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Geotechnical Engineering Report
Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600,-700, & -100
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INTRODUCTION

This geotechnical engineering report summarizes our site observations, subsurface explorations, laboratory testing, and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed multi-family residential development to be constructed at 5224, 5228, and 5216 – 15th Avenue NE in the Olympia area of Thurston County, Washington. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our email discussions with your civil engineer Mr. Chris Cramer of Patrick Harron & Associates; our December 31, 2019 and February 11, 2020 site visits and subsurface explorations; our understanding of the Thurston County Development Codes; our understanding of the 2016 Thurston County Drainage Design and Erosion Control Manual (TCDDECM); and our experience in the site area. The site consists of three contiguous tax parcels, one of which is currently developed with an existing single-family residence. In addition, two wetlands have been delineated in the lower, northern portion of the site. We understand that the proposed development may include several multi-family residential buildings, single-family residential structures, paved access roads and parking stalls, associated utilities, and stormwater facilities. We understand that the multi-family residential buildings will likely be three-story, wood-framed structures and we anticipate that the single-family residences will be one- to two-story, wood-framed structures. The proposed structures will likely be supported by conventional shallow foundations.

SCOPE OF SERVICES

The purpose of our services was to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed residential development. Specifically, the scope of services for this project included the following:

1. Reviewing existing geological, hydrogeological, and geotechnical literature for the site area;

2. Exploring the subsurface conditions across the site by monitoring the excavation of nine test pits at select locations and by monitoring the drilling of two borings that were completed as groundwater monitoring wells;
3. Collecting select soil samples from the explorations and conducting grain size analyses and moisture content determinations, as appropriate;
4. Describing surface and subsurface conditions, including soil type, depth to groundwater, and estimate of high groundwater, if encountered;
5. Addressing the appropriate criteria for Geologic Hazards per the current Thurston County Geologic Hazard Areas Title 24.15;
6. Providing geotechnical conclusions and recommendations regarding site grading activities including: site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, and drainage and erosion control measures;
7. Providing recommendations for seismic design parameters, including 2015 IBC site class;
8. Providing geotechnical conclusions and design criteria for shallow foundations, including shallow foundation parameters and floor slabs, including bearing capacity and subgrade modulus, as appropriate;
9. Providing recommendations for cast-in-place subgrade walls, including lateral earth pressures and applicable seismic surcharges;
10. Providing recommendations for erosion and sediment control during wet weather grading and construction; and,
11. Preparing this 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 December 10, 2019. We received written authorization to proceed by you on December 12, 2019. We understand that groundwater monitoring is being required through the wet season (October 1 through April 30) and we are currently monitoring both wells at the site. Once our monitoring is complete, we will summarize the results in an addendum letter.

SITE CONDITIONS

Surface Conditions

The site is located at 5224, 5228, and 5216 – 15th Avenue NE in the Lacey area of Thurston County, Washington. The parcels, when combined, are generally rectangular in shape, measure approximately 475 to 675 feet wide (east to west) by approximately 1,025 to 1,300 feet deep (north to south), and encompasses approximately 18.73 acres. The site is bounded by existing residential development to the east and west, an undeveloped forested parcel to the north, and 15th Avenue NE to the south. The southeast portion of the site is currently developed with a single-family residence.

Based off information obtained from the from a site survey completed by MTN2COAST, LLC dated November 6, 2019 and generally confirmed in the field, the site generally slopes down from south to north. From 15th Avenue NE, the site gently slopes up to the north at about 3 percent before sloping back down to the north at about 3 to 5 percent. North of the existing residence, in the central portion of the site, the site slopes more steeply down to the north at about 15 to 40 percent. These steeper slopes have a vertical relief of about 15 to 50 feet. A more gently sloping ridgeline cuts across the northern portion of the site trending southwest to northeast. The ridge slopes down to the northeast at about 3 to 10 percent with side slopes of about 20 to 35 percent. The lower northeast and northwest corners of the site are generally flat to gently sloping down to then northeast and north at about 4 to 6 percent. Total topographic relief across the site is on the order of 64 feet. The existing site configuration and topography is shown on the Site & Exploration Map, Figure 2.

Vegetation across the upper southern half of the site generally consists of grassy areas with scattered coniferous trees. The northern, sloping portion of the site is generally vegetated with a medium to dense stand of fir, cedar, and deciduous trees with a moderate to dense understory of ferns, salal, evergreen huckleberries, and blackberries. No areas of surficial erosion, seeps, springs, or deep-seated slope movement was observed during our site visits. Some small areas of standing water were observed across the lower, northern portion of a trail/footpath that winds across the site.

Site Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey maps the site as being underlain by Giles silt loam (39), Hoogdal silt loam (43), Indianola loamy sand (48), and Skipopa silt loam (108) soils. The Giles soils, mapped as underlying the upper southeastern portion of the site, are derived from volcanic ash and glacial outwash and form on slopes of 3 to 15 percent. These soils have a “slight” erosion hazard when exposed and are included in hydrologic soils group B. The Hoogdal soils, mapped along the more steeply sloping, central portion of the site, are derived from loess and glaciolacustrine deposits, form on slopes of 15 to 30 percent, have a “moderate” erosion hazard when exposed, and are included in hydrologic soils group D. The Indianola soils, underlying the northeastern and northwestern corners of the site, are derived from sandy glacial outwash and form on slopes of 15 to 30 percent. These soils have a “moderate” erosion hazard when exposed and are included in hydrologic soils group A. The Skipopa soils, mapped in the upper southwestern and lower northern portions of the site, are derived from volcanic ash over glaciomarine deposits, form on slopes of 3 to 15 percent, have a “slight” erosion hazard when exposed, and are included in hydrologic soils group D. A copy of the soils map for the site vicinity is provided as Figure 3.

Site Geology

The *Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington (Logan et al., 2003)* maps the site as being underlain by Vashon recessional sand and minor silt (Qgos). These soils were generally deposited during the most recent Vashon Stade of the Fraser Glaciation, some 12,000 to 15,000 years ago. The recessional outwash is typically comprised of poorly-sorted, lightly stratified mixture of sand and gravel that was deposited by meltwater streams emanating from the retreating ice mass. Because the recessional outwash soils were not subsequently overridden by the ice mass, they are considered to be normally-consolidated and generally provide moderate strength and compressibility characteristics, where undisturbed. Infiltration characteristics of outwash depends on the distribution of sand and gravel particles, but is generally favorable. An excerpt of the above reference geologic map is attached as Figure 4.

Subsurface Explorations

On December 31, 2019 a representative from GeoResources, LLC (GeoResources) visited the site and monitored the excavation of nine test pits to depths of about 8.5 to 13 feet below the existing ground surface. We returned to the site on February 11, 2020 to monitor the drilling of two borings to 36.5 to 51.5 feet below the existing ground surface. The test pits were excavated by a licensed earthwork contractor operating a track-mounted excavator and the borings were drilled by a licensed drilling contractor operating a small track-mounted drill rig, both working under contract for GeoResources.

The specific number, locations, and depths of our explorations were selected based on the configuration of the proposed development and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations, and encountered stratigraphy. Representative soil samples obtained from the test pits were placed in sealed plastic bags and then taken to our laboratory for further examination and testing as deemed necessary. Soil densities presented on the test pit logs are based on the difficulty of excavation and our experience. The test pits were backfilled with the excavated soils and bucket tamped, but not otherwise compacted, while the borings were completed as groundwater monitoring wells by the driller in general accordance with Washington State Department of Ecology requirements.

During drilling, soil samples were obtained at 2½- and 5-foot depth intervals in accordance with Standard Penetration Test (SPT) as per the test method outlined by ASTM D1586. The SPT method consists of driving a standard 2-inch-diameter split-spoon sampler 18-inches into the soil with a 140-pound hammer. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “SPT blow count”. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The subsurface explorations completed 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.

The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D2488. The approximate locations of our explorations are indicated on the attached Site & Exploration Map, Figure 2. The USCS is included in Appendix A as Figure A-1, while descriptive logs of the soils encountered are included as Figures A-2 through A-6.

Subsurface Conditions

Our test pit explorations encountered relatively uniform subsurface conditions that, in our opinion, generally agree with the mapped stratigraphy within the site vicinity. In general, our test pits encountered about 0.1 to 1 foot of topsoil overlying about 1 to 3 feet of brown silty sand in a loose, moist condition. We interpret these soils to be consistent with weathered outwash. Underlying the weathered soils, our explorations encountered brown-grey sand to sand with silt in a loose to medium dense, moist condition to the full depth explored. We interpret these soils to be consistent with recessional outwash. Overlying the outwash in Test Pits TP-2 and TP-7, we encountered about 1 to 8.5 feet of brown to tan silt in a medium stiff, moist condition. We interpret these soils to be consistent with recessional lacustrine or slackwater deposits.

Our borings encountered similar subsurface conditions across the site. Boring B-1, located in the lower, northern portion of the site encountered about 1.5 feet of silty topsoil overlying about 4 feet of mottled tan silt in a stiff, moist condition. Underlying these upper fine-grained soils, our boring encountered sand to sand with silt in a loose to medium dense, moist to wet condition to the full depth explored. Silt interbeds were encountered within these sandy soils at about 16 and 30 feet below the ground surface. Boring B-2, in the upper portion of the site, encountered about 1 foot of sandy dark brown topsoil overlying about 1.5 feet of tan to brown silty sand in a loose, moist condition. Underlying these upper soils, our exploration encountered grey brown sand to sand with silt in a medium dense, moist condition to the full depth explored. We interpret these soils to be consistent with weathered outwash over recessional outwash.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the test pits to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D2488, moisture content determinations per ASTM D2216, and grain size analyses per ASTM D6913 standard procedures. The results of the laboratory tests are included in Appendix B.

Groundwater Conditions

Groundwater seepage was not observed in our test pit explorations at the time of excavation. However, groundwater was encountered in our lower boring (B-1) at about 31 feet below the ground surface at the time of drilling. A small seepage zone was also observed in Boring B-1 at about 16 feet below ground surface where fine grained soils were encountered. We interpret the observed groundwater seepage to be associated with a localized perched groundwater table and the lower groundwater to be more representative of regional levels. Perched groundwater typically develops when the vertical infiltration of precipitation through a more permeable soil is slowed at depth by a deeper, less permeable soil type. We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off-site construction activities, and site utilization.

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 residential development. Infiltration into the recessional sand soils appears to be feasible at the site, especially in the upper portion of the site. Discontinuous impermeable fine-grained deposits were encountered within the recessional sands in the northern portion of the site and may limit facility siting and depths if proposed in those areas. Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed development are presented below.

Landslide Hazard Areas – Per TCC 24.03.010

According to the Thurston County Code 24.03.010 , landslide hazard areas means those areas which are potentially subject to risk of mass movement due to a combination of geologic, topographic, and hydrologic factors; and where the vertical height is fifteen feet or more, excluding those wholly manmade slopes created under the design and inspection of a geotechnical professional. The following areas are considered to be subject to landslide hazards:

A. Any area with a combination of:
    1. Slopes of fifteen percent or steeper, and
    2. Impermeable subsurface material (typically silt and clay), frequently interbedded with granular soils (predominantly sand and gravel), and

3. Springs or seeping groundwater during the wet season (November to February);

B. Steep slopes of forty percent or greater;

C. Any areas located on a landslide features which has shown movement during the Holocene Epoch (post glacial) or which is underlain by mass wastage debris from that period of time;

D. Known hazard areas, such as areas of historic failures, including areas of unstable, old and recent landslides;

E. Breaks between landslide hazard areas shall be considered part of the landslide hazard area under the following condition: The length of the break is twice the height or less than the height of the slope below or above the break, whichever is greater; and the combined height is fifteen feet or more. When this condition is present, the upper and lower landslide hazard areas and the break shall be combined into one landslide hazard area.

Slopes of 15 percent or steeper are present across the central and northern portions of the site. Our lower boring encountered fine grained deposits interbedded with more granular soil; however, we would not interpret these to be adverse contacts based on the depth at which they were encountered. No evidence of springs or groundwater seepage along the slopes at the site were observed during our site visit. Groundwater was encountered at approximately Elevation 73 feet at the location of Boring B-1. This elevation is approximately the same as the wetlands delineated in the lower northern portion of the site.

No evidence of seepage on slopes, landslide activity, or significant erosion was observed at the site at the time of our visit. Slopes of 40 percent or steeper with 15 feet or more of vertical relief were not observed or mapped at the site. No planes of weakness, geomorphic features, tension cracks, or structural failure indicative of slope failure, toppling or leaning tress, gullying or surface erosion were observed at the site at the time of our visit. No areas of soft or liquefiable soils, alluvial deposits, or areas at risk of seismically induce mass movement were observed or mapped at or within 300 feet of the site.

Based on the above, it does appear that the site has one of the above listed indicators (slopes of forty percent); however, no evidence of landslide activity was observed at the site. Therefore, it is our opinion that no prescriptive buffer should be required by the County. Building setbacks in accordance with the 2015 International Building Code (IBC) may still be required by the Thurston County building department.

Recommended Setback from Steep Slopes

The 2015 International Building Code (IBC), Section 1808.7 requires a building setback from slopes that are steeper than 3H:1V (Horizontal: Vertical) or 33 percent with greater than 10 feet in vertical height, unless evaluated and reduced and/or a structural setback is provided by a licensed geotechnical engineer. The setback distance is calculated based on the vertical height of the slope. The typical 2015 IBC setback from the top of the slope equals one third the height of the slope or 40 feet, whichever is less, while a setback from the toe of the slope equals one half the height of the slope or 15 feet, whichever is less.

As stated above, portions of the site steeper than 33 percent. These slopes have vertical heights on the order of 10 to 15 feet in the northeastern portion of the site. Per the 2015 IBC, these slopes should have a minimum setback of 4 to 5 feet from the top of the slopes and 5 to 8 feet from the toe of the slopes.

Where the setback from the top of the slope cannot be met, a structural setback may be used. A structural setback is created by deepening the foundation elements so that, when measured horizontally from the font of the foundation to the face of the slope, the top of slope setback discussed above is met. If necessary, we can provide structural setback recommendations at your request.

Erosion Hazards – Per TCC 24.03.010

According to the TCC Critical Areas 24.03.010, an erosion hazard area means land characterized by soil types that are subject to severe erosion when disturbed. These include, but are not limited to, those identified by the United States Department of Agriculture Soil Conservation Service Soil Classification System, with a water erosion hazard of “severe” or “high” (See Table 24.15-3, Erosion Soils of Thurston County). These areas may not be highly erodible until or unless the soil is disturbed by activities such as clearing or grading.

As previously stated, the site is underlain by Giles silt loam (39) and Skipopa silt loam (108) which both have a “slight” erosion hazard when exposed and Hoogdal silt loam (43) and Indianola loamy sand (48) which have a “moderate” erosion hazard when exposed. No evidence of active or ongoing erosion was observed at the time of our site visits. In our opinion, the site does not have an active erosion hazard.

Seismic Design

The site is located in the Puget Sound region of western Washington, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American plate at the Cascadia Subduction Zone (CSZ). This produces both intercrustal (between plates) and intracrustal (within a plate) earthquakes. In the following sections we discuss the design criteria and potential hazards associated with the regional seismicity.

Seismic Site Class

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 range of SPT (Standard Penetration Test) blow counts for the soils encountered in our borings. These conditions are assumed to be representative for the subsurface across the site.

Design parameters

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.

TABLE 1:
2015 IBC PARAMETERS FOR DESIGN OF SEISMIC STRUCTURES

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.319	S_1 = 0.536
Site Coefficients (Site Class D)	F_a = 1.000	F_v = 1.500
Maximum Considered Earthquake SRA	S_{MS} = 1.319	S_{M1} = 0.804
Design SRA	S_{DS} = 0.880	S_{D1} = 0.536

Peak Ground Acceleration

The mapped peak ground acceleration (PGA) for this site is 0.5g. 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 0.5g. In general, estimating seismic earth pressures (k_h) by the Mononobe-Okabe method are taken as 50 percent of the PGA_M, or 0.25g.

Seismic Hazards

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure in soils. The increase in pore water pressure is induced by seismic vibrations. Liquefaction primarily affects geologically recent deposits of loose, uniformly graded, fine-grained sands and granular silts that are below the groundwater table. Based on our review of the Department of Natural Resources Liquefaction Susceptibility Map (Geologic Information Portal) the site appears to be in an area mapped as having a "low to moderate" susceptibility to liquefaction (Figure 5). In our opinion, this coincides with the conditions observed in the explorations performed at the site. Because of the relatively low susceptibility of site soils to liquefaction, it is our opinion that the likelihood of lateral spreading is also low.

Based on our review of the Department of Natural Resources Geologic Hazards Map (Geologic Information Portal), the site is located about 2 miles northeast of the Olympia structure faults (Figure 6). No evidence of ground fault rupture was observed in the subsurface explorations or out site reconnaissance. Therefore, in our opinion, the proposed structure should have no greater risk for ground fault rupture than other structures located in the area.

Foundation Support

Based on the subsurface conditions encountered across the site and our understanding of the preliminary plans, we recommend that spread footings be founded on the medium dense native 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 or recompacted, as appropriate. 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 18 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Footings founded as described above on the medium dense sand or on imported clean "**Structural Fill**" may be designed with a maximum allowable bearing pressure of 2,000 psf (pounds per square foot). 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 300 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 less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of ½ inch or less. 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. We recommend that all foundations be provided with footing drains constructed in accordance with the 2015 IBC Section 1805.4.2.

Floor Slab Support

Slab-on-grade floors, where constructed, should be supported on the medium dense recessional outwash or on structural fill prepared as described above. Any areas of old fill material should be evaluated during grading activity for suitability of structural support. Areas of significant organic debris should be removed.

We recommend that floor slabs be directly underlain by a minimum 4-inch thick capillary break that consists of clean, granular material, such as pea gravel or ⅝-inch clean crushed rock and should contain less than 2 percent fines. This layer 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 medium dense recessional soils, or where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab.

A subgrade modulus of 200 pounds per cubic inch (pci) 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.

Cast-in-Place Subgrade/Basement Walls

The lateral pressures acting on retaining walls (such as basement or grade separation walls) will depend upon the nature and density of the soil behind the wall as well as the presence or absence of hydrostatic pressure. Below we provide recommended design values and drainage recommendations for retaining walls.

<u>Design Values</u>

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 at rest 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 of this report.

Wall Drainage

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure 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 retained on the US No. 4 sieve.

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. Typical wall drainage and backfilling details are shown on Figure 7.

A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions. A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also 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 maximum dry density (MDD), as determined in accordance with ASTM D1557. Over-compaction should be avoided as this can lead to excessive lateral pressures on the wall.

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 loose to medium dense 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.

Permanent Cut and Fill Slopes

Fill slopes constructed on grades that are steeper than 5H:1V should be constructed in accordance with Appendix J of the 2015 IBC and should utilize proper keying and benching methods. The benches should be 1½ times the width of the equipment used for grading and be a maximum of 3 feet in height. Subsurface drainage may be required in areas where significant seepage is encountered during grading. Collected drainage should be directed to an appropriate discharge point. Surface drainage should be directed away from all slope faces.

Permanent slopes in soil should be no steeper than 2H:1V. All permanent slopes should be protected from erosion as soon as feasible after grading is completed. Typical erosion control methods per the 2016 Thurston County Drainage Design and Erosion Control Manual should be sufficient for proposed site grading activities. Additionally, permanent slopes should be planted with a hardy vegetative groundcover, mulched, or armored with quarry spalls as soon as feasible after grading is completed.

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 residence in accordance with the 2015 IBC, Section 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

Based on our subsurface explorations and our site observations, it is our opinion that onsite infiltration of stormwater runoff generated by the proposed development is feasible in the well-graded to poorly graded sand with variable silt and gravel content encountered across the upper, southern portions of the site.

Prior to the selection of an infiltration facility location, all minimum vertical separation and horizontal separation requirements should be considered. Per the 2016 TCDDECM, Volume III, Section 2.3, a minimum vertical separation of 1 foot is required between the bottom of a non-treatment infiltration Best Management Practice (BMP) and the top of an impermeable layer, such as hard pan, that serves 10,000 square feet (sf) of hard surfacing or less. A minimum of 3 feet of vertical separation is required for non-treatment infiltration BMPs serving 10,000 sf or more. Infiltration BMPs that provide water quality treatment for the stormwater require a minimum vertical separation of 5 feet between the bottom of the facility and the top of a restrictive layer, such as a seasonal high water table (2016 TCDDECM, Volume I, Section 4.7.3.3). Per Volume V, Chapter 2.2.6.8.1 of the 2016 TCDDECM, permeable pavement should not be located where seasonal high groundwater or an underlying impermeable/low permeable layer would create saturated conditions within 1 foot of the bottom of the lowest gravel base course. Based on our subsurface explorations, it is our opinion the above minimum vertical separation criteria could be met in the upper southern portions of the site. Vertical separation criteria could potentially be met in the lower, northern portion of the site but will be dependent on the proposed site grading. However, horizontal setback would also have to be considered, especially from steep slopes.

Soil gradation analyses were completed in accordance with ASTM D6913 and a site specific infiltration rate was determined in accordance with the Volume III Appendix III-A Method 3 – Soil Grain Size Analysis Method. Based on the Massmann equation we recommend a preliminary infiltration rate for the sand with silt soils of 4 inches per hour be used. Correction factors for testing method (0.4) and plugging (0.8) have been applied to this value in accordance with the 2016 TCDDECM. A factor of safety for geometry and below grade facilities should be applied by the civil engineer in accordance with the 2016 TCDDECM.

While the above recommended infiltration rate is suitable for the design of permeable pavement sections, the infiltration rate may not be suitable for treatment of runoff from the pollution generating surfaces. Appropriate soil amendments should be added to the soils below permeable pavement, if used, for water quality treatment in accordance with the 2016 DDECM.

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. In-situ infiltration testing should be performed at the time of stormwater design to verify the recommended infiltration rate within the proposed facility locations.

Appropriate design, construction, and maintenance are required to ensure the infiltration rate can be effectively maintained over time. It should be noted that special care is required during the grading and construction periods to avoid fine sediment contamination of the infiltration system. This may be accomplished through the use of an alternative stormwater management location during construction or by leaving the bottom of the system 1 to 2 feet higher than the design elevation and subsequently excavating to the finished grade after paving and landscaping installation are complete. All contractors, builders, and subcontractors working on the site should be advised to avoid allowing "dirty" stormwater to flow into the stormwater system during construction and landscaping activities. No concrete trucks should be washed or cleaned onsite.

All proposed infiltration facilities should be designed and constructed in accordance with the 2016 TCDDECM. All minimum separation, setback requirements, and infeasibility criteria per the 2016 TCDDECM should be considered prior to the selection, design, and location of any stormwater facility for the proposed development. The slopes located in the central portion of the site slope down to the north at greater than 15 percent. Per Volume V Appendix E of the 2016 TCDDECM, slopes steeper than 15 percent with greater than 10 feet of vertical relief are required to be setback at least 50 feet from the top of the slope.

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be graded 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. Based on our subsurface exploration, we anticipate that stripping depth will likely range from about 6 to 12 inches. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

Where placement of fill material or structural elements is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of new 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 ½-inch diameter steel T-probe during wet weather conditions.

Soft, loose or otherwise unsuitable areas delineated during proof-rolling 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 maximum dry density (MDD) as determined in accordance with ASTM D1557.

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used, but it is typically limited to 4- to 6-inches for hand operated equipment. For planning purposes, we recommend a maximum loose-lift thickness of 12 inches for heavier equipment such as hoe-packs or drum rollers. 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 a material such as well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the ¾-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, any non-organic onsite 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 soil material is over optimum moisture at the time of excavation, 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 explorations.

The recessional outwash encountered in our explorations is generally comparable to *Common Borrow* (WSDOT Standard Specification 9-03.14(3)). These soils should be suitable for use as structural fill provided the moisture content is maintained within 2 to 3 percent of the optimum moisture level. Because of the fines content in the shallow recessional lacustrine soils encountered in the lower portion of the site, we do not recommend that these soils be used for structural fill. These shallow, silty soils may be used as fill in non-structural areas.

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 be in place prior to grading activity on the site. Erosion hazards can be mitigated by applying Best Management Practices (BMP's) outlined in the 2016 TCDDECM. To manage and reduce the potential for these natural processes, we recommend the following:

- No drainage of concentrated surface water or significant sheet flow onto or near the steep slope area.
- No fill should be placed within any buffers or setback areas unless retained by engineered retaining walls or constructed as an engineered fill.
- Grading should be limited to providing surface grades that promote surface flows away from the top of slope to an appropriate discharge location.

If the recommended erosion and sediment control BMPs are properly implemented and maintained, it is our opinion that the planned development should not increase the potential for erosion of the site.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, the wet season generally begins October 1st and continues through about April 30th, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months. Most of the soil at the site does not contain sufficient fines to produce an unstable mixture when wet. Soils with high fines contents are 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 increase, 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 when not being worked. 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 (ASTM D1140) 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 specification.

LIMITATIONS

We have prepared this report for use by Three's Company, 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

Jordan L. Kovash, GIT
Staff Geologist in Training

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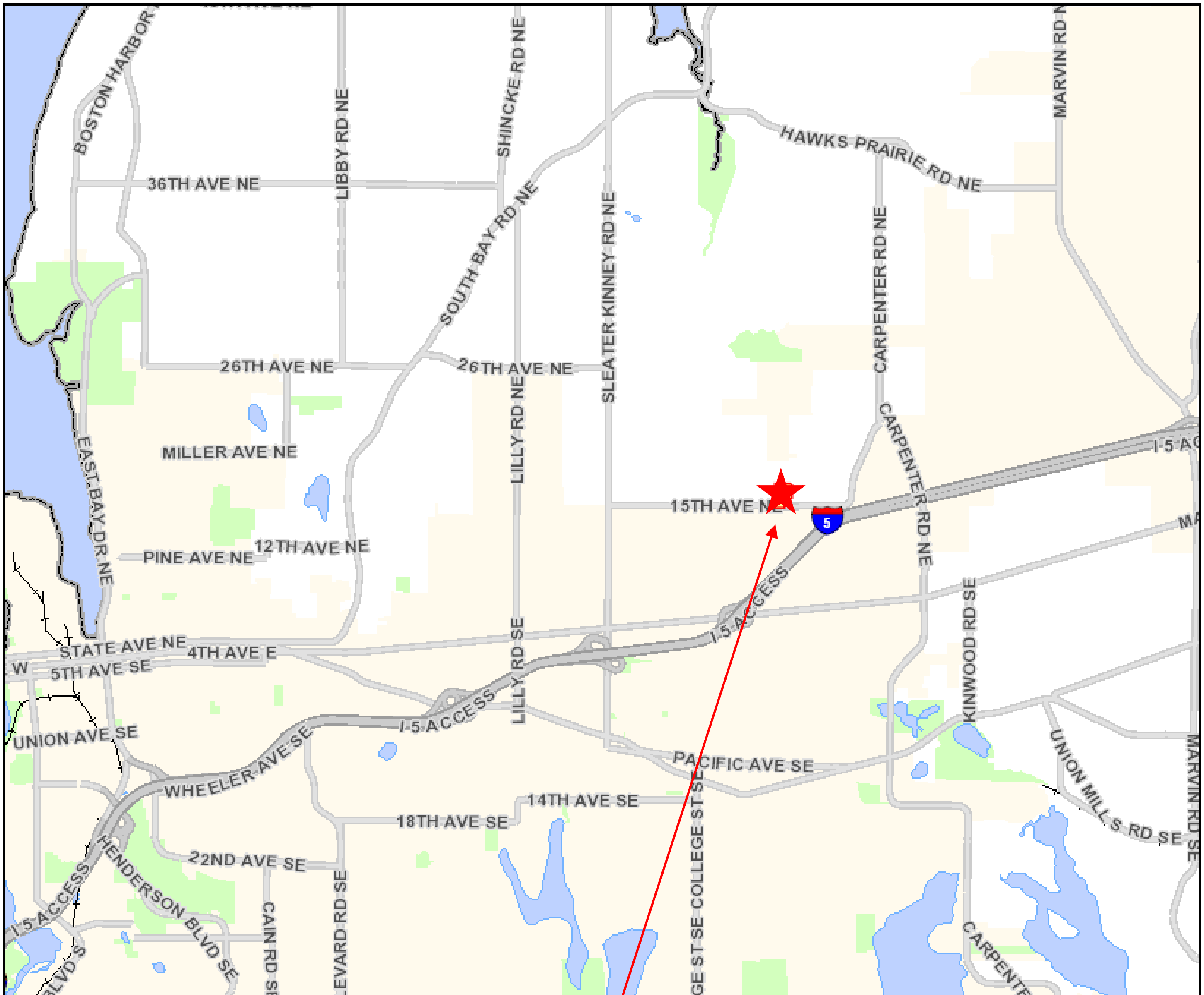
JLK:DCB:EWH/jlk
Doc ID: ThreesCompanyLLC.15thAveNE.RG
Attachments:
- Figure 1: Site Location Map
- Figure 2: Site & Exploration Map
- Figure 3: NRCS Soils Map
- Figure 4: Geologic Map
- Figure 5: Liquefaction Susceptibility Map
- Figure 6: Active Faults & Folds Map
- Figure 7: Typical Wall Drainage & Backfill Detail
- Appendix A - Subsurface Explorations
- Appendix B - Laboratory Test Results



Approximate Site Location

Map created from Thurston County Public GIS (http://www.geodata.org/parcelinfo/#)

N W E S

Not to Scale

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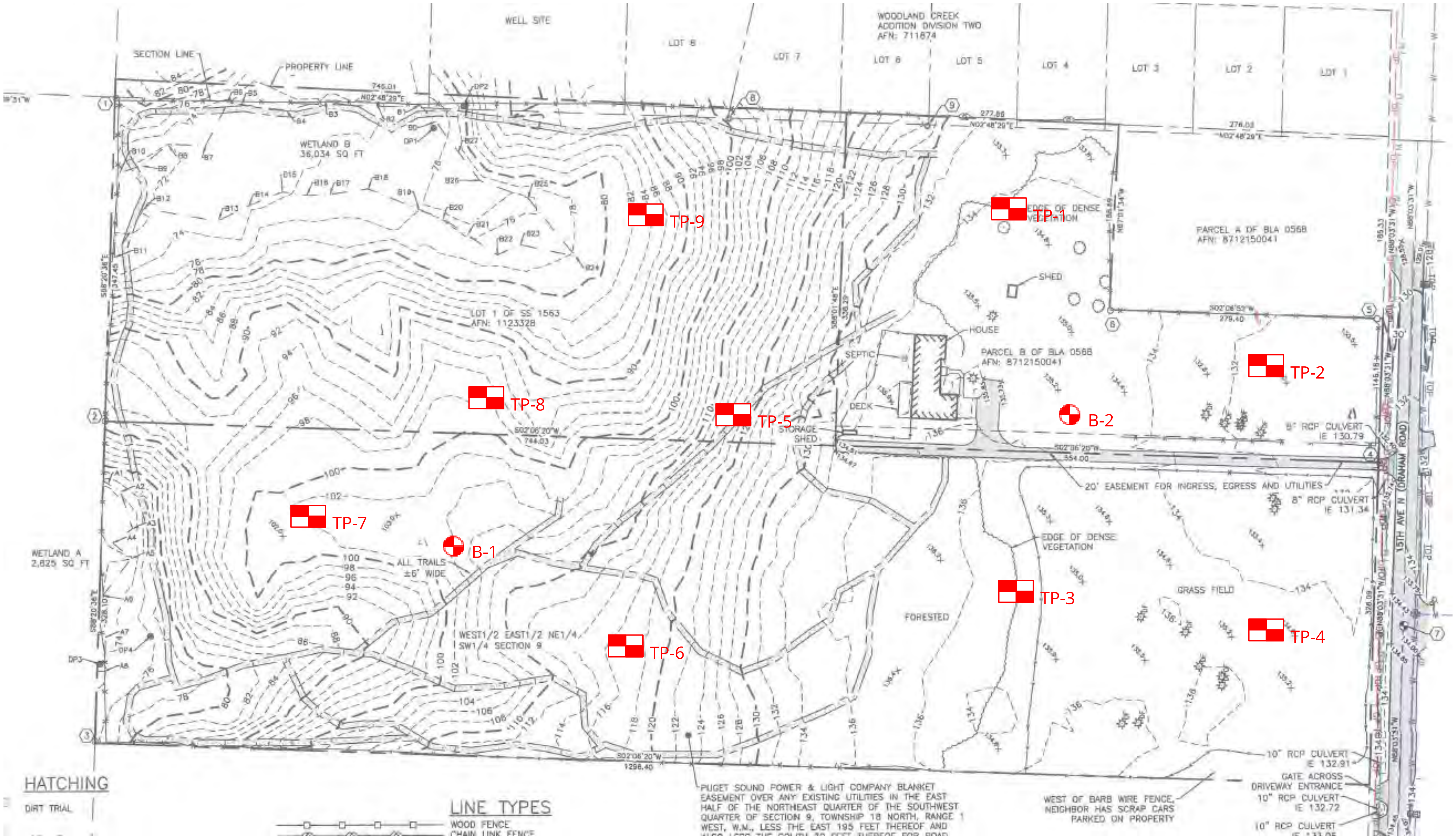
Site Location Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 1



Notes:
Site Survey prepared by MTN2COAST, LLC dated November 6, 2019

Scale 1:120

NORTH

TP-1 Exploration number and approximate location (GeoResources 2019)
B-1 Exploration number and approximate location (GeoResources 2020)

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Site & Exploration Map
Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.SEM	March 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
39	Giles Silt Loam	Volcanic ash and glacial outwash	3 to 15	Slight	B
43	Hoogdal silt loam	Loess and glaciolacustrine deposits	15 to 30	Moderate	D
48	Indianola loamy sand	Sandy glacial outwash	15 to 30	Moderate	A
108	Skipopa silt loam	Volcanic ash over glaciolacustrine deposits	3 to 15	Slight	D

N W E S

Not to Scale

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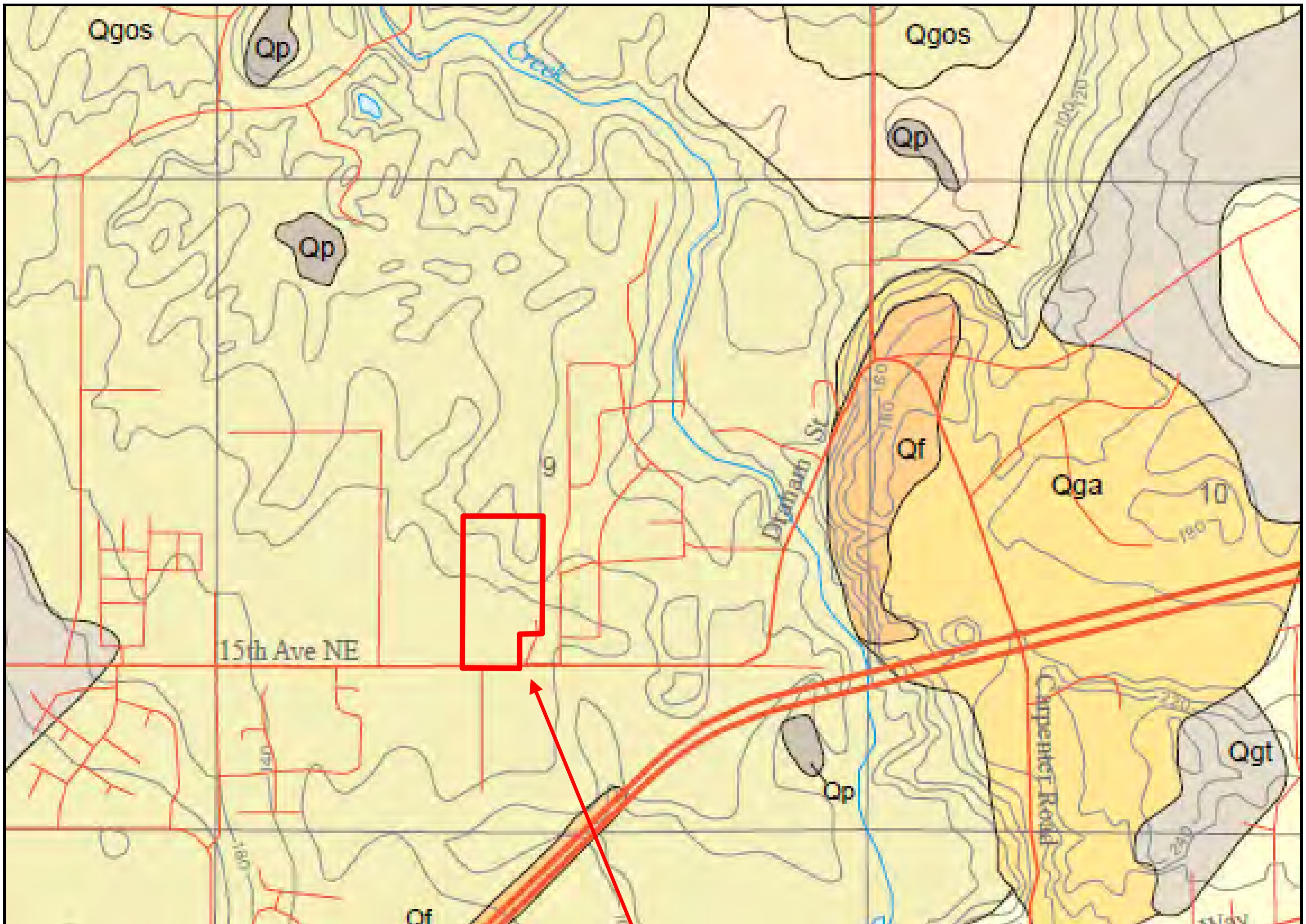
NRCS Soils Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 3



Approximate Site Location

An excerpt from *Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington* by Robert L. Logan, Timothy J. Walsh, Henry W. Schasse, and Michael Polenz (2003)

Qf	Fill
Qp	Peat
Qgos	Vashon recessional sand and minor silt

N W E S

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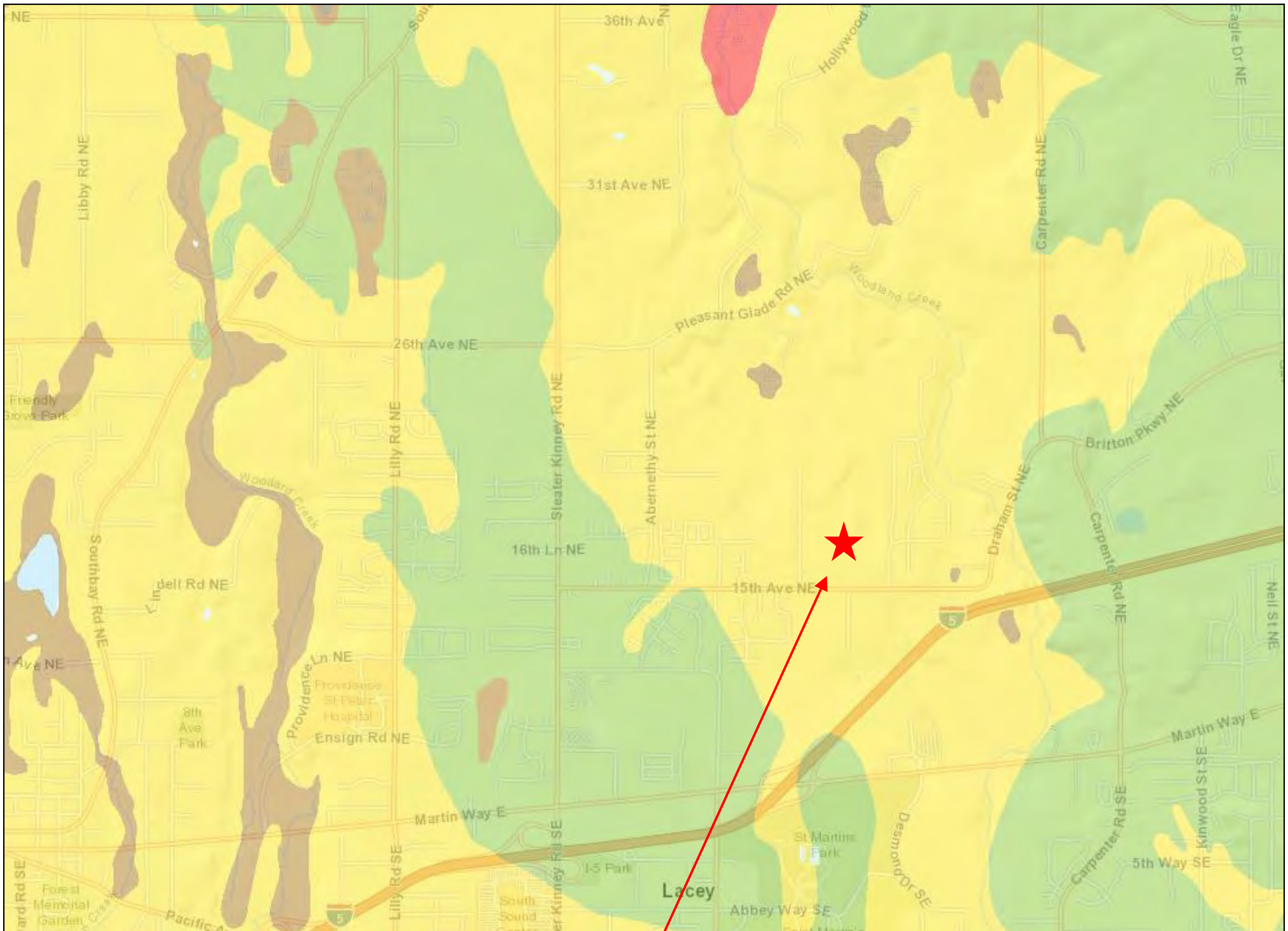
Geologic Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 4



Approximate Site Location

Map created from Washington DNR Geologic Information Portal (https://geologyportal.dnr.wa.gov/)

Liquefaction Susceptibility

- High
- Low to moderate
- Very low
- Peat
- Water

Not to Scale

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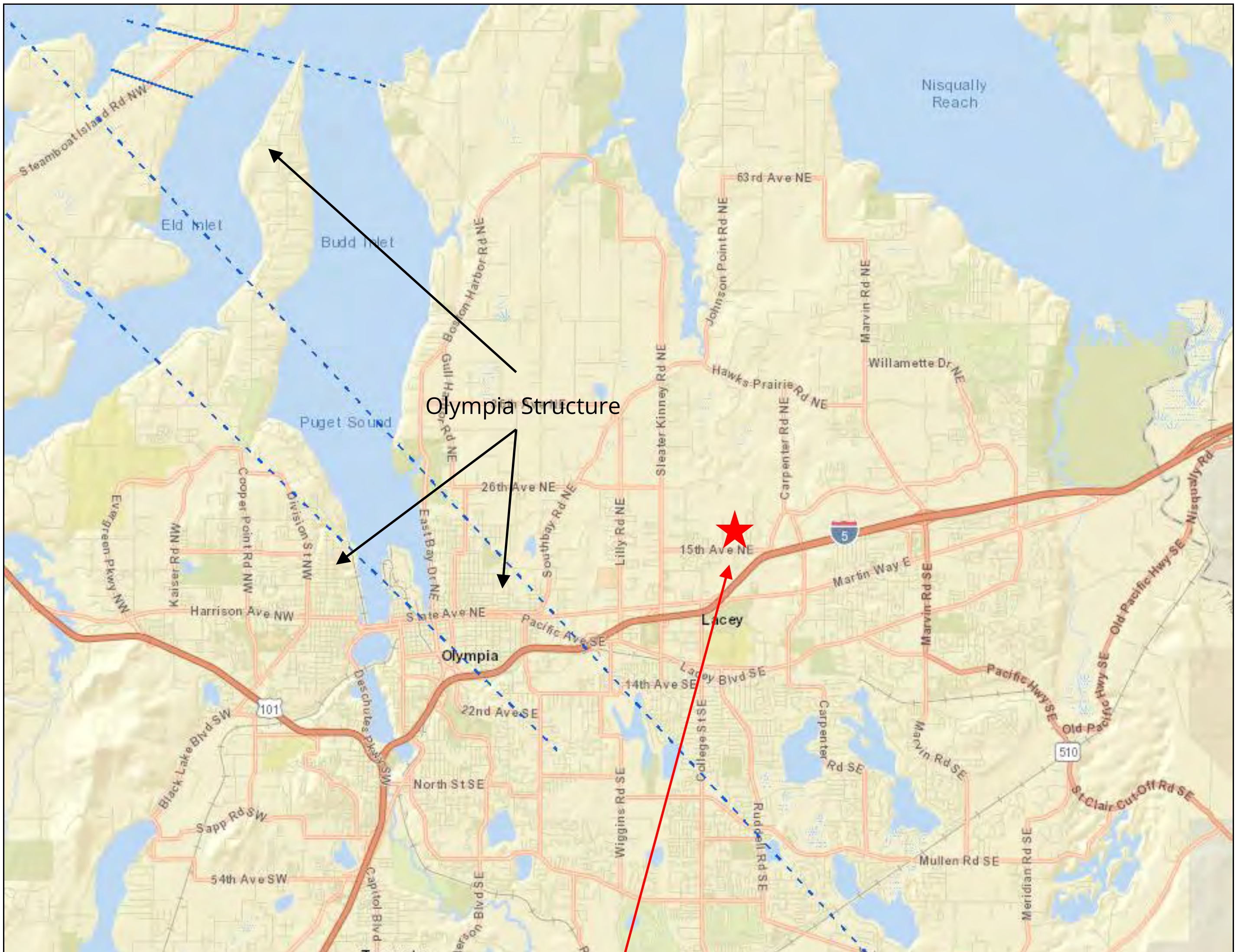
WA DNR Liquefaction Susceptibility Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 5



Approximate Site Location

Map created from Washington DNR Geologic Information Portal (https://geologyportal.dnr.wa.gov/)

Not to Scale

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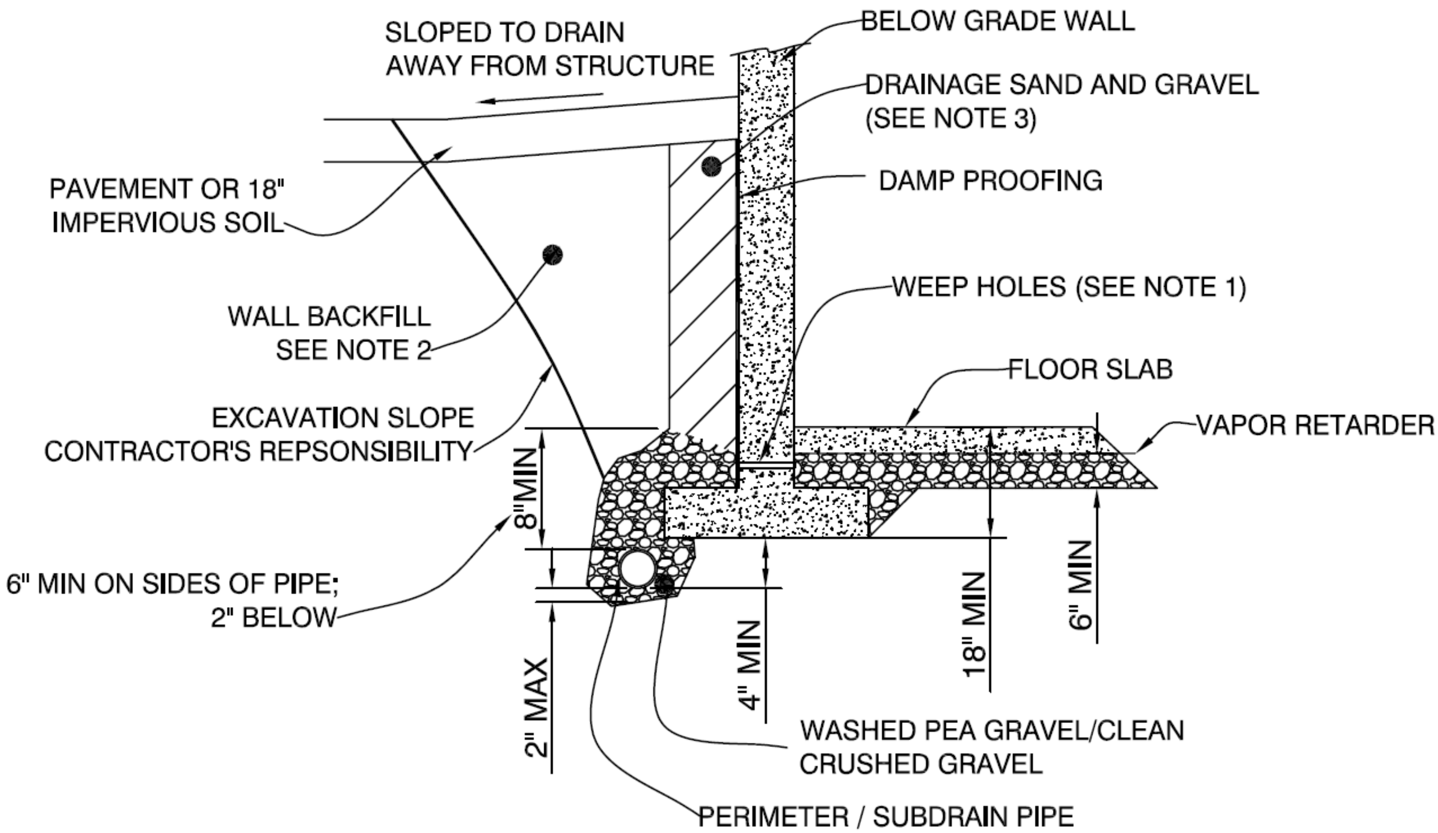
WA DNR Active Faults & Folds Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 6



Notes

1. Washed pea gravel/crushed rock beneath floor slab could be hydraulically connected to perimeter/subdrain pipe. Use of 1" diameter weep holes as shown is one applicable method. Crushed gravel should consist of 3/4" minus. Washed pea gravel should consist of 3/8" to No. 8 standard sieve.

2. Wall backfill should meet WSDOT Gravel Backfill for walls Specification 9-03-12(2).

3. Drainage sand and gravel backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall. The table below presents the drainage sand and gravel gradation.

4. All wall back fill should be placed in layers not exceeding 4" loose thickness for light equipment and 8" for heavy equipment and should be densely compacted. Beneath paved or sidewalk areas, compact to at least 95% Modified Proctor maximum density (ASTM: 01557-70 Method C). In landscaping areas, compact to 90% minimum.

5. Drainage sand and gravel may be replaced with a geocomposite core sheet drain placed against the wall and connected to the subdrain pipe. The geocomposite core sheet should have a minimum transmissivity of 3.0 gallons/minute/foot when tested under a gradient of 1.0 according to ASTM 04716.

6. The subdrain should consist of 4" diameter (minimum), slotted or perforated plastic pipe meeting the requirements of AASHTO M 304; 1/8-inch maximum slot width; 3/16- to 3/8-inch perforated pipe holes in the lower half of pipe, with lower third segment unperforated for water flow; tight joints; sloped at a minimum of 6"/100' to drain; cleanouts to be provided at regular intervals.

7. Surround subdrain pipe with 8 inches (minimum) of washed pea gravel (2" below pipe" or 5/8" minus clean crushed gravel. Washed pea gravel to be graded from 3/8-inch to No.8 standard sieve.

8. See text for floor slab subgrade preparation.

Materials

Drainage Sand and Gravel

Sieve Size	% Passing by Weight
¾"	100
No 4	28 – 56
No 8	20 – 50
No 50	3 – 12
No 100	0 – 2

¾" Minus Crushed Gravel

Sieve Size	% Passing by Weight
¾"	100
½"	75 – 100
¼"	0 – 25
No 100	0 – 2
(by wet sieving)	(non-plastic)

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Typical Wall Drainage & Backfill Detail

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Thurston County, Washington
PN: 11809310-600, -700, & -100

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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 D2487-90.

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 Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure A-1

Test Pit TP-1

Location: East of existing residence
Approximate Elevation: 134’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	3.5	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
3.5	-	10.0	SM	Brown-grey poorly graded SAND (loose, moist)(recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-2

Location: south of existing residence
Approximate Elevation: 136’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	1.5	ML	Brown SILT with sand (medium stiff, moist) (Recessional lacustrine/slackwater)
1.5	-	7.5	SP	Brown-grey poorly graded SAND (loose) (Recessional outwash)
7.5	-	13.0	SP-SM	Brown-grey poorly graded SAND with some chunks of silty sand (loose, moist) (Recessional outwash)

Terminated at 13 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 4 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-3

Location: West of existing residence
Approximate Elevation: 132’

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil
1.0	-	3.0	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
3.0	-	10.5	SP	Brown-grey poorly graded SAND (loose, moist) (Recessional outwash)

Terminated at 10.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3.5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC **Excavated on: December 31, 2019**

Test Pit TP-4

Location: SW corner of site
Approximate Elevation: 136’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.8	-	Dark brown topsoil
0.8	-	2.5	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
2.5	-	10.0	SP	Brown-grey poorly graded SAND (loose, moist) (recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-5

Location: Central portion of site, halfway down slope
Approximate Elevation: 102’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	8.5	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 8.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 2 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-6

Location: Western edge, central portion of site
Approximate Elevation: 92’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	3.0	SM	Brown-tan silty SAND (loose, moist) (Weathered recessional outwash)
3.0	-	10.5	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 10.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC **Excavated on: December 31, 2019**

Test Pit TP-7

Location: NW corner of site
Approximate Elevation: 84’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	9.0	MH	Tan-grey SILT (medium stiff, moist) (Recessional lacustrine deposits)
9.0	-	11.0	SP	Brown-grey poorly graded SAND (medium dense, moist) (Recessional outwash)

Terminated at 11 feet below ground surface.
No iron oxide staining or mottling observed.
No caving observed at the time of excavation.
No groundwater seepage observed at time of excavation.

Test Pit TP-8

Location: North portion of site, base of slope
Approximate Elevation: 74’

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil
1.0	-	3.5	SM	Brown-tan silty SAND (loose, moist) (Weathered recessional outwash)
3.5	-	12.0	SP-SM	Brown-grey poorly graded SAND with silt (loose to medium dense, moist) (Recessional outwash)

Terminated at 12 feet below ground surface.
Mottling/iron oxide staining observed at about 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed at time of excavation.

Test Pit TP-9

Location: West central portion of site
Approximate Elevation: 78’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.1	-	Dark brown topsoil
0.1	-	10.0	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC

Excavated on: December 31, 2019

TOTAL DEPTH: 36.5	**DRILLING METHOD:** HSA	**LOGGED BY:** JLK
TOP ELEVATION: 104	**DRILLING COMPANY:** Boretec 1, Inc	**HAMMER TYPE:** cat head
LATITUDE:	**DRILL RIG:** EC 95 Track Drill	**HAMMER WEIGHT:** 140 lbs
LONGITUDE:	**NOTES:** NW portion of site	

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Blow Count	Ground Water
0	104	Grey brown silty SAND/sandy SILT (loose, moist) (Topsoil)				
		Mottled tan sandy SILT, some gravel (loose, moist to wet) (Slackwater)		1	3 5 5	
5	100	Grey brown SAND (medium dense, moist) (Recessional Outwash)		2a 2b	3 7 9	
				3	5 5 5	
10	95			4	6 7 7	
15	90	Grey brown silty fine SAND (loose, moist)		5a		
		Grey brown sandy SILT (medium stiff, moist to wet) (Slackwater) (ML)		5b	5 4 2	
20	85	Grey SAND (medium dense, moist) (Recessional Outwash)		6	5 7 8	
25	80			7a	4 6 6	
		Grey silty fine SAND (medium dense, moist to wet)		7b		
30	75	Mottled grey brown silty SAND sandy SILT (medium stiff, moist to wet) (Slackwater)		8	1 2 4	ATD

TEST RESULTS

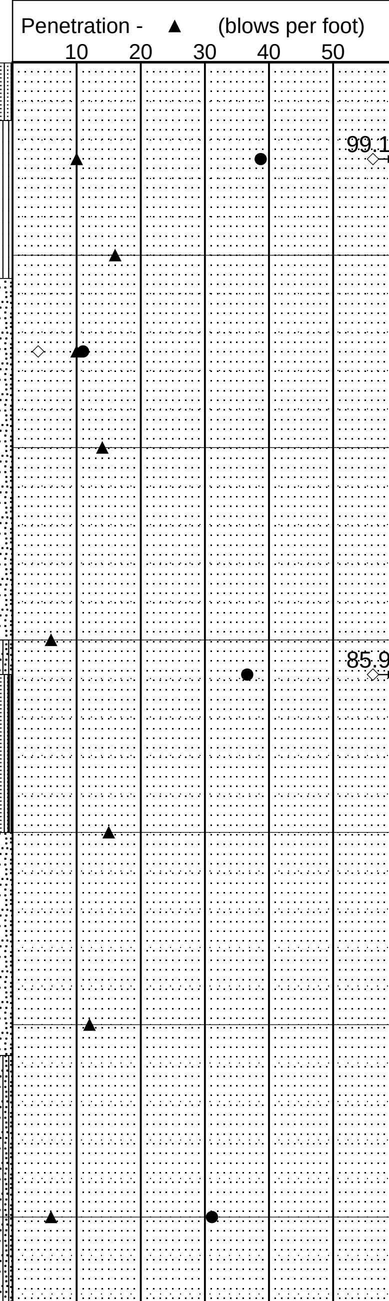
Test Results

Plastic Limit ├──┤ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blows per foot)



NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered
5. ATD = At the Time of Drilling

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-1

JOB: ThreesCompanyLLC.15thAveNE

GeoResources, LLC **FIG.A-5**

TOTAL DEPTH:	36.5	**DRILLING METHOD:**	HSA	**LOGGED BY:**	JLK
TOP ELEVATION:	104	**DRILLING COMPANY:**	Boretec 1, Inc	**HAMMER TYPE:**	cat head
LATITUDE:		**DRILL RIG:**	EC 95 Track Drill	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	NW portion of site		

TEST RESULTS

Test Results

Plastic Limit ├──┤ Liquid Limit
% Water Content ●
% Fines (<0.075mm) ◇

Penetration - ▲ (blows per foot)
10 20 30 40 50

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Sampler	Symbol	Blow Count	Ground Water
	70							
35		Grey silty SAND (medium dense, wet) (Recessional Outwash)		9			4 10 14	
		Bottom of Boring Completed2/11/2020						
	65							
40								
	60							
45								
	55							
50								
	50							
55								
	45							
60								
	40							

NOTES
1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered
5. ATD = At the Time of Drilling

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-1

JOB: ThreesCompanyLLC.15thAveNE Sheet 2 of 2

GeoResources, LLC FIG. A-5

TOTAL DEPTH: 51.5 **DRILLING METHOD:** HSA **LOGGED BY:** JLK

TOP ELEVATION: 135 **DRILLING COMPANY:** Boretec 1, Inc **HAMMER TYPE:** cat head

LATITUDE: **DRILL RIG:** EC 95 Track Drill **HAMMER WEIGHT:** 140 lbs

LONGITUDE: **NOTES:**

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Blow Count	Ground Water
0	135	Dark brown to brown silty SAND (loose, moist) (Topsoil)				
		Tan to brown silty SAND (loose, moist) (Weathered Recessional Outwash)				
		Tan to brown SAND with silt (loose, moist) (SP-SM) (Recessional Outwash)		1	4 4 5	
5	130	Grey brown SAND with silt (medium dense, moist)		2	5 7 7	
		Grey to grey brown SAND with silt and siltier interbeds (loose to medium dense, moist) (SP-SM)		3	6 5 5	
10	125	(loose, moist)		4	4 4 4	
15	120	(medium dense, moist)		5	4 5 6	
20	115	Grey brown SAND (medium dense, moist) (SP)		6b 6a	7 10 10	
25	110			7	7 9 10	
30	105			8	9 11 14	

TEST RESULTS

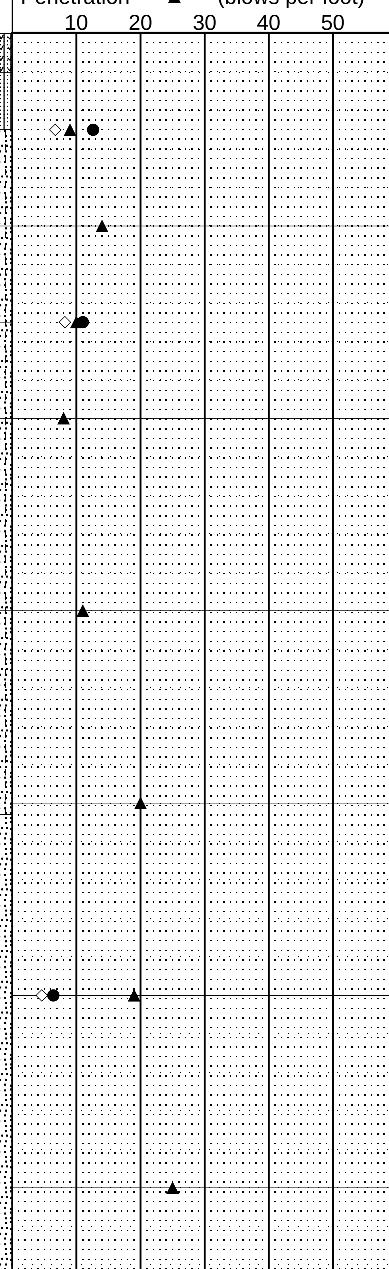
Test Results

Plastic Limit ├──┤ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blows per foot)



NOTES
1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered
5. ATD = At the Time of Drilling

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-2

JOB: ThreesCompanyLLC.15thAveNE

GeoResources, LLC **FIG.A-6**

TOTAL DEPTH: 51.5	DRILLING METHOD: HSA	LOGGED BY: JLK
TOP ELEVATION: 135	DRILLING COMPANY: Boretec 1, Inc	HAMMER TYPE: cat head
LATITUDE:	DRILL RIG: EC 95 Track Drill	HAMMER WEIGHT: 140 lbs
LONGITUDE:	NOTES:	

TEST RESULTS: Plastic Limit ├──┤ Liquid Limit; % Water Content ●; % Fines (<0.075mm) ◇; Penetration - ▲ (blows per foot) 10 20 30 40 50

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Sampler	Symbol	Test Results	Blow Count	Ground Water
35	100	(dense, moist)		9			▲ ~31	10 14 17	
40	95	(medium dense, moist)		10			● ~6, ▲ ~25	7 11 14	
45	90	(dense, moist) Grey brown fine SAND (dense, moist) (SP)		11a 11b			▲ ~31	9 16 15	
50	85	Grey brown SAND (medium dense, moist) (SP)		12			● ~6, ▲ ~20	9 10 10	
		Bottom of Boring Completed2/11/2020							
55	80								
60	75								

NOTES
1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered
5. ATD = At the Time of Drilling

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-2

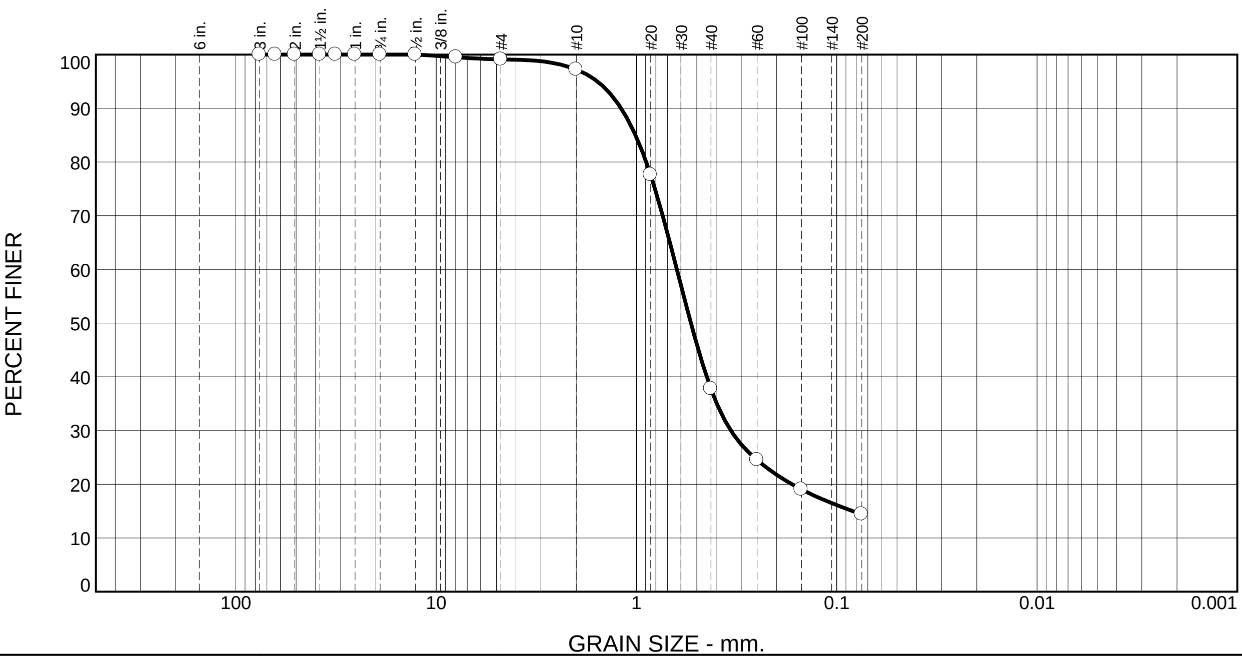
JOB: ThreesCompanyLLC.15thAveNE Sheet 2 of 2

GeoResources, LLC FIG. A-6

Appendix B

Laboratory Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	1.9	59.4	23.4	14.4	

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	100.0		
.5	100.0		
.3125	99.5		
#4	99.1		
#10	97.2		
#20	77.6		
#40	37.8		
#60	24.5		
#100	19.0		
#200	14.4		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 1.1930 D_{85}= 1.0117 D_{60}= 0.6282
D_{50}= 0.5348 D_{30}= 0.3379 D_{15}= 0.0831
D_{10}= C_u= C_c=

Remarks

NM:12.6%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-1 S-2
Sample Number: 099034 **Depth:** 3.5-10'

Date Sampled: 12/31/2019

GeoResources, LLC

Fife, WA

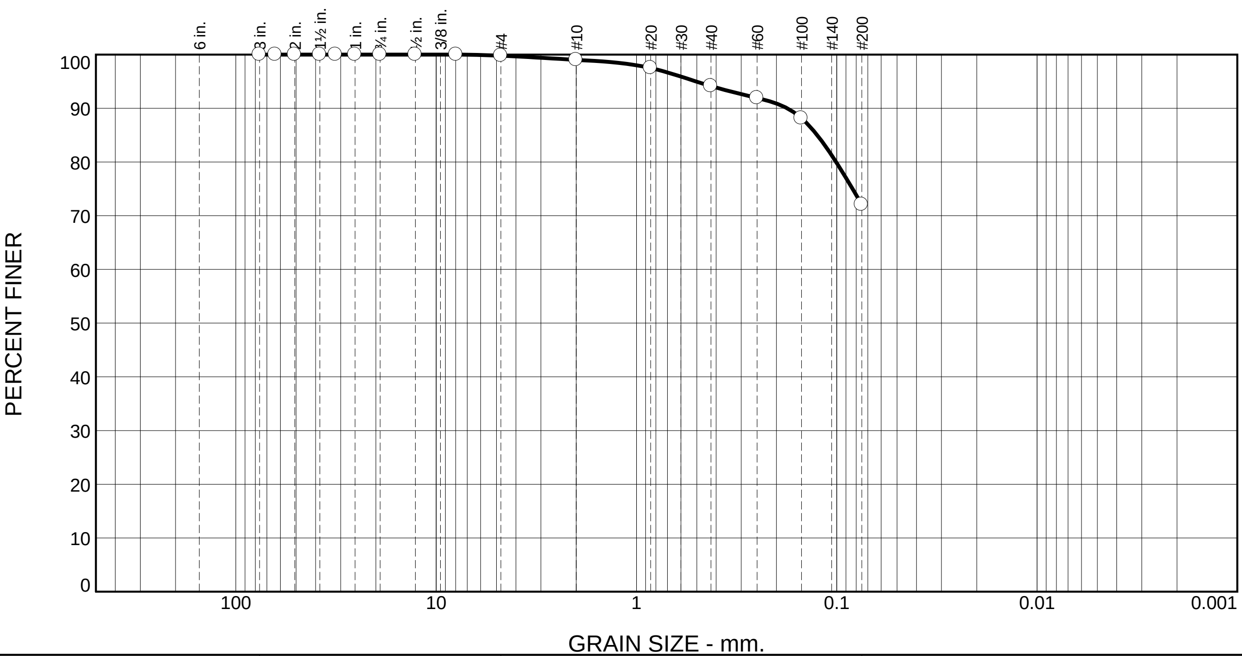
Client: Three's Company LLC
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-1

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	0.0	0.2	0.8	4.9	22.0	72.1	

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	100.0		
.5	100.0		
.3125	100.0		
#4	99.8		
#10	99.0		
#20	97.5		
#40	94.1		
#60	91.9		
#100	88.2		
#200	72.1		

* (no specification provided)

Material Description

SILT with Sand (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= ML **AASHTO (M 145)=**

Coefficients

D_{90}= 0.1768 D_{85}= 0.1251 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 25.4%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-2 S-1
Sample Number: 099035 **Depth:** 0.5-1.5
Date Sampled: 12/31/2019

GeoResources, LLC

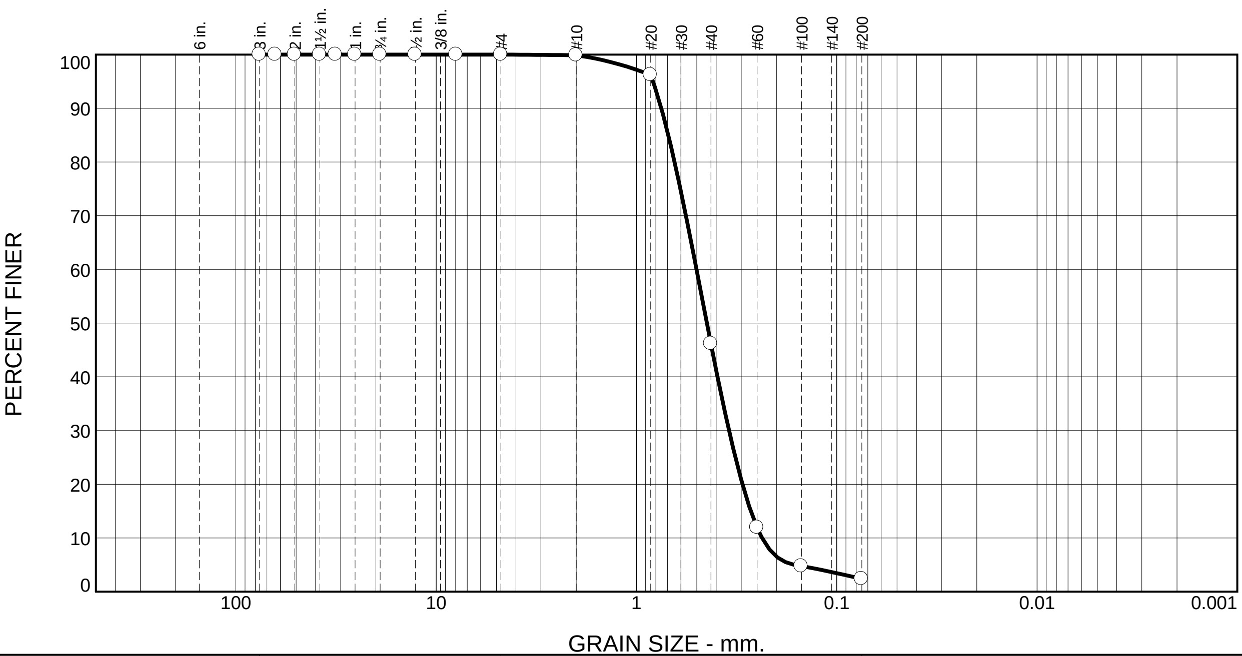
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-2

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	0.0	0.0	0.1	53.7	43.8	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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.9		
#20	96.2		
#40	46.2		
#60	11.9		
#100	4.7		
#200	2.4		

* (no specification provided)

Material Description

poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.7509 D_{85}= 0.6930 D_{60}= 0.5015
D_{50}= 0.4451 D_{30}= 0.3449 D_{15}= 0.2688
D_{10}= 0.2359 C_u= 2.13 C_c= 1.01

Remarks

NM: 4.3%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-3 S-1
Sample Number: 099038 **Depth:** 3-10' **Date Sampled:** 12/31/2019

GeoResources, LLC

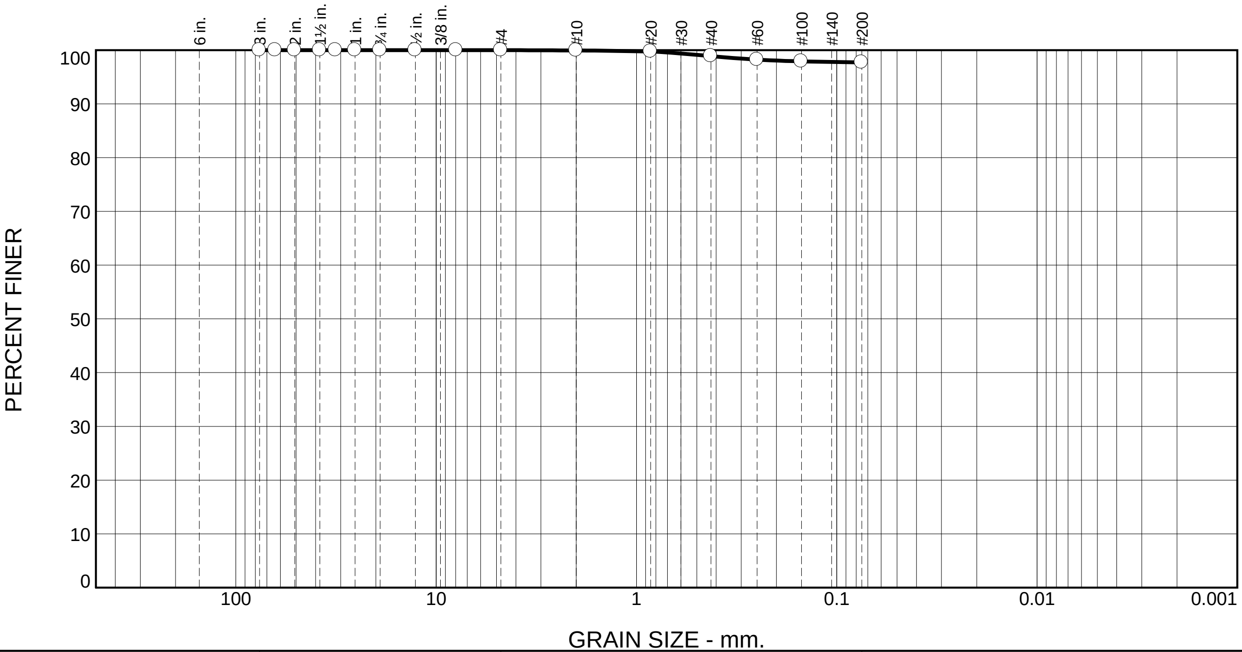
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-3

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	0.0	0.0	0.0	1.1	1.2	97.7	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	100.0		
#20	99.8		
#40	98.9		
#60	98.2		
#100	97.9		
#200	97.7		

* (no specification provided)

Material Description

SILT (MH)

Atterberg Limits (ASTM D 4318)

PL= 33 **LL=** 52 **PI=** 19

Classification

USCS (D 2487)= MH **AASHTO (M 145)=** A-7-5(24)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 22.1%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-7 S-1

Sample Number: 099042 **Depth:** 1-9'

Date Sampled: 12/31/2019

GeoResources, LLC

Fife, WA

Client: Three's Company LLC

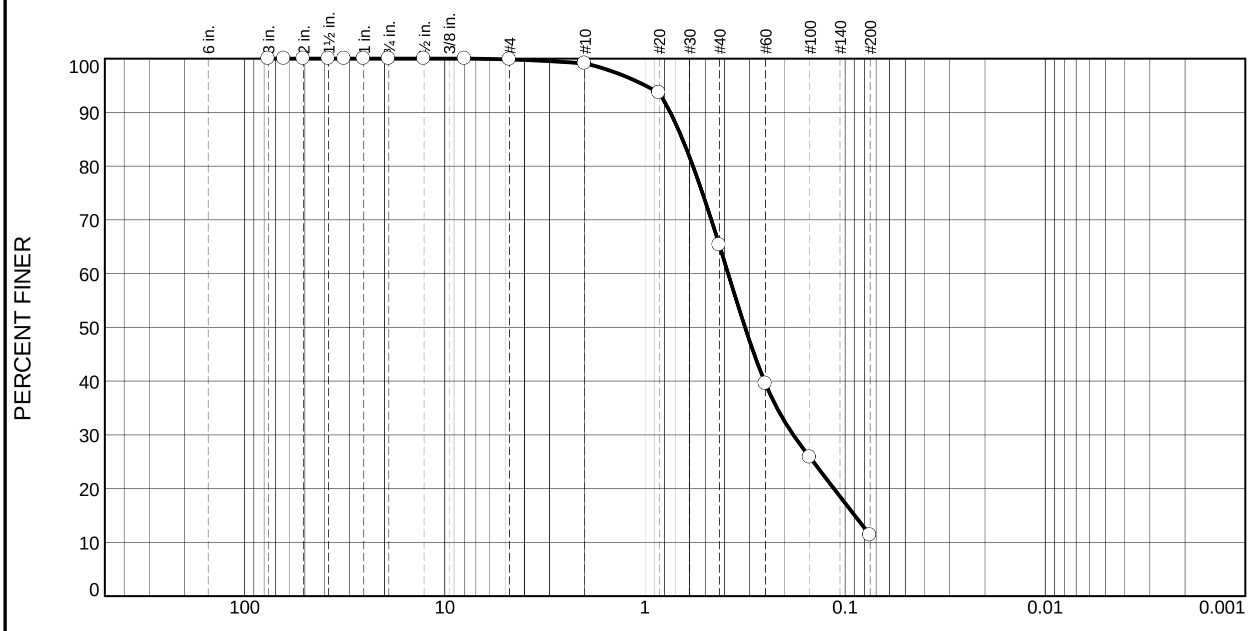
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-4

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	0.0	0.2	0.7	33.8	54.0	11.3	

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	100.0		
.5	100.0		
.3125	100.0		
#4	99.8		
#10	99.1		
#20	93.6		
#40	65.3		
#60	39.5		
#100	25.8		
#200	11.3		

* (no specification provided)

Material Description

Poorly graded SAND with silt (SP-SM)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.7467 D_{85}= 0.6488 D_{60}= 0.3840
D_{50}= 0.3162 D_{30}= 0.1814 D_{15}= 0.0894
D_{10}= C_u= C_c=

Remarks

NM: 18.3%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-8 S-2 **Date Sampled:** 12/31/2019
Sample Number: 099043 **Depth:** 3.5-12

GeoResources, LLC

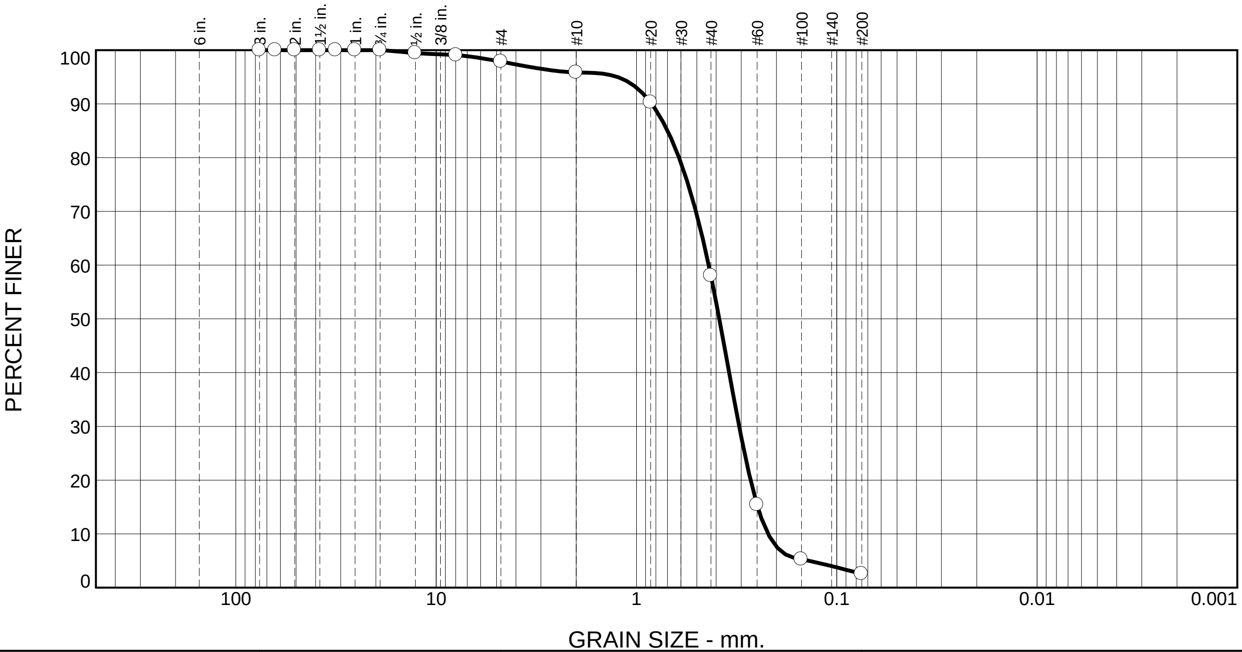
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-5

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	0.0	2.1	2.1	37.8	55.5	2.5	

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	100.0		
.5	99.4		
.3125	99.1		
#4	97.9		
#10	95.8		
#20	90.3		
#40	58.0		
#60	15.4		
#100	5.3		
#200	2.5		

* (no specification provided)

Material Description

poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.8395 D_{85}= 0.6988 D_{60}= 0.4359
D_{50}= 0.3858 D_{30}= 0.3071 D_{15}= 0.2482
D_{10}= 0.2201 C_u= 1.98 C_c= 0.98

Remarks

NM:6.0%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-9 S-1
Sample Number: 099045 **Depth:** 1-10'
Date Sampled: 12/31/2019

GeoResources, LLC

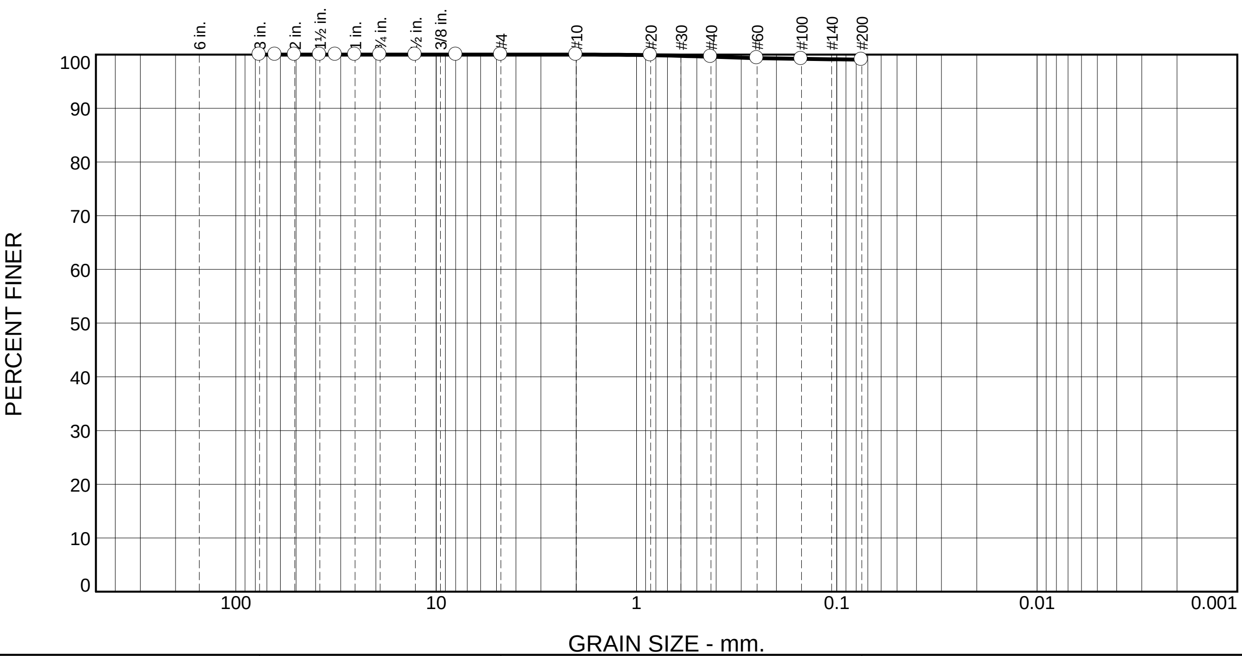
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-6

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	0.0	0.0	0.0	0.4	0.5	99.1	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.6		
#60	99.4		
#100	99.2		
#200	99.1		

* (no specification provided)

Material Description

Mottled tan sandy SILT (stiff, moist) (Slackwater) (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= ML **AASHTO (M 145)=**

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 38.7%
SAMPLE ID: 099244

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-1 **Depth:** 2.5 **Date Sampled:** 2/11/2020
Sample Number: 1

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.

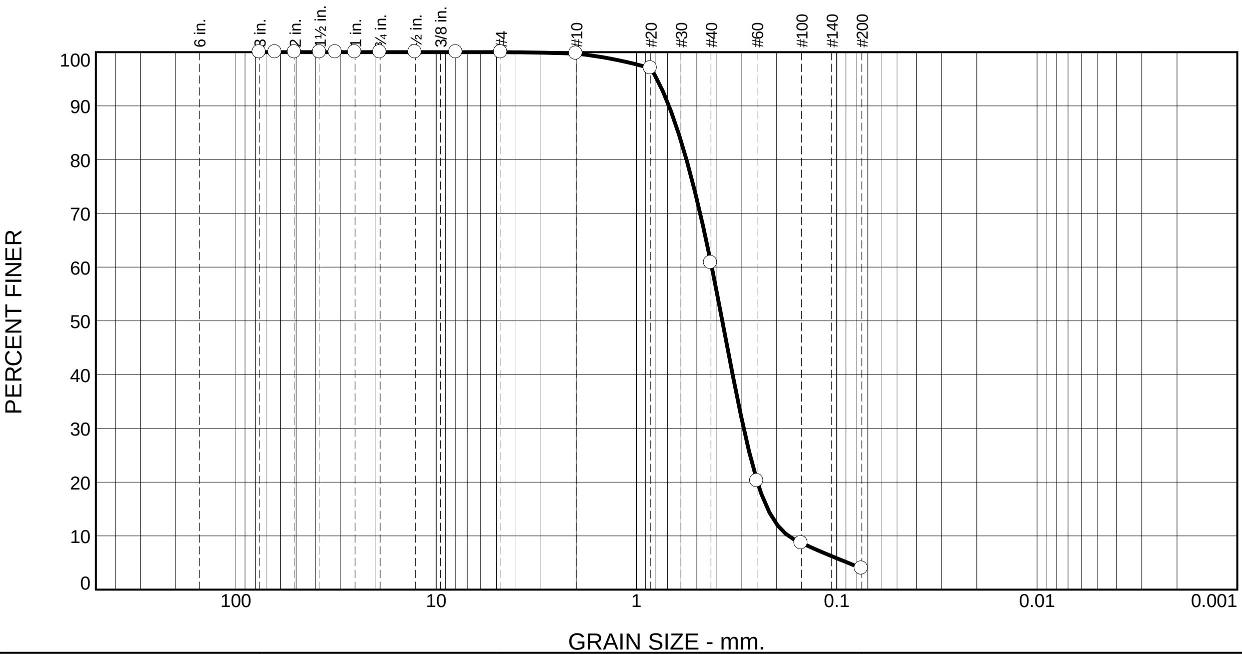
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-7

Tested By: ________________ **Checked By:** ________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	38.9	56.8	4.0	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.7		
#20	97.0		
#40	60.8		
#60	20.2		
#100	8.7		
#200	4.0		

* (no specification provided)

Material Description

Poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SP **AASHTO (M 145)=**

Coefficients

D_{90}= 0.6880 D_{85}= 0.6173 D_{60}= 0.4207
D_{50}= 0.3727 D_{30}= 0.2914 D_{15}= 0.2212
D_{10}= 0.1743 C_u= 2.41 C_c= 1.16

Remarks

NM: 11.0%
SAMPLE ID: 099247

Date Received: 2/11/2020 **Date Tested:** 2/19/2020

Tested By: JLK

Checked By: DCB

Title: PM

Source of Sample: B-1 **Depth:** 7.5 **Date Sampled:** 2/11/2020
Sample Number: 3

GeoResources, LLC

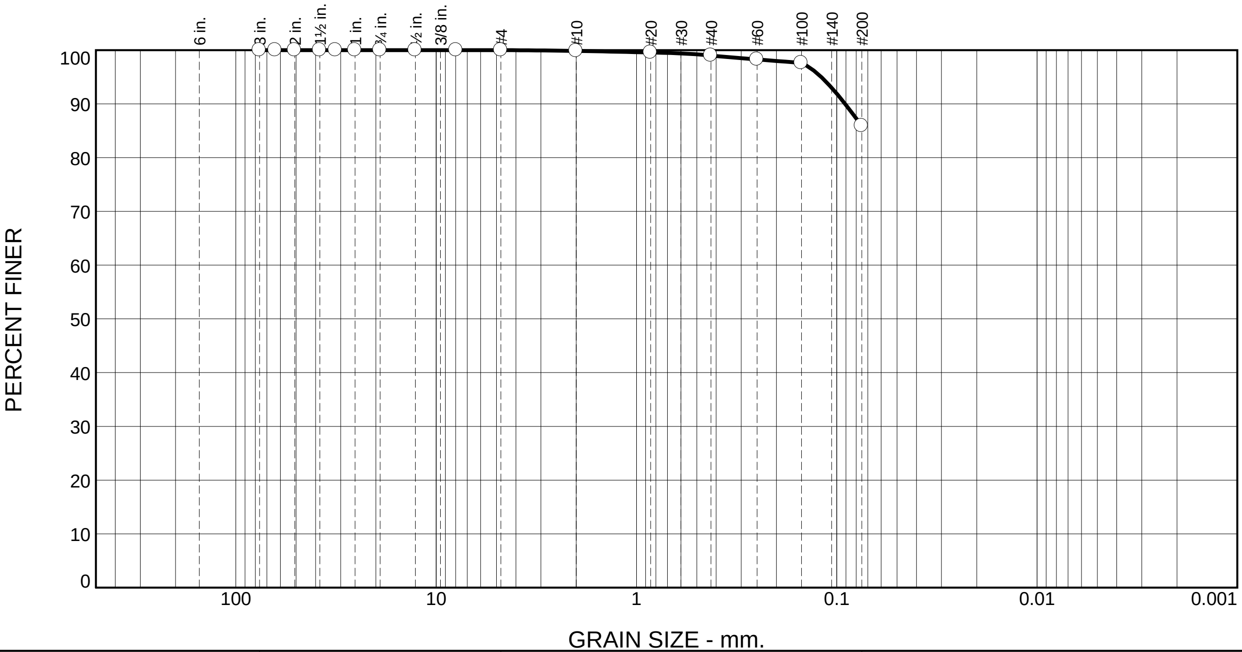
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-8

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	0.0	0.0	0.1	0.9	13.1	85.9	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.0		
#60	98.3		
#100	97.6		
#200	85.9		

* (no specification provided)

Material Description

Grey brown sandy SILT (medium stiff, moise to wet) (Slackwater) (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= ML **AASHTO (M 145)=**

Coefficients

D_{90}= 0.0909 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 36.6%
SAMPLE ID: 099250

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-1 **Depth:** 15.9 **Date Sampled:** 2/11/2020
Sample Number: 5b

GeoResources, LLC

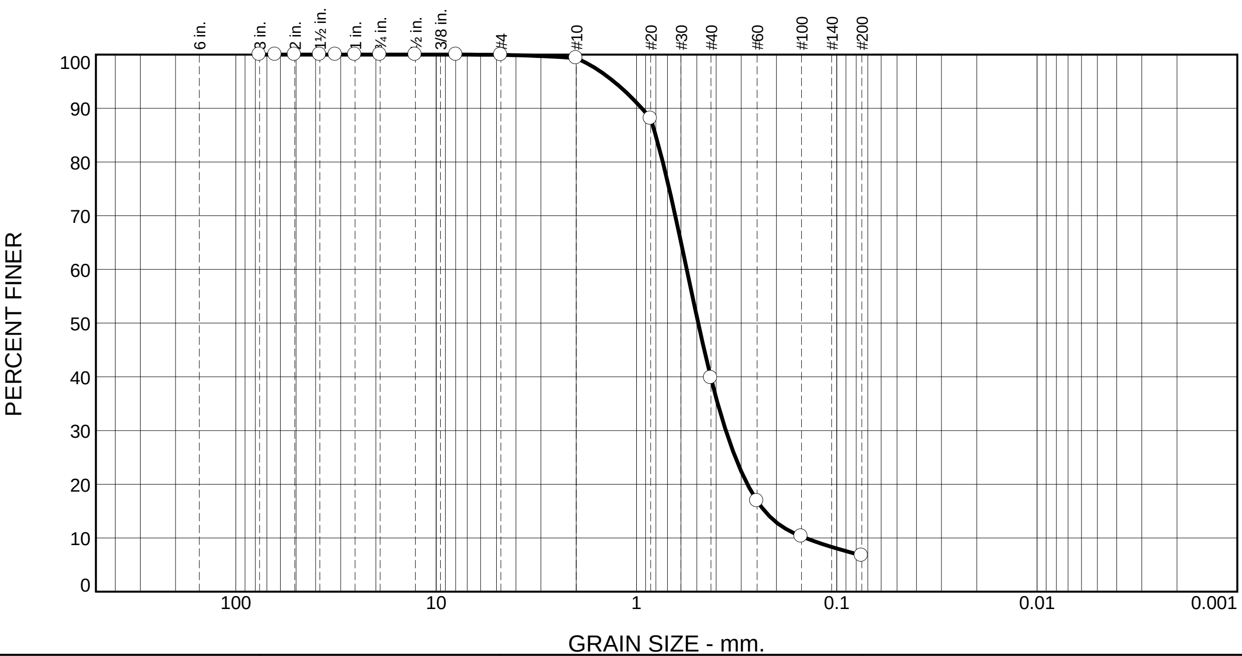
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-9

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	0.0	0.0	0.6	59.6	33.1	6.7	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.4		
#20	88.1		
#40	39.8		
#60	16.9		
#100	10.3		
#200	6.7		

* (no specification provided)

Material Description

Slightly mottled tan to brown SAND with silt (loose, moist) (SP-SM)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.9408 D_{85}= 0.8015 D_{60}= 0.5611
D_{50}= 0.4918 D_{30}= 0.3579 D_{15}= 0.2287
D_{10}= 0.1432 C_u= 3.92 C_c= 1.59

Remarks

NM: 12.6%
SAMPLE ID: 099256

Date Received: 2/11/2020 **Date Tested:** 2/19/2020

Tested By: JLK

Checked By: DCB

Title: PM

Source of Sample: B-2 **Depth:** 2.5 **Date Sampled:** 2/11/2020
Sample Number: 1

GeoResources, LLC

Fife, WA

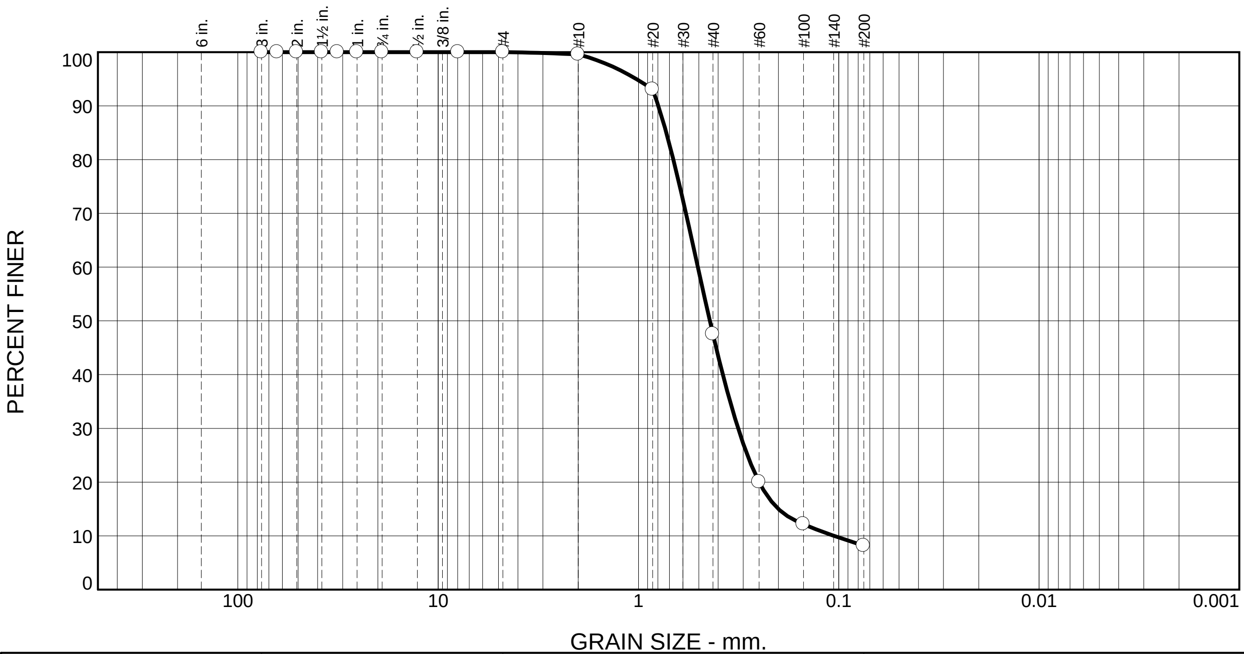
Client: Three's Company LLC
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-10

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	0.0	0.0	0.4	52.1	39.3	8.2	

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	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.6		
#20	93.1		
#40	47.5		
#60	20.0		
#100	12.2		
#200	8.2		

* (no specification provided)

Material Description

Grey to grey brown SAND with silt and siltier interbeds (loose to medium dense, moist) (SP-SM)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.7950 D_{85}= 0.7253 D_{60}= 0.5053
D_{50}= 0.4403 D_{30}= 0.3180 D_{15}= 0.2000
D_{10}= 0.1055 C_u= 4.79 C_c= 1.90

Remarks

NM: 11.0%
SAMPLE ID: 099258

Date Received: 2/11/2020 **Date Tested:** 2/19/2020

Tested By: JLK

Checked By: DCB

Title: PM

Source of Sample: B-2 **Depth:** 7.5 **Date Sampled:** 2/11/2020
Sample Number: 3

GeoResources, LLC

Fife, WA

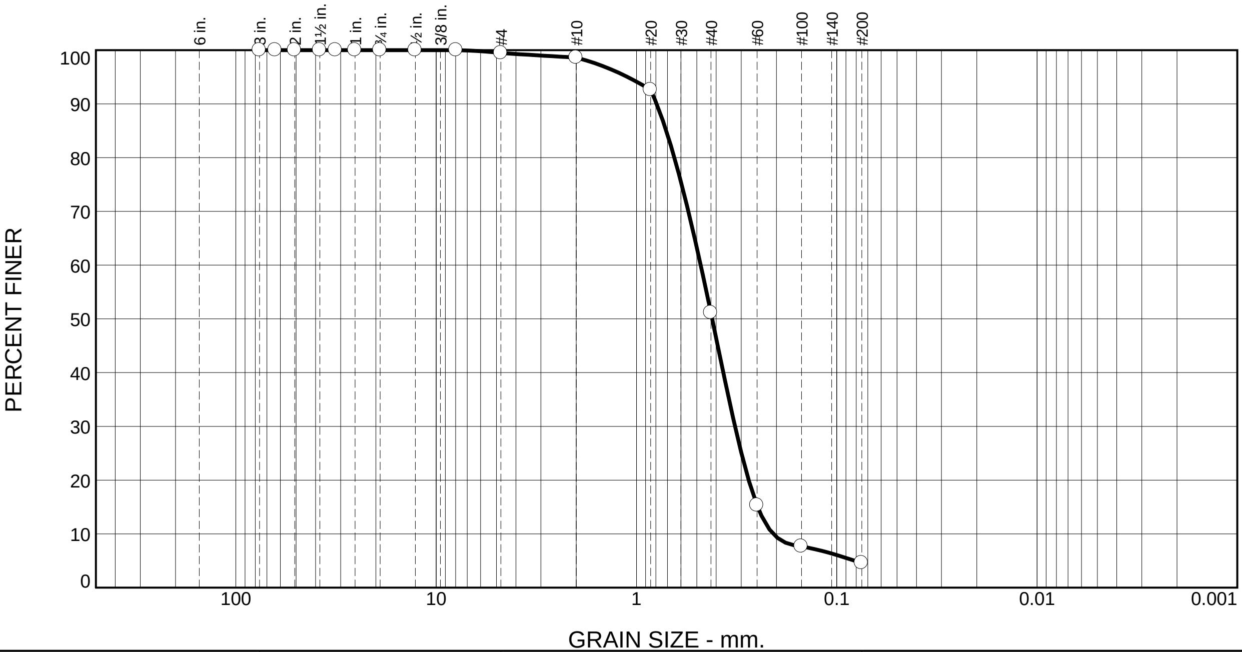
Client: Three's Company LLC
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-11

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	0.0	0.5	0.9	47.5	46.5	4.6	

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	100.0		
.5	100.0		
.3125	100.0		
#4	99.5		
#10	98.6		
#20	92.6		
#40	51.1		
#60	15.3		
#100	7.6		
#200	4.6		

* (no specification provided)

Material Description

Poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= SP **AASHTO (M 145)=**

Coefficients

D_{90}= 0.7924 D_{85}= 0.7097 D_{60}= 0.4779
D_{50}= 0.4188 D_{30}= 0.3221 D_{15}= 0.2482
D_{10}= 0.2077 C_u= 2.30 C_c= 1.05

Remarks

NM:6.4%
SAMPLE ID: 099263

Date Received: 2/11/2020 **Date Tested:** 2/19/2020

Tested By: JLK

Checked By: DCB

Title: PM

Source of Sample: B-2 **Depth:** 25 **Date Sampled:** 2/11/2020
Sample Number: 7

GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-12

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:** ____________________