

# Geotechnical Engineering Report

Proposed 3-Lot Short-Plat  
4405 188<sup>th</sup> Street NE  
Arlington, WA 98223  
Parcel No. 31051600400300

Prepared For:

**Mr. Jon King**  
6705 67<sup>th</sup> Drive NE  
Marysville, WA 98270



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An RMA Company

June 22, 2023  
Project No. 23-0276

**Mr. Jon King**  
6705 67<sup>th</sup> Drive NE  
Marysville, WA 98270

**Regarding: Geotechnical Engineering Report**  
Proposed 3-Lot Short-Plat  
4405 188<sup>th</sup> Street NW  
Arlington, WA 98223  
Parcel No. 31051600400300

Dear Mr. King,

As requested, GeoTest Services, Inc. [GeoTest] is pleased to submit the following report summarizing the results of our geotechnical engineering evaluation for the proposed 3-lot short-plat development, located at 4405 188<sup>th</sup> Street NE in Arlington, WA (see *Vicinity Map*, Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement dated April 18, 2023 and authorized by yourself (Proposal No. 23-252G).

GeoTest appreciates the opportunity to provide geotechnical services on this project and looks forward to assisting you during the construction phase. Should you have any further questions regarding the information contained within the report, or if we may be of service in other regards, please contact the undersigned.

Respectfully,  
**GeoTest Services, Inc.**

Gunnar Sterlington, G.I.T.  
Staff Geologist



Gerry D. Bautista, Jr., P.E.  
Project Geotechnical Engineer

Enclosure: Geotechnical Engineering Report

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## PURPOSE AND SCOPE OF SERVICES

The purpose of this evaluation is to establish general subsurface conditions beneath the site from which conclusions and recommendations pertaining to project design can be formulated. Our scope of services includes the following tasks:

- Explore soil and groundwater conditions underlying the site by advancing four test pit explorations with a client-provided tracked excavator.
- Perform laboratory testing on representative samples to classify and evaluate the engineering characteristics of the soils encountered and to assess on-site infiltration capability.
- Provide a written report containing a description of subsurface conditions and exploration logs. The findings and recommendations in this report pertain to site preparation and earthwork, fill and compaction, seismic design, foundation recommendations, concrete slab-on-grade construction, foundation and site drainage, utilities, temporary and permanent slopes, stormwater infiltration feasibility, geotechnical consultation, and/or construction monitoring.
- Assess Geologically Hazardous Areas (if present) per Arlington Municipal Code (AMC).

## PROJECT DESCRIPTION

The subject property consists of a level, irregular-shaped, 1-acre parcel. The property is located on the northern side of 188<sup>th</sup> Street NE in Arlington, WA, on the northern outskirts of the Arlington Municipal Airport. A 1.5-story residence originally constructed in 1938 is currently situated near the center of the subject property. Scattered outbuildings are also located around the existing residence.

GeoTest understands that the existing residence and outbuildings will be demolished, and the parcel will then be divided into three smaller residential lots. No preliminary drawings were available as of the writing of this report. However, GeoTest anticipates that the proposed structures will be wood framed and utilize shallow conventional foundations and slab-on-grade floors. An access driveway will extend from 188<sup>th</sup> Street NE and will parallel either the eastern or western property line.

We anticipate that stormwater infiltration facilities will be incorporated into the new development. Preliminary information regarding these facilities was not available at the time that this report was written.

## SITE CONDITIONS

This section includes a description of the general surface and subsurface conditions observed at the project site during the time of our field investigation. Interpretations of site conditions are based on the results and review of available information, site reconnaissance, subsurface explorations, laboratory testing, and previous experience in the project vicinity.

### Surface Conditions

The subject property is located on the northern outskirts of the Arlington Municipal Airport in Arlington, WA. The property is currently occupied by a single-family residence on its southern portion. There is a gravel driveway that enters the property at its southeast corner, travels northwards, and terminates in a gravel parking area on the eastern side of the property. Scattered ornamental trees and large stumps are located along the northern edge of the property. Behind the single-family residence is an outbuilding and dry well. The open space in the northern half of the property is covered with grass.

The proposed development area is situated within a residential neighborhood. Single-family properties border the parcel on the west, north, and east sides.



Image 1: Site photo of the northern half of the property, facing southwest. (Images 1 through 3 taken on May 9, 2023)

## Subsurface Soil Conditions

Subsurface conditions were explored by advancing four test pits (TP-1 through TP-4) on May 9, 2023. Our test pit explorations were advanced to depths of between 7.5 and 9.9 feet below ground surface (BGS) using a client-provided, track-mounted excavator. The approximate locations of these explorations have been plotted on the *Site and Exploration Plan* (Figure 2).

The subsurface soils consisted of approximately 0.9 to 1.0 foot of topsoil composed of loose, dark brown, damp, silty sand with organics. This topsoil overlaid a native, loose to medium-dense, reddish to light brown, damp, slightly gravelly to gravelly sand, with trace silt. At approximately 2 feet BGS, these soils became medium-dense with interbedded lenses of sand and gravel, with increased gravel content observed with depth. The medium-dense soils were encountered to the maximum explored depth of the test pits. GeoTest interpreted these soils as recessional outwash, or the Marysville Sand Member of the Recessional Outwash (see following section). For the purposes of this report, the native soils are referred to as 'Marysville Sand'.



**Image 2:** Test Pit TP-1 displaying subsurface soils comprised of Marysville Sand.



**Image 3:** Test Pit TP-3 displaying subsurface soils comprised of Marysville Sand.

## General Geologic Conditions

Geologic information for the project site was obtained from the *Geologic Map of the Arlington West 7.5 Minute Quadrangle*, Snohomish County, Washington (Minard, 1985), published by the U.S. Geological Survey. According to the referenced map, subsurface soils in the vicinity of the project site consist of Marysville Sand Member of the Recessional Outwash (Qvrm) deposited during the Fraser glaciation event. The Marysville Sand Member generally consists of well-drained, stratified to massive, outwash sand with some pebble gravel with localized areas of silt and clay.

Native soils encountered during our subsurface exploration were generally consistent with the mapped outwash deposits and exhibited an increasing fines content with depth. In this report, we have referred to these soils as ‘Marysville Sand’.

## Groundwater

Groundwater was not observed within our test pit explorations. The groundwater conditions reported on the exploration logs are for the specific locations and dates indicated, and therefore may not be indicative of other locations and/or times. A review of the Washington State Department of Ecology *Well Log Viewer* indicates that a nearby well at 4617 188<sup>th</sup> Street NE that was installed in 2003 encountered groundwater at approximately 40 feet BGS at the time of installation.

Groundwater levels are variable and groundwater conditions will fluctuate depending on local subsurface conditions, precipitation, and changes in on-site and off-site use. Seasonal groundwater monitoring is not currently part of our scope and does not apply to this project scope.

## Soil Survey

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service website, soils within the vicinity of the subject property are classified as Lynnwood loamy sand, 0 to 3 percent slopes. Values of K range from 0.02 to 0.69; the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Soils classified as “s” are those soils where the soils have a soil limitation within the rooting zone, such as shallowness of rooting zone, stone, low moisture-holding capacity (USDA, 1961).

| Table 1<br>USDA NRCS Soil Classifications |  |
|---|--|
| Map Unit Symbol                           | 30   |
| Map Unit Name                             | Lynnwood loamy sand, 0 to 3 percent slopes |
| Landform                                  | Terraces, and outwash plains               |
| Parent Material                           | Glacial outwash                            |
| Land Capability Classification            | 4s   |
| Hydrologic Soil Group                     | A  |
| Erosion K Factor, Whole Soil              | 0.20 (moderate)                            |

Table 1 summarizes the soil properties obtained from the USDA Web Soil Survey website. Native soils observed at the project site appeared to be generally consistent with the *Web Soil Survey* descriptions.

## **GEOLOGIC HAZARDS**

The subject property and surrounding areas are flat. Thus, there does not appear to be Geologic Hazards, as defined by the Arlington Municipal Code Chapter 20.93 Part VI, for landslide hazards. Thus, GeoTest does not have any formal recommendations for mitigating landslide hazards, as these types of hazards are not present on the project site.

### **Erosion Hazard Areas**

The mapped soils within the majority of the subject property are classified as having a moderate erosion potential per the Web Soil Survey. However, the site itself is relatively flat. Thus, it is GeoTest's opinion that the subject property does not contain Erosion Hazards. That said, GeoTest still recommends that the following recommendations be implemented to prevent excessive erosion from occurring:

- All clearing and grading activities for future residence construction will need to incorporate Best Management Practices (BMPs) for erosion control in compliance with current City of Arlington codes and standards.
- GeoTest recommends that appropriate silt fencing be incorporated into the construction plan for erosion control.
- GeoTest recommends that on-site BMPs be implemented during construction. Areas of native vegetation left in place, could also be enhanced by adding additional native plant species and/or other vegetation enhancements.
- All areas disturbed by construction practices should be vegetated or otherwise protected to limit the potential for erosion as soon as practical during and after construction. Areas requiring immediate protection from the effects of erosion should be covered with either plastic, mulch, or erosion control netting/blankets. Areas requiring permanent stabilization should be seeded with an approved grass seed mixture, hydroseeded with an approved seed-mulch-fertilizer mixture or landscaped with a suitable planting design.

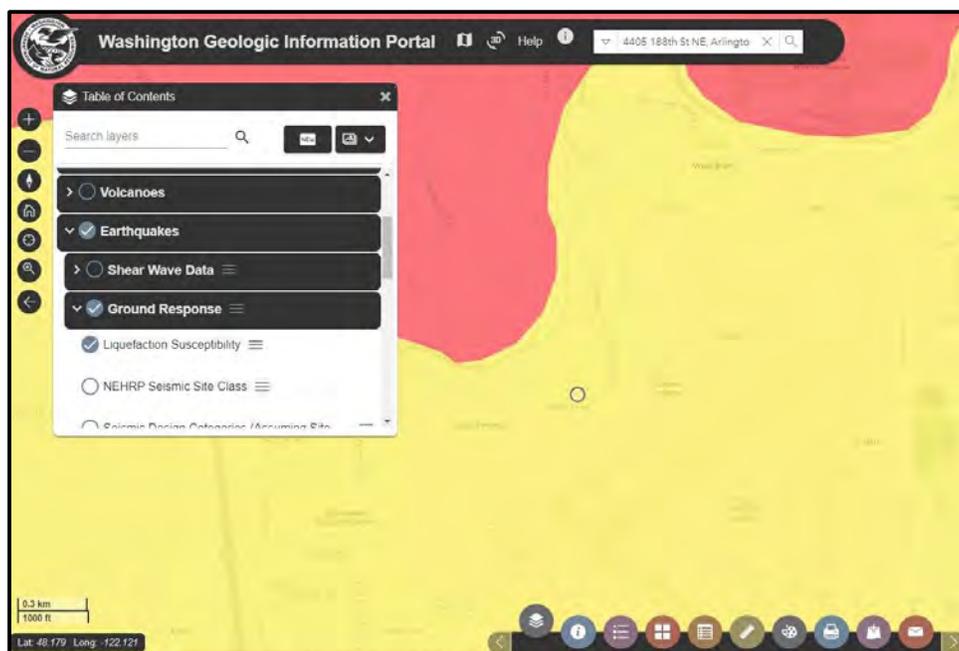
In addition to the preceding recommendations, typical erosion control measures during construction will be required. These measures can include a rockered construction entrance or downslope silt fencing, depending on the regulations of the City of Arlington and/or the governing jurisdiction. No other mitigations are required to address erosion hazards on the property.

## Seismic Hazard Areas

*Seismic Hazard Areas* are typically defined as areas that, due to a combination of soil and groundwater conditions, are subject to severe risk of ground shaking, subsidence, or liquefaction of soils during earthquakes. These areas are typically underlain by soft or loose saturated soils (such as alluvium), have a shallow groundwater table, and are typically located on the floors of river valleys.

AMC 20.93.600(b4) describes “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.”

Based on a review of information obtained from the Washington State Department of Natural Resources *Geologic Information Portal* and the Snohomish County *PDS Map Portal*, the subject property is mapped as having a “low to moderate” potential for seismic liquefaction. However, these maps only provide an estimate of the likelihood that soils will liquefy as a result of an earthquake and are meant as a general guide to indicate areas potentially susceptible to liquefaction. The *Geologic Information Portal* also illustrates that the nearest active fault trenches and mapped folds are located approximately 9 miles northeast towards Lake Cavanaugh, as part of the Mount Washington Fault Zone.



**Image 4:** Clip from DNR *Geologic Information Portal* showing liquefaction susceptibility. Red is High, Yellow is low to moderate. Note the zone boundaries are approximate. Property denoted by the black circle. Image retrieved on May 30, 2023.

Based on the mapped geology, the proposed development is underlain by native recessional outwash soils (Marysville Sand). It is GeoTest's opinion that the site is in general accordance with the mapped low liquefaction susceptibility and therefore is **not located in a Seismic Hazard Area**. Outside of complying with applicable provisions in the International Building Code (IBC) for seismic design, no mitigations are required to address Seismic Hazards for this site.

## CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the data collected during this investigation, it is our opinion that the subsurface conditions at the site are suitable for the proposed development, provided the recommendations contained herein are incorporated into the project design.

Our explorations throughout most of the site exposed approximately 1 foot of organic topsoil overlying native, loose to medium-dense, Marysville Sand soils that became medium-dense at approximately 2 feet BGS. Marysville Sand soils were encountered to the maximum explored depth of the test pits.

The soils within the vicinity of the proposed residence will likely require minimal grading in the proposed building footprint to remove loose, near-surface topsoil, fill (if present) and expose the competent Marysville Sand. Footings can be poured directly on properly prepared, firm and unyielding native soil. Footings may also be placed on compacted Structural Fill overlying firm and unyielding native soil. Qualified geotechnical personnel should carefully observe footing areas prior to placing Structural Fill and/or foundation forms to determine if soil conditions are as expected.

The native Marysville Sand soils encountered in our explorations contain a low percentage of fines and appear to be suitable for conventional stormwater infiltration designs. Perched groundwater was not encountered within the test pits during the time of our explorations.

### Site Preparation and Earthwork

The portions of the site proposed for foundations and floor slabs should be prepared by removing existing topsoil, deleterious material, and significant accumulations of organics from the area to be developed. GeoTest anticipates up to 1 foot of excavation to expose suitable subgrade soils for the building foundations.

At a minimum, all subgrades within the proposed areas of development should be recompacted to a firm and unyielding condition and observed by qualified geotechnical personnel. The purpose of this effort is to identify loose or soft soil deposits so that, if feasible, the soil disturbed during site work can be recompacted.

Proof rolling should be carefully observed by qualified geotechnical personnel. Areas exhibiting significant deflection, pumping, or elevated moisture contents that prevent the soil from being adequately compacted should be overexcavated to firm soil. Overexcavated areas should be backfilled with compacted granular material placed in accordance with subsequent recommendations for Structural Fill. During periods of wet weather, proof rolling could damage the exposed subgrade. Under these conditions, GeoTest personnel should observe subgrade conditions to determine if proof rolling is feasible.

Proof rolling may not be feasible for certain locations within excavations, trench areas, or other difficult access zones when using a full-size dump truck or other large machinery. In this situation, we recommend alternate means of verification such as Dynamic Cone Penetrometer (DCP) testing or soil probe methods be employed to verify suitability of field conditions.

### **Fill and Compaction**

Structural Fill must be properly placed and compacted. In most cases, suitable, non-organic, predominantly granular soil may be used for fill material provided the material is properly moisture conditioned prior to placement and compaction, and the specified degree of compaction is obtained. Material containing topsoil, wood, trash, organic material, or construction debris is not suitable for reuse as Structural Fill and should be properly disposed offsite or placed in nonstructural areas. GeoTest generally expects about 1 foot of stripping to remove topsoil and near-surface asphalt/concrete debris prior to the placement of new fill materials.

Soils containing more than approximately 5 percent fines are considered moisture sensitive and are difficult to compact to a firm and unyielding condition when over the optimum moisture content by more than approximately 2 percent. The optimum moisture content is that which allows the greatest dry density to be achieved at a given level of compactive effort.

#### *Reuse of On-Site Soil*

The non-organic, native Marysville Sand is suitable for reuse as Structural Fill when placed at or near optimum moisture content, and if allowed for in the plans and specifications. The near-surface, native soils have fines contents of about 5 percent and are considered moisture sensitive. Reuse of moisture sensitive soils could be difficult depending on weather conditions and compaction efforts utilized.

If using on-site materials, the Contractor and Owner should be prepared to manage over optimum moisture content soils. The moisture content of the soils may be difficult to control during periods of wet weather.

### *Imported Structural Fill*

GeoTest recommends that imported Structural Fill for raising site grades consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run) or a well-graded crushed rock. We recommend Structural Fill for dry weather construction meet Washington State Department of Transportation (WSDOT) Standard Specification 9-03.14(2) for “Select Borrow” with the added requirement than 100 percent pass a 4-inch-square sieve.

Soil containing more than about 5 percent fines (that portion passing the U.S. No. 200 sieve) cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than optimum. Accordingly, GeoTest recommends that imported Structural Fill for wet weather construction meet WSDOT Standard Specification 9-03.14(1) for “Gravel Borrow” with the added requirement that no more that 5 percent pass the U.S. No. 200 sieve. Due to wet weather or wet site conditions, soil moisture contents could be high enough that it may be very difficult to compact even ‘clean’ imported select granular fill to a firm and unyielding condition. Soils with over-optimum moisture contents should be scarified and dried back to more suitable moisture contents during periods of dry weather or removed and replaced with fill soils at a more suitable range of moisture contents.

### *Backfill and Compaction*

Structural Fill should be placed in horizontal lifts. The Structural Fill must measure 8 to 10 inches in loose thickness and be thoroughly compacted. All Structural Fill placed under load bearing areas should be compacted to at least 95 percent of the maximum dry density, as determined using test method ASTM D1557. The top of the compacted Structural Fill should extend outside all foundations and other structural improvements a minimum distance equal to the thickness of the fill. We recommend that compaction be tested after placement of each lift in the fill pad.

### **Wet Weather Earthwork**

The upper portions of the Marysville Sand have fines contents on the order of 4 to 5 percent by weight. As such, these soils may be susceptible to degradation during wet weather. If construction takes place during wet weather, GeoTest recommends that Structural Fill consist of imported, clean, well-graded sand or sand and gravel as described above. If fill is to be placed or earthwork is to be performed in wet conditions, the contractor may reduce soil disturbance by:

- Limiting the size of areas that are stripped of topsoil and left exposed
- Accomplishing earthwork in small sections
- Limiting construction traffic over unprotected soil
- Sloping excavated surfaces to promote runoff
- Limiting the size and type of construction equipment used

- Providing gravel 'working mats' over areas of prepared subgrade
- Removing wet surficial soil prior to commencing fill placement each day
- Sealing the exposed ground surface by rolling with a smooth drum compactor or rubber-tired roller at the end of each working day
- Providing up-gradient perimeter ditches or low earthen berms and using temporary sumps to collect runoff and prevent water from ponding and damaging exposed subgrades

### **Seismic Design Considerations**

The Pacific Northwest is seismically active, and the site could be subject to movement from a moderate or major earthquake. Consequently, moderate levels of seismic shaking should be accounted for during the design life of the project, and the proposed structure should be designed to resist earthquake loading using appropriate design methodology.

For structures designed using the seismic design provisions of the 2018 International Building Code, the medium dense Marysville Sand underlying the site is classified as Site Class D, according to ASCE 7-16. The structural engineer should select the appropriate design response spectrum based on Site Class D soil and the geographical location of the proposed construction.

### **Foundation Support**

To provide proper support for house foundations, GeoTest recommends that existing topsoil and existing fill, if present, be removed from beneath the building foundation area. Most of this near-surface material would be removed assuming that the proposed structure will have shallow conventional foundations. Medium dense, native soils are unlikely to require much preparation. Soils disturbed during stripping or footing excavation should be compacted with a large compactor such as a smooth-drum roller, hoe-pack, or a similar piece of construction equipment. Once suitable bearing conditions have been confirmed, foundations can be placed directly on native soils or on properly compacted Structural Fill as described in the *Fill and Compaction* section of this report.

Continuous and isolated spread footings should be founded 18 inches, minimum, below the lowest adjacent final grade for freeze/thaw protection. The footings should be sized in accordance with the structural engineer's prescribed design criteria and seismic considerations.

#### *Allowable Bearing Capacity*

Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on remedially compacted, native, firm, and unyielding Marysville Sand soils, or on Structural Fill placed atop competent native soils may be proportioned using a net allowable soil bearing pressure of 2,500 pounds per square foot (psf). The 'net allowable bearing

pressure' refers to the pressure that can be imposed on the soil at foundation level. This pressure includes all dead loads, live loads, the weight of the footing, and any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

#### *Foundation Settlement*

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. If construction is accomplished as recommended and at the maximum allowable soil bearing pressure, GeoTest estimates the total settlement of building foundations to be less than one inch. Differential settlement between two adjacent load-bearing components supported on competent soil is estimated to be less than one half the total settlement.

#### **Floor Support**

Floor slabs for the residential structure can be supported on firm and unyielding, properly prepared native subgrade or on properly placed and compacted Structural Fill placed over firm and unyielding native soil. The native subgrade should be proof rolled as recommended in the *Site Preparation and Earthwork* section of this report.

GeoTest recommends that interior concrete slab-on-grade floors be underlain with at least 6 inches of clean, compacted, free-draining gravel. The gravel should contain less than 3 percent passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The purpose of this gravel layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer. To help reduce the potential for water vapor migration through floor slabs, a continuous 10-mil minimum thick polyethylene sheet with tape-sealed joints should be installed below the slab to serve as an impermeable vapor barrier. The vapor barrier should be installed and sealed in accordance with the manufacturer's instructions.

Exterior concrete slabs-on-grade, such as sidewalks, may be supported directly on undisturbed native soil or on properly placed and compacted structural fill; however, long-term performance will be enhanced if exterior slabs are placed on a layer of clean, durable, well-draining granular material.

#### **Foundation and Site Drainage**

Positive surface gradients should be provided adjacent to the proposed building to direct surface water away from the building and toward suitable drainage facilities. Roof drainage should not be introduced into the perimeter footing drains but should be separately discharged directly to the stormwater collection system or similar municipality-approved outlet. Pavement and

sidewalk areas, if present, should be sloped and drainage gradients should be maintained to carry surface water away from the building towards an approved stormwater collection system. Surface water should not be allowed to pond and soak into the ground surface near buildings or paved areas during or after construction. Construction excavations should be sloped to drain to sumps where water from seepage, rainfall, and runoff can be collected and pumped to a suitable discharge facility.

To reduce the potential for groundwater and surface water to seep into interior spaces, GeoTest recommends that an exterior footing drain system be constructed around the perimeter of new building foundations as shown in the *Conceptual Footing and Wall Drain Section* (Figure 3) of this report. The drain should consist of a perforated pipe measuring 4 inches in diameter at minimum, surrounded by at least 12 inches of filtering media. The pipe should be sloped to carry water to an approved collection system.

The filtering media may consist of open-graded drain rock wrapped in a nonwoven geotextile fabric such as Mirafi 140N (or equivalent) or wrapped with a graded sand and gravel filter. For foundations supporting retaining walls, drainage backfill should be carried up the back of the wall and be at least 12 inches wide. The drainage backfill should extend from the foundation drain to within approximately 1 foot of the finished grade and consist of open-graded drain rock containing less than 3 percent fines by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drainpipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade (whichever is deeper) so that water will be contained. This process prevents water from seeping through walls or floor slabs. The drain system should include cleanouts to allow for periodic maintenance and inspection.

Please understand that the above recommendations are intended to assist the design engineer and/or architect in development of foundation and site drainage parameters and are based on our experience with similar projects in the area. The final foundation and site drainage plan that will be incorporated into the project plans is to be determined by the design team.

### **Resistance to Lateral Loads**

The lateral earth pressures that develop against foundation walls will depend on the method of backfill placement, degree of compaction, slope of backfill, type of backfill material, provisions for drainage, magnitude and location of any adjacent surcharge loads, and the degree to which the wall can yield laterally during or after placement of backfill. If the wall can rotate or yield so the top of the wall moves an amount equal to or greater than about 0.001 to 0.002 times its height (a yielding wall), the soil pressure exerted comprises the active soil pressure. When a wall is restrained against lateral movement or tilting (a nonyielding wall), the soil pressure exerted comprises the at rest soil pressure. Wall restraint may develop if a rigid structural network is constructed prior to backfilling or if the wall is inherently stiff.

GeoTest recommends that yielding walls under drained conditions be designed for an equivalent fluid density of 35 pounds per cubic foot (pcf), for Structural Fill in active soil conditions. Nonyielding walls under drained conditions should be designed for an equivalent fluid density of 55 pcf, for Structural Fill in at-rest conditions. GeoTest should be contacted if the final design includes submerged walls, so that we may provide updated recommendations.

Design of walls should include appropriate lateral pressures caused by surcharge loads located within a horizontal distance equal to or less than the height of the wall. For uniform surcharge pressures, a uniformly distributed lateral pressure equal to 35 percent and 50 percent of the vertical surcharge pressure should be added to the lateral soil pressures for yielding and nonyielding walls, respectively. GeoTest also recommends that a seismic surcharge of 8H be included where H is the wall height. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the wall.

Passive earth pressures developed against the sides of building foundations, in conjunction with friction developed between the base of the footings and the supporting subgrade, will resist lateral loads transmitted from the structure to its foundation. For design purposes, the passive resistance of well-compacted fill placed against the sides of foundations is equivalent to a fluid with a density of 300 pcf. The recommended value includes a safety factor of about 1.5 and assumes that the ground surface adjacent to the structure is level in the direction of movement for a distance equal to or greater than twice the embedment depth. The recommended value also assumes drained conditions that will prevent the buildup of hydrostatic pressure in the compacted fill. Retaining walls should include a drain system constructed in general accordance with the recommendations presented in the *Foundation and Site Drainage* section of this report. In design computations, the upper 12 inches of passive resistance should be neglected if the soil is not covered by floor slabs or pavement. If future call for the removal of the soil providing resistance, the passive resistance should not be considered.

An allowable coefficient of base friction of 0.35, applied to vertical dead loads only, may be used between the underlying soil and the base of the footing. If passive and frictional resistance are considered together, one half the recommended passive soil resistance value should be used since larger strains are required to mobilize the passive soil resistance as compared to frictional resistance. A safety factor of about 1.5 is included in the base friction design value. GeoTest does not recommend increasing the coefficient of friction to resist seismic or wind loads.

### **Temporary and Permanent Slopes**

The contractor is responsible for construction slope configurations and maintaining safe working conditions, including temporary excavation stability. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 feet should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-66403.

Temporary unsupported excavations in native Marysville Sand soils encountered at the project site are classified as a Type C soil according to WAC 296-155-66401 and may be sloped as steep as 1.5H :1V (Horizontal: Vertical). Temporary excavations in existing fill soils are classified as Type C soils and may be sloped as steep as 1.5H:1V. All soils encountered are classified as Type C soil in the presence of groundwater seepage and may be sloped as steep as 1.5:1. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

Temporary slopes and excavations should be protected as soon as possible using appropriate methods to prevent erosion from occurring during periods of wet weather.

GeoTest recommends that permanent cut or fill slopes be designed for inclinations of 2H: 1V or flatter. Permanent cuts or fills used in earth slopes intended to hold water should be 3H: 1V or flatter. No ponds should be located above or on existing steep slopes. All permanent slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction.

### **Stormwater Infiltration Potential**

At the time of our site visit, the near-surface soils in the upper portion of the property consisted of approximately 1 foot of topsoil. Underlying these surficial soils, GeoTest observed poorly graded Marysville Sand soils to the maximum explored depth of the test pits. It is GeoTest's opinion that the conventional infiltration of on-site stormwater is feasible, given that the bottom of infiltration facilities are placed within native Marysville Sand soils.

#### *Test Pit Gradation Results*

From the explorations excavated in the areas of interest, five representative soil samples were selected and mechanically tested for grain size distribution and calculation according to the soil grain size analysis method per the *Stormwater Management Manual for Western Washington* [Manual]. This document is the current stormwater manual adopted by the City of Arlington. A summary of these results is reproduced in Table 2. The rates presented in this table are representative of loose soil conditions and do not take the relative density of the soil into account.

Stormwater infiltration potential is a function of the relative permeability of the site soils, and the separation between the base of the proposed stormwater facility and the groundwater table. For facilities based in the Marysville Sand typically encountered below 1 foot BGS, we recommend a **preliminary design infiltration rate of 10 inches per hour**.

| Table 2<br>Preliminary Infiltration Results Based on Grain Size Analysis   |                 |  |
|--|-----------------|--|
| Boring ID & Depth  | Geologic Unit   | Preliminary, Corrected $K_{sat}$ Infiltration Rate [in/hr] |
| TP-1 (5.4 ft)  | Marysville Sand | 10.0*  |
| TP-2 (4.2 ft)  | Marysville Sand | 10.0*  |
| TP-2 (8.7 ft)  | Marysville Sand | 10.0*  |
| TP-3 (6.8 ft)  | Marysville Sand | 10.0*  |
| TP-4 (2.5 ft)  | Marysville Sand | 10.0*  |
| Notes:<br>- $K_{sat}$ = Initial Saturated Hydraulic Conductivity<br>- Correction Factors Used: $CF_v = 0.70$ , $CF_t = 0.40$ , $CF_m = 0.90$<br>- Total Correction Factor = 0.252<br>- Rates presented are representative of loose conditions and do not consider the relative density of the soil<br>* <b>GeoTest does not recommend a corrected infiltration rate of more than 10 inches per hour.</b> |                 |  |

Please note that the rates given in this section are representative of preliminary design infiltration rates. If a higher infiltration rate is required, the design rate would best be established by performing a Pilot Infiltration Test. This testing is outside the scope of work for this project. However, GeoTest can provide a fee estimate for this testing upon request.

Also note that native soil will likely infiltrate at a faster rate than treatment soil, as described in the next section. Thus, the proposed facilities will need to be designed for the media with the slowest infiltration rate. As discussed above, GeoTest does not recommend a corrected infiltration rate of more than 10 inches per hour.

### *Stormwater Treatment*

The stormwater facilities on-site may require some form of pollutant pretreatment with an amended soil prior to on-site infiltration or off-site discharge. The reuse of on-site topsoil is often the most sustainable and cost-effective method for pollutant treatment purposes. Cation exchange capacities, organic contents, and pH of site subsurface soils were also tested to determine possible pollutant treatment suitability.

Cation exchange capacity, organic content, and pH tests were performed by Northwest Agricultural Consultants on two soil samples collected from the explorations shown in Table 3. A summary of the laboratory test results is presented in Table 3 below.

| Table 3<br>Cation Exchange Capacity, Organic Content, and pH Laboratory Test Results |                   |  |                     |     |
|--|-------------------|--|---------------------|-----|
| Boring ID  | Sample Depth (ft) | Cation Exchange Capacity (meq/100 grams) | Organic Content (%) | pH  |
| TP-1   | 3.7               | 2.0                                      | 0.58                | 6.5 |
| TP-3   | 0.7               | 12.7                                     | 4.93                | 6.3 |

Suitability for on-site pollutant treatment is determined in accordance with SSC-6 of the Manual. Soils with an organic content of greater than or equal to 1 percent and a cation exchange capacity of greater than or equal to 5 meq/100 grams are characterized as suitable for stormwater treatment. Based on the results shown in Table 3, the topsoil and near-surface Marysville Sand are expected to be suitable for the treatment of stormwater without amendment, while the soils deeper than about 18 inches are not suitable without amendment.

### Geotechnical Consultation and Construction Monitoring

GeoTest recommends that we be involved in the project design review process. The purpose of the review is to verify that the recommendations presented in this report are understood and incorporated in the design and specifications.

We also recommend that geotechnical construction monitoring services be provided. These services should include observation by GeoTest personnel during subgrade preparation operations, Structural Fill placement, and compaction efforts to confirm that design subgrade conditions are obtained beneath the areas of improvement.

Periodic field density testing should be performed to verify that the appropriate degree of compaction is obtained. The purpose of these services is to observe compliance with the design concepts, specifications, and recommendations of this report. If subsurface conditions differ from those anticipated before the start of construction, GeoTest would be pleased to provide revised recommendations appropriate to the conditions revealed during construction.

GeoTest is available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, reinforced masonry, wood framing, and structural steel. These services are supported by our fully accredited materials testing laboratories.

### USE OF THIS REPORT

GeoTest Services, Inc. has prepared this report for the exclusive use of Mr. Jon King, and his design consultants for specific application to the design of the proposed 3-lot short-plat located

at 4405 188<sup>th</sup> Street NE in Arlington, WA. Use of this report by others is at the user's sole risk. This report is not applicable to other site locations. Our services are conducted in accordance with accepted practices of the geotechnical engineering profession; no other warranty, express or implied, is made as to the professional advice included in this report.

Our site explorations document subsurface conditions at the dates and locations indicated. It is not warranted that these conditions are representative of conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth and time of our explorations, a geological reconnaissance of the area, and a review of previously published geological information for the site. If variations in subsurface conditions are encountered during construction that differ from those contained within this report, GeoTest should be allowed to review the recommendations and, if necessary, make revisions. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

The earthwork contractor is responsible to perform all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. is not responsible for job site safety on this project, and this responsibility is specifically disclaimed.

|                       |   |
|-----------------------|---|
| Attachments: Figure 1 | Vicinity Map                                  |
| Figure 2              | Site and Exploration Plan                     |
| Figure 3              | Conceptual Footing and Wall Drain Section     |
| Figure 4              | Soil Classification System and Key            |
| Figures 5 – 6         | Logs of Test Pits                             |
| Figure 7              | Grain Size Test Data                          |
| Attached              | Northwest Agricultural Consultants Results    |
| Attached              | Report Limitations and Guidelines for its Use |

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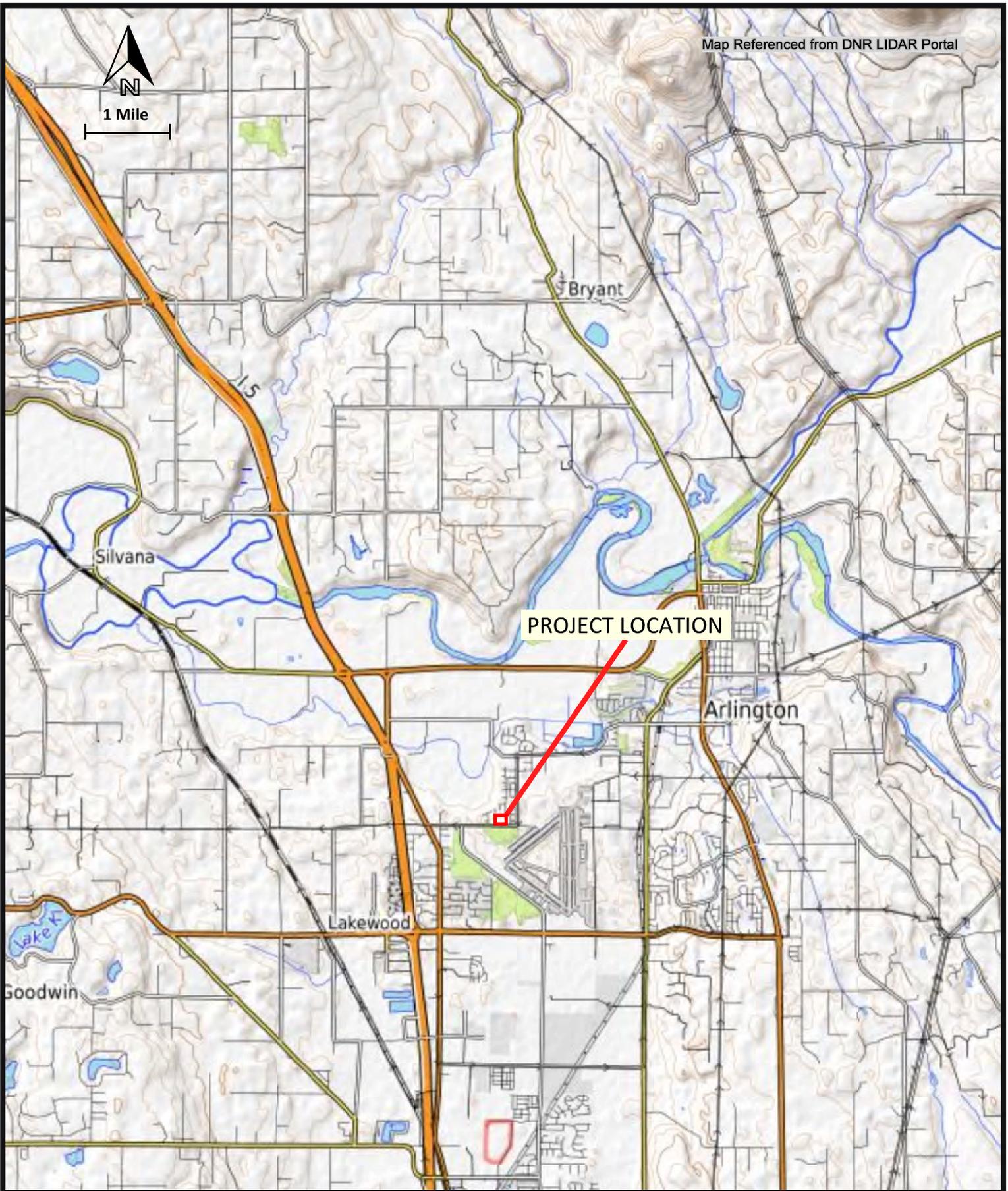
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1 Mile



Date: 6-7-23

By: GS

Scale: As Shown

Project

**23-0276**

**VICINITY MAP**  
**PROPOSED 3-LOT SHORT-PLAT**  
**4405 188TH STREET NE**  
**ARLINGTON, WA 98223**

Figure

**1**



 APPROXIMATE TEST PIT LOCATIONS



Date: 6-12-23

By: GDB

Scale: As Shown

Project

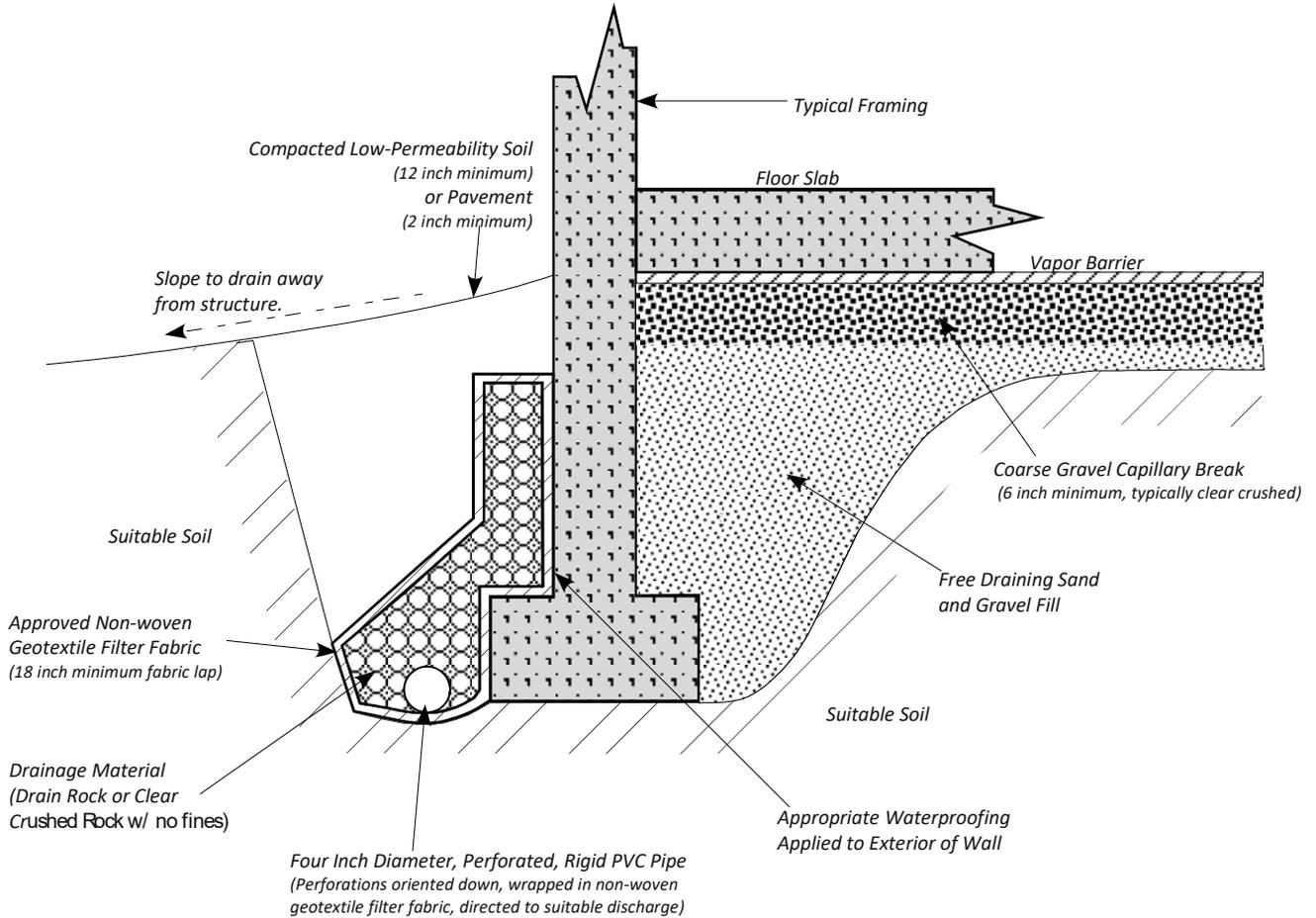
**SITE AND EXPLORATION PLAN**  
**PROPOSED 3-LOT SHORT-PLAT**  
**4405 188TH STREET NE**  
**ARLINGTON, WA 98223**

**23-0276**

Figure

**2**

## CONCEPTUAL FOOTINGS WITH INTERIOR SLAB-ON-GRADE



**Notes:**

This figure is not intended to be representative of a design. This figure is intended to present concepts that can be incorporated into a functional foundation drain designed by a Civil Engineer. In all cases, refer to the Civil plan sheet for drain details and elevations.

Footings should be properly buried for frost protection in accordance with International Building Code or local building codes (Typically 18 inches below exterior finished grades).

The footing drain will need to be modified from this typical drawing to fit the dimensions of the planned footing and slab configuration.

|   |  |         |             |                           |
|---|--|---------|-------------|---------------------------|
|  | Date: 6-7-23   | By: GDB | Scale: None | Project<br><b>23-0276</b> |
|   | <b>CONCEPTUAL FOOTING &amp; WALL DRAIN SECTION</b>                       |         |             | Figure<br><b>3</b>        |
|   | PROPOSED 3-LOT SHORT-PLAT<br>4405 188TH STREET NE<br>ARLINGTON, WA 98223 |         |             |                           |

## Soil Classification System

|  | MAJOR DIVISIONS  | CLEAN GRAVEL<br>(Little or no fines)               | GRAPHIC SYMBOL | USCS LETTER SYMBOL   | TYPICAL DESCRIPTIONS <sup>(1)(2)</sup>                           |
|--|--|--|----------------|--|--|
| COARSE-GRAINED SOIL<br>(More than 50% of material is larger than No. 200 sieve size) | GRAVEL AND GRAVELLY SOIL<br><br>(More than 50% of coarse fraction retained on No. 4 sieve) | CLEAN GRAVEL<br>(Little or no fines)               |                | <b>GW</b>  | Well-graded gravel; gravel/sand mixture(s); little or no fines   |
|  |  | GRAVEL WITH FINES<br>(Appreciable amount of fines) |                | <b>GP</b>  | Poorly graded gravel; gravel/sand mixture(s); little or no fines |
|  | SAND AND SANDY SOIL<br><br>(More than 50% of coarse fraction passed through No. 4 sieve)   | CLEAN SAND<br>(Little or no fines)                 |                | <b>SW</b>  | Well-graded sand; gravelly sand; little or no fines              |
|  |  | SAND WITH FINES<br>(Appreciable amount of fines)   |                | <b>SP</b>  | Poorly graded sand; gravelly sand; little or no fines            |
|  |  |  |                | <b>SM</b>  | Silty sand; sand/silt mixture(s)                                 |
|  |  |  |                | <b>SC</b>  | Clayey sand; sand/clay mixture(s)                                |
| FINE-GRAINED SOIL<br>(More than 50% of material is smaller than No. 200 sieve size)  | SILT AND CLAY<br><br>(Liquid limit less than 50)   |  | <b>ML</b>      | Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity |  |
|  |  |  | <b>CL</b>      | Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay                   |  |
|  |  |  | <b>OL</b>      | Organic silt; organic, silty clay of low plasticity  |  |
|  | SILT AND CLAY<br><br>(Liquid limit greater than 50)  |  | <b>MH</b>      | Inorganic silt; micaceous or diatomaceous fine sand  |  |
|  |  |  | <b>CH</b>      | Inorganic clay of high plasticity; fat clay  |  |
|  |  |  | <b>OH</b>      | Organic clay of medium to high plasticity; organic silt  |  |
|  | HIGHLY ORGANIC SOIL  |  | <b>PT</b>      | Peat; humus; swamp soil with high organic content  |  |

| OTHER MATERIALS | GRAPHIC SYMBOL | USCS LETTER SYMBOL | TYPICAL DESCRIPTIONS                                  |
|-----------------|----------------|--------------------|---|
| PAVEMENT        |                | <b>AC or PC</b>    | Asphalt concrete pavement or Portland cement pavement |
| ROCK            |                | <b>RK</b>          | Rock (See Rock Classification)                        |
| WOOD            |                | <b>WD</b>          | Wood, lumber, wood chips                              |
| DEBRIS          |                | <b>DB</b>          | Construction debris, garbage                          |

- Notes: 1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

- Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.  
 Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.  
 > 12% and ≤ 30% - "gravelly," "sandy," "silty," etc.  
 Additional Constituents: > 5% and ≤ 12% - "slightly gravelly," "slightly sandy," "slightly silty," etc.  
 ≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

| Drilling and Sampling Key  |              | Field and Lab Test Data        |   |
|--|--------------|--------------------------------|---|
| SAMPLE NUMBER & INTERVAL   | SAMPLER TYPE | Code                           | Description                                     |
|  | Code         |                                |   |
|  |              | a                              | 3.25-inch O.D., 2.42-inch I.D. Split Spoon      |
|  |              | b                              | 2.00-inch O.D., 1.50-inch I.D. Split Spoon      |
|  |              | c                              | Shelby Tube                                     |
|  |              | d                              | Grab Sample                                     |
|  | e            | Other - See text if applicable |   |
|  | 1            | 300-lb Hammer, 30-inch Drop    |   |
|  | 2            | 140-lb Hammer, 30-inch Drop    |   |
|  | 3            | Pushed                         |   |
|  | 4            | Other - See text if applicable |   |
| <b>Groundwater</b>   |              |                                |   |
| Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors. |              |                                |   |
|  |              | Code                           | Description                                     |
|  |              | PP = 1.0                       | Pocket Penetrometer, tsf                        |
|  |              | TV = 0.5                       | Torvane, tsf                                    |
|  |              | PID = 100                      | Photoionization Detector VOC screening, ppm     |
|  |              | W = 10                         | Moisture Content, %                             |
|  |              | D = 120                        | Dry Density, pcf                                |
|  |              | -200 = 60                      | Material smaller than No. 200 sieve, %          |
|  |              | GS                             | Grain Size - See separate figure for data       |
|  |              | AL                             | Atterberg Limits - See separate figure for data |
|  |              | GT                             | Other Geotechnical Testing                      |
|  |              | CA                             | Chemical Analysis                               |



Proposed 3-Lot Short-Plat  
 4405 188th Street NE  
 Arlington, WA 98223

Soil Classification System and Key

Figure  
4

## TP-1

| SAMPLE DATA   |                          |              | SOIL PROFILE |   | GROUNDWATER |                              |
|---|--------------------------|--------------|--------------|---|-------------|------------------------------|
| Depth (ft)  | Sample Number & Interval | Sampler Type | Test Data    | Graphic Symbol  | USCS Symbol |                              |
| Excavation Method: <u>Tracked Excavator</u><br>Ground Elevation (ft): <u>137</u><br>Excavated By: <u>Client Provided/Logged: GS</u> |                          |              |              |   |             |                              |
| 0   |                          |              |              |  | SM/<br>OL   | Groundwater not encountered. |
| 1   | 1                        | d            |              |  | SP          |                              |
| 2   | 2                        | d            |              |   |             |                              |
| 4   | 3                        | d            |              |   |             |                              |
| 6   | 4                        | d            | W = 3<br>GS  |   |             |                              |
| 8   | 5                        | d            |              |   |             |                              |
| 10  | 6                        | d            |              |   |             |                              |
| Test Pit Completed 05/09/23<br>Total Depth of Test Pit = 9.8 ft.  |                          |              |              |   |             |                              |

## TP-2

| SAMPLE DATA   |                          |              | SOIL PROFILE |   | GROUNDWATER |                              |
|---|--------------------------|--------------|--------------|---|-------------|------------------------------|
| Depth (ft)  | Sample Number & Interval | Sampler Type | Test Data    | Graphic Symbol  | USCS Symbol |                              |
| Excavation Method: <u>Tracked Excavator</u><br>Ground Elevation (ft): <u>137</u><br>Excavated By: <u>Client Provided/Logged: GS</u> |                          |              |              |   |             |                              |
| 0   |                          |              |              |  | SM/<br>OL   | Groundwater not encountered. |
| 1   | 7                        | d            |              |  | SP          |                              |
| 2   | 8                        | d            |              |   |             |                              |
| 4   | 9                        | d            | W = 6<br>GS  |   |             |                              |
| 6   | 10                       | d            |              |   |             |                              |
| 8   | 11                       | d            | W = 4<br>GS  |   |             |                              |
| 10  | 12                       | d            |              |   |             |                              |
| Test Pit Completed 05/09/23<br>Total Depth of Test Pit = 9.8 ft.  |                          |              |              |   |             |                              |

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



Proposed 3-Lot Short-Plat  
 4405 188th Street NE  
 Arlington, WA 98223

Log of Test Pits

Figure  
5

### TP-3

| SAMPLE DATA  |                          |              | SOIL PROFILE |                | GROUNDWATER |   |
|--|--------------------------|--------------|--------------|----------------|-------------|---|
| Depth (ft)   | Sample Number & Interval | Sampler Type | Test Data    | Graphic Symbol | USCS Symbol |   |
| 0  |                          |              |              |                | SM/OL       | Excavation Method: <u>Tracked Excavator</u><br>Ground Elevation (ft): <u>137</u><br>Excavated By: <u>Client Provided/Logged: GS</u>   |
| 13   | 13-14                    | d            | W = 4<br>GS  |                | SP          | Loose, dark brown, damp, silty SAND, abundant grass roots (Topsoil)<br><br>Loose to medium dense, reddish brown to gray, damp, gravelly SAND, trace silt, slight mottling (Marysville Sand)<br>-@2' BGS becomes medium-dense, brown, with gravel<br>-Easy to moderate difficulty penetrating test pit side wall with a piece of #4 rebar using a 5lb hammer at 3.3' BGS.<br>-Color grades to gray blue at 5.3' BGS.<br>-Interbedded lenses of gravel and sand from 6' BGS to test pit termination.<br>-Increase in gravel size at 7' BGS. |
| 2  | 14-15                    | d            |              |                |             |   |
| 4  | 15-16                    | d            |              |                |             |   |
| 6  | 16-17                    | d            |              |                |             |   |
| 8  | 17-18                    | d            |              |                |             |   |
| 10   |                          |              |              |                |             | Groundwater not encountered.  |
| Test Pit Completed 05/09/23<br>Total Depth of Test Pit = 9.9 ft. |                          |              |              |                |             |   |

### TP-4

| SAMPLE DATA  |                          |              | SOIL PROFILE |                | GROUNDWATER |  |
|--|--------------------------|--------------|--------------|----------------|-------------|--|
| Depth (ft)   | Sample Number & Interval | Sampler Type | Test Data    | Graphic Symbol | USCS Symbol |  |
| 0  |                          |              |              |                | SM/OL       | Excavation Method: <u>Tracked Excavator</u><br>Ground Elevation (ft): <u>138</u><br>Excavated By: <u>Client Provided/Logged: GS</u>  |
| 2  | 18-19                    | d            | W = 6<br>GS  |                | SP          | Loose, dark brown, damp, silty SAND, abundant grass roots (Topsoil)<br><br>Loose to medium dense, reddish brown to gray, damp, fine to medium grained SAND, trace silt (Marysville Sand)<br>-@2' BGS becomes medium-dense, brown, with gravel<br>-Easy to moderate difficulty penetrating test pit side wall with a piece of #4 rebar using a 5lb hammer at 3.1' BGS.<br>-Increase in sand grain size and gravel content at approximately 4.1' BGS.<br>-Color grades to gray blue at approximately 4.2' BGS.<br>-Increase in gravel size at 6.0' BGS.<br>-Cave in at 7.2' BGS. |
| 4  | 19-20                    | d            |              |                |             |  |
| 6  | 20-21                    | d            |              |                |             |  |
| 8  | 21-22                    | d            |              |                |             |  |
| 10   | 22-23                    | d            |              |                |             |  |
| Test Pit Completed 05/09/23<br>Total Depth of Test Pit = 7.5 ft. |                          |              |              |                |             |  |

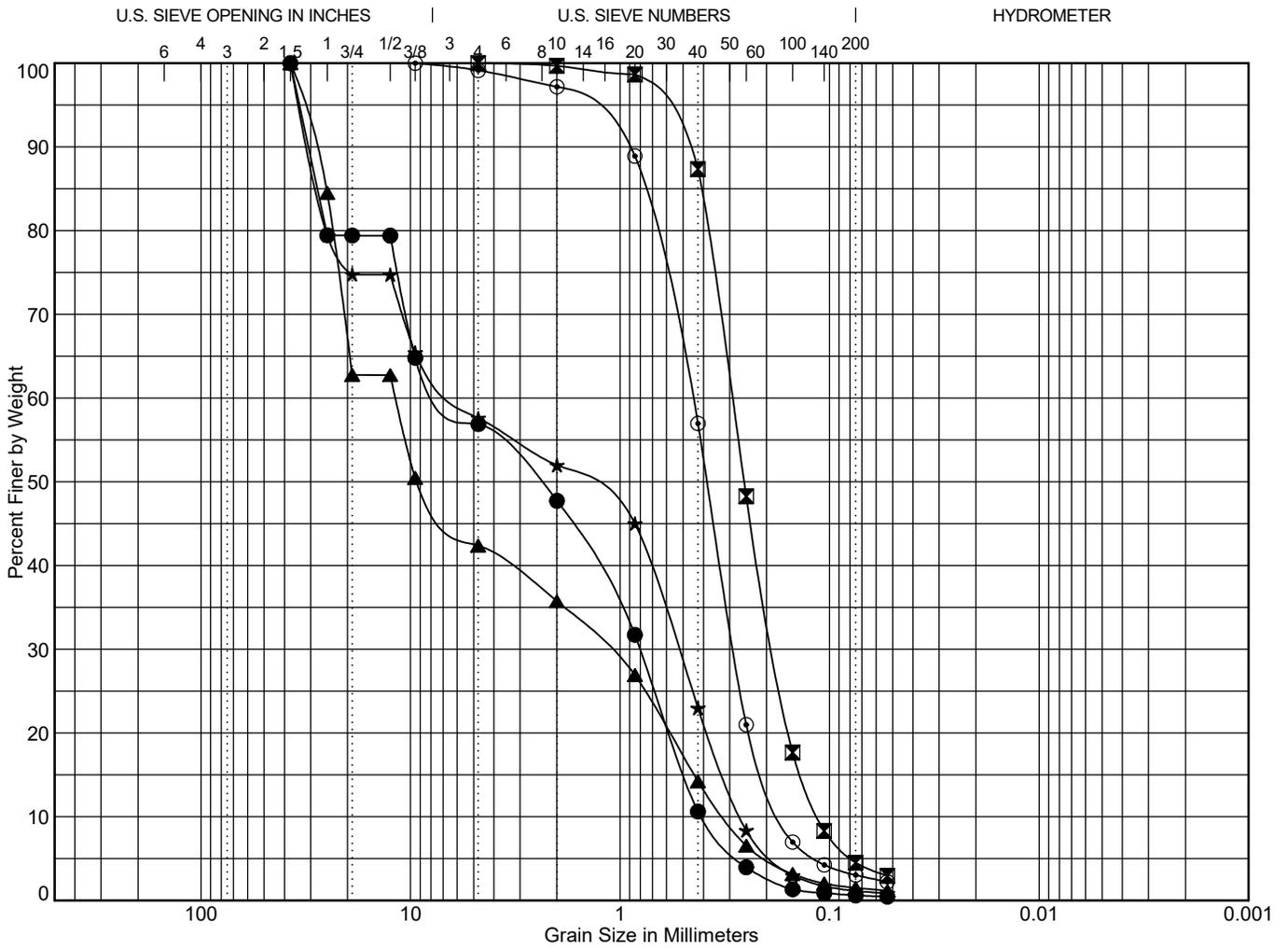
- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



Proposed 3-Lot Short-Plat  
 4405 188th Street NE  
 Arlington, WA 98223

Log of Test Pits

Figure  
6



| Cobbles | Gravel |      | Sand   |        |      | Silt or Clay |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| Point | Depth | Classification  |   |                 |                 |                 |                 |               | LL            | PL            | PI          | C <sub>c</sub> | C <sub>u</sub> |       |
|-------|-------|-----------------|---|-----------------|-----------------|-----------------|-----------------|---------------|---------------|---------------|-------------|----------------|----------------|-------|
| ●     | TP-1  | 5.4             | gravelly SAND, trace silt (SP)                  |                 |                 |                 |                 |               |               |               |             |                | 0.26           | 15.42 |
| ☒     | TP-2  | 4.2             | poorly graded SAND, trace silt (SP)             |                 |                 |                 |                 |               |               |               |             |                | 1.03           | 2.60  |
| ▲     | TP-2  | 8.7             | very sandy GRAVEL, trace silt (GP)              |                 |                 |                 |                 |               |               |               |             |                | 0.35           | 37.04 |
| ★     | TP-3  | 6.8             | gravelly SAND, trace silt (SP)                  |                 |                 |                 |                 |               |               |               |             |                | 0.18           | 22.12 |
| ⊙     | TP-4  | 2.5             | poorly graded SAND, trace gravel, and silt (SP) |                 |                 |                 |                 |               |               |               |             |                | 1.07           | 2.71  |
| Point | Depth | D <sub>90</sub> | D <sub>60</sub>                                 | D <sub>50</sub> | D <sub>30</sub> | D <sub>10</sub> | % Coarse Gravel | % Fine Gravel | % Coarse Sand | % Medium Sand | % Fine Sand | % Fines        |                |       |
| ●     | TP-1  | 5.4             | 30.788  | 6.24            | 2.479           | 0.803           | 0.405           | 20.6          | 22.5          | 9.2           | 37.1        | 10.0           | 0.6            |       |
| ☒     | TP-2  | 4.2             | 0.5   | 0.293           | 0.256           | 0.184           | 0.113           | 0.0           | 0.0           | 0.3           | 12.3        | 82.8           | 4.5            |       |
| ▲     | TP-2  | 8.7             | 28.864  | 11.757          | 9.134           | 1.147           | 0.317           | 37.2          | 20.4          | 6.7           | 21.5        | 12.7           | 1.5            |       |
| ★     | TP-3  | 6.8             | 30.796  | 5.871           | 1.569           | 0.53            | 0.265           | 25.2          | 17.2          | 5.6           | 29.0        | 21.8           | 1.1            |       |
| ⊙     | TP-4  | 2.5             | 0.952   | 0.454           | 0.384           | 0.286           | 0.168           | 0.0           | 0.9           | 2.0           | 40.2        | 53.9           | 3.0            |       |

\*Extrapolated from data

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

To be well graded:  $1 < C_c < 3$  and  $C_u > 4$  for GW or  $C_u > 6$  for SW



Proposed 3-Lot Short-Plat  
4405 188th Street NE  
Arlington, WA 98223

Grain Size Test Data

Figure  
7



**Northwest Agricultural  
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PAP-Accredited



GeoTest Services Inc.  
741 Marine Drive  
Bellingham, WA 98225

**Report:** 63618-1-1  
**Date:** May 12, 2023  
**Project No:** 23-0276  
**Project Name:** Proposed 3-Lot Plat

| Sample ID     | pH                             | Organic Matter    | Cation Exchange Capacity |
|---------------|--------------------------------|-------------------|--------------------------|
| B1 @ 3.7'     | 6.5                            | 0.58%             | 2.0 meq/100g             |
| B3 @ 0.7'     | 6.3                            | 4.93%             | 12.7 meq/100g            |
| <b>Method</b> | <b>SM 4500-H<sup>+</sup> B</b> | <b>ASTM D2974</b> | <b>EPA 9081</b>          |



## REPORT LIMITATIONS AND GUIDELINES FOR ITS USE<sup>1</sup>

Subsurface issues may cause construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help:

### **Geotechnical Services are Performed for Specific Purposes, Persons, and Projects**

At GeoTest our geotechnical engineers and geologists structure their services to meet specific needs of our clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of an owner, a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineer who prepared it. And no one – not even you – should apply the report for any purpose or project except the one originally contemplated.

### **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

### **A Geotechnical Engineering Report is Based on a Unique Set of Project-Specific Factors**

GeoTest's geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the clients goals, objectives, and risk management preferences; the general nature of the structure involved its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless GeoTest, who conducted the study specifically states otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.



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Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed, for example, from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed construction,
- alterations in drainage designs; or
- composition of the design team; the passage of time; man-made alterations and construction whether on or adjacent to the site; or by natural alterations and events, such as floods, earthquakes or groundwater fluctuations; or project ownership.

Always inform GeoTest's geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

### **Subsurface Conditions Can Change**

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. Do not rely on the findings and conclusions of this report, whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact GeoTest before applying the report to determine if it is still relevant. A minor amount of additional testing or analysis will help determine if the report remains applicable.

### **Most Geotechnical and Geologic Findings are Professional Opinions**

Our site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoTest's engineers and geologists review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ – sometimes significantly – from those indicated in your report. Retaining GeoTest who developed this report to provide construction observation is the most effective method of managing the risks associated with anticipated or unanticipated conditions.



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## **A Report's Recommendations are Not Final**

Do not over-rely on the construction recommendations included in this report. Those recommendations are not final, because geotechnical engineers or geologists develop them principally from judgment and opinion. GeoTest's geotechnical engineers or geologists can finalize their recommendations only by observing actual subsurface conditions revealed during construction. GeoTest cannot assume responsibility or liability for the report's recommendations if our firm does not perform the construction observation.

## **A Geotechnical Engineering or Geologic Report may be Subject to Misinterpretation**

Misinterpretation of this report by other design team members can result in costly problems. Lower that risk by having GeoTest confer with appropriate members of the design team after submitting the report. Also, we suggest retaining GeoTest to review pertinent elements of the design teams plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having GeoTest participate in pre-bid and preconstruction conferences, and by providing construction observation.

## **Do not Redraw the Exploration Logs**

Our geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors of omissions, the logs included in this report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable; but recognizes that separating logs from the report can elevate risk.

## **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In that letter, consider advising the contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoTest and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.



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In addition, it is recommended that a contingency for unanticipated conditions be included in your project budget and schedule.

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering or geology is far less exact than other engineering disciplines. This lack of understanding can create unrealistic expectations that can lead to disappointments, claims, and disputes. To help reduce risk, GeoTest includes an explanatory limitations section in our reports. Read these provisions closely. Ask questions and we encourage our clients or their representative to contact our office if you are unclear as to how these provisions apply to your project.

### **Environmental Concerns Are Not Covered in this Geotechnical or Geologic Report**

The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated containments, etc. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. Do not rely on environmental report prepared for some one else.

### **Obtain Professional Assistance to Deal with Biological Pollutants**

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts biological pollutants from growing on indoor surfaces. Biological pollutants includes but is not limited to molds, fungi, spores, bacteria and viruses. To be effective, all such strategies should be devised for the express purpose of prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional biological pollutant prevention consultant. Because just a small amount of water or moisture can lead to the development of severe biological infestations, a number of prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of this study, the geotechnical engineer or geologist in charge of this project is not a biological pollutant prevention consultant; none of the services performed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.