot; &lt;1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>S-10</td>
<td>18</td>
<td>▲ 79/12&quot; &lt;1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Testing Key

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample
- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

#### Groundwater Legend

- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

---

### Sky Valley Switching Station
19622 Tjerne Place SE
Monroe, WA

### Zipper Geo Associates
19019 36th Ave. W, Suite E
Lynnwood, WA

### Project No.:
2326.01

### Boring Log:
B-3

---

Boring completed at approximately 31 feet. Groundwater observed at approximately 16 feet at time of drilling.
**Boring Location:** See Figure 1, Site and Exploration Plan  
**Elevation:** 126 feet  
**Date Drilled:** 5/21/2020  
**Drilling Method:** Hollow Stem Auger  
**Hammer Type:** Cathead  
**Drill Rig:** Track  
**Logged by:** BF  
**Drilling Company:** Boretec  
**Borehole Dia.:** 6 in.  

### SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample Recovery (Inches)</td>
<td>Groundwater</td>
</tr>
<tr>
<td></td>
<td>S-1</td>
<td>▲ Standard Penetration Test</td>
</tr>
<tr>
<td></td>
<td>S-2</td>
<td>▲ Hammer Weight and Drop:</td>
</tr>
<tr>
<td></td>
<td>S-3</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>S-4</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>S-5</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>S-6</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>S-7</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>S-8</td>
<td>▲</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blowcount</th>
<th>PID</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>32</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>35</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>35</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>42</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>36</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>22</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>25</td>
<td>&lt;1.0</td>
</tr>
</tbody>
</table>

- **Depth:** 0 to 2 inches  
  - Grass and weeds over loose, moist to wet, dark gray-brown, silty SAND with roots (Fill)
  
- **Depth:** 5 to 10 feet
  - Dense, moist, dark gray, silty SAND/sandy SILT

- **Depth:** 10 to 15 feet
  - Hard, moist, dark gray, sandy SILT

- **Depth:** 15 to 20 feet
  - Very stiff, wet, dark gray SILT, trace to some fine sand

- **Depth:** 20 to 25 feet
  - PP = 5.0 tsf
  - Dense, moist, dark gray, laminated silty fine SAND

### SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

### GROUNDWATER LEGEND

- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing

### TESTING KEY

- **GSA** = Grain Size Analysis  
- **200W** = 200 Wash Analysis  
- **Consol.** = Consolidation Test  
- **Att.** = Atterberg Limits  
- **Plastic Limit**  
- **Natural Water Content**

---

Sky Valley Switching Station  
19622 Tjerne Place SE  
Monroe, WA

Zipper Geo Associates  
19019 36th Ave. W, Suite E  
Lynnwood, WA

**Project No.:** 2326.01  
**BORING LOG:** B-4  
Page 1 of 2
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Recovery (Inches)</th>
<th>Soil Type</th>
<th>Blowcount</th>
<th>Penetration Resistance (blows/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-25</td>
<td>S-9</td>
<td>18</td>
<td>Dense to very dense, moist, dark gray, silty fine laminated SAND</td>
<td>42</td>
<td>1.0</td>
</tr>
<tr>
<td>-30</td>
<td>S-10</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring completed at approximately 31 feet. No groundwater observed at time of drilling.

2-inch O.D. split spoon sample
3-inch I.D. Shelby tube sample

- Stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.
- **Groundwater level at time of drilling** (ATD) or on date of measurement.
- **GSA** = Grain Size Analysis
- **200W** = 200 Wash Analysis
- **Consol.** = Consolidation Test
- **Att.** = Atterberg Limits
**Boring Location:** See Figure 1, Site and Exploration Plan

**Drilling Company:** Boretec1

**Drilling Method:** Hollow Stem Auger

**Drill Rig:** Track

**Logged by:** BF

**Borehole Dia.:** 6 in.

**Hammer Type:** Cathead

**Elevation:** 125 feet

**Date Drilled:** 5/21/2020

---

### SOIL DESCRIPTION

*The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
<th>Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>S-1</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>S-2</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>S-3</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td>5</td>
<td>S-4</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>S-5</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>S-6</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td>10</td>
<td>S-7</td>
<td>18</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>S-8</td>
<td>18</td>
<td>△</td>
</tr>
</tbody>
</table>

### GROUNDWATER LEGEND

- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

### TESTING KEY

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample
- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

---

**Sky Valley Switching Station**

19622 Tjerne Place SE

Monroe, WA

**Project No.:** 2326.01

**Zipper Geo Associates**

19019 36th Ave. W, Suite E

Lynnwood, WA

**BORING LOG:** B-5

---

See Figure 1, Site and Exploration Plan

5/21/2020

Boretec1

Hollow Stem Auger

Track

BF

11/2/12

Sky Valley Switching Station

19622 Tjerne Place SE

Monroe, WA

200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

---

**Notes:**

- Blowing Location: See Figure 1, Site and Exploration Plan
- Date Drilled: 5/21/2020
- Drilling Method: Hollow Stem Auger
- Drilling Company: Boretec1
- Logged by: BF
- Borehole Dia.: 6 in.
- Hammer Type: Cathead
- Elevation: 125 feet

---

**SOIL DESCRIPTION**

- The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

- Depth (ft):
  - 0: 1 to 2-inches grass and weeds over medium dense, moist to wet, gray, silty SAND/sandy SILT, trace gravels and roots (Fill)
  - 5: Dense, moist, gray, silty fine SAND
  - 10: Medium dense to dense, moist, gray, silty fine SAND, scattered silty clasts
  - 15: Hard, wet, gray, SILT
  - 20: Hard, moist to wet, gray, SILT, trace to some clay, interbedded sandy horizons
  - 25: Very stiff, moist, dark gray, CLAY with sandy laminations

- PP = 5.0 tsf

---

**GROUNDSWATER LEGEND**

- △ Standard Penetration Test
- □ Hammer Weight and Drop:

---

**SAMPLE LEGEND**

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

---

**TESTING KEY**

- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25</td>
<td>Dense to very dense, wet, dark gray, silty fine SAND</td>
</tr>
<tr>
<td>30-50</td>
<td>Boring completed at approximately 31.5 feet. No groundwater observed at time of drilling.</td>
</tr>
</tbody>
</table>

**SOIL DESCRIPTION**

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

**GROUNDWATER LEGEND**

- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- Groundwater level at time of drilling (ATD) or on date of measurement.

**SAMPLE LEGEND**

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

**TESTING KEY**

- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

**Groundwater Legend**

- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

**Sky Valley Switching Station**

19622 Tjerne Place SE
Monroe, WA

Project No.: 2326.01

**Zipper Geo Associates**

19019 36th Ave. W, Suite E
Lynnwood, WA

**BORING LOG:**

B-5

Page 2 of 2
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 to 2-inches grass, weeds, scattered crushed rock ballast over very dense, wet,</td>
</tr>
<tr>
<td></td>
<td>brown, GRAVEL with sand and silt, some roots (Fill) blowcount overstated</td>
</tr>
<tr>
<td>5</td>
<td>Medium dense, wet, brown, silty SAND with gravel</td>
</tr>
<tr>
<td>10</td>
<td>Stiff to very stiff, wet, gray, sandy SILT, some gravel, brown sandy seams</td>
</tr>
<tr>
<td>15</td>
<td>Very stiff to hard, wet, gray, SILT, trace clay, trace to some sand</td>
</tr>
<tr>
<td>20</td>
<td>PP = 2.75 tsf</td>
</tr>
<tr>
<td>25</td>
<td>PP = 5.0 tsf</td>
</tr>
</tbody>
</table>

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

**Sample Legend**
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

**Testing Key**
- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

**Groundwater Legend**
- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

Sky Valley Switching Station
19622 Tjerne Place SE
Monroe, WA

Zipper Geo Associates
19019 36th Ave. W, Suite E
Lynnwood, WA

Project No.: 2326.01

BORING LOG: B-6

Page 1 of 2
# SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Number</th>
<th>Recovery (Inches)</th>
<th>Groundwater</th>
<th>PENETRATION RESISTANCE (blows/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>S-9</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>S-10</td>
<td>18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hard, wet, dark gray, SILT, interbedded fine sand

Hard, wet, dark gray, fine sandy SILT

Boring completed at approximately 31.5 feet. No groundwater observed at time of drilling.

---

**SAMPLE LEGEND**
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

**GROUNDWATER LEGEND**
- % Fines (<0.075 mm)
- % Water (Moisture) Content
- Plastic Limit
- Liquid Limit
- Natural Water Content

**TESTING KEY**
- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

---

Sky Valley Switching Station
19622 Tjerne Place SE
Monroe, WA

Zipper Geo Associates
19019 36th Ave. W, Suite E
Lynnwood, WA

Project No.: 2326.01

---

Boring Location: See Figure 1, Site and Exploration Plan
Elevation: 126 feet
Date Drilled: 5/21/2020

Drilling Company: Boretec
Drilling Method: Hollow Stem Auger
Hammer Type: Cathead
Logged by: BF

---

Boring Location: B-6
Date Drilled: 5/21/2020

---

Borehole Dia.: 6 in.
Drill Rig: Track

---

25 feet:
- Hard, wet, dark gray, SILT, interbedded fine sand

30 feet:
- Hard, wet, dark gray, fine sandy SILT

---

Boring completed at approximately 31.5 feet. No groundwater observed at time of drilling.
### Test Pit TP-1

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 123  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist to wet, brown, SAND with silt, some gravel, trace cobbles (Fill)</td>
<td>S-1 @ 2.5 feet</td>
<td>&lt;1</td>
<td>ACM</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3         | Test pit completed at approximately 3 feet due to encountering vault lid  
No groundwater or caving observed during excavation. | | | | |

---

### Test Pit TP-2

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 123  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist, brown, SAND with silt, some gravel, trace cobbles (Fill)</td>
<td>S-1 @ 2.5 feet</td>
<td>&lt;1</td>
<td>ACM</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3         | Test pit completed at approximately 3.5 feet due to encountering vault lid  
No groundwater or caving observed during excavation. | | | | |
### Test Pit TP-3

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 114  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass over 2 inches loose, moist, brown, silty SAND, some gravel, trace fine roots and organics. (Topsoil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Loose to medium dense, moist, brown, SAND, trace silt, trace gravel (Possible Fill)</td>
<td>S-1</td>
<td>@ 1.5 feet</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Medium dense, moist to wet, gray, SAND, trace silt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Moderate perched groundwater seepage at approximately 3 feet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Moderate caving from approximately 3 feet to 5.5 feet</td>
<td>S-2</td>
<td>@ 5 feet</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Light soil mottling, thinly laminated</td>
<td>S-3</td>
<td>@ 5.5 feet</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>S-4</td>
<td>@ 9.5 feet</td>
<td>&lt;1</td>
<td></td>
</tr>
</tbody>
</table>

Test pit completed at approximately 10 feet.  
Moderate groundwater seepage observed at approximately 3 feet while excavating.  
Moderate caving observed from approximately 3 to 5.5 feet.
### Test Pit TP-4

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 116  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
</table>
| 1         | Grass over 1 inches loose, moist, brown, silty SAND, some gravel, trace fine roots and organics. (Topsoil)  
Loose to medium dense, moist, brown, SAND, some silt, trace gravel (Possible Fill)          | S-1 @ 1.5 feet | <1  |     |         |
| 2         |                                                                                                                                                                                                                       |        |     |     |         |
| 3         | Medium dense, moist to wet, gray, SAND, trace silt  
Moderate perched groundwater seepage at approximately 3.5 feet  
Moderate caving from approximately 3.5 feet to 5.5 feet | S-2 @ 4 feet | <1  |     |         |
| 4         |                                                                                                                                                                                                                       |        |     |     |         |
| 5         |                                                                                                                                                                                                                       |        |     |     |         |
| 6         | Medium dense, wet, gray, silty SAND  
Light soil mottling, thinly laminated                                                                                                                                   | S-3 @ 8.5 feet | <1  |     |         |
| 7         |                                                                                                                                                                                                                       |        |     |     |         |
| 8         |                                                                                                                                                                                                                       |        |     |     |         |
| 9         | Test pit completed at approximately 8.5 feet.  
Moderate groundwater seepage observed at approximately 3.5 feet while excavating.  
Moderate caving observed from approximately 3.5 to 5.5 feet.                           |        |     |     |         |
### Test Pit TP-5

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 115  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass over 2 inches loose, moist, brown, silty SAND, some gravel, trace fine roots and organics. (Topsoil) Loose to medium dense, moist, gray to brown, SAND, some silt, trace gravel (Possible Fill)</td>
<td>S-1 @ 1.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Medium dense, moist to wet, gray, SAND, trace silt</td>
<td>S-2 @ 5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Light perched groundwater seepage at approximately 2 feet, slight caving from approximately 1.5 to 3 feet</td>
<td>S-3 @ 8.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Medium dense, wet, gray, silty SAND Light soil mottling, thinly laminated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
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<td>6</td>
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<tr>
<td>7</td>
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<tr>
<td>8</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>9</td>
<td>Test pit completed at approximately 9 feet. Light groundwater seepage observed at approximately 2 feet while excavating. Slight caving observed from approximately 1.5 to 3 feet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Test Pit TP-6

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 128

**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel, trace cobbles (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td>S-1 @ 1 feet</td>
<td>&lt;1</td>
<td></td>
<td>ACM</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Becomes medium dense, moist to wet, gray, Gravelly SAND with silt, scattered organics (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>S-2 @ 8 feet</td>
<td>&lt;1</td>
<td>11</td>
<td>GSA</td>
</tr>
<tr>
<td>9</td>
<td>Medium dense, moist, tan, SAND, some silt, trace gravel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 10        | Test pit completed at approximately 10 feet.  
No groundwater or caving observed during excavation. | S-4 @ 10 feet | <1 |    |         |
**Test Pit TP-7**

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 132  

**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020  

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel, trace organics and cobbles (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 2         | Brick fragment  
ACM = Non-detect |        |     |     |         |
| 3         | Becomes loose to medium dense, moist, gray, SAND with silt and gravel, scattered organics and wood debris (Fill) |        |     |     | ACM    |
| 4         | Becomes loose to medium dense, moist, gray, SAND with silt and gravel, scattered organics and wood debris (Fill) |        |     |     |         |
| 5         |        |        |     |     |         |
| 6         |        |        |     |     |         |
| 7         |        |        |     |     |         |
| 8         |        |        |     |     |         |
| 9         |        |        |     |     |         |
| 10        | Brick Fragment |        |     |     |         |
| 11        |        |        |     |     |         |
| 12        | Loose, moist, brown, SAND with silt, trace gravel, thin root intrusions (Fill) | S-3 @ 11.5 feet | 1.3 |     |         |

Test pit completed at approximately 12 feet. No groundwater or caving observed during excavation.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel, trace organics and cobbles (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Becomes loose to medium dense, moist, gray, SAND with silt and gravel, scattered organics and wood debris (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Medium dense, moist, tan, SAND, some silt, trace gravel</td>
<td>S-1 @ 7 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test pit completed at approximately 8 feet. No groundwater or caving observed during excavation.
**Test Pit TP-9**

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 140  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel, trace organics and cobbles (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>..................................................................................................................</td>
<td>S-1 @ 3 feet</td>
<td>&lt;1</td>
<td>ACM</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Becomes loose to medium dense, moist, gray, SAND, some silt and gravel, scattered organics and wood debris (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Piece of carpet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>8</td>
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<td></td>
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<tr>
<td>9</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
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</tr>
<tr>
<td>11</td>
<td>Test pit completed at approximately 11.5 feet.</td>
<td>S-2 @ 11 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>No groundwater or caving observed during excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Test Pit TP-10

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 130  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel, trace organics and cobbles (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Very light groundwater seepage at approximately 2 feet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Becomes loose to medium dense, moist, gray, SAND with silt and gravel, scattered organics and wood debris (Fill)</td>
<td>S-1 @ 3 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Medium dense, moist, tan, SAND, with silt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Thinly laminated silt lensing from 8 feet to exploration terminus, becomes stiff, moist, tan, sandy SILT</td>
<td>S-2 @ 8 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Test pit completed at approximately 9.5 feet. Very light groundwater seepage observed at approximately 2 feet while excavating. No caving observed during excavation.</td>
<td>S-3 @ 9 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Test Pit TP-11**

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 128

**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist, brown, SAND with silt, trace organics (Fill) ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td>ACM</td>
</tr>
<tr>
<td>2</td>
<td>Medium dense, moist, gray, silty SAND</td>
<td>S-1 @ 1 feet</td>
<td>&lt;1</td>
<td></td>
<td>ACM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S-2 @ 4.5 feet</td>
<td>&lt;1</td>
<td>17</td>
<td>GSA</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Increasing silt content, becomes medium dense, moist, gray SILT with sand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Test pit completed at approximately 8.5 feet. No groundwater or caving observed during excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth (ft)</td>
<td>Material Description</td>
<td>Sample</td>
<td>PID</td>
<td>%M</td>
<td>Testing</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>---------</td>
<td>-------</td>
<td>----</td>
<td>---------</td>
</tr>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist to wet, brown, GRAVEL, with sand, some silt (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Light perched groundwater seepage at approximately 2 feet, slight caving from approximately 2 feet to 4 feet</td>
<td>5-1 @ 1 feet</td>
<td>&lt;1</td>
<td></td>
<td>ACM</td>
</tr>
<tr>
<td>3</td>
<td>Plastic sheeting fragment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Stiff, moist, gray, sandy SILT, trace gravel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Thinly laminated silt lensing from 7.5 feet to exploration terminus, becomes stiff, moist, gray sandy SILT</td>
<td>5-2 @ 6.5 feet</td>
<td>&lt;1</td>
<td>20</td>
<td>GSA</td>
</tr>
<tr>
<td>8</td>
<td>Test pit completed at approximately 9 feet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Light groundwater seepage observed at approximately 2 feet while excavating.</td>
<td>5-3 @ 8.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slight caving observed from approximately 2 to 4 feet during excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Test Pit TP-13

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 121  
**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist, brown, SAND with silt and gravel (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2-inch PVC conduit</td>
<td>S-1 @ 2 feet</td>
<td>&lt;1</td>
<td>ACM</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2-inch PVC conduit</td>
<td>S-2 @ 4 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
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<td>6</td>
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<tr>
<td>7</td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Medium dense, moist, tan, SAND, some silt</td>
<td>S-3 @ 8.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test pit completed at approximately 9 feet.  
No groundwater or caving observed during excavation.
**Test Pit TP-14**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
</table>
| 1          | Wood chips (no topsoil) over loose to medium dense, moist, brown, SAND, some silt and gravel (Fill)  
ACM = Non-detect                                                                                                                                       |        |     |     | ACM     |
| 2          | Medium dense, moist, tan, SAND, some silt                                                                                                                                                                             | 5-1 @ 1 feet | <1  |     | ACM     |
| 3          | Slight caving from 3 feet to 8 feet                                                                                                                                                                                 |        |     |     |         |
| 4          |                                                                                                                                                                                                                     |        |     |     |         |
| 5          |                                                                                                                                                                                                                     |        |     |     |         |
| 6          |                                                                                                                                                                                                                     |        |     |     |         |
| 7          |                                                                                                                                                                                                                     | 5-2 @ 6 feet | <1  |     |         |
| 8          |                                                                                                                                                                                                                     |        |     |     |         |
| 9          |                                                                                                                                                                                                                     |        |     |     |         |
| 10         | Test pit completed at approximately 9.5 feet.  
Slight caving observed from approximately 3 feet to 8 feet during excavation.  
No groundwater observed during excavation.                                                                                                           | 5-3 @ 9.5 feet | <1  |     |         |
**Test Pit TP-15**

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 121

**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over loose to medium dense, moist, brown, silty SAND (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Metal post</td>
<td></td>
<td></td>
<td></td>
<td>&lt;1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dense to very dense, moist, gray, silty SAND with gravel Light soil mottling, weakly cemented</td>
<td>S-2 @ 4 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Test pit completed at approximately 8 feet. No groundwater or caving observed during excavation.</td>
<td>S-3 @ 7.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Test Pit TP-16**

**Location:** See Site and Exploration Plan, Figure 1  
**Approx. Ground Surface Elevation (feet):** 138

**Project:** Sky Valley Switching Station  
**Project No:** 2326.01  
**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over loose to medium dense, moist, brown, silty SAND with gravel, scattered organics and wood debris (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>5-1</td>
<td>&lt;1</td>
<td>ACM</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Metal fragment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Light soil mottling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Test pit completed at approximately 8 feet. No groundwater or caving observed during excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Depth:** 3 feet  
**Material:** <1  
**Testing:** ACM

**Depth:** 7.5 feet  
**Material:** <1  
**Testing:** ACM
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brambles (no topsoil) over medium dense, moist, gray, silty SAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Decreasing sand grain size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Test pit completed at approximately 9 feet. No groundwater or caving observed during excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Project: Sky Valley Switching Station  
Project No: 2326.01  
Date Excavated: 21 May 2020
**Test Pit TP-18**

**Location:** See Site and Exploration Plan, Figure 1

**Approx. Ground Surface Elevation (feet):** 126

**Project:** Sky Valley Switching Station

**Project No:** 2326.01

**Date Excavated:** 21 May 2020

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material Description</th>
<th>Sample</th>
<th>PID</th>
<th>%M</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass (no topsoil) over medium dense, moist, gray, Quarry spalls and filter fabric ACM = Non-detect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Medium dense, moist, gray, SAND, trace silt</td>
<td>S-1 @ 2 feet</td>
<td>&lt;1</td>
<td></td>
<td>ACM</td>
</tr>
<tr>
<td>3</td>
<td>Stiff, moist, gray, sandy SILT, some gravel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Light soil mottling</td>
<td>S-2 @ 3.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dense to very dense, moist, gray, SAND with silt and gravel</td>
<td>S-3 @ 6 feet</td>
<td>&lt;1</td>
<td>14</td>
<td>GSA</td>
</tr>
<tr>
<td>6</td>
<td>Test pit completed at approximately 9 feet. No groundwater or caving observed during excavation.</td>
<td>S-4 @ 8.5 feet</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS
LABORATORY PROCEDURES AND RESULTS

A series of laboratory tests were performed during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification
Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with ASTM D 2488. Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations
Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM D 2216. The results are shown on the exploration logs in Appendix A.

Grain Size Analysis
A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM D 6913. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

Atterberg Limits
Atterberg limits are used primarily for classification and indexing of cohesive soils. The liquid and plastic limits are two of the five Atterberg limits and are defined as the moisture content of a cohesive soil at arbitrarily established limits for liquid and plastic behavior, respectively. Liquid and plastic limits were established for selected samples in general accordance with ASTM D 423 and ASTM D 424, respectively. The results of the Atterberg limits are presented on a plasticity chart in this appendix where the plasticity index (liquid limit minus plastic limit) is related to the liquid limit. The plastic limits and liquid limits are also presented adjacent to appropriate samples on the exploration logs in Appendix A.

Asbestos Containing Material (ACM)
Samples of existing fill material were collected from the test pits in order to test for the presence of ACM. Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with both EPA 600/M4-82-020, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and EPA 600/R-93/116.
Method for the Determination of Asbestos in Bulk Building Materials. Results of the tests are presented in the attached NVL report in this appendix.
Per Cent Finer by Weight

PARTICLE SIZE IN MILLIMETERS

<table>
<thead>
<tr>
<th>SIZE OF OPENING IN INCHES</th>
<th>U.S. STANDARD SIEVE SIZE</th>
<th>HYDROMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>36&quot;</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>12&quot;</td>
<td>0.010</td>
<td>0.010</td>
</tr>
<tr>
<td>6&quot;</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>3&quot;</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>10.000</td>
<td>10.000</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>100.000</td>
<td>100.000</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>1000.000</td>
<td>1000.000</td>
</tr>
</tbody>
</table>

Comments:

Exploration | Sample | Depth (feet) | Moisture (%) | Fines (%) | Description                      |
-------------|--------|--------------|--------------|-----------|----------------------------------|
B-2          | S-3    | 5.0          | 14.8         | 29.9      | SAND with silt, trace gravel    |

Zipper Geo Associates, LLC  
Geotechnical and Environmental Consultants

PROJECT NO: 2326.01  
DATE OF TESTING: 6/2/2020  
PROJECT NAME:  
Sky Valley Substation
GRAIN SIZE ANALYSIS

PARTICLE SIZE IN MILLIMETERS

SIZE OF OPENING IN INCHES

U.S. STANDARD SIEVE SIZE

HYDROMETER

PERCENT FINER BY WEIGHT

Comments:

Exploration | Sample | Depth (feet) | Moisture (%) | Fines (%) | Description
---|---|---|---|---|---
B-3 | S-4 | 7.5 | 6.1 | 9.4 | SAND some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

PROJECT NO: 2326.01
DATE OF TESTING: 6/2/2020
PROJECT NAME:
Sky Valley Substation
### GRAIN SIZE ANALYSIS

#### Test Results Summary

**ASTM D6913**

---

**SIZE OF OPENING IN INCHES**

- 36"  12"  6"  3"  1 1/2"  3/4"  3/8"  4"  10"  20"  40"  60"  140"  200"

**U.S. STANDARD SIEVE SIZE**

- 100  90  80  70  60  50  40  30  20  10  4  1  0.4  0.1  0.04  0.01  0.004  0.001

**PERCENT FINER BY WEIGHT**

**PARTICLE SIZE IN MILLIMETERS**

<table>
<thead>
<tr>
<th>BOULDERS</th>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coarse</strong></td>
<td><strong>Fine</strong></td>
<td><strong>Coarse</strong></td>
<td><strong>Medium</strong></td>
<td><strong>Fine</strong></td>
<td><strong>FINE GRAINED</strong></td>
</tr>
</tbody>
</table>

**Comments:**

**SIZE OF OPENING IN INCHES**

- 36"  12"  6"  3"  1 1/2"  3/4"  3/8"  4"  10"  20"  40"  60"  140"  200"

**U.S. STANDARD SIEVE SIZE**

- 100  90  80  70  60  50  40  30  20  10  4  1  0.4  0.1  0.04  0.01  0.004  0.001

**PERCENT FINER BY WEIGHT**

**PARTICLE SIZE IN MILLIMETERS**

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Sample</th>
<th>Depth (feet)</th>
<th>Moisture (%)</th>
<th>Fines (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-6</td>
<td>S-2</td>
<td>8.0</td>
<td>10.8</td>
<td>14.8</td>
<td>Gravelly SAND with silt</td>
</tr>
</tbody>
</table>

---

**Zipper Geo Associates, LLC**

Geotechnical and Environmental Consultants

**PROJECT NO:** 2326.01

**DATE OF TESTING:** 6/2/2020

**PROJECT NAME:** Sky Valley Substation
GRAIN SIZE ANALYSIS

SIZE OF OPENING IN INCHES

PARTICLE SIZE IN MILLIMETERS

U.S. STANDARD SIEVE SIZE

HYDROMETER

PERCENT FINER BY WEIGHT

Comments:

Exploration | Sample | Depth (feet) | Moisture (%) | Fines (%) | Description
---|---|---|---|---|---
TP-11 | S-2 | 4.5 | 17.1 | 32.5 | Silty SAND

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

PROJECT NO: 2326.01
DATE OF TESTING: 6/2/2020
PROJECT NAME:
Sky Valley Substation
**Grain Size Analysis**

**Test Results Summary**

**ASTM D6913**

**Size of Opening in Inches**

- 36" 12" 6" 3" 1 1/2" 3/4" 3/8" 4" 10 20 40 60 140 200

**U.S. Standard Sieve Size**

**Hydrometer**

**Percent Finer by Weight**

**Particle Size in Millimeters**

<table>
<thead>
<tr>
<th>Boulevards</th>
<th>Coarse</th>
<th>Fine</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine Grained</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

- Sandy Silt
- Trace gravel

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Sample</th>
<th>Depth (feet)</th>
<th>Moisture (%)</th>
<th>Fines (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-12</td>
<td>S-2</td>
<td>6.5</td>
<td>20.1</td>
<td>49.9</td>
<td>Sandy Silt</td>
</tr>
</tbody>
</table>

**Zipper Geo Associates, LLC**

Geotechnical and Environmental Consultants

**Project No:** 2326.01

**Date of Testing:** 6/2/2020

**Project Name:** Sky Valley Substation
## Grain Size Analysis

![Grain Size Analysis Graph](image)

### Comments:

- Sandy SILT
- some gravel

### Table: Test Results Summary

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Sample</th>
<th>Depth (feet)</th>
<th>Moisture (%)</th>
<th>Fines (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-18</td>
<td>S-3</td>
<td>6.0</td>
<td>14.3</td>
<td>58.7</td>
<td>Sandy SILT some gravel</td>
</tr>
</tbody>
</table>

### Project Information

- **Zipper Geo Associates, LLC**
  - Geotechnical and Environmental Consultants
- **Project No:** 2326.01
- **Date of Testing:** 6/2/2020
- **Project Name:** Sky Valley Substation
RESULTS OF ATTERBERG LIMITS TESTS
ASTM D4318

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Boring</th>
<th>Sample</th>
<th>Depth (ft.)</th>
<th>USCS Description</th>
<th>Received Moisture Content (%)</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>B-1</td>
<td>S-7</td>
<td>15</td>
<td></td>
<td>34</td>
<td>62</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>▲</td>
<td>B-5</td>
<td>S-8</td>
<td>20</td>
<td></td>
<td>32</td>
<td>61</td>
<td>30</td>
<td>31</td>
</tr>
</tbody>
</table>

Results presented on chart per ASTM D2487

Comments:

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants
19019 36th Ave. West, Suite E Lynnwood, WA 98036

PROJECT NO:  
DATE OF TESTING: 6/2/2020
PROJECT NAME: Sky Valley Substation
June 9, 2020

Dave Williams
Zipper Geo Associates, LLC
19019 36th Avenue West, Suite E
Lynnwood, WA 98036

RE: Bulk Asbestos Fiber Analysis; NVL Batch # 2009285.00

Client Project: 2326.01
Location: Monroe, WA

Dear Mr. Williams,

Enclosed please find test results for the 12 sample(s) submitted to our laboratory for analysis on 5/29/2020.

Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with both EPA 600/M4-82-020, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and EPA 600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials.

For samples containing more than one separable layer of materials, the report will include findings for each layer (labeled Layer 1 and Layer 2, etc. for each individual layer). The asbestos concentration in the sample is determined by calibrated visual estimation.

For those samples with asbestos concentrations between 1 and 10 percent based on visual estimation, the EPA recommends a procedure known as point counting (NESHAPS, 40 CFR Part 61). Point counting is a statistically more accurate means of quantification for samples with low concentrations of asbestos.

The detection limit for the calibrated visual estimation is <1%, 400 point counts is 0.25% and 1000 point counts is 0.1%

Samples are archived for two weeks following analysis. Samples that are not retrieved by the client are discarded after two weeks.

Thank you for using our laboratory services. Please do not hesitate to call if there is anything further we can assist you with.

Sincerely,

Matt Macfarlane, Asbestos Lab Supervisor

Enc.: Sample Results
### Lab ID: 20067453  Client Sample #: TP-1 S-1

**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.

#### Layer 1 of 1  
**Description:** Tan sandy material

<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>None Detected</td>
</tr>
<tr>
<td>Mineral grains, Sand</td>
<td>ND</td>
</tr>
</tbody>
</table>

**Asbestos Type:** None Detected ND

### Lab ID: 20067454  Client Sample #: TP-2 S-1

**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.

#### Layer 1 of 1  
**Description:** Tan sandy material

<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>None Detected</td>
</tr>
<tr>
<td>Mineral grains, Sand</td>
<td>ND</td>
</tr>
</tbody>
</table>

**Asbestos Type:** None Detected ND

### Lab ID: 20067455  Client Sample #: TP-6 S-1

**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.

#### Layer 1 of 1  
**Description:** Tan sandy material

<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>Wood fibers 2%</td>
</tr>
<tr>
<td>Mineral grains, Sand</td>
<td></td>
</tr>
</tbody>
</table>

**Asbestos Type:** None Detected ND

### Lab ID: 20067456  Client Sample #: TP-7 S-1

**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.

---

**Sampled by:** Client  
**Analyzed by:** Alla Prysyazhnyuk  
**Reviewed by:** Matt Macfarlane  
**Date:** 06/05/2020  
**Date:** 06/09/2020

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and 600/M4-82-020 Methods with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government.

ASB-02

page 2 of 8
Client: Zipper Geo Associates, LLC  
Address: 19019 36th Avenue West, Suite E  
Lynnwood, WA 98036

Attention: Mr. Dave Williams  
Project Location: Monroe, WA

Layer 1 of 1  
Description: Tan sandy material  
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mineral grains, Sand  
Other Fibrous Materials:%  
Wood fibers <1%  
Asbestos Type: %  
None Detected ND

Lab ID: 20067457  
Client Sample #: TP-9 S-1  
Location: Monroe, WA  
Comments: Wet sample was dried prior to analysis.

Layer 1 of 1  
Description: Tan sandy material  
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mineral grains, Sand  
Other Fibrous Materials:%  
Wood fibers 2%  
Asbestos Type: %  
None Detected ND

Lab ID: 20067458  
Client Sample #: TP-11 S-1  
Location: Monroe, WA  
Comments: Wet sample was dried prior to analysis.

Layer 1 of 1  
Description: Tan sandy material  
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mineral grains, Sand  
Other Fibrous Materials:%  
Wood fibers 2%  
Asbestos Type: %  
None Detected ND

Lab ID: 20067459  
Client Sample #: TP-12 S-  
Location: Monroe, WA  
Comments: Wet sample was dried prior to analysis.

Layer 1 of 1  
Description: Tan sandy material  
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mica, Mineral grains, Sand  
Other Fibrous Materials:%  
Wood fibers <1%  
Asbestos Type: %  
None Detected ND

Sampled by: Client  
Analyzed by: Alla Prysyazhnyuk  
Reviewed by: Matt Macfarlane  
Date: 06/05/2020  
Date: 06/09/2020  
Matt Macfarlane, Asbestos Lab Supervisor

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples were analyzed using both EPA 600/R-93/116 and 600/M4-82-020 Methods with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government.
### Lab ID: 20067460  
**Client Sample #:** TP-13 S-1  
**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.  
**Layer 1 of 1**  
**Description:** Tan sandy material  
<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials: %</th>
<th>Asbestos Type: %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>Wood fibers</td>
<td>None Detected ND</td>
</tr>
<tr>
<td>Mineral grains, Sand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lab ID: 20067461  
**Client Sample #:** TP-14 S-1  
**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.  
**Layer 1 of 1**  
**Description:** Tan sandy material  
<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials: %</th>
<th>Asbestos Type: %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>Wood fibers</td>
<td>None Detected ND</td>
</tr>
<tr>
<td>Mineral grains, Sand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lab ID: 20067462  
**Client Sample #:** TP-16 S-1  
**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.  
**Layer 1 of 1**  
**Description:** Tan sandy material  
<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials: %</th>
<th>Asbestos Type: %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>Wood fibers</td>
<td>None Detected ND</td>
</tr>
<tr>
<td>Mineral grains, Sand, Wood flakes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lab ID: 20067463  
**Client Sample #:** TP-18 S-1  
**Location:** Monroe, WA  
**Comments:** Wet sample was dried prior to analysis.  
**Layer 1 of 1**  
**Description:** Tan sandy material  
<table>
<thead>
<tr>
<th>Non-Fibrous Materials:</th>
<th>Other Fibrous Materials: %</th>
<th>Asbestos Type: %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder/Filler, Granules, Gravel</td>
<td>Wood fibers</td>
<td>None Detected ND</td>
</tr>
<tr>
<td>Mineral grains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sampled by: Client  
Analyzed by: Alla Prysyazhnyuk  
Reviewed by: Matt Macfarlane  
Date: 06/05/2020  
Date: 06/09/2020  

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and 600/M4-82-020 Methods with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government.
Client: Zipper Geo Associates, LLC
Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Attention: Mr. Dave Williams
Project Location: Monroe, WA

Layer 1 of 1
Description: Tan sandy material
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mineral grains, Sand, Wood flakes

Other Fibrous Materials:%
Wood fibers 2%

Asbestos Type: %
None Detected ND

Lab ID: 20067464
Client Sample #: TP-7 S-2
Location: Monroe, WA
Comments: Wet sample was dried prior to analysis.

Layer 1 of 1
Description: Tan sandy material
Non-Fibrous Materials:
Binder/Filler, Granules, Gravel
Mineral grains, Sand, Wood flakes

Other Fibrous Materials:%
Wood fibers 2%

Asbestos Type: %
None Detected ND

Sampled by: Client
Analyzed by: Alla Prysyazhnyuk
Reviewed by: Matt Macfarlane
Date: 06/05/2020
Date: 06/09/2020

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and 600/M4-82-020 Methods with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government.

ASB-02 page 5 of 8
Zipper Geo Associates, LLC

Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Project Manager: Mr. Dave Williams
Phone: (425) 582-9928
Cell: (425) 218-4619

NVL Batch Number: 2009285.00
TAT: 5 Days
AH: No
Rush TAT: No
Due Date: 6/8/2020
Time: 12:00 PM
Email: dwilliams@zippergeo.com
Fax: (425) 582-9930

Project Name/Number: 2326.01
Project Location: Monroe, WA

Subcategory: PLM Bulk
Item Code: ASB-02
EPA 600/R-93-116 Asbestos by PLM <bulk>

Total Number of Samples: 12

<table>
<thead>
<tr>
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<th>Sample ID</th>
<th>Description</th>
<th>A/R</th>
</tr>
</thead>
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<td>TP-1 S-1</td>
<td>A</td>
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<tr>
<td>2</td>
<td>20067454</td>
<td>TP-2 S-1</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>20067455</td>
<td>TP-6 S-1</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>20067456</td>
<td>TP-7 S-1</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>20067457</td>
<td>TP-9 S-1</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
<td>20067458</td>
<td>TP-11 S-1</td>
<td>A</td>
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<tr>
<td>7</td>
<td>20067459</td>
<td>TP-12 S-1</td>
<td>A</td>
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<tr>
<td>8</td>
<td>20067460</td>
<td>TP-13 S-1</td>
<td>A</td>
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<tr>
<td>9</td>
<td>20067461</td>
<td>TP-14 S-1</td>
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<td>TP-16 S-1</td>
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<td>11</td>
<td>20067463</td>
<td>TP-18 S-1</td>
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</tr>
<tr>
<td>12</td>
<td>20067464</td>
<td>TP-7 S-2</td>
<td>A</td>
</tr>
</tbody>
</table>

Print Name: Hilary Crumley
Signature: NVL
Company: NVL
Date: 5/29/20
Time: 1200

Print Name: Alla Prysyazhnyuk
Signature: NVL
Company: NVL
Date: 6/5/20
Time: 2000

Special Instructions: Received CC payment 6/1 at 1200 - KA
**CHAIN OF CUSTODY**

**Company:** Zipper Geo Associates  
**Address:** 19019 - 36th Avenue West, Lynnwood, WA 98036  
**Phone:** 425 - 218 - 4619

**Project Manager:** Mr. Dave Williams  
**Cell:** (425) 218 - 4619  
**Email:** dwilliams@zippergeo.com

**Project Name/Number:** 2326.01  
**Project Location:** Monroe, WA

- PCM Air (NIOSH 7400)  
- PLM (EPA 600/R-93-116)  
- PLM Gravimetry (600/R-93-116)  
- Asbestos Friable/Non-Friable (EPA 600/R-93/116)  
- Other

**Reporting Instructions:** email Dave  
- Call ( )  
- Fax ( )  
- Email dwilliams@zippergeo.com

**Total Number of Samples:** 12

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Description</th>
<th>A/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 TP-1 S-1</td>
<td>Fill Soils</td>
<td></td>
</tr>
<tr>
<td>2 TP-2 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 TP-3 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 TP-7 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 TP-9 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 TP-11 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 TP-12 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 TP-13 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 TP-14 S-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 TP-16 S-2</td>
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<td></td>
</tr>
<tr>
<td>11 TP-18 S-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 TP-7 S-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sampled by:** Bogdan Tirtu  
**Relinquish by:** Bogdan Tirtu

**Company:** ZGA  
**Date:** 5.29.20  
**Time:** 12:00

**Office Use Only**

**Received by:**  
**Analyzed by:**  
**Called by:**  
**Faxed/Email by:**

---

4708 Aurora Ave N, Seattle, WA 98103  
f 206.634.1936  www.nvllabs.com
ZZA-Terracon advanced several borings along the west side of Woods Creek Road in 2007 on behalf of the City of Monroe as part of a geotechnical evaluation of the feasibility of providing frontage improvements along the road. Borings B-1, B-2, and B-3 were advanced on the Sky Valley Switching Station site at the approximate locations shown on Figure 1. Logs of these borings, which are excerpted from the ZGA-Terracon report titled *Geotechnical Engineering Report, West Alignment Retaining Wall Alternatives Evaluation, Woods Creek Road Improvements Phase 1, Oaks Street to Country Crescent Road* (Project No. 81075061 dated 5 September 2008) are presented in this Appendix.
# LOG OF BORING NO. B-1

## CLIENT
City of Monroe

## SITE
Monroe, WA

Boring Location: Sta. 9+64 (70' L)

## PROJECT
Woods Creek Road Improvements

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>USCS SYMBOL</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY, %</th>
<th>SPT - N BLOWS, / ft.</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT WT, lbf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silty gravelly fine sand with occasional cobbles &amp; boulders, brown, loose to medium dense, moist</td>
<td></td>
<td>1</td>
<td>SPT 12</td>
<td>10</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy silt, brown, stiff, wet</td>
<td></td>
<td>2</td>
<td>SPT 12</td>
<td>11</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy silt with trace gravel, brown, medium dense, wet</td>
<td></td>
<td>3</td>
<td>SPT 12</td>
<td>9</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clayey silt with some sand, brown, stiff, wet</td>
<td></td>
<td>4</td>
<td>SPT 12</td>
<td>13</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grades to Mottled at 11 feet</td>
<td></td>
<td>5</td>
<td>SPT 12</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clayey silt with trace sand, gray, very stiff, wet</td>
<td></td>
<td>6</td>
<td>SPT 12</td>
<td>13</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy silt, brown, stiff, wet</td>
<td></td>
<td>7</td>
<td>SPT 12</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy silt, brown, hard, wet to saturated</td>
<td></td>
<td>8</td>
<td>SPT 12</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

## WATER LEVEL OBSERVATIONS, ft

- WL 25.0
- ATD

## BORING STARTED
7-12-07

## BORING COMPLETED
7-13-07

## APPROVED
RAR

## JOB #
81075061
## LOG OF BORING NO. B-1

**CLIENT**
City of Monroe

**SITE**
Monroe, WA

**PROJECT**
Woods Creek Road Improvements

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td><strong>FINE SAND</strong>, brown, dense, saturated</td>
</tr>
<tr>
<td>41.5</td>
<td>Grades to fine to medium, very dense</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY, in.</th>
<th>SPT - N BLOWS / ft.</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT WT, lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>9</td>
<td>SPT</td>
<td>12</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>SPT</td>
<td>12</td>
<td>69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring completed at 41.5 feet on 7/12/07. Hole backfilled with bentonite. Groundwater observed at 25 feet at time of drilling.

---

### WATER LEVEL OBSERVATIONS, ft

<table>
<thead>
<tr>
<th>WL</th>
<th>V</th>
<th>25.0</th>
<th>ATD</th>
<th>V</th>
</tr>
</thead>
</table>

**BOARING STARTED** 7-12-07

**BOARING COMPLETED** 7-13-07

**RIG** 18905 33rd Avenue West, Ste. 117
Lynnwood, WA 98036
T: (425) 771-3304  F: (425) 771-3549

**APPROVED RAR JOB #** 81075061
The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.
## BORING COMPLETED

**LOG OF BORING NO. B-2**

**CLIENT**  
City of Monroe

**SITE**  
Monroe, WA

**PROJECT**  
Woods Creek Road Improvements

### GRAPHIC LOG

**DESCRIPTION**

- Boring completed at 31.5 feet on 7/12/07.
- 1" piezometer set at 30' with 10' screen.
- Sand to 18' b.g.s.
- Bentonite chips to 1' b.g.s.
- Flush mount monument set in concrete.
- Groundwater observed at 10 feet at time of drilling.
- Groundwater observed at 7.2 feet on 1/2/08.

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>USCS SYMBOL</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY, in.</th>
<th>SPT - BLOWS / ft</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT WT,pcf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

### WATER LEVEL OBSERVATIONS, ft

<table>
<thead>
<tr>
<th>WL</th>
<th>ATD</th>
<th>1/2/08</th>
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<tr>
<td>10.0</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>7.2</td>
<td></td>
</tr>
</tbody>
</table>

---

**BORING STARTED**  
7-11-07

**BORING COMPLETED**  
7-11-07

**RIG**

**CO.**

BoreTec

**T:** (425) 771-3304  **F:** (425) 771-3549

**APPROVED**

RAR  JOB #  81075061
## LOG OF BORING NO. B-3

### CLIENT
City of Monroe

### SITE
Monroe, WA

Boring Location: Sta. 10+80 (35' L)

### DESCRIPTION

<table>
<thead>
<tr>
<th>DEPTH, ft</th>
<th>USCS SYMBOL</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY, in.</th>
<th>SPT - N</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT WT, pdf</th>
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</thead>
<tbody>
<tr>
<td>4.5</td>
<td>SPT</td>
<td>1</td>
<td>12</td>
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<td>11.5</td>
<td>SPT</td>
<td>2</td>
<td>12</td>
<td>5</td>
<td>34</td>
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<td></td>
</tr>
<tr>
<td>17.5</td>
<td>SPT</td>
<td>3</td>
<td>12</td>
<td>3</td>
<td>29</td>
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<td>24</td>
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<td>SPT</td>
<td>5</td>
<td>12</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>SPT</td>
<td>6</td>
<td>12</td>
<td>21</td>
<td></td>
<td></td>
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<tr>
<td>34</td>
<td>SPT</td>
<td>8</td>
<td>12</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GRAVITY LOG

- **Silty Fine Sand to Sandy Silt.** brown, medium stiff, wet to saturated
- **Clayey Silt with Some Sand and Trace Organics.** gray and brown, medium stiff, saturated
  - Grades to soft with thin layers of gray fine sand at 8 feet
- **Gravelly Sand with Some Silt.** brown, loose, saturated
- **Sandy Gravel with Trace Silt.** brown, medium dense, saturated
- **Clayey Silt with Some Sand and Trace Gravel.** gray, stiff, saturated
- **Sandy Silt with Some Gravel.** gray, very stiff, saturated

### WATER LEVEL OBSERVATIONS, ft

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<thead>
<tr>
<th>WL</th>
<th>ATD</th>
</tr>
</thead>
<tbody>
<tr>
<td>WV 7.0</td>
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</tr>
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<td>WV</td>
<td></td>
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</tbody>
</table>

---

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.
<table>
<thead>
<tr>
<th>BORING COMPLETED at 31.5 feet on 7/11/07. Groundwater observed at approximately 7' at time of drilling.</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER LEVEL OBSERVATIONS, ft</td>
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<td></td>
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APPENDIX D
GEOENGINEERS BORING LOG AND SLOPE STABILITY ANALYSIS
GeoEngineers completed a geotechnical report addressing design and construction of Tjerne Place SE for the City of Monroe in March 2015 (*Geotechnical Engineering Report, Tjerne Place SE Extension, Chain Lake Road to Woods Creek Road, Monroe, Washington*, dated 30 March 2015, File No. 1783-008-00). GeoEngineers boring B-3 was advanced along what is now Tjerne Place SE at the approximate location shown on Figure 1 and was included in a cross section of the north slope of Tjerne Place SE below the Sky Valley site used for a slope stability analysis; the location of the Cross Section A-A’ is shown on Figure 1. Appendix D includes the log of boring B-3 and the cross sections used by GeoEngineers in their slope stability analysis.
**FIELD DATA**

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**WELL LOG**

- **MATERIAL DESCRIPTION**
  - GM: Brown silty fine to coarse gravel with sand (medium dense, moist) (recessional outwash)
  - ML: Gray silt with sand (very stiff, moist) (Whidbey Formation)
  - SM: Gray silty fine to medium sand (dense, moist)
  - CL: Gray lean clay with sand (hard, moist to wet)
  - Light brown silty fine to medium sand with occasional gravel (very dense, wet)

**Notes:** See Figure A-1 for explanation of symbols.
Gray sandy silt (hard, wet)

Gray fine to medium sand with silt (dense, wet)

2-inch Schedule 40 PVC screen, 0.010-inch slot width

Bentonite plug

Note: See Figure A-1 for explanation of symbols.
Spencer's method of analysis was used for global stability analyses.

Notes:
1. Spencer's method of analysis was used for global stability analyses.


2H:1V Cut Slope
Static Global Stability
Tjerne Place SE Extension
Monroe, Washington

Figure 6
Spencer’s method of analysis was used for global stability analyses. The horizontal seismic coefficient, $k_h$, used to evaluate pseudo-static (seismic) stability is based on ½ of the peak ground acceleration (PGA) for the design event (recurrence interval of 1000 years).

Notes:

1. Spencer’s method of analysis was used for global stability analyses.
2. The horizontal seismic coefficient, $k_h$, used to evaluate pseudo-static (seismic) stability is based on ½ of the peak ground acceleration (PGA) for the design event (recurrence interval of 1000 years).


2H:1V Cut Slope
Seismic Global Stability
Tjerne Place SE Extension
Monroe, Washington

Figure 7