GEOTECHNICAL REPORT

Tapert Arlington Jensen
Jensen Farm Lane and Anna Lane
Arlington, Washington

Project No. T-9025

Terra Associates, Inc.

Prepared for:

Land Pro Group
Lake Stevens, Washington

April 19, 2024

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

April 19, 2024
Project No. T-9025

Ms. Abigail Toyer
Land Pro Group
10515 – 20th Street Southeast, Suite 202
Lake Stevens, Washington 98258

Subject: Geotechnical Report
Tapert Arlington Jensen
Jensen Farm Lane and Anna Lane
Arlington, Washington

Dear Ms. Toyer:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the site is generally underlain by four to nine inches of topsoil over approximately two and one-half to three feet of possible fill material overlying medium dense to dense sand and gravel deposits with varying silt and cobble content (recessional outwash) to the termination of the test pits. The possible fill material was composed of inorganic, medium dense to dense sand with silt and gravel to gravel with silt and sand. Moderate to heavy groundwater seepage was observed in each test pit between approximately seven and one-half to nine feet below existing surface grades.

In our opinion, soil and groundwater conditions at the site will be suitable for support of the development as planned, provided recommendations contained herein are incorporated into project design and construction specifications.

We trust the information provided in the attached report is sufficient for your current needs. If you have any questions or need additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

Michael J. Xenos, P.E.
Staff Engineer

CAROLYN S. DECKER
STATE OF WASHINGTON
47016
REGISTERED PROFESSIONAL ENGINEER

4-19-2024

Carolyn S. Decker, P.E.
President

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1.0 PROJECT DESCRIPTION

The project consists of developing the property with two duplex buildings along with associated access and utilities. Grading plans were not available at the time of this report. Based on the site topography, we expect grading will be minimal with cuts and fills between one and five feet.

We expect that the duplex structures constructed at the site will be two- to three-story, wood-framed buildings with their main floor levels constructed at grade. Structural loading should be relatively light with bearing walls carrying loads of 2 to 3 kips per foot and isolated columns carrying maximum loads of 30 to 40 kips.

The recommendations contained in the following sections of this report are based on the above design features. If actual features vary or changes are made, we should review them in order to modify our recommendations, as required. We should review the final design drawings and specifications to verify our recommendations have been properly interpreted and incorporated into project design and construction.

2.0 SCOPE OF WORK

Our work was completed in accordance with our proposal, dated March 14, 2024. Accordingly, on March 29, 2024, we observed soil and groundwater conditions at three test pits excavated with a mini excavator to maximum depths of approximately ten feet below current site grades. Using the information obtained from this subsurface exploration, we performed analyses to develop geotechnical recommendations for development at the site.

Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Geologic hazards per the City of Arlington Municipal Code.
- Seismic design parameters per the 2021 International Building Code (IBC).
- Site preparation and grading.
- Excavations.
- Foundations.
- Slab-on-grade floors.
- Lateral earth pressures for wall design.
- Stormwater facilities.
- Infiltration feasibility.

- Drainage.
- Utilities.
- Pavements.

It should be noted, recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates, Inc.'s purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site consists of a single tax parcel totaling approximately 0.31 acres located north of the intersection of Jensen Farm Lane and Anna Lane in Arlington, Washington. The approximate location of the site is shown on Figure 1.

The site is currently undeveloped and covered with grass. Site topography is relatively flat with no obvious signs of sloping.

3.2 Soils

The site soils generally consist of approximately four to nine inches of topsoil over approximately two and one-half to three feet of possible fill material overlying medium dense to dense sand and gravel deposits with varying silt and cobble content (recessional outwash) to the termination of the test pits. The fill material was composed of inorganic, medium dense to dense silty sand with gravel and silty gravel with sand. The one exception to this general condition was observed at Test Pit TP-3 where no possible fill material was observed.

The *Geologic Map of the Arlington East Quadrangle, Snohomish County, Washington,* by J.P. Minard (1985) maps the site as recessional outwash known locally as Arlington Gravel Member (Qvrm). This map unit is consistent with the native sand and gravel soils observed at depth in the test pits.

The United States Department of Agriculture Natural Resources Conservation Service (NRCS) classifies the onsite soils as Norma loam material. A soil horizon, consisting of this material is typically deposited by alluvial processes in the form of drainageways and depressions, and is derived from alluvium which is not consistent with our exploratory findings and knowledge of the area's geologic setting.

The preceding discussion is intended to be a brief review of the soil conditions observed at the site. More detailed descriptions are presented on the Test Pit Logs attached in Appendix A. The approximate location of the test pits is shown on attached Figure 2.

3.3 Groundwater

We observed moderate to heavy groundwater seepage in every test pit between depths of approximately seven and one-half to nine feet below existing grades. The groundwater observed appears to be a part of the regional groundwater. We expect groundwater levels and flow rates will fluctuate seasonally and will typically reach their highest levels during, and shortly following, the wet winter months (November through May). Given the time of year our field work was completed, and our experience with groundwater conditions in the area, the groundwater levels observed likely represent near seasonal high levels. To evaluate the seasonal weather influence, slotted PVC piezometers were installed in the test pits to allow for winter groundwater monitoring through the 2024-2025 wet season.

3.4 Geologic Hazards

Chapter 20.93.600.a of the City of Arlington Municipal Code (AMC) defines geologically hazardous areas as "…areas susceptible to erosion, sliding, earthquakes, liquefaction, or other geological events. Geologically hazardous areas shall be classified based upon the history or existence of landslides, unstable soils, steep slopes, high erosion potential or seismic hazards." Discussions related to erosion, landslide, mine, and seismic hazards are presented below.

3.4.1 Erosion Hazard Areas

Chapter 20.93.600.b.1 of the AMC defines erosion hazard areas as areas that are "… as defined by the USDA Soil Conservation Service, United States Geologic Survey, or by the Department of Ecology Coastal Zone Atlas. The following classes are high erosion hazard areas:

a) Class 3, class U (unstable) includes severe erosion hazards and rapid surface runoff areas;

b) Class 4, class UOS (unstable old slides) includes areas having severe limitations due to slope; and,

c) Class 5, class URS (unstable recent slides)."

The site soils site are mapped as Norma loam by the United States Department of Agriculture Natural Resources Conservation Service (NRCS). Over the site with existing slope gradients, these soils will have a slight potential for erosion when exposed. Therefore, in our opinion, the site would not be classified as an erosion hazard area as defined by the AMC.

We did not observe any indications of significant active erosion at the site. However, the potential for soil erosion will increase during construction. In our opinion, proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sediment control, in conjunction with appropriate site drainage, will adequately mitigate the erosion potential in the planned development area. Erosion protection measures as required by the City of Arlington will need to be in place prior to and during grading activities at the site.

3.4.2 Landslide Hazard Areas

Chapter 20.93.600.b.2 of the AMC defines landslide hazard areas as "…areas subject to severe risk of landslide based on a combination of geologic, topographic and hydrologic factors. Some of these areas may be identified in the Department of Ecology Coastal Zone Atlas, or through site-specific criteria. Landslide hazard areas include any of the following:

a) Areas characterized by slopes greater than fifteen percent and impermeable soils (typically silt and clay) frequently interbedded with permeable granular soils (predominantly sand and gravel) or impermeable soils overlain with permeable soils or springs or groundwater seepage;

b) Any area that has exhibited movement during the Holocene epoch (from ten thousand years ago to present) or which is underlain by mass wastage debris of that epoch;

c) Any area potentially unstable due to rapid stream incision, stream bank erosion or undercutting by wave action;

d) Any area located on an alluvial fan presently subject to or potentially subject to inundation by debris flows or deposition of steam-transported sediments;

e) Any area with a slope of thirty-three percent or greater and with a vertical relief of ten or more feet except areas composed of consolidated rock;

f) Any area with slope defined by the United States Department of Agriculture Soil Conservation Service as having a severe limitation for building site development; and

g) Any shoreline designated or mapped as class U, UOS, or URS by the Department of Ecology Coastal Zone Atlas."

Site topography is relatively flat with no obvious signs of sloping and none of the conditions listed above are met. Therefore, it is our opinion that the site is not a landslide hazard per the AMC.

3.4.3 Seismic Hazard Areas

Chapter 20.93.600.b.4 of the AMC defines seismic hazard areas as "… areas subject to severe risk of earthquake damage as a result of seismic induced settlement, shaking, slope failure or soil liquefaction. These conditions occur in areas underlain by cohesion less soils of low density usually in association with a shallow groundwater table."

A review of a map titled *Faults and Earthquakes in Washington State*, dated 2014 by Jessica L. Czajkowski and Jeffrey D. Bowman shows the site does not reside within any active fault zone. The nearest fault, which is a spur of the Darrington-Devils Mountain Fault, is categorized as "Class B" and is located approximately 6 miles north of the site. Accordingly, during a seismic event, the risk of ground rupture along a fault line at the site is low.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sands underlying the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength.

The predominant gravel and sand formation at the site exhibits relatively high permeability and would allow dissipation of pore water pressures generated by a seismic event, thereby not significantly impacting the effective strength of the deposit. Additionally, we observed no indication of groundwater seepage during our subsurface explorations. Therefore, it is our opinion that the risk for soil liquefaction to occur at this site and its associated impacts is low.

3.5 Seismic Site Class

Based on soil conditions observed in the test pits, and our knowledge of the area geology, per Chapter 20 of the 2021 International Building Code (IBC), Site Class "D" should be used in structural design.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

In our opinion, there are no geotechnical conditions that would preclude the planned development. The residential buildings can be supported on conventional spread footings bearing on competent native soils and/or competent possible existing fill soils below the organic topsoil layer or on structural fill placed above the competent soils. Floor slabs and pavements can be similarly supported.

The native silty sand with gravel soils observed in the upper approximately four feet of soil in Test Pit TP-3 typically contain a sufficient amount of soil fines that will make it difficult to compact as structural fill when too wet. The ability to use these soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. The relatively clean outwash sand and gravel observed below these upper soils have a low percentage of soil fines and should be suitable for use as structural fill in most weather conditions. The availability of the relatively clean outwash soils may be limited due to site grading requirements. If there is insufficient sand and gravel available, the contractor should be prepared to import free-draining granular material for use as structural fill and backfill during the wet season.

Our explorations indicate that the contractor should be prepared to excavate into abundant cobbles and occasional boulders. We were able to excavate through the cobbles and boulders for the test pits, but the test pits are limited in size. Larger excavations and utility excavations may impacted by the cobbles and boulders. Additionally, as observed during our explorations, pockets of cobbles or boulders may become loose and present a caving hazard during excavation procedures.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious material should be stripped and removed from the site. Surface stripping depths of approximately four to nine inches should be expected to remove the organic surface soils and vegetation. Where applicable, demolition of existing structures should include abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Organic topsoil will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired building grades. Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify soil conditions are as expected and suitable for support of new fill or building elements. Our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics such as, Mirafi 500X or an equivalent fabric can be used in conjunction with clean granular structural fill. Our experience has shown, in general, a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

Our study indicates that some of the existing fill soils and the native silty sand soils encountered in the upper approximately two and one-half to four feet of the site contain a sufficient amount of soil fines that will make them difficult to compact as structural fill when too wet or too dry. The ability to use these soils from site excavations as structural fill will depend on its moisture content, the prevailing weather conditions at the time of construction and the contractor's ability to compact the native silt soils. If wet soils are encountered, the contractor will need to dry the soils by aeration during dry weather conditions. Alternatively, the use of an additive, such as Portland cement or lime to stabilize the soil moisture can be considered. If the soil is amended, additional Best Management Practices (BMPs) addressing the potential for elevated pH levels will need to be included in the Stormwater Pollution Prevention Program (SWPPP) prepared with the Temporary Erosion and Sedimentation Control (TESC) plan. The relatively clean sand and gravels observed throughout the site, should be suitable to reuse as structural fill in most weather conditions.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet-weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as those for utility construction, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, the site's soils would be classified as Type C soils.

Accordingly, temporary excavations in Type C soils should have their slopes laid back at an inclination of 1.5:1 (Horizontal: Vertical) or flatter, from the toe to the crest of the slope. If there is insufficient space to complete the excavations in this manner, or if excavations greater than 20 feet in depth are planned, then temporary shoring to support the excavations may be required. Properly designed and installed shoring trench boxes can be used to support utility trench excavations where required.

Based on our subsurface explorations, groundwater seepage should be anticipated within excavations extending below a depth of about seven to nine feet. We expect that the volume of water and rate of flow into the excavation would be sufficient to warrant the use of conventional wellpoints to maintain a relatively dry excavation for construction purposes.

Our explorations indicate that the contractor should be prepared to excavate into abundant cobbles and occasional boulders. We were able to excavate through the cobbles and boulders for the test pits, but the test pits are limited in size. Larger excavations and utility excavations may impacted by the cobbles and boulders. Additionally, as observed during our explorations, pockets of cobbles or boulders may become loose and present a caving hazard during excavation procedures.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.4 Foundations

The residential buildings may be supported on conventional spread footing foundations bearing on competent native soils, competent possible existing fill soils, or on structural fill placed above competent soils. Foundation subgrades should be prepared as recommended in Section 4.2 of this report. Foundations exposed to the weather should bear at a minimum depth of 1.5 feet below adjacent exterior grades for frost protection. Interior foundations should be supported at a minimum depth of one foot below the finished floor elevation.

As discussed earlier, the native silty sand with gravel soils observed in some of the test pits will be easily disturbed by normal construction activity particularly when wet. Care will need to be exercised during construction to avoid excessively disturbing the subgrade. If disturbed, the material should be removed, and footings lowered to undisturbed material or grade restored with structural fill. During wet-weather conditions, to avoid disturbance, consideration should be given to protecting the fill foundation subgrade with a four-inch layer of crushed rock or lean mix concrete.

We recommend designing foundations bearing on competent soils for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With the expected building loads and this bearing stress applied, in general, total, and differential settlements should not exceed one inch and one-half inch, respectively.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings should be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We do not recommend including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be backfilled with structural fill, as described in Section 4.2 of this report. The values recommended include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slabs, we recommend placing a four-inch-thick capillary break layer of clean, free-draining, coarse sand or fine gravel that has less than five percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slabs. Installation of a capillary break layer will not be necessary where the floor subgrade is composed of the clean native outwash or structural fill comprised of the clean outwash. A representative of Terra Associates should observe the subgrade at the time of construction to verify it’s condition and determine if an imported capillary break layer is required.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer, then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction and aid in uniform curing of the concrete slab. It should be noted, if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting in uniform curing of the slab and can actually serve as a water supply for moisture transmission through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

4.6 Lateral Earth Pressures for Below-Grade Walls

The magnitude of earth pressure development on below-grade walls will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To guard against hydrostatic pressure development, wall drainage must also be installed. A typical recommended wall drainage detail is shown on Figure 3.

With wall backfill placed and compacted as recommended and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an active earth pressure equivalent to a fluid weighing 50 pcf may be used. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.4 of this report.

4.7 Stormwater Facilities

Site stormwater plans were not available at the time of this report.

Detention Vault

We expect the bottom of the excavations for a detention vault will expose medium dense to dense sand and gravel deposits. Vault foundations supported by these medium dense to dense native soils may be designed for an allowable bearing capacity of 3,000 psf. For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used.

Vault walls should be designed as below-grade retaining walls following the recommendations in Section 4.6 of this report. The magnitude of earth pressure development on engineered retaining walls will partly depend upon the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 3.

If it is not possible to discharge collected water at the footing invert elevation, the invert elevation of the wall drainpipe could be set equivalent to the outfall invert. For any portion of the wall that falls below the invert elevation of the wall drain, an earth pressure equivalent to a fluid weighing 85 pcf should be used.

Stormwater Ponds

If fill berms will be constructed, the berm locations should be stripped of topsoil, duff, and soils containing organic material prior to the placement of fill. The fill berms should be constructed by placing structural fill in accordance with recommendations outlined in Section 4.2 of this report. Material used to construct pond berms should consist of predominately granular soils with a maximum size of three inches and a minimum of 20 percent fines. Terra Associates, Inc. should examine and test all onsite or imported materials proposed for use as berm fill prior to their use.

It is likely that sand and gravel soils may be exposed within the pond area. Therefore, it may be necessary to line the dead storage portion of the pond for water quality purposes depending on the final grades and exposed soils.

Due to the exposure to fluctuating stored water levels and wave action, soils exposed on the interior side slopes of the ponds may be subject to some risk of periodic shallow instability or sloughing. Establishing interior slopes at a 3:1 gradient will significantly reduce or eliminate this potential. Exterior berm slopes and interior slopes above the maximum water surface should be graded to a finished inclination no steeper than 2:1. Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

We should review the stormwater plans when they are completed and revise our recommendations, if required.

4.8 Infiltration Feasibility

On a preliminary basis, it is our opinion that the outwash sand and gravel observed has a relatively low fines content and will support infiltration of project stormwater. Moderate to heavy groundwater seepage was observed in each test pit between depths of approximately seven and one-half to nine feet below existing grades. Slotted PVC piezometers were installed at the test pit locations to allow for winter groundwater monitoring during the 2024 – 2025 wet season. A minimum separation distance of three feet must be maintained between the seasonal high groundwater and the bottom of the infiltration facility.

We used the Soil Grain Size Analysis Method as outlined in Volume V of the Department of Ecology 2021 Stormwater Management Manual for Western Washington to determine a preliminary long-term design infiltration rate. This method correlates the saturated hydraulic conductivity with the D_{10}, D_{60}, and D_{90} particle sizes determined from gradation testing of the soils in accordance with ASTM Test Designation D-422. The D_{10} particle size represents the grain size below which ten percent of the soil is smaller in size. The D_{60} particle size represents the grain size below which 60 percent of the soil is smaller in size. The D_{90} particle size represents the grain size below which 90 percent of the soil is smaller in size. Gradation curves from laboratory testing on the soils are attached in Appendix A. Based on the testing results, a preliminary long-term design infiltration rate of 2 inches per hour can be used.

We should review the stormwater infiltration facility plans, when available, to confirm facility design and location is consistent with the ground conditions observed at the site.

The permeability of the native outwash soils will be significantly impacted by the intrusion of soil fines (silt- and clay-sized particles). A relatively minor amount of soil fines can reduce the permeability of the formation by a factor of ten. The greatest exposure to soil fines contamination will occur during mass grading and construction. Therefore, we recommend that the Temporary Erosion and Sedimentation Control (TESC) plans route construction stormwater to a location other than the permanent infiltration facility.

4.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building areas. We recommend providing a positive drainage gradient away from the building perimeters. If this gradient cannot be provided, then surface water should be collected adjacent to the structures and directed to appropriate storm facilities.

Subsurface

Considering the well-drained nature of the site soils, provided the finish floor grade is at or above the adjacent exterior grade and positive drainage away from the structure is maintained, in our opinion, perimeter foundation drains would not be required.

4.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA), or City of Arlington specifications. At a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 4.2 of this report. The native sands and gravels should generally be suitable for use as backfill material.

As noted, some of the surficial fill soils are moisture sensitive and close moisture control will be required to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

As noted above, our explorations indicate that the contractor should be prepared to excavate into abundant cobbles and occasional boulders. We were able to excavate through the cobbles and boulders for the test pits, but the test pits are limited in size. Larger excavations and utility excavations may impacted by the cobbles and boulders. Additionally, as observed during our explorations, pockets of cobbles or boulders may become loose and present a caving hazard during excavation procedures.

4.11 Pavements

Pavement subgrades should be prepared as described in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For residential access, with traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of Hot Mix Asphalt (HMA) over four inches of Crushed Rock Base (CRB)
- Three and one-half inches of full depth HMA

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for half-inch class HMA and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

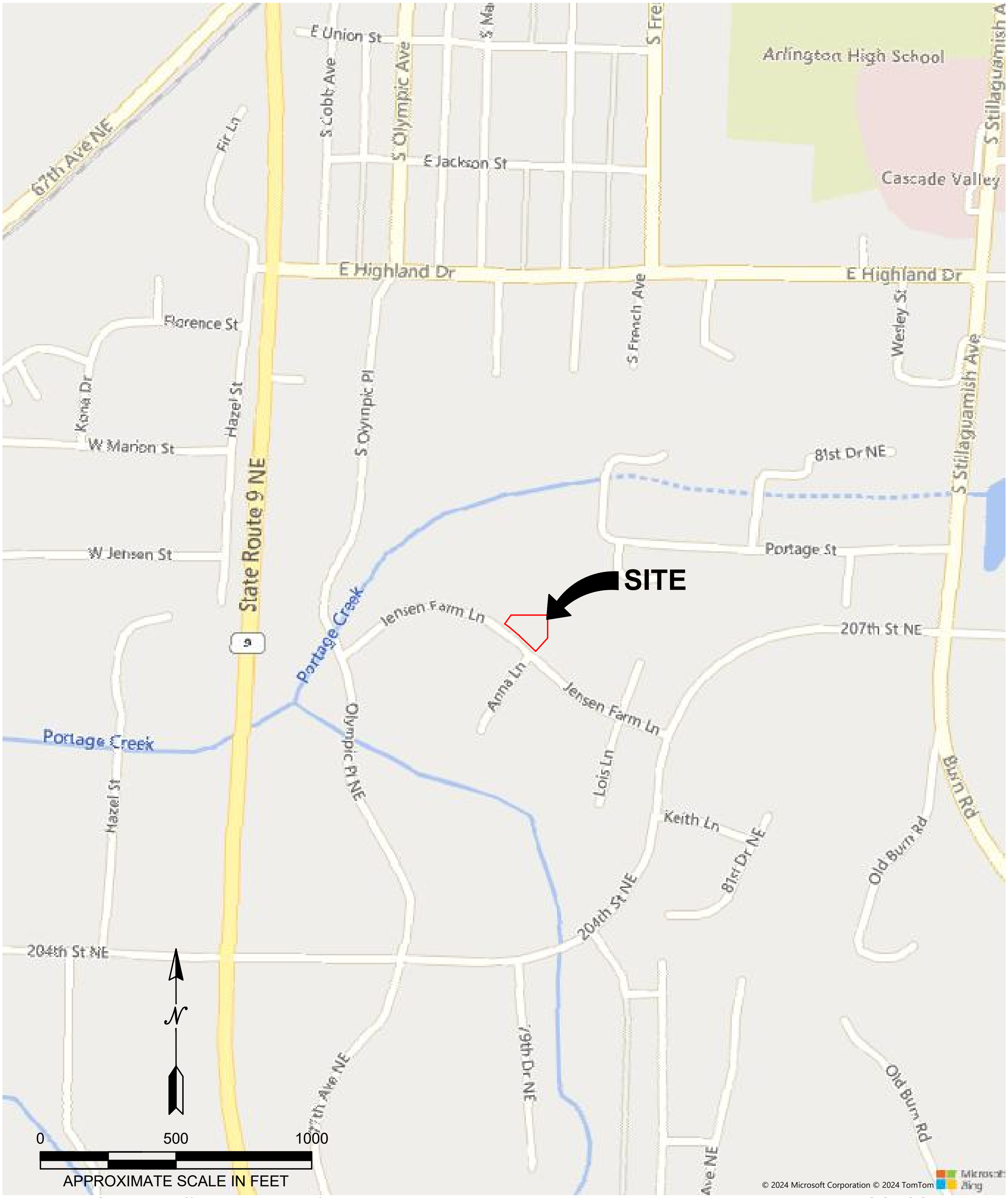
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Tapert Arlington Jensen project in Arlington, Washington. This report is for the exclusive use of Land Pro Group, and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the test pits excavated on the site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.



REFERENCE: https://www.bing.com/maps ACCESSED 2024

Terra Associates, Inc. Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences	VICINITY MAP TAPERT ARLINGTON JENSEN ARLINGTON, WASHINGTON

Proj.No. T-9025	Date: APR 2024	Figure 1

NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE: SITE PLAN PROVIDED BY BING MAPS.

LEGEND:

APPROXIMATE TEST PIT LOCATION

0 20 40

APPROXIMATE SCALE IN FEET

N

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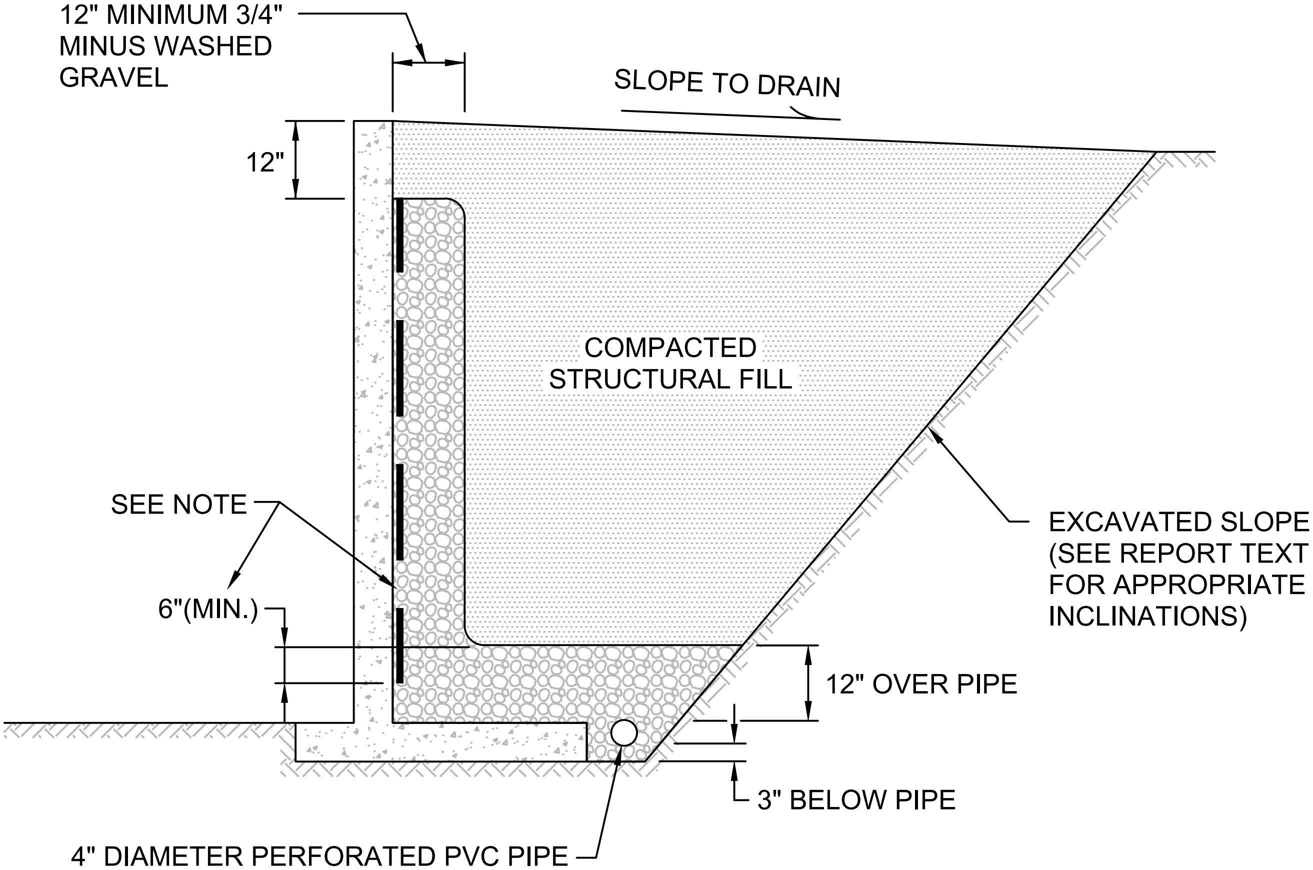
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
TAPERT ARLINGTON JENSEN
ARLINGTON, WASHINGTON

Proj.No. T-9025	Date: APR 2024	Figure 2



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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TYPICAL WALL DRAINAGE DETAIL
TAPERT ARLINGTON JENSEN
ARLINGTON, WASHINGTON

Proj.No. T-9025	Date: APR 2024	Figure 3

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Tapert Arlington Jensen
Arlington, Washington

On March 29, 2024, we investigated subsurface conditions at the site by excavating 3 test pits with a mini-excavator to depths of about 10 feet below existing grades. The test pit locations were approximately determined in the field using GPS coordinates. The approximate test pit locations are shown on Figure 2. The Test Pit Logs are presented as Figures A-2 through A-4.

An engineering geologist from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test pit, obtained representative soil samples, and recorded water levels observed during excavations. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test pits were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Pit Logs. Grain size analyses were performed on select soil samples. The results are shown on Figures A-5 through A-8.

MAJOR DIVISIONS				LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
			Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
		SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
				SP	Poorly-graded sands, sands with gravel, little or no fines.
			Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity. (Lean clay)
				OL	Organic silts and organic clays of low plasticity.
		SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
				CH	Inorganic clays of high plasticity. (Fat clay)
				OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS				PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

<u>Density</u>	<u>Standard Penetration Resistance in Blows/Foot</u>
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

<u>Consistancy</u>	<u>Standard Penetration Resistance in Blows/Foot</u>
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

Symbol	Definition
I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
‖	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

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UNIFIED SOIL CLASSIFICATION SYSTEM
TAPERT ARLINGTON JENSEN
ARLINGTON, WASHINGTON

Proj.No. T-9025	Date: APR 2024	Figure A-1

LOG OF TEST PIT NO.TP-1

FIGURE A-2

PROJECT NAME: Tapert Arlington Jensen **PROJ. NO:** T-9025 **LOGGED BY:** MJX

LOCATION: Arlington, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: March 29, 2024 **DEPTH TO GROUNDWATER:** 8.5 ft **DEPTH TO CAVING:** 5-10 ft

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–3		(8-inches organic TOPSOIL) FILL?: Black GRAVEL with silt and sand, fine to coarse sand, fine to coarse gravel, moist, trace cobbles, occasional boulder, occasional rootlet. (GP-GM)	Medium Dense	20.0 (at 1.5 ft)
3–10		Brown GRAVEL with sand, fine to coarse sand, fine to coarse gravel, moist to wet, scattered cobbles, trace boulders. (GP)	Medium Dense to Dense	6.2 (at 3 ft) 8.2 (at 6 ft) 10.7 (at 10 ft)
10–12		Test Pit terminated at approximately 10 feet. Heavy groundwater seepage observed at approximately 8.5 feet. Slotted PVC piezometer installed in excavation. Moderate caving observed from approximately 5 to 10 feet.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO.TP-2

FIGURE A-3

PROJECT NAME: Tapert Arlington Jensen **PROJ. NO:** T-9025 **LOGGED BY:** MJX

LOCATION: Arlington, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: March 29, 2024 **DEPTH TO GROUNDWATER:** 9 ft **DEPTH TO CAVING:** 6-10 ft

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2.5		(9-inches organic TOPSOIL) FILL?: Gray SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, moist, trace cobbles, trace silty sand inclusions. (SP-SM)	Medium Dense to Dense	10.1 (at 1 ft)
2.5–4		Gray SAND with silt, fine to coarse sand, moist, trace gravel, occasional cobble.(SP-SM)	Medium Dense	19.4 (at 3 ft)
4–8		Grayish-brown GRAVEL with sand, fine to coarse sand, fine to coarse gravel, moist to wet, scattered cobbles, occasional boulder, occasional silty gravel inclusion. (GP)	Medium Dense to Dense	6.4 (at 4 ft)
8–10		Grayish-brown SAND with gravel, fine to coarse sand, fine to coarse gravel, moist to wet, scattered cobbles, occasional boulder, occasional silty gravel inclusion. (SP)		11.9 (at 10 ft)
10–12		Test Pit terminated at approximately 10 feet. Moderate groundwater seepage observed at approximately 9 feet. Slotted PVC piezometer installed in excavation. Minor caving observed from approximately 6 to 10 feet.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO.TP-3

FIGURE A-4

PROJECT NAME: Tapert Arlington Jensen **PROJ. NO:** T-9025 **LOGGED BY:** MJX

LOCATION: Arlington, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: March 29, 2024 **DEPTH TO GROUNDWATER:** 7.5 ft **DEPTH TO CAVING:** 5-10 ft

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(4-inches organic TOPSOIL)		
1		Dark brown silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, trace cobbles, trace rootlets, occasional boulder. (SM)	Medium Dense	23.5
4		Dark brown SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, moist, trace cobbles, trace rootlets, occasional boulder. (SP-SM)		
5				8.6
6		Gray SAND gravel, fine to coarse sand, fine to coarse gravel, moist to wet, scattered cobbles, occasional boulder. (SP)	Medium Dense to Dense	6.3
7.5 (groundwater)				
10		Test Pit terminated at approximately 10 feet. Heavy groundwater seepage observed at approximately 7.5 feet. Slotted PVC piezometer installed in excavation. Moderate caving observed from approximately 5 to 10 feet.		10.8
12				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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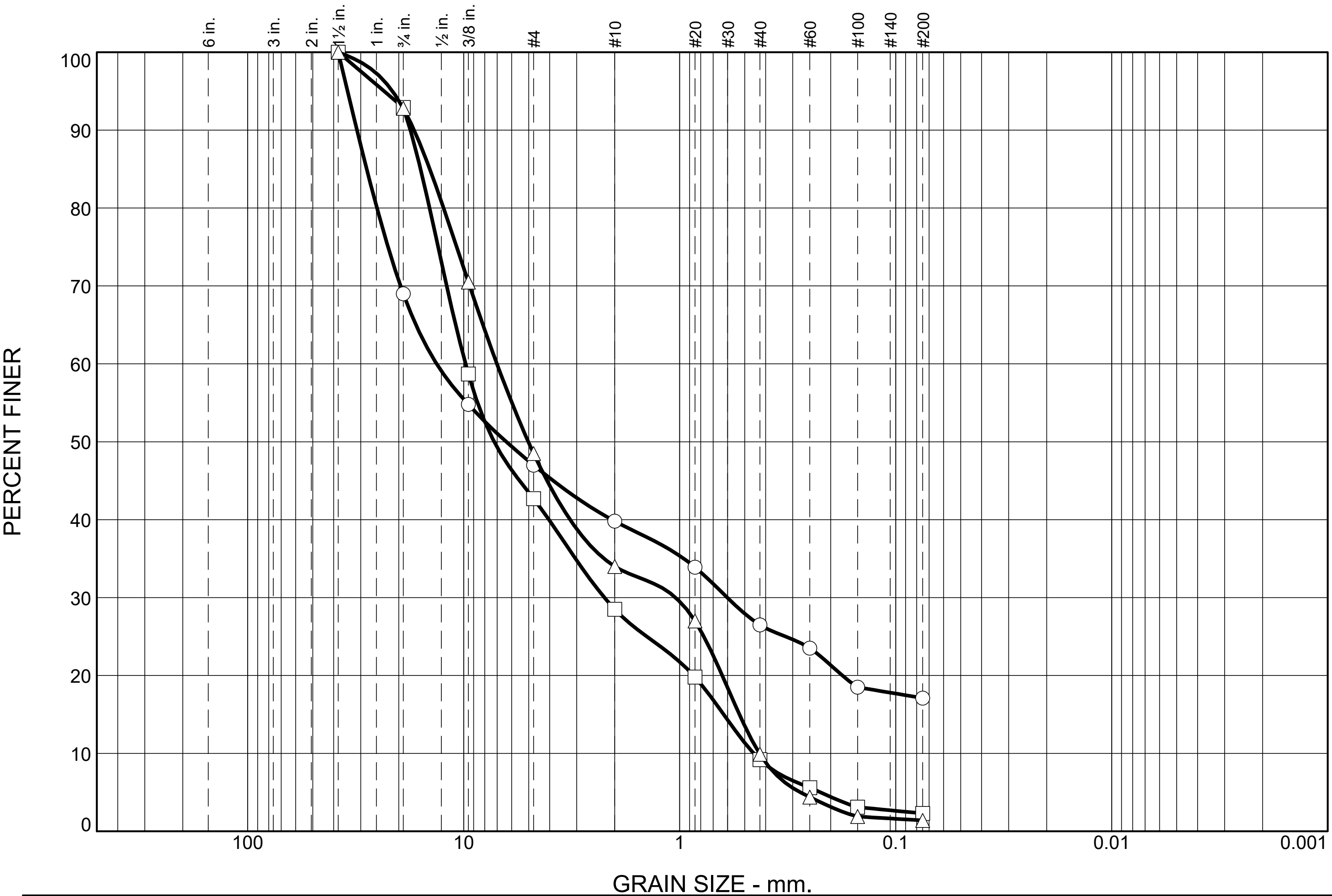
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	31.0	22.0	7.2	13.3	9.4	17.1	
□	0.0	7.1	50.2	14.2	19.3	6.9	2.3	
△	0.0	7.2	44.3	14.5	24.1	8.5	1.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			28.1340	13.3482	6.3578	0.6026				
□			15.8513	9.8180	7.2276	2.2336	0.6263	0.4538	1.12	21.64
△			14.3614	7.0192	5.0272	1.0447	0.5291	0.4272	0.36	16.43

	Material Description	USCS	AASHTO
○	GRAVEL with silt and sand	GP-GM	
□	GRAVEL with sand	GP	
△	GRAVEL with sand	GP	

Project No. T-9025 **Client:** Land Pro Group

Project: Tapert Arlington Jensen

○ **Location:** Test Pit TP-1 **Depth:** -1.5 ft **Sample Number:** 1

□ **Location:** Test Pit TP-1 **Depth:** -3 ft **Sample Number:** 2

△ **Location:** Test Pit TP-1 **Depth:** -6 ft **Sample Number:** 3

Remarks:

○ Tested on April 3, 2024

□ Tested on April 3, 2024

△ Tested on April 3, 2024

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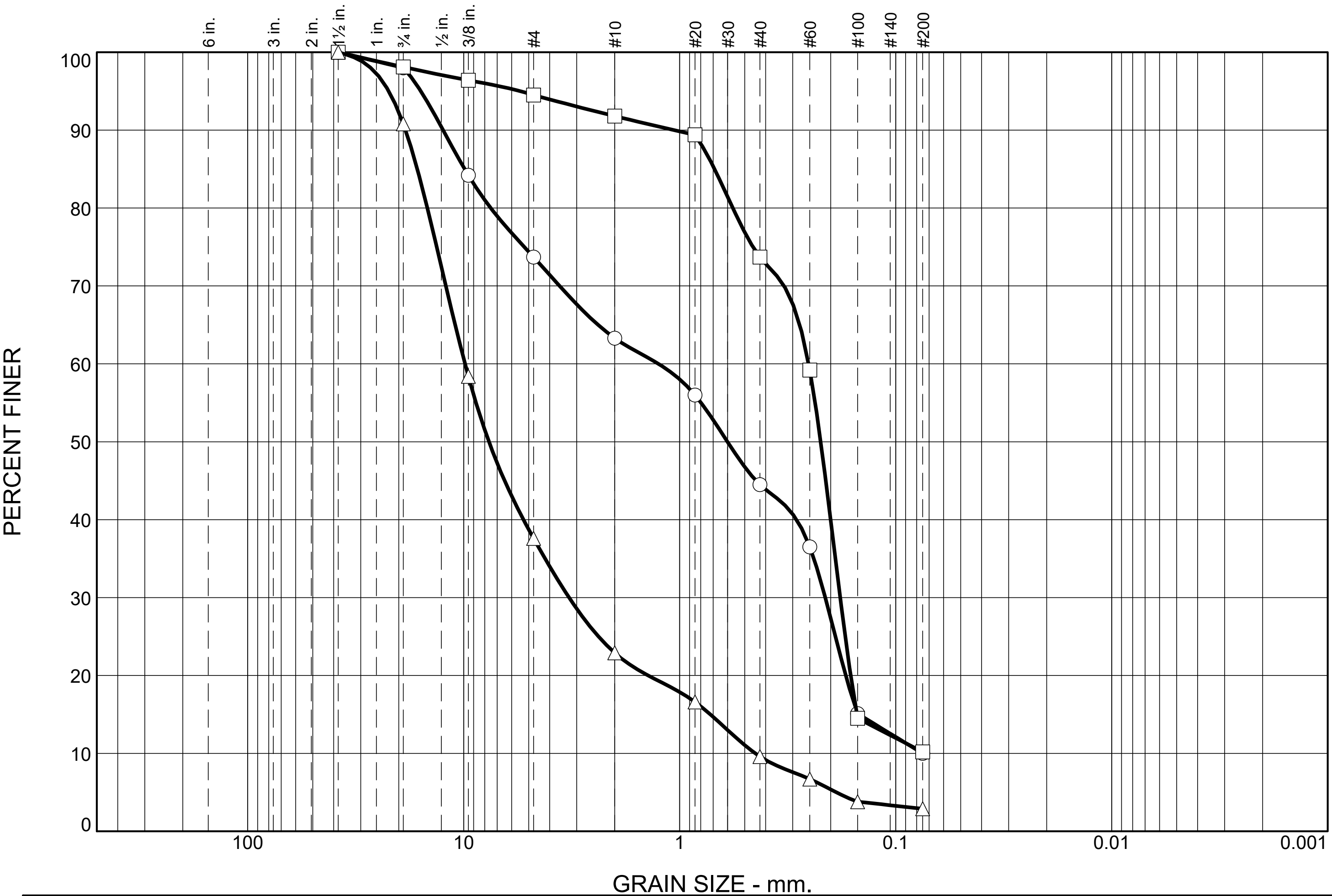
Kirkland, WA

Figure A-5

Tested By: FQ/KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	2.0	24.3	10.4	18.8	34.5	10.0	
□	0.0	1.9	3.6	2.7	18.1	63.5	10.2	
△	0.0	9.2	53.2	14.7	13.3	6.7	2.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			9.9098	1.2536	0.6013	0.2119	0.1480	0.0750	0.48	16.71
□			0.6903	0.2531	0.2225	0.1806	0.1511			
△			16.4133	9.8720	7.6419	3.2519	0.7214	0.4463	2.40	22.12

Material Description	USCS	AASHTO
○ SAND with silt and gravel	SP-SM	
□ SAND with silt	SP-SM	
△ GRAVEL with sand	GP	

Project No. T-9025 **Client:** Land Pro Group

Project: Tapert Arlington Jensen

○ **Location:** Test Pit TP-2 **Depth:** -1 ft **Sample Number:** 1

□ **Location:** Test Pit TP-2 **Depth:** -3 ft **Sample Number:** 2

△ **Location:** Test Pit TP-2 **Depth:** -4 ft **Sample Number:** 3

Remarks:

○ Tested on April 3, 2024

□ Tested on April 3, 2024

△ Tested on April 3, 2024

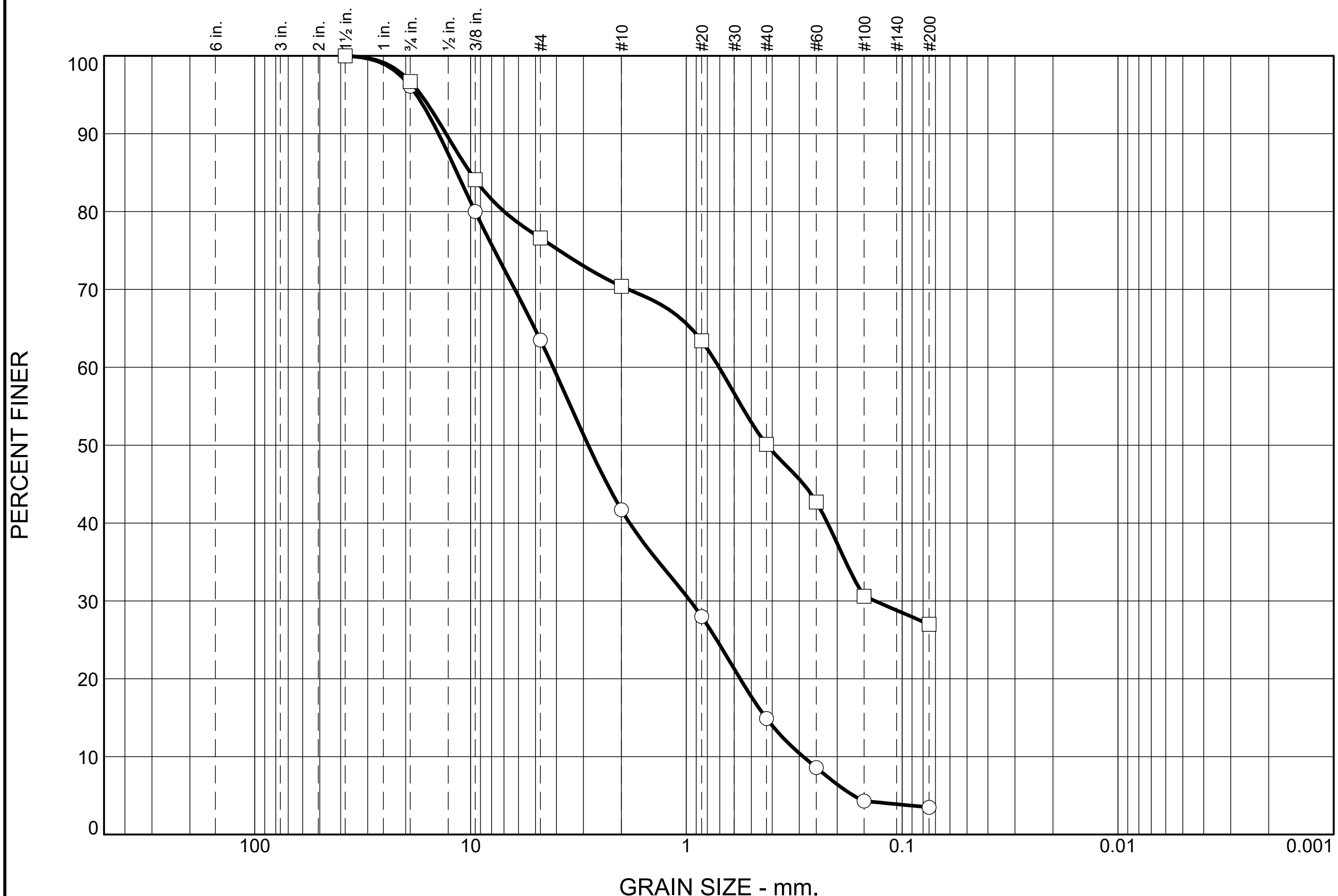
Terra Associates, Inc.

Kirkland, WA

Figure A-6

Tested By: FQ/KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	3.9	32.6	21.8	26.8	11.4	3.5	
□	0.0	3.3	20.1	6.2	20.3	23.1	27.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			11.5569	4.1470	2.8476	0.9587	0.4277	0.2873	0.77	14.43
□			10.0389	0.7054	0.4222	0.1336				

Material Description	USCS	AASHTO
○ SAND with gravel	SP	
□ silty SAND with gravel	SM	

Project No. T-9025 **Client:** Land Pro Group

Project: Tapert Arlington Jensen

○ **Location:** Test Pit TP-2 **Depth:** -10 ft **Sample Number:** 4

□ **Location:** Test Pit TP-3 **Depth:** -1 ft **Sample Number:** 1

Remarks:

○ Tested on April 3, 2024

□ Tested on April 3, 2024

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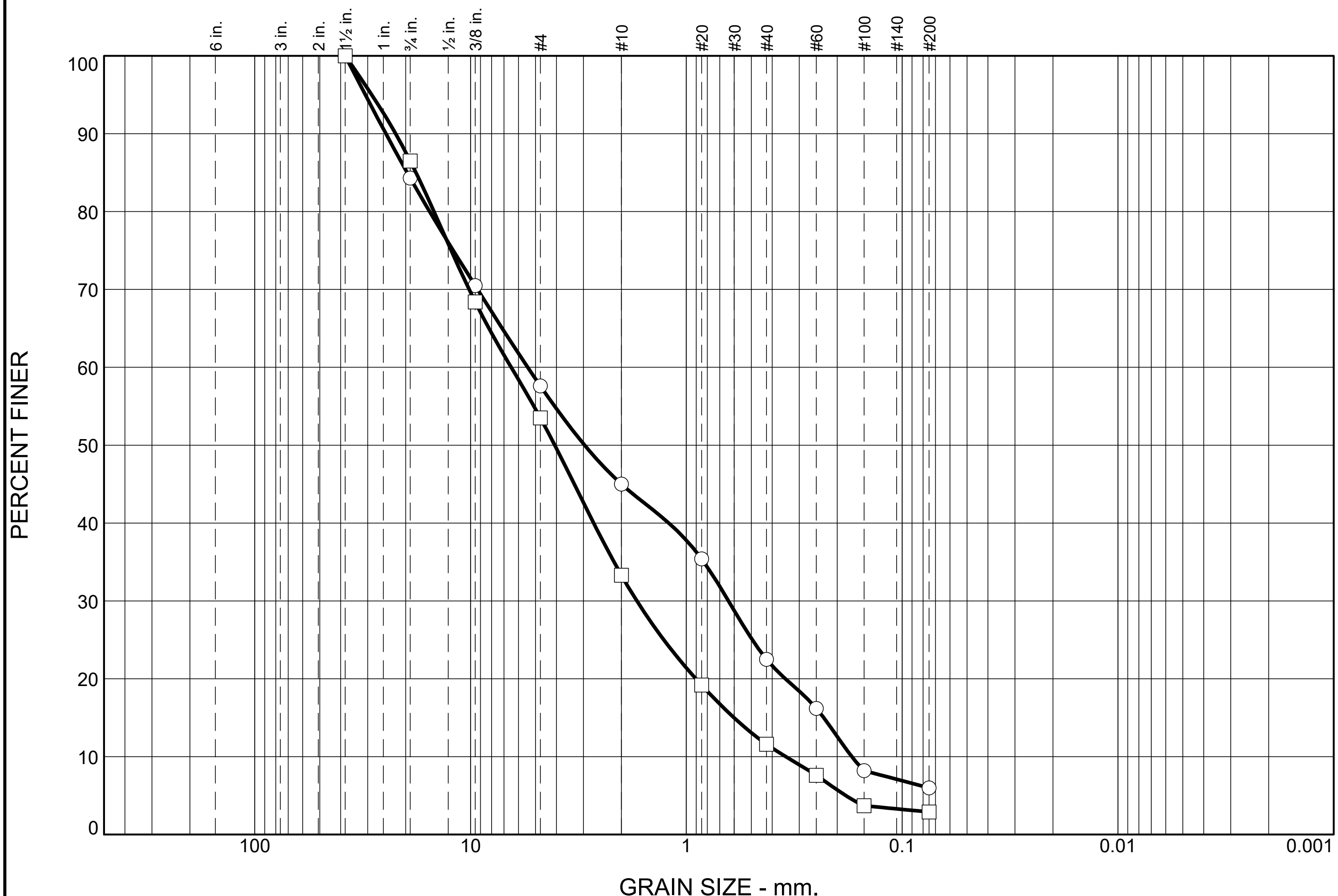
Figure A-7

Tested By: FQ/KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	15.7	26.7	12.6	22.5	16.5	6.0	
□	0.0	13.5	33.0	20.2	21.7	8.7	2.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			19.6836	5.4389	2.9606	0.6383	0.2309	0.1710	0.44	31.81
□			17.9125	6.4816	4.0735	1.6958	0.6013	0.3459	1.28	18.74

Material Description	USCS	AASHTO
○ SAND with silt and gravel	SP-SM	
□ SAND with gravel	SP	

Project No. T-9025 **Client:** Land Pro Group

Project: Tapert Arlington Jensen

○ **Location:** Test Pit TP-3 **Depth:** -5 ft **Sample Number:** 2

□ **Location:** Test Pit TP-3 **Depth:** -6 ft **Sample Number:** 3

Remarks:

○ Tested on April 3, 2024

□ Tested on April 3, 2024

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Kirkland, WA

Figure A-8

Tested By: FQ/KJ