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April 15, 2020

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Geotechnical Engineering Report
Proposed Multi-Family Development
xxx- 7th Street Southwest
Puyallup, Washington
PN: 4320000160
Doc ID: AVTServices.7thStSW.RG

INTRODUCTION

This geotechnical engineering report summarizes our site observations, our subsurface explorations, geotechnical data review and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed multi-family residential development to be constructed on the above referenced parcel. Our understanding of the project is based on our discussions with the project owner, Mr. Vladimir Tkach and the project Civil Engineer, Mr. Tres Kirkebo, our experience in the site area, and our understanding of the City of Puyallup Critical Areas and development codes. We understand the current proposal is to construct a multi-family residential development at the site that includes four new structures, and a paved parking area. We anticipate each new structure will be two to three stories, with 12 to 18 units each, and will be of wood frame construction founded on shallow spread footings. Additional development will include typical underground utilities and a stormwater facility. Based on the proposed site plan, we anticipate the stormwater facility will be constructed below grade, within the parking area.

SCOPE

The scope of our services was to evaluate the surface and subsurface conditions across the site as a basis for developing recommendations and conclusions to aid in development of the site, including addressing potential geologic hazards and the potential for stormwater infiltration. Specifically, the scope of services included the following:

1. Reviewing the readily available geologic, hydrogeologic and geotechnical data for the site area;
2. Conducting a geologic reconnaissance of the site area;
3. Exploring the subsurface conditions by monitoring the excavation of six test pits at the site with a subcontracted backhoe to depths of 8 to 12 feet;
4. Collecting soil samples from the explorations and conducting two grain size analyses on selected samples;

5. Installing open standpipe piezometers at one test pit location to a depth of 10 feet.
6. Return to the site to collect water level data from the piezometer during the wet season
7. Addressing the appropriate criteria for potential geologic hazards per the current City of Puyallup Municipal Code (PMC) Chapter 21.06 Geologically Hazardous Areas;
8. Providing recommendations for development on or near sloping ground based on City of Puyallup development codes;
9. Providing recommended seismic design criteria, including seismic site class;
10. Providing geotechnical conclusions for shallow foundation design, including allowable bearing capacity;
11. Providing recommendations for earthwork including site preparation, fill placement and compaction and an evaluation of on-site materials for use as structural fill;
12. Performing one small scale pilot infiltration test (PIT) at the site;
13. Providing our evaluation of site drainage issues, including an evaluation of the feasibility of onsite infiltration of stormwater or the use of Low Impact Development best management practices;
14. Preparing a written Geotechnical *Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

The above scope of work was summarized in our Proposal for Geotechnical Engineering Services dated February 20, 2020. We received written authorization to proceed with our scope of services from you the same day.

SITE CONDITIONS

Surface Conditions

The site is an unaddressed parcel located adjacent west of the existing single-family residence at 629 – 43rd Avenue southwest in Puyallup, Washington. Based on information obtained from Pierce County Public GIS the site is generally rectangular in shape, measures approximately 305 feet wide (north to south) by 240 feet deep (east to west) and encompasses approximately 1.67 acres. The site is bounded by existing multi-family residential development to the north, existing single-family residences to the west, 43rd Avenue Southwest to the south, and 7th Street Southwest to the east.

Based on topographic data obtained from the Pierce County Public GIS website and our site observations, other than a small open depression along 7th Street Southwest, the ground surface of the site generally slopes up in all directions towards the center of the site at 20 to 35 percent. These slopes truncate somewhat abruptly and then slope down towards the center of the site in all directions at 50 to more than 100 percent, forming a topographic depression approximately 6 to 12 feet in depth. Along the northern property boundary, the site slopes down to the north at 30 to 40 percent. This slope continues offsite and steepens to approximately 100 percent. Total topographic relief across the site is on the order of 14 to 18 feet. Topographic relief of the steep offsite slope is on the order of 14 to 32 feet. The existing site topography is shown on the Site and Exploration Map, Figure 2.

Vegetation across the site generally consists of a dense to very dense stand of mature conifers with a typical understory of native and invasive plants and shrubs. No areas of seeps, springs, or standing water were observed at the time of our reconnaissance. No areas of erosion or slope instability

were noted at the site at the time of our reconnaissance.

Site Soils

The USDA Natural Resources Conservation Service (NRCS) Web Soil Survey maps the site as being underlain by Everett very gravelly sandy loam (13B) soils. The Everett very gravelly sandy loam soils are derived from sandy and gravelly glacial outwash, form on slopes of 0 to 8 percent, have a "slight" erosion hazard when exposed, and are included in hydrologic soils group A. A copy of the soils map for the site area is shown as Figure 3.

Site Geology

The draft *Geologic Map of the Puyallup 7.5-minute Quadrangle, Washington* by K. W. Troost (in review) maps the site as being underlain by Steilacoom Gravel-Bradley Channel ($Qvsb_2$). Steilacoom gravel is described as consisting of gravel and cobbles with lesser amounts of poorly to well sorted sand, deposited by episodic discharges from glacial Lake Puyallup. The Steilacoom gravel deposits are generally in a medium dense condition and considered normally consolidated. An excerpt of the above referenced geologic map is included as Figure 4.

Subsurface Explorations

On February 22, 2020, a GeoResources geologist was on site and monitored the excavation of 6 test pits to a depth of 6 to 9.5 feet below existing ground surface. The test pit explorations were excavated by a small track-mounted machine (Cat 304) and operator provided by you. The specific number, locations, and depths of our explorations were selected by GeoResources personnel based on the configuration of the proposed development and were adjusted in the field based on site access limitations. Our exploration locations were limited by the dense spacing of mature conifers and steep slopes the track-mounted machine could not negotiate. Our geologist continuously monitored the explorations, maintained logs of the subsurface conditions encountered, obtained representative soil samples, and observed pertinent site features. The soil densities presented on the logs was based on the difficulty of excavation and our experience. Representative soil samples obtained from the explorations were placed in sealed containers and taken to our laboratory for further examination and testing as deemed necessary. Each test pit was then backfilled and bucket tamped in place, but not otherwise compacted.

The subsurface explorations excavated as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun. Given the access limitations at the time of exploration, we recommend additional explorations are performed prior to final design or construction.

The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D: 2488. The USCS is included in Appendix A as Figure A-1. The approximate locations of our explorations are indicated on the attached Site and Exploration Map, Figure 2, while the descriptive logs of our explorations and are included in Appendix A. The exploration locations were determined by taping, pacing, and estimating from permanent site features or by terrain association. The approximate elevation of each exploration was determined by interpolating between contours shown on Pierce County public GIS data. Accordingly, the locations and elevations of our explorations should only be considered accurate to the degree implied by our measurement methods.

Subsurface Conditions

The soils encountered at the site generally consist of brown poorly graded gravel with silt and sand with some occasional cobbles and trace boulders in a medium dense to dense, moist condition. We interpret these soils to be consistent with gravelly recessional outwash soils. These soils were encountered in all of our test pits and were encountered to the full extent explored in test pits TP-2, TP-3, and TP-5. In test pits TP-1, TP-4, TP-6 we observed tan poorly graded sand in a medium dense, moist condition underlying the gravelly recessional outwash. We interpret these soils to be consistent with sandy recessional outwash. These soils were encountered to the full extent explored in test pits TP-1, TP-4, and TP-6. We interpret subsurface conditions to consist of three soil units: topsoil, gravelly recessional outwash, and sandy recessional outwash.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the borings and test pits to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D: 2488, moisture content determinations per ASTM D: 2216, and grain size analyses per ASTM D: 6913 standard procedures. The results of the laboratory tests are included in Appendix B.

Groundwater Conditions

No groundwater or evidence of groundwater was observed within the depth explored at the time of excavation. Based on the nature of the near surface soils, we anticipate fluctuations in the local groundwater levels may occur in response to precipitation patters, off-site construction activities, and site utilization. Based on our experience in the area and our review of water well logs within the site vicinity, we anticipate that the regional groundwater table is many tens of feet below the existing ground surface.

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations and our experience in the area, it is our opinion that the site is suitable for the proposed development. Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed development are presented below.

Landslide Hazards per PMC 21.06.1210(3)(b)

The PMC defines landslide hazard areas as areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide

because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

1. Areas of historic failures, such as:
    a. Those areas delineated by the United States Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development;
    b. Those coastal areas mapped as class u (unstable), uos (unstable old slides), and urs (unstable recent slides) in the Department of Ecology Washington coastal atlas; or
    c. Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington Department of Natural Resources.
2. Areas with all three of the following characteristics:
    a. Slopes steeper than 15 percent;
    b. Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and
    c. Springs or groundwater seepage.
3. Areas that have shown movement during the holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of this epoch;
4. Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;
5. Slopes having gradients steeper than eighty percent subject to rockfall during seismic shaking
6. Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones;
7. Areas that show evidence of, or are at risk from snow avalanches;
8. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and
9. Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

PMC Chapter 21.06.1210(3)(b) uses the above referenced 9 item checklist to define a landslide hazard area. Based on our observations of the site and review of published information, we offer the following comments.

No areas of the site are delineated by the United Stated Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development. The site is not in a coastal area and is not mapped in the Washington Department of Ecology Coastal Atlas. No areas of the site or site area are designated as quaternary slumps, earthflows, mudflows, lahars, or landslides. No areas at the site are mapped as having shown movement during the Holocene epoch or underlain or covered by mass wastage debris. No planes of weakness, slopes steeper than 80 percent subject to rockfall during seismic shaking, areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action were observed at the site. The site is not at risk from snow avalanches, located in a canyon or active alluvial fan, subject to inundation by debris flow or catastrophic flooding. There are areas of slopes steeper than 40 percent with more than 10 feet of vertical relief.

Based on the above, the site exhibits one of above landslide hazard indicators on or within 200 feet of the site (slopes with inclinations greater than 40 percent with a vertical of relief of more than 10 feet. In accordance with PMC 21.06.1240, a 25-foot native vegetation buffer should be established from the top of any portion of the steep slope area in the northern portion of the site that is steeper than 40 percent with a vertical height of more than 10 feet. We anticipate the site will be regraded to a generally level condition to accommodate the development. Regrading should effectively reduce any hazard associated with these slopes. The slopes around the central depression have a vertical height of 10 feet or less. Accordingly, regrading should be allowed per PMC 21.06.1240.

Seismic Hazards per PMC 21.06.1210(3)(c)

The PMC defines seismic hazard areas as "areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting. Settlement and soil liquefaction conditions occur in areas underlain by cohesionless, loose, or soft-saturated soils of low density, typically in association with a shallow ground water table".

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure. The increase in pore water pressure is induced by seismic vibrations. Liquefaction mainly affects geologically recent deposits of loose, fine-grained sands that located below the groundwater table. The soils observed at the site generally consisted gravelly outwash soils. Additionally, the site is located within an area mapped as having a very low susceptibility to liquefaction. An excerpt from the published liquefaction susceptibility map for the site area is included as Figure 6. In our opinion, the potential for liquefaction and lateral spreading is not significant because of the gravelly nature of the on-site soils and lack of a shallow groundwater table.

The ground surface within the site boundaries consists of moderate slopes that we anticipate will be regraded to a generally level condition; therefore, the potential for earthquake-induced slope instability on the site is low. The prescriptive 25-foot native vegetation buffer should ameliorate the potential hazards of earthquake induced slope stability of the on and offsite northern steep slope. The site is approximately X miles from the nearest mapped location of the Tacoma fault and no evidence of ground fault rupture was observed during our site reconnaissance. Therefore, in our opinion the potential for ground surface fault rupture is also low.

Volcanic Hazards per PMC 21.06.1210(3)(d)

The PMC defines volcanic hazard areas as "those areas subject to pyroclastic flows, lava flows, debris avalanche, and inundation by debris flows, lahars, mudflows, or related flooding resulting from volcanic activity". Volcanic hazard areas shall be classified as Case I or Case II lahars, as identified in the report Sedimentology, Behavior, and Hazards of Debris Flows at Mount Rainier, Washington, U.S. Geological Survey Professional Paper 1547, 1995. The site is not mapped as being in an area of the lahar flow path from Mt Rainer, as mapped by the Washington Department of Natural Resources. Accordingly, the risk of inundation via lahar, mudflow, or lava flow should be considered low. An excerpt from The Volcanic Hazard Areas map (WA State DNR) for the site area is provided as Figure 7.

Recommended Setback

Proposed structures may require a building setback from slopes steeper than 3H:1V (Horizontal: Vertical) percent to satisfy requirements of the International Building Code (IBC) Section

1805. The typical IBC setback from the top of the slope equals the lesser of one third the height of the slope or 40 feet unless evaluated and reduced, and/or a "structural setback" is provided, by a licensed geotechnical engineer. Based on the vertical height of the steep slope area north of the site, an IBC building setback of 5 to 12 feet would be required. However, it is our opinion the prescriptive 25-foot native vegetation buffer provides

Seismic Design

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class "D" in accordance with the 2015 IBC documents and American Society of Civil Engineers (ASCE) standard 7-10 Chapter 20 Table 20.3-1. This is based on the soil types encountered in the site area. These conditions were assumed to be representative for the subsurface conditions for the site. The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. We used the *ATC Hazard by Location* website to estimate seismic design parameters at the site. Table 1, below, summarizes the recommended design parameters.

TABLE1:
2015 IBC Parameters for Design of Seismic Structures

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.247	S_1 = 0.48
Site Coefficients (Site Class C)	F_a = 1.001	F_v = 1.52
Maximum Considered Earthquake SRA	S_{MS} = 1.248	S_{M1} = 0.729
Design SRA	S_{DS} = 0.832	S_{D1} = 0.486

The mapped peak ground acceleration (PGA) for this site is 0.50g. To account for site class, the PGA is multiplied by a site amplification factor (F_{PGA}) of 1.0. The resulting site modified peak ground acceleration (PGA_M) is 0.50g. In general, estimating seismic earth pressures (k_h) by the Mononobe-Okabe method or seismic inputs for slope stability analysis are taken as 30 to 50 percent of the PGA_M, or 0.15g to 0.25g.

Foundation Support

Based on the subsurface conditions encountered at the locations explored, we recommend that spread footings be founded on the medium dense native gravelly recessional outwash soils, or on structural fill that extends to suitable native soils.

The soil at the base of the footing excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed from the excavation. A representative from our firm should observe the foundation excavations to determine if suitable bearing surfaces have been prepared.

We recommend a minimum width of 24 inches for isolated footings and at least 16 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Footings founded on the native, undisturbed outwash soils or appropriately prepared structural fill can be designed using an allowable soil bearing capacity of 3,000 psf (pounds per square foot) for combined dead and long-term live loads. The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 350 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be on the order of 1 inch for the anticipated load conditions, with differential settlements between comparably loaded footings of 1/2 inch or less over a span of 50 feet. Most of the settlements should occur essentially as loads are being applied. However, disturbance of the foundation subgrade during construction could result in larger settlements than predicted.

Floor Slab Support

Slab-on-grade floors, where constructed, should be supported on the native outwash soils or appropriately prepared structural fill.

We recommend that floor slabs be directly underlain by a minimum 6-inch thickness capillary break material such as coarse sand, pea gravel, or crushed rock containing less than 2 percent fines. The capillary break material should be placed in one lift and compacted to an unyielding condition.

A synthetic vapor retarder is recommended to control moisture migration through the slabs. This is of particular importance where the foundation elements are underlain by the silty alluvial subgrade, or where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab or where slabs are present below heated, enclosed spaces.

A subgrade modulus of 300 pci (pounds per cubic inch) may be used for floor slab design. We estimate that settlement of the floor slabs designed and constructed as recommended, will be ½- inch or less over a span of 50 feet.

Subgrade/Basement Walls

Adequate drainage behind retaining structures is imperative. Positive drainage can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent greater than the US No. 4 sieve. A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions. The soil drainage zone should extend horizontally at least 18 inches from the back of the wall and extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the MDD (maximum dry density) as determined by ASTM D: 1557. Over-compaction should be avoided as this can lead to excessive lateral pressures. Typical wall drainage and backfilling details are shown in Figure 4. Recommended earth pressures for the native and fill soils are shown in Figure 5.

A minimum 4-inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill and should be extended over the top of the drainage zone.

For walls backfilled with granular well-drained soil and a level backslope, the design active pressure may be taken as 35 pcf (equivalent fluid density). For walls that are braced or otherwise restrained, the design active pressure may be taken as 55 pcf. For the condition of an inclined back slope, higher lateral pressures would act on the walls. For a 3H:1V (Horizontal to Vertical) slope above the wall, the active pressure may be taken as 48 pcf; for a 2H:1V back slope condition, a wall design pressures of 55 pcf may be assumed If basement walls taller than 6 feet are required, as seismic surcharge of 10H should be included where required by the code. If walls will be constructed with a backslope and will be braced or otherwise restrained against movement, we should be notified so that we can evaluate the anticipated conditions and recommend an appropriate at-rest earth pressure.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation. All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements including Washington Administrative Code (WAC) and Washington Industrial Safety and Health Administration (WISHA). Excavation, trenching, and shoring is covered under WAC 296-155 Part N.

Based on WAC 296-155-66401, it is our opinion that the medium dense recessional and outwash soils on the site would be classified as Type C soils. According to WAC 296-155-66403, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be sloped at a maximum inclination of 1½H:1V or flatter from the toe to top of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Retaining structures greater than 4-feet in height (bottom of footing to top of structure) or that have slopes of greater than 15 percent above them, should be engineered per Washington Administrative Code (WAC 51-16-080 item 5). This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Site Drainage

All ground surfaces, pavements and sidewalks at the site should be sloped away from the structures. Surface water runoff should be controlled by a system of curbs, berms, drainage swales, and or catch basins, and conveyed to an appropriate discharge point.

We recommend that footing drains are installed for the development in accordance with IBC 1805.4.2, and basement walls (if utilized) have a wall drain as describe above. The roof drain should not be connected to the footing drain.

Stormwater Infiltration

The City of Puyallup uses the Department of Ecology's (Ecology) Stormwater Management Manual for Western Washington. We reviewed the *2012 Stormwater Management Manual for Western Washington, as Amended in December 2014* (*2014 SWMMWW*).

Per the *2014 SWMMWW*, Volume III, Section 3.3.7, *Site Selection Criteria-5*, a minimum of 5 feet of separation is required between the bottom of a proposed infiltration facility and the top of seasonal high groundwater, bedrock, or other low permeability layer. No evidence of seasonal high groundwater was observed was observed in our subsurface explorations. Based on our review of the above referenced documents, our subsurface explorations, and our laboratory testing, it is our opinion that stormwater infiltration is feasible onsite.

Test Method

For the purposes of this project we used the small-scale pilot infiltration test method as defined by (2014 SWMMWW).

Preliminary Design Infiltration Rate

The design infiltration rate is determined based on the procedure provided in Volume III, Appendix III section 3.3.6 of the 2014 SWMMWW. Three correction factors are applied to the measured infiltration rate to account for site variability (CF_y), test method used (CF_t), and influent control to prevent siltation and bio-buildup (CF_m). The design infiltration rate is determined as follows:

$$I_{design} = I_{measured} * CF_y * CF_t * CF_m$$

Where:
I_{design} = Infiltration rate to be used for design of infiltration facility
$I_{measured}$ = Infiltration rate measured in the field or estimated by grain size analysis
CF_y = Accounts for number of tests relative to infiltration area and site variability (0.33 to 1)
CF_t = Test method used (Small Scale PIT = 0.5)
CF_m = Degree of influent control to prevent siltation and bio-buildup (0.9)

Based on our observations, we used a value of 0.5 for CF_y, a value of 0.5 for CF_t, and a value of 0.9 for CF_m. Applying these correction factors to the measured infiltration rate, as outlined in Volume III, Section 3.3.6 of the 2014 SWMMWW results in a preliminary long-term (design) infiltration rates. Based on the sample collected and our analysis, we recommend using a **preliminary long-term design rate of 2.0 inches per hour.** Additional information regarding preliminary infiltration rates is included in Appendix C.

For the purposes of estimating a preliminary infiltration and to reflect the early design stages of the project, we selected relatively conservative correction factors. It is possible, that during the design process these values may be reduced potentially resulting in a higher design infiltration rate.

Construction Considerations

We recommend that a representative from our firm be onsite at the time of excavation of the proposed infiltration facilities to verify that the soils encountered during construction are consistent with the soils observed in our subsurface explorations. Verification infiltration testing should also be performed at the time of construction to verify the recommended infiltration rate per the 2014 SWMMWW.

Appropriate design, construction and maintenance measures will be required to ensure the infiltration rate can be effectively maintained over time. Appropriate temporary erosion and sediment control methods should be included in the project plans and specifications to minimize the potential for fines contamination of infiltration facility utilized at the site. To further reduce the potential for fines migration, the infiltration system should not be connected to the stormwater runoff system until after construction is complete and the site area is landscaped, paved or otherwise protected.

Additional measures may also be taken during construction to minimize the potential of fines contamination of the proposed infiltration system, such as utilizing an alternative storm water management location during construction or leaving the bottom of the permanent systems 1 to 2 feet high, and subsequently excavating to the finished grade once the site soils have been stabilized. All contractors working on the site (builders and subcontractors) should divert sediment laden stormwater away from proposed infiltration facilities during construction and landscaping activities. No concrete trucks should be washed or cleaned, and washout areas should not be within the vicinity of the proposed infiltration facilities. After construction activities have been completed, periodic sweeping of the paved areas will help extend the life of the infiltration system.

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be developed should be stripped of vegetation, organic surface soils, and other deleterious materials including existing structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill, but may be used for limited depths in non-structural areas. Stripping depths ranging from 8 to 16 inches should be expected to remove these unsuitable soils. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions. Initial estimation of stripping depths should consider the limitations of the initial subsurface exploration program and contingencies should be incorporated into the grading plan and bid documents for the project until additional explorations can be completed.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of any fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the "**Structural Fill**" section of this report.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a 1/2-inch-diameter steel rod during wet weather conditions.

Soft, loose or otherwise unsuitable areas delineated during proofrolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of overexcavation should be evaluated by our field representative at the time of construction. The areas of old fill material should be evaluated during grading operations to determine if they need mitigation; recompaction or removal.

Structural Fill

All material placed as fill associated with mass grading, as utility trench backfill, under building areas, or under roadways should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Structural fill should be compacted to at least 95 percent of MDD as determined in accordance with ASTM D: 1557.

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the 3/4-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash, and cobbles greater than 6-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, non-organic on-site soil may be considered for use as structural fill; provided it meets the criteria described above in the "**Structural Fill"** section and can be compacted as recommended. If the moisture content of the soil material is over-optimum when excavated, it will be necessary to aerate or dry the soil prior to placement as structural fill. We generally did not observe the site soils to be excessively moist at the time of our subsurface exploration program.

The native gravelly outwash at the site generally consisted of gravel with sand. These soils are generally comparable to *Common Borrow* (WSDOT) 9-03.14(3). According to our grain size analysis, the outwash soils had a fines content of approximately 0.7 to 5.4 percent. These soils should be suitable for use as structural fill provided the moisture content is maintained within 3 percent of the optimum moisture level. Because of the low fines content and gravelly nature of the outwash soils, these soils are considered moderately moisture sensitive and should be suitable for reuse in a wider range of moisture conditions and periods of wet weather.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base,

a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend erosion protection measures will need to be in place prior to grading activity on the site. Erosion hazards can be mitigated by applying Best Management Practices (BMP's).

Wet Weather and Wet Condition Considerations

In the Puget Sound area, wet weather generally begins about mid-October and continues through about May, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months of June through September. Most of the soil at the site contains sufficient fines to produce an unstable mixture when wet. Such soil is highly susceptible to changes in water content and tends to become unstable and impossible to proof-roll and compact if the moisture content exceeds the optimum.

In addition, during wet weather months, the groundwater levels could rise, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil. However, should wet weather/wet condition earthwork be unavoidable, the following recommendations are provided:

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet-sieving the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above).

- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

We recommend that the above requirements for wet weather/wet condition earthwork be incorporated into the contract specifications.

LIMITATIONS

We have prepared this report for use by AVT Services LLC, and other members of the design team, for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

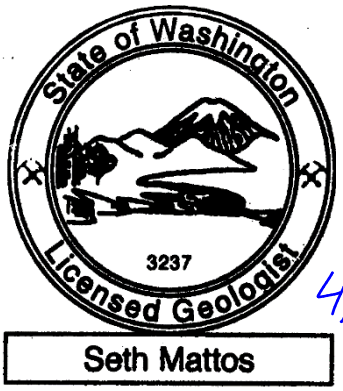
If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.

◆ ◆ ◆

We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC

Davis Carlsen
Staff Geologist



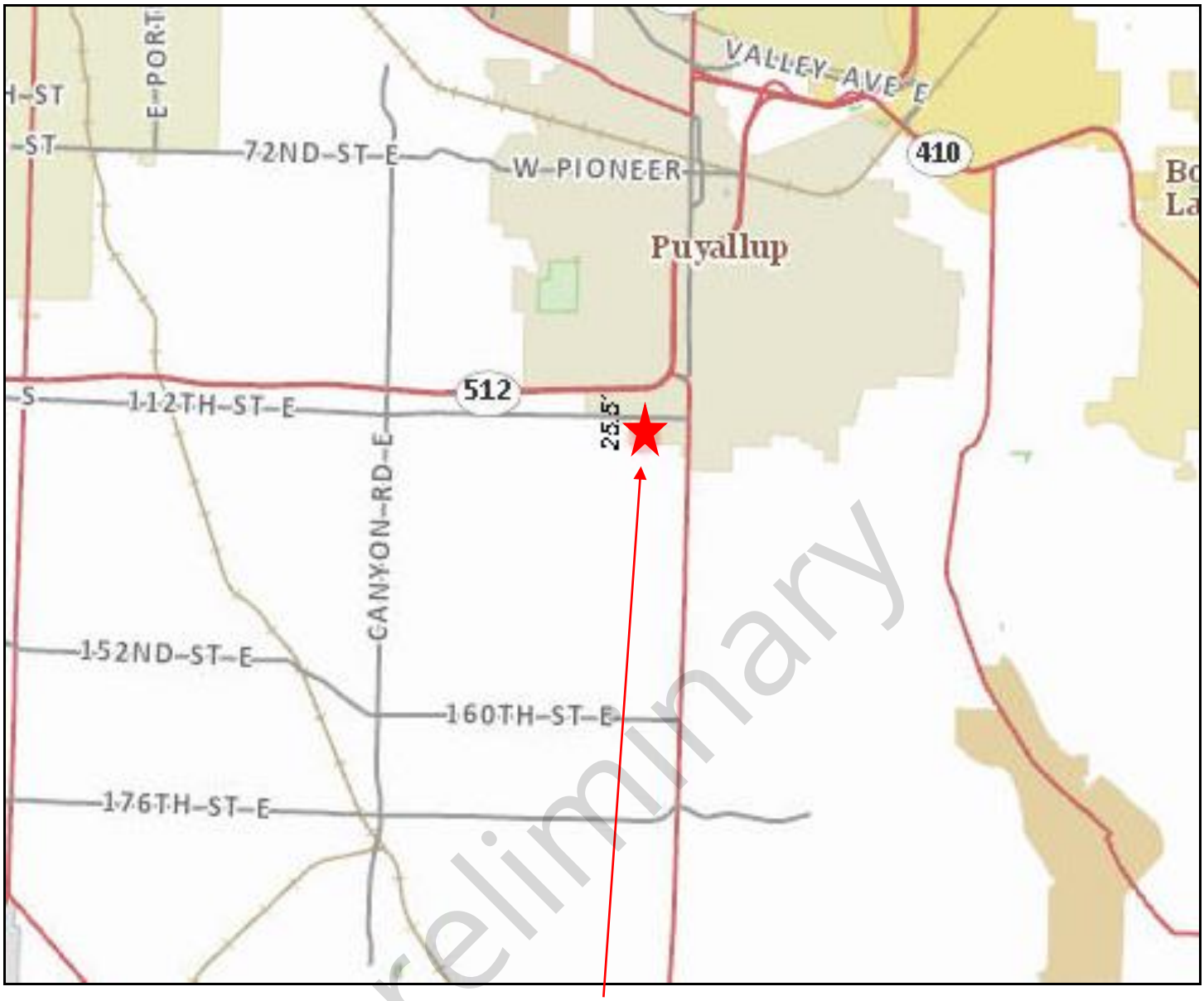
4/15/2020

4/15/2020

Seth Mattos, LG
Senior Geologist

Eric W. Heller, PE, LG
Senior Geotechnical Engineer

STM:EWH/dc
DocID:AVTServices.7thStSW.RG
Attachments:
Figure 1: Site Location Map
Figure 2: Site and Exploration Map
Figure 3: NRCS Soils Map
Figure 4: Geologic Map
Figure 5: WA DNR Landslide Susceptibility Map
Figure 6: Liquefaction Susceptibility Map
Figure 7: WA DNR Volcanic Hazards Map
Appendix "A" - Subsurface Explorations
Appendix "B" - Laboratory Test results



Approximate Site Location

Map created from Pierce County Public GIS (https://matterhornwab.co.pierce.wa.us/publicgis/)

N W E S

Not to Scale

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Site Location Map

Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

DocID: AVTServices.7thStSW.F	April 2020	Figure 1

Map created from Pierce County Public GIS
(https://matterhornwab.co.pierce.wa.us/publicgis/)

Number and approximate location of test pit

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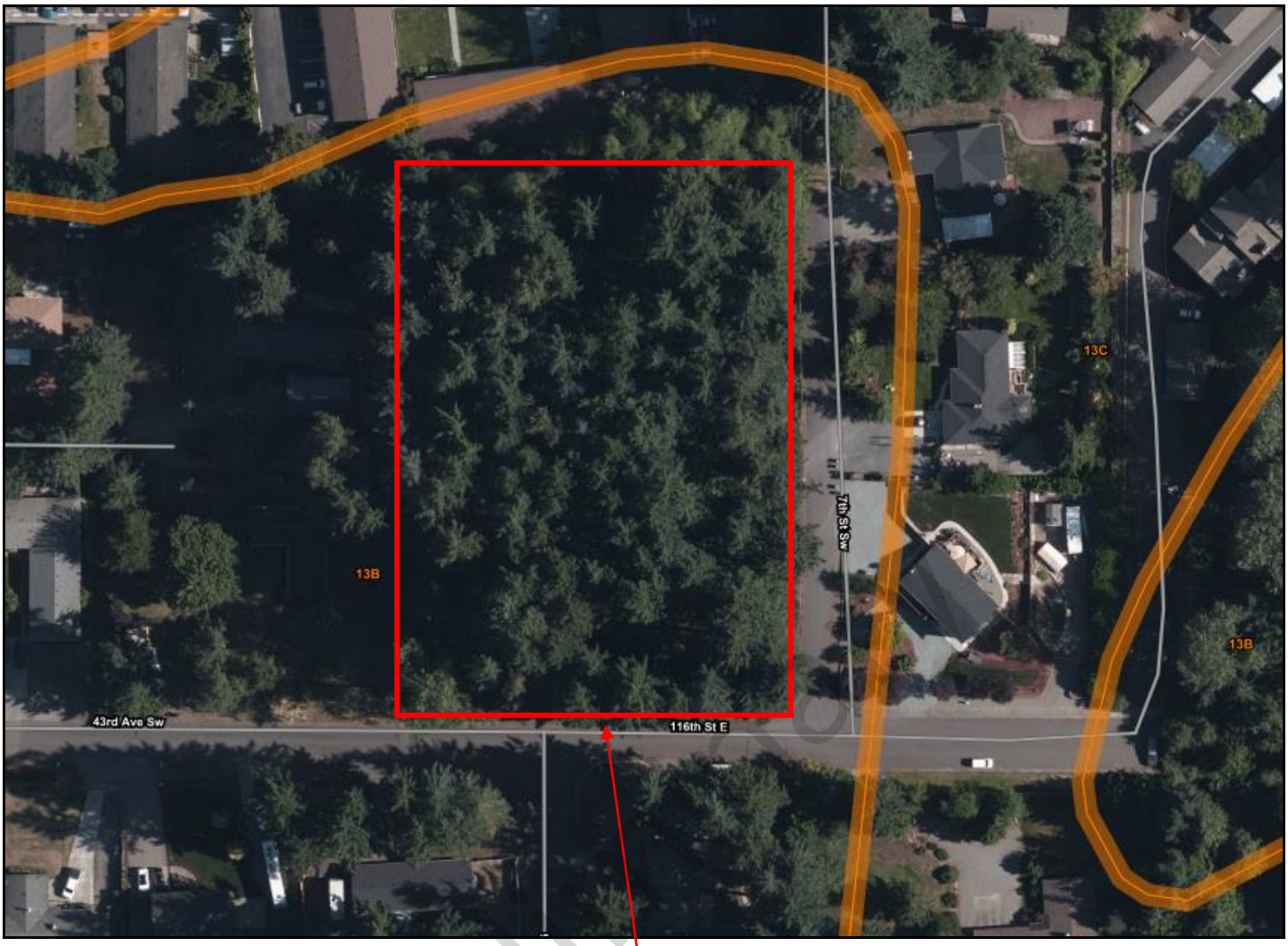
Site and Exploration Map
Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 2



Approximate Site Location

Map created from Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
13B	Everett very gravelly sandy loam	Sandy and gravelly glacial outwash	0 to 8	Slight	A
13C			8 to 15	Slight to moderate	

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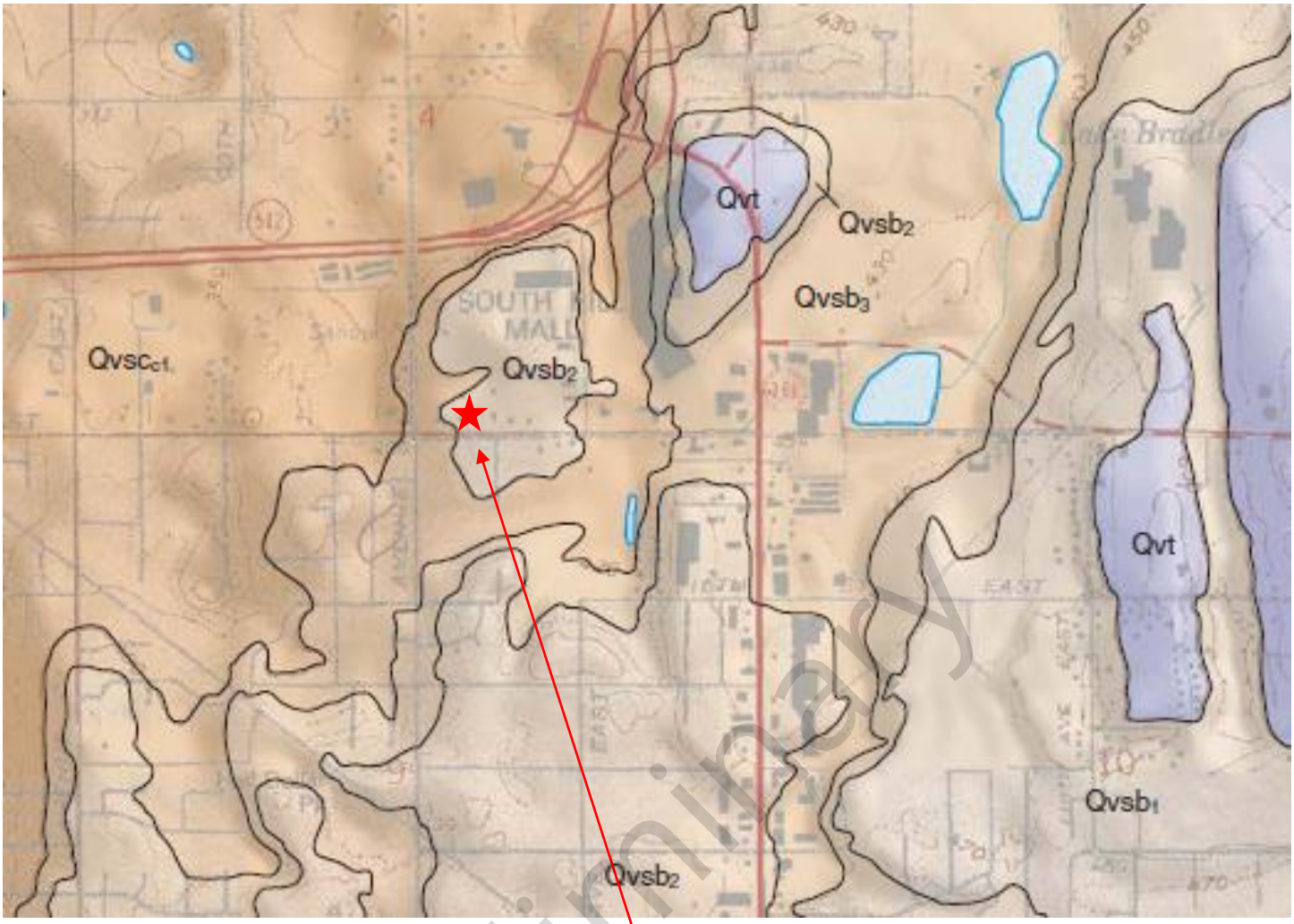
NRCS Soils Map

Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 3



Approximate Site Location

An excerpt from *the draft Geologic Map of the Puyallup 7.5-minute Quadrangle, Washington*, by Troost, K.G.

$Qvsb_3$	Steilacoom Gravel-Bradley Channel
$Qvsb_2$	Steilacoom Gravel-Bradley Channel
$Qvsc_{c1}$	Steilacoom Gravel-Clover Creek Channel

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Geologic Map

Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 4

Shallow Susceptibility

- Moderate
- High

Deep Susceptibility

- Moderate
- High

Approximate Site Location

Map created from the Washington State Department of Natural Resources Landslide Inventory
(Information Portal https://geologyportal.dnr.wa.gov/)

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WA DNR Landslide Susceptibility Map

Proposed Multi-family Development
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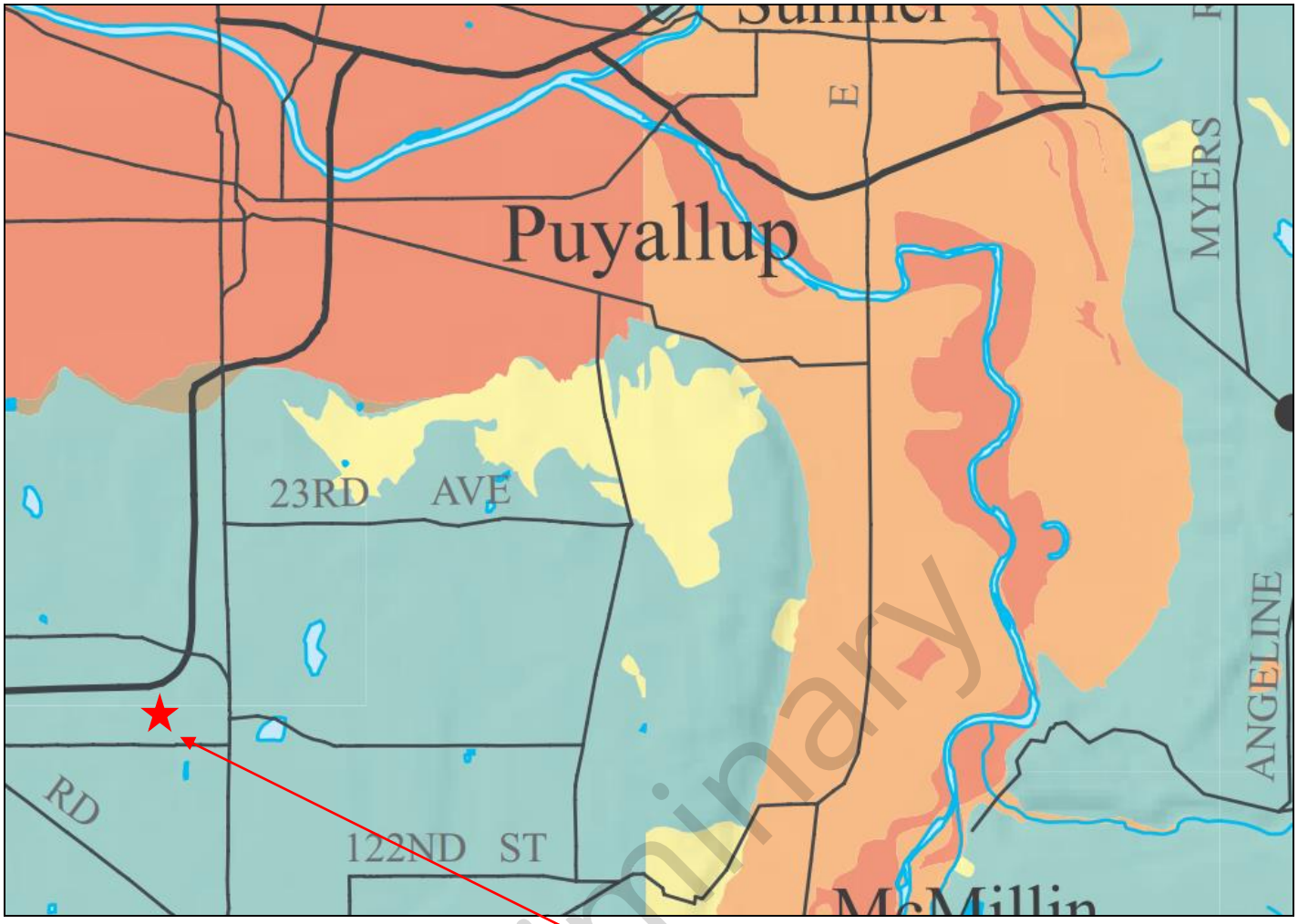
Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 5



Approximate Site Location

An excerpt from the *Liquefaction Susceptibility Map of Pierce County, Washington* by Palmer, et al. (2004)

EXPLANATION

- Liquefaction susceptibility: HIGH
- Liquefaction susceptibility: MODERATE to HIGH
- Liquefaction susceptibility: MODERATE
- Liquefaction susceptibility: LOW to MODERATE
- Liquefaction susceptibility: LOW
- Liquefaction susceptibility: VERY LOW to LOW
- Liquefaction susceptibility: VERY LOW

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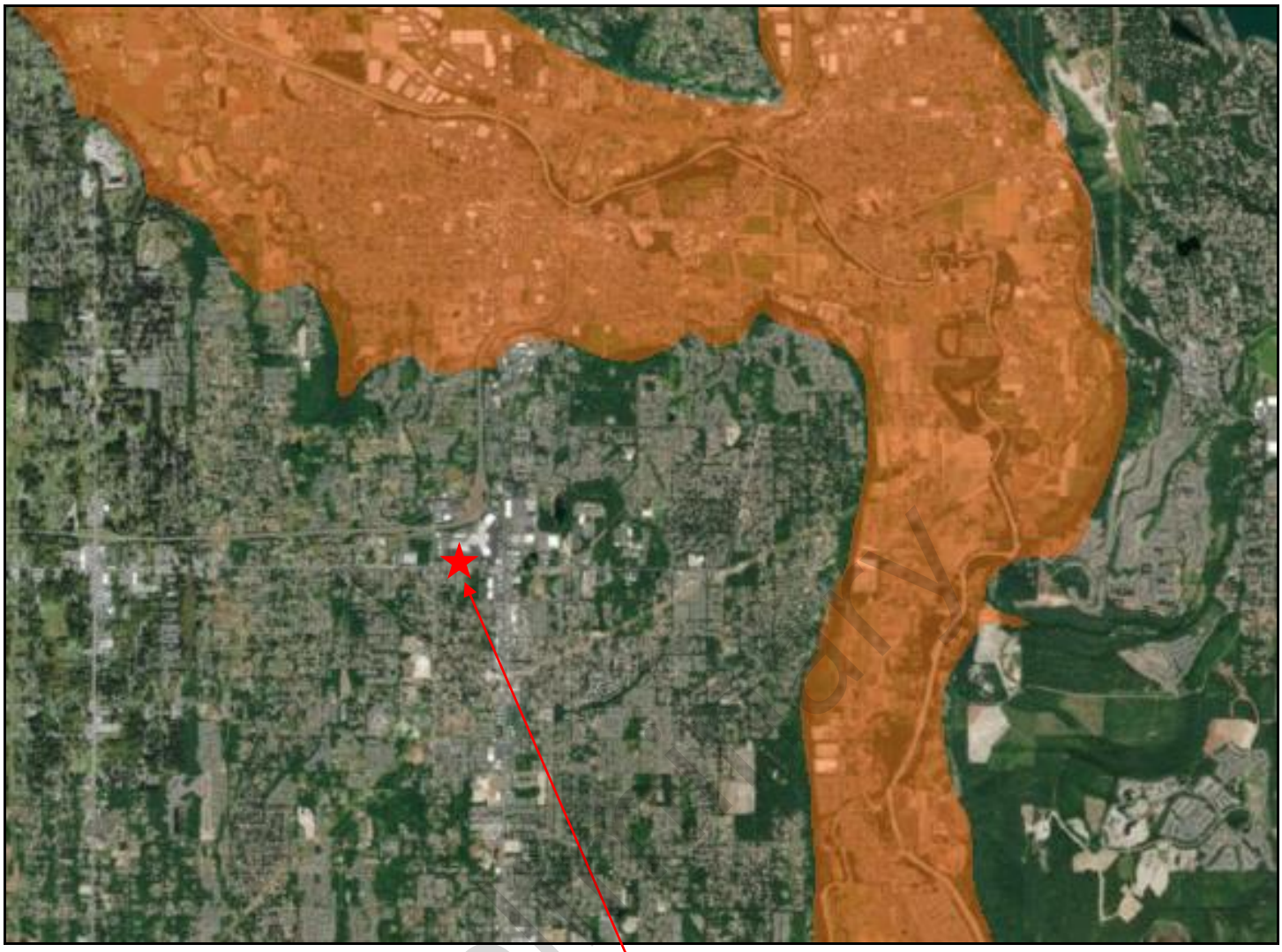
Liquefaction Susceptibility Map

Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 6



Approximate Site Location

Map created from the Washington State Department of Natural Resources Volcanic Hazards Map
(Information Portal https:// geologyportal.dnr.wa.gov/)

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WA DNR Volcanic Hazards Map

Proposed Multi-family Development
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Puyallup, Washington
PN: 4320000160

Doc ID: AVTServices.7thStSW.F	April 2020	Figure 7

Appendix A

Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or more	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D6913.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

Dry- Absence of moisture, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

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Unified Soils Classification System

Proposed Multi-family Development
xxx - 7th Street SW
Puyallup, Washington
PN: 4320000160

Test Pit TP-1

Location: Eastern extent of site
Approximate Elevation: 460 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	1.25	-	Dark brown topsoil/forest duff (loose, moist)
1.25	-	3.5	GP	Light brown to orange-brown sandy GRAVEL with silt to silty GRAVEL with sand (medium dense, moist) (recessional outwash)
3.5	-	8.5	SP	Tan gravelly SAND with trace cobbles (medium dense, moist) (recessional outwash)

Terminated at 8.5 feet below the existing ground surface.
No iron oxide staining observed at time of excavation
No caving observed at time of excavation
No groundwater seepage observed at time of excavation

Test Pit TP-2

Location: Southeast corner of site
Approximate Elevation: 464 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil/forest duff (loose, moist)
1.0	-	2.5	GP	Orange-reddish brown poorly graded GRAVEL with silt and sand (medium dense, moist) (recessional outwash)
2.5	-	7.5	GP	Orange-reddish brown poorly graded GRAVEL with silt and sand, occasional cobble, trace boulders (medium dense to dense, moist) (recessional outwash)

Terminated at 7.5feet below the existing ground surface.
No iron oxide staining observed at the time of excavation.
No caving observed at the time of excavation.
No groundwater seepage observed at the time of excavation.

Logged by: STM **Excavated on: February 20, 2020**

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Test Pit Logs
Proposed Multi-family Development
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Puyallup, Washington
PN: 4320000160

Test Pit TP-3

Location: Southern extent of site
Approximate Elevation: 456 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil/forest duff (loose, moist)
1.0	-	3.0	GP	Orange-reddish brown poorly graded GRAVEL with silt and sand (medium dense, moist) (recessional outwash)
2.0	-	6.0	GP	Orange-reddish brown poorly graded GRAVEL with silt and sand, occasional cobble, trace boulders (medium dense to dense, moist) (recessional outwash)

Terminated at 6.0 feet below the existing ground surface.
No iron oxide staining observed at the time of excavation.
No caving observed at the time of excavation.
No groundwater seepage observed at the time of excavation.

Test Pit TP-4

Location: Southwest portion of site
Approximate Elevation: 456 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil/forest duff (loose, moist)
1.0	-	2.5	GP	Weathered dark brown poorly graded GRAVEL with silt and sand (medium dense, moist) (recessional outwash)
2.5	-	4.0	GP	Brown poorly graded GRAVEL with silt and sand, occasional cobble, trace boulders (medium dense to dense, moist) (recessional outwash)
4.0	-	7.5	SP	Tan poorly graded SAND (medium dense, moist) (recessional outwash)

Terminated at 7.5 feet below the existing ground surface.
No iron oxide staining observed at the time of excavation.
No caving observed at the time of excavation.
No groundwater seepage observed at the time of excavation.

Logged by: STM **Excavated on: February 20, 2020**

Test Pit TP-5

Location: Northeast corner of the site
Approximate Elevation: 458 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	0.75	-	Dark brown topsoil/forest duff (loose, moist)
0.75	-	2.5	GP	Weathered dark brown poorly graded GRAVEL with silt and sand (medium dense, moist) (recessional outwash)
2.5	-	9.5	GP	Brown poorly graded GRAVEL (Medium dense to dense, moist) (recessional outwash)

Terminated at 9.5 feet below the existing ground surface.
No iron oxide staining observed at the time of excavation.
No caving observed at the time of excavation.
No groundwater seepage observed at the time of excavation.

Test Pit TP-6

Location: Eastern edge of site
Approximate Elevation: 460 feet (NAVD88)

Depth (ft)			Soil Type	Soil Description
0.0	-	0.75	-	Dark brown topsoil/forest duff (loose, moist)
0.75	-	4.0	GP	Orange brown GRAVEL with sand (medium dense, moist) (recessional outwash)
1.8	-	9.0	SP	Tan fine to medium sand (medium dense, moist) (recessional outwash)

Terminated at 9.0 feet below the existing ground surface.
No iron oxide staining observed at the time of excavation.
No caving observed at the time of excavation.
No groundwater seepage observed at the time of excavation.

Logged by: STM **Excavated on: February 20, 2020**

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Test Pit Logs
Proposed Multi-family Development
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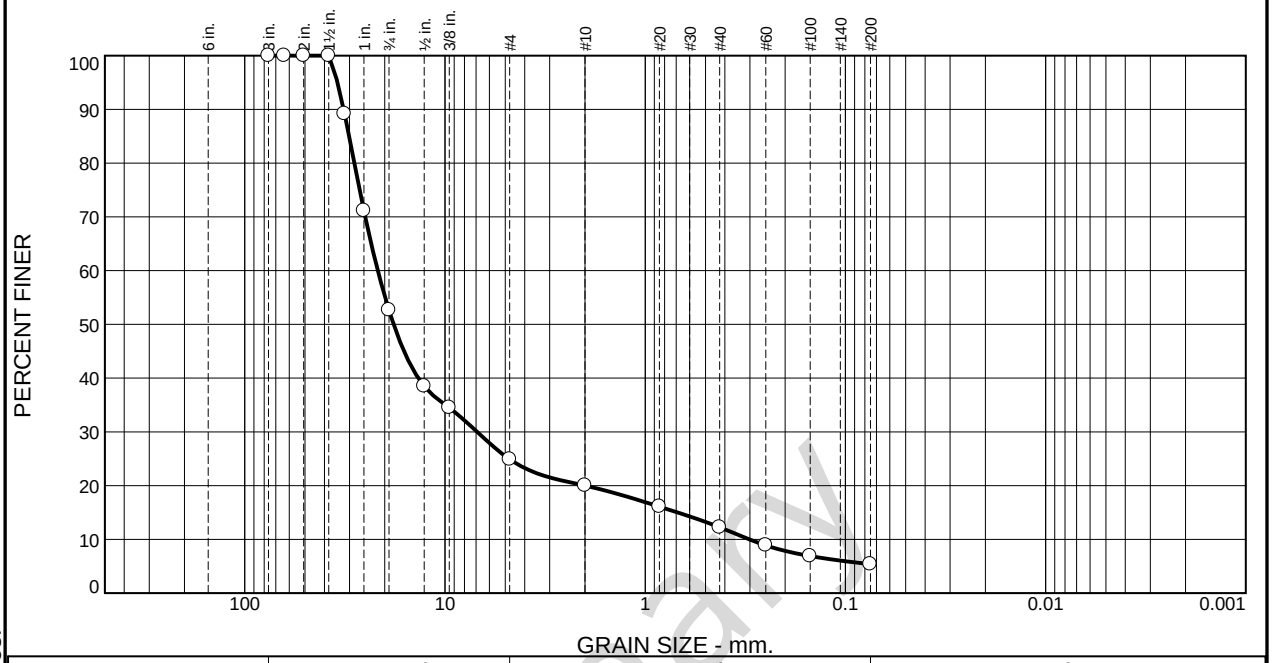
Puyallup, Washington
PN: 4320000160

Appendix B

Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	47.4	27.7	4.9	7.8	6.8	5.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	89.2		
1	71.1		
.75	52.6		
.5	38.5		
0.375	34.5		
#4	24.9		
#10	20.0		
#20	16.1		
#40	12.2		
#60	8.9		
#100	6.9		
#200	5.4		

* (no specification provided)

Material Description

poorly graded gravel with silt and sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NV

Classification

USCS (D 2487)= GP-GM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 32.0883 D_{85}= 30.1172 D_{60}= 21.6665
D_{50}= 18.0484 D_{30}= 6.9144 D_{15}= 0.6881
D_{10}= 0.3018 C_u= 71.80 C_c= 7.31

Remarks

Date Received: _____ **Date Tested:** 2/20/2020

Tested By: DC

Checked By: STM

Title: PM

Location: TP-2 S-1 **Date Sampled:** 2/20/2020
Sample Number: 099315 **Depth:** 1.5'-2.5'

GeoResources, LLC

Fife, WA

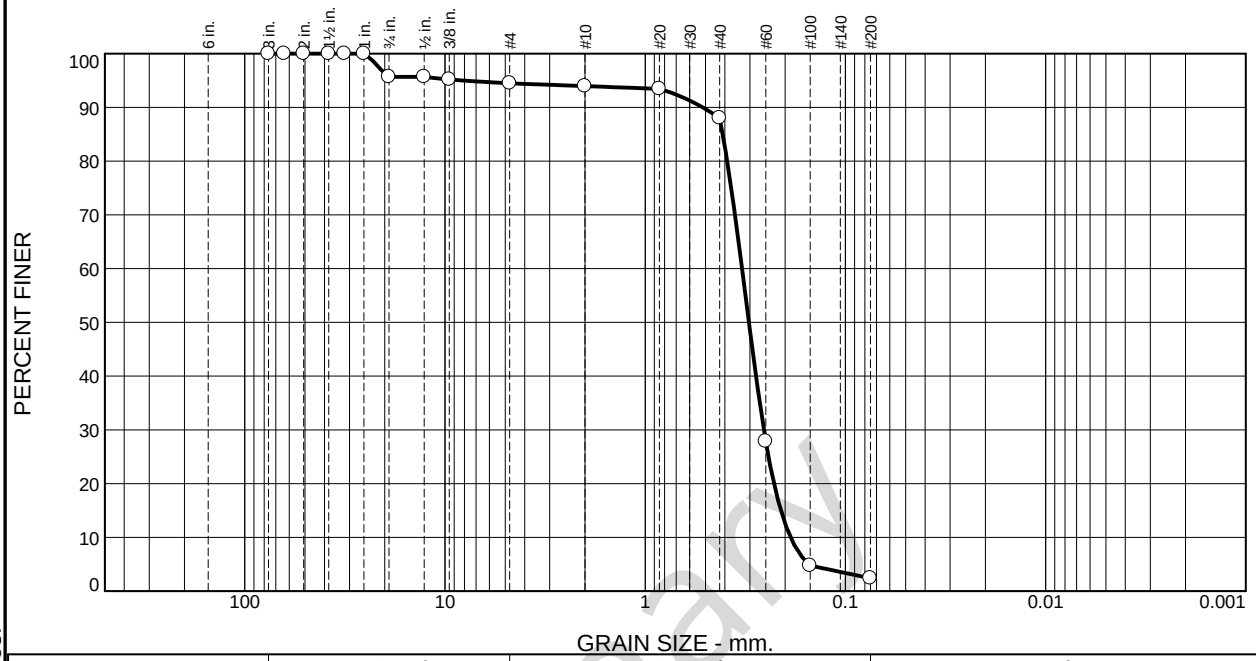
Client: AVT Services
Project: AVT.Services.7thStSW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.3	1.2	0.5	6.0	85.6	2.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	95.7		
.5	95.7		
0.375	95.2		
#4	94.5		
#10	94.0		
#20	93.4		
#40	88.0		
#60	27.9		
#100	4.8		
#200	2.4		

* (no specification provided)

Material Description

poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NV

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.5166 D_{85}= 0.4099 D_{60}= 0.3283
D_{50}= 0.3034 D_{30}= 0.2555 D_{15}= 0.2101
D_{10}= 0.1880 C_u= 1.75 C_c= 1.06

Remarks

Date Received: _____ **Date Tested:** 2/20/2020

Tested By: DC

Checked By: STM

Title: PM

Location: TP-4 S-1
Sample Number: 099317 **Depth:** 6'

Date Sampled: 2/20/2020

GeoResources, LLC

Fife, WA

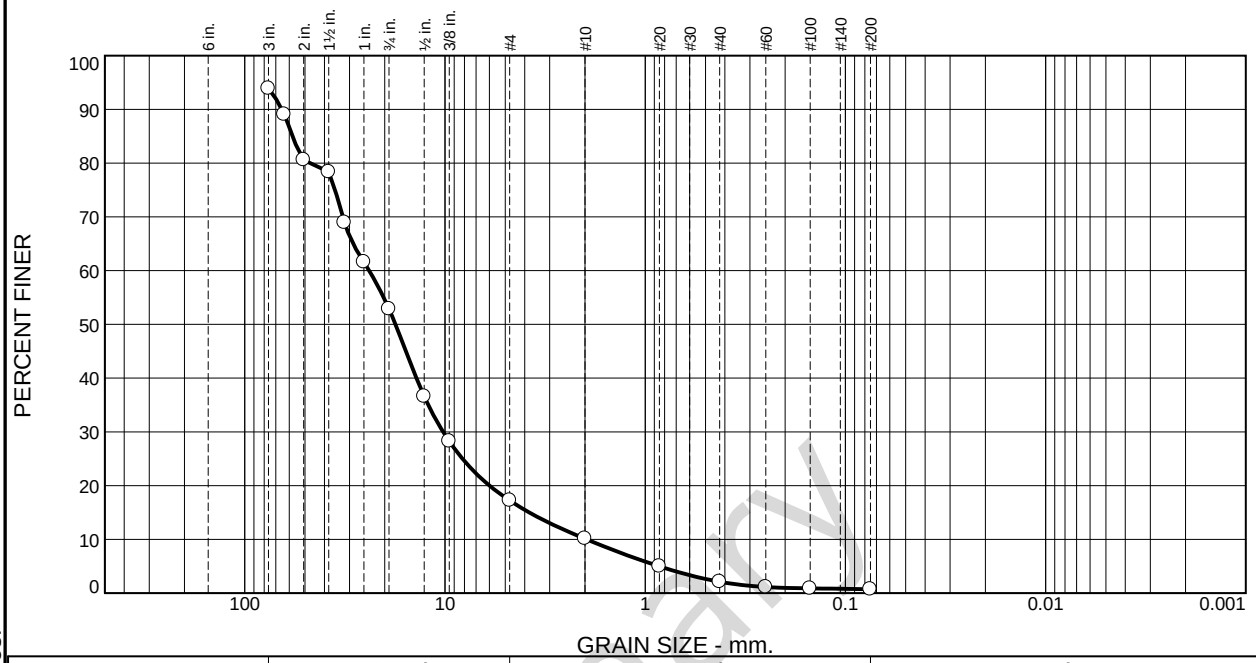
Client: AVT Services
Project: AVT.Services.7thStSW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	41.0	35.7	7.1	8.0	1.4	0.7	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	93.9		
2.5	89.1		
2.0	80.6		
1.5	78.4		
1.25	68.9		
1	61.6		
.75	52.9		
.5	36.6		
0.375	28.3		
#4	17.2		
#10	10.1		
#20	5.0		
#40	2.1		
#60	1.1		
#100	0.9		
#200	0.7		

* (no specification provided)

Material Description

well-graded gravel with sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 65.2363 D_{85}= 57.6816 D_{60}= 23.9129
D_{50}= 17.6724 D_{30}= 10.2243 D_{15}= 3.7892
D_{10}= 1.9640 C_u= 12.18 C_c= 2.23

Remarks

Date Received: 2/20/2020 **Date Tested:** 2/20/2020

Tested By: DC

Checked By: STM

Title: PM

Location: TP-4 S-2
Sample Number: 099318 **Depth:** 8'

Date Sampled:

GeoResources, LLC

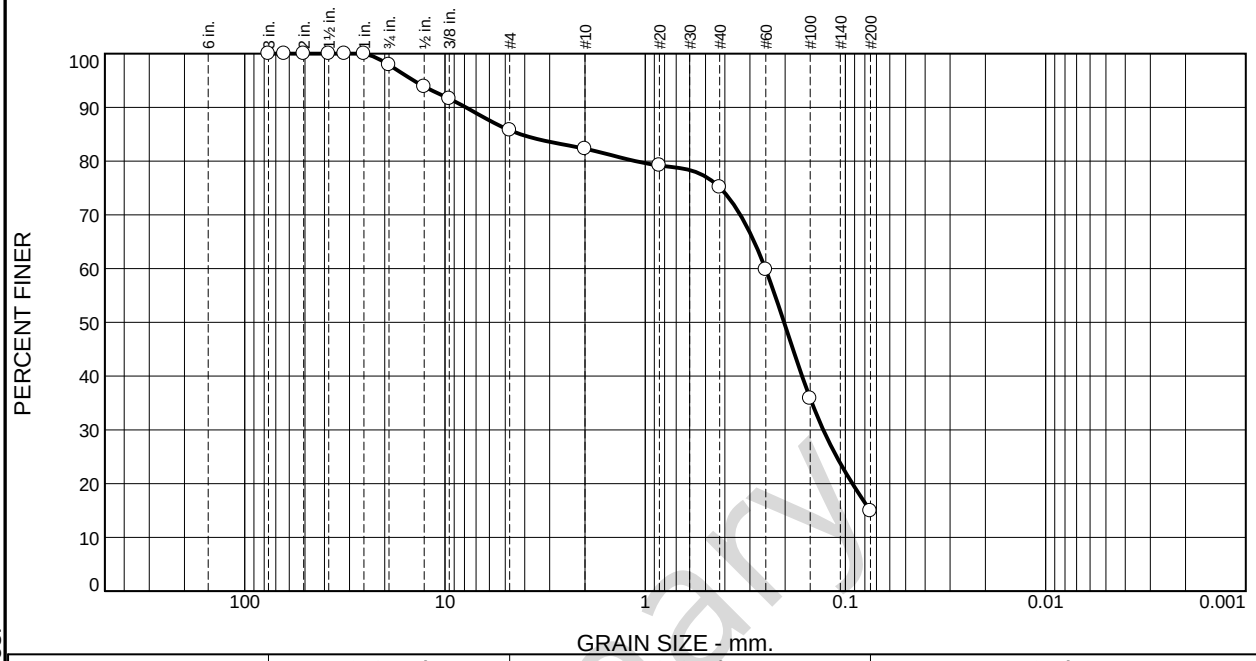
Fife, WA

Client: AVT Services
Project: AVT.Services.7thStSW

Project No: **Figure**

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.1	12.2	3.4	7.2	60.2	14.9	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	97.9		
.5	93.9		
0.375	91.6		
#4	85.7		
#10	82.3		
#20	79.2		
#40	75.1		
#60	59.8		
#100	35.8		
#200	14.9		

* (no specification provided)

Material Description

silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NV

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 7.8667 D_{85}= 4.1971 D_{60}= 0.2510
D_{50}= 0.2023 D_{30}= 0.1290 D_{15}= 0.0753
D_{10}= C_u= C_c=

Remarks

Date Received: _____ **Date Tested:** 2/20/2020

Tested By: DC

Checked By: STM

Title: PM

Location: TP-5 S-1
Sample Number: 099319 **Depth:** 7'-7.5'

Date Sampled: 2/20/2020

GeoResources, LLC

Fife, WA

Client: AVT Services
Project: AVT.Services.7thStSW

Project No: **Figure**

Tested By: _____ **Checked By:** _____