Geotechnical Engineering Report

Pea Patch Property
55 Pea Patch Lane
Eastsound, Washington 98245

Prepared For:

OPAL Community Land Trust
P.O. Box 1133
Eastsound, WA 98245

C/O: Jeanne Beck
Project and Stewardship Manager

GEOTEST

1.888.251.5276
Bellingham | Arlington | Oak Harbor
www.geotest-inc.com

GEOTEST

1.888.251.5276
Bellingham | Arlington | Oak Harbor
www.geotest-inc.com

September 10, 2024
Project No. 24-1958

OPAL Community Land Trust
P.O. Box 1133
Eastsound, WA 98245

C/O: **Jeanne Beck**
Project and Stewardship Manager

Regarding: **Geotechnical Engineering Investigation**
Pea Patch Property
55 Pea Patch Lane
Eastsound, Washington 98245
(Parcel No: 271412006000)

Dear Ms. Beck:

As requested, GeoTest Services, Inc. (GeoTest) is pleased to submit the following report summarizing the results of our geotechnical evaluation for the proposed development, located at Pea Patch Lane in Eastsound, WA (see *Vicinity Map*, Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement (Proposal No. 00-241958-P) dated July 12th, 2024.

GeoTest appreciates the opportunity to provide geotechnical services on this project and look forward to assisting you in further phases of the project. Should you have any 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.

.

Engineering Geologist
19110664
HARRISON G. SIMONS
9.10.2024.

Jeff Vanfossen
Staff Geologist

Harrison Simons, L.E.G.
Geotechnical Project Manager

Enclosure: Geotechnical Engineering Report

TABLE OF CONTENTS

PURPOSE AND SCOPE OF SERVICES

The purpose of this investigation is to establish general surface and subsurface conditions beneath the site from which conclusions and recommendations pertaining to project design can be formulated. Our study includes a review of the potential geologic hazards that are present on, or adjacent to, the property. Our scope of services includes the following tasks:

- Explore soil and groundwater conditions underlying the site by advancing 12 test pit explorations to approximate depths of between 6 and 8 feet below the ground surface (BGS) with a track-mounted excavator subcontracted to GeoTest.
- Perform laboratory testing on representative samples to classify and evaluate the engineering characteristics of the soils encountered and to assess the preliminary feasibility of on-site stormwater infiltration.
- Provide a summary of surface and subsurface soil and groundwater conditions observed at the site during our field exploration. The summary will include descriptions of subsurface profiles of bearing stratum and the potential seasonal effects of groundwater.
- Recommendations for site preparation and earthwork, including reuse of site soil, and criteria for selection, placement, and compaction of structural fill. Included will be a discussion of the effects of weather and/or construction equipment on subgrade soils.
- A discussion of the site seismic considerations based on 2018/2021 IBC. GeoTest has evaluated the liquefaction potential for this site based on our review of regional maps and documented soil conditions to determine what mitigation should be implemented into the plan for development.
- Recommendations for foundation support, including subgrade preparation, site grading, allowable soil bearing pressures, estimates of settlement, subsurface drainage and soil parameters for lateral load resistance.
- Assess Geologically Hazardous Areas in accordance with San Juan County Code (SJCC) sections 18.35.055 – 18.35.070. Contained within this report is a description of potential geologically hazardous areas on the project site. Also presented are our findings and recommended mitigative measures pertaining to the geologic hazards on the subject property.

PROJECT DESCRIPTION

The irregularly shaped subject property is roughly 11.5-acres in size and is located along the northern margin of Enchanted Forest Drive, in the northern portion of Eastsound, on Orcas Island in Washington. The property currently supports gravel surfaced access roads and several residential structures. It is anticipated that the existing structures will be demolished to facilitate the planned improvements.

Based on a conceptual site plan provided by the project team, we understand that the eastern (roughly 5.5-acre portion) of the parcel will be developed with a total of 5 multi-family structures, a new Orcas Island Food Bank building, and a new Orcas Community Resource Center building. Site development is also expected to include new access roadways and parking areas, as well as underground utilities and stormwater management facilities.

GeoTest is not aware of any specific stormwater plan for the property. However, based on communication with the project team, we understand a detention pond is being considered in the southwest corner of the project site. Furthermore, although structural plans were not available at the time this report was written, we anticipate that the proposed multifamily buildings will be 2 to 3 stories in height, will be framed with wood or cold formed steel, and will utilize conventional concrete foundations. Similarly, we anticipate that the proposed commercial buildings will be one to two stories in height and that they will utilize either wood, cold formed steel or structural steel framing with conventional foundations and slabs on grade. As such, we anticipate that structural loading conditions will be light to moderate in scale.

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 investigations on July 31st, 2024. 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 area currently supports two single-family residential structures, a concrete foundation for a former structure, and a looped gravel surfaced access roadway that exits the property to the north as an unsurfaced, dirt road. Otherwise, the site is surfaced with grass and scattered trees. Ornamental vegetation exists around the southwestern residence and dense trees are concentrated to the west of the predominant bedrock high point as well as within the southwestern portion of the subject area. The project site is bordered to the south by Enchanted Forest Road, while the eastern margin of the site is bound by the Orcas Island Children's House, the Salmonberry School and Orcas Funhouse developments. The Orcas Island Fire and Rescue development lies immediately to the north. A generally undeveloped parcel that is surfaced with field grasses and predominantly deciduous tree species bounds the site to the west.

The project site contains gradually sloping terrain of generally southwestern aspect. The northeastern corner of the parcel exists at an elevation of about 65 feet above sea level and extends down to about 35 feet above sea level along the parcel's southwestern margin (*Bare*

Earth Imagery, Figure 3). In addition, several relatively abrupt high points exist across the parcel, the largest of which is located immediately west of the planned improvements. This high point is composed of relatively well exposed bedrock that exhibits up to about 25 feet of vertical relief relative to adjacent grades. This high point appears to exceed 50 percent slope inclinations in limited areas along its margins. There was no surface water observed at the time of our field investigations on July 31st, 2024.

Image 1 (left) and Image 2 (right): Both images depict typical surface conditions at the project site. Note presence of well vegetated, gently sloping topography and existing residence/ concrete foundation. Both images face generally south. Image 1 was taken from near the northeast property corner. Image 2 was captured from the location of TP-4, facing south. Photos taken on July 31, 2024.

Image 3 (left) and Image 4 (right): Both images depict typical surface conditions at the project site. Note bedrock outcropping in Image 3, to the right (east) of the existing access road. From the approximate location of TP-7, Image 3 faces southeast and Image 4 faces southwest.

Subsurface Soil Conditions

Subsurface conditions were explored by advancing 12 exploratory test pits (TP-1 through TP-12) on July 31st, 2024. Depths of the test pit explorations ranged from 6 to 8 feet below ground surface (BGS), where contact with very dense soil conditions prevented continued advancement. Due to the generally dense subsurface conditions, explorations were limited in total depth to allow for a full characterization of soil conditions across the project site overall.

Test pit explorations consisted of the excavation of shallow open pits with the use of a subcontracted excavator, under the direction of a GeoTest Staff Geologist. Select grab samples were obtained based on the encountered changes in soil stratum. Soil classification followed the guidelines of the American Society for Testing and Materials (ASTM) D2487 and D2488. Approximate locations of our explorations have been plotted on the *Site and Exploration Plan* (Figure 2A). A *Soil Classification System Key* can be found as Figure 5 and detailed test pit logs can be found as Figures 6 through 10 and the associated laboratory test results presented as figures 12 through 14.

Image 5 (left) and Image 6 (right): Image 5 depicts typical blocky excavated texture and indurated character of the native undifferentiated glacial deposits as observed in the majority of our explorations. Image 6 depicts conditions in TP-11, with topsoil over weathered glacial deposits (undifferentiated) over glacial deposits (undifferentiated). Note seepage collecting in base of excavation.

Subsurface conditions were similar across the project site. From a general standpoint, we encountered between 0.5 and 1 foot of topsoil. Topsoil materials were typically described as loose, dark brown, damp, gravelly, silty sand with numerous organics. Below the topsoil, we commonly encountered weathered glacial deposits (undifferentiated). These materials were commonly described as medium dense to dense, light brown to gray-brown with moderate MOTTLING, gravelly, silty sand materials. These materials were typically observed to depths of between 3.5 to 4.5 feet BGS across the site. Below the weathered glacial deposits (undifferentiated), we encountered unweathered glacial deposits that were typically described as medium dense to very dense, orange to brown to light brown or blue gray, gravelly very silty sand to medium stiff sandy clay in one location. These deposits were encountered in all exploration locations to terminal test pit depths between 6 and 8 feet BGS. Please note that the native deposits (glacial deposits, undifferentiated) were variable in terms of observed consistency / density and gradation across the project site. In some locations these materials contains very low fines contents (TP-8), while in TP-9 these deposits were characterized as soft to medium stiff sandy clays (TP-9).

Additionally, within TP-8, gravel road base was observed at the surface and extended to a depth of about 1.5 feet BGS before encountering the native weathered and unweathered glacial deposits, as described above. In TP-6, medium dense, brown, gravelly, very silty sand with numerous organics and wood debris was observed to a depth of about 2.5 feet BGS. This material was interpreted as uncontrolled fill.

General Geologic Conditions

General geologic conditions were obtained from the *Geologic map of the Bellingham 1:100,000 quadrangle, Washington* (Lapen, T.J., 2000). Based on this map, the general geologic conditions at the project site are mapped Undifferentiated glacial deposits, undifferentiated (Qgd) with marine outwash (Qgom$_e$) mapped in proximity to the north. Additionally, the East Sound Group of Brandon and Others (Unit PDvs$_e$) and the Turtleback Complex of McLellan (Unit pDi$_t$) bedrock units are mapped to the east, west and south of the project site. These geologic units are described below in accordance with the reference map description.

Marine Outwash (unit Qgom$_e$): Loose, moderately to well-sorted cobbly gravel with local boulders and mixtures of sand and gravel with lesser silt and clay layers. Clasts are generally subrounded to rounded and derived from the Coast Plutonic Complex of British Columbia and local sources, including, but not limited to, andesite from Mount Baker, dunite of probable Twin Sisters origin, and phyllite and vein quartz from the Easton Metamorphic Suite and older glacial deposits. Color is some combination of brown and gray, depending on oxidation state. Thickness is 7 to 25 m. The unit is commonly thickly to thinly bedded.

<u>Glacial Deposits, undifferentiated (unit Qgd):</u> May include any and all glacial deposits described in the site vicinity. This unit is mapped where data are lacking or differing geologic interpretations of quaternary glacial units are unreconcilable.

<u>East Sound Group of Brandon and Others (Unit $PDvs_E$):</u> Volcanic breccia, volcanic sandstone and siltstone, pebble and cobble conglomerate, tuff, and minor basaltic to dacitic flows and hypabyssal rocks with lesser fossiliferous limestone. Bedding in clastic rocks ranges from massive (typically volcanic breccia) to very well bedded. Graded and laminar beds are common. Sorting is highly variable. Massive volcanic breccia (commonly andesitic to dacitic) consists of angular volcanic clasts set in a matrix of finer grained volcanic material of similar composition. Bedded volcanic rich sandstone and siltstone are associated with and are likely derived from this volcanic material. Quartz rich siltstone occurs locally. Pebble and cobble conglomerate consists of volcanic as well as plutonic clasts that are lithologically similar to plutonic and hypabyssal rocks of the Turtleback Complex. Tuff is commonly fine to medium grained and massive to well bedded. It ranges from crystal to lithic-rich and is usually interbedded with volcanic breccia and volcanic sandstone and siltstone. Siliceous fine-grained tuff is locally abundant.

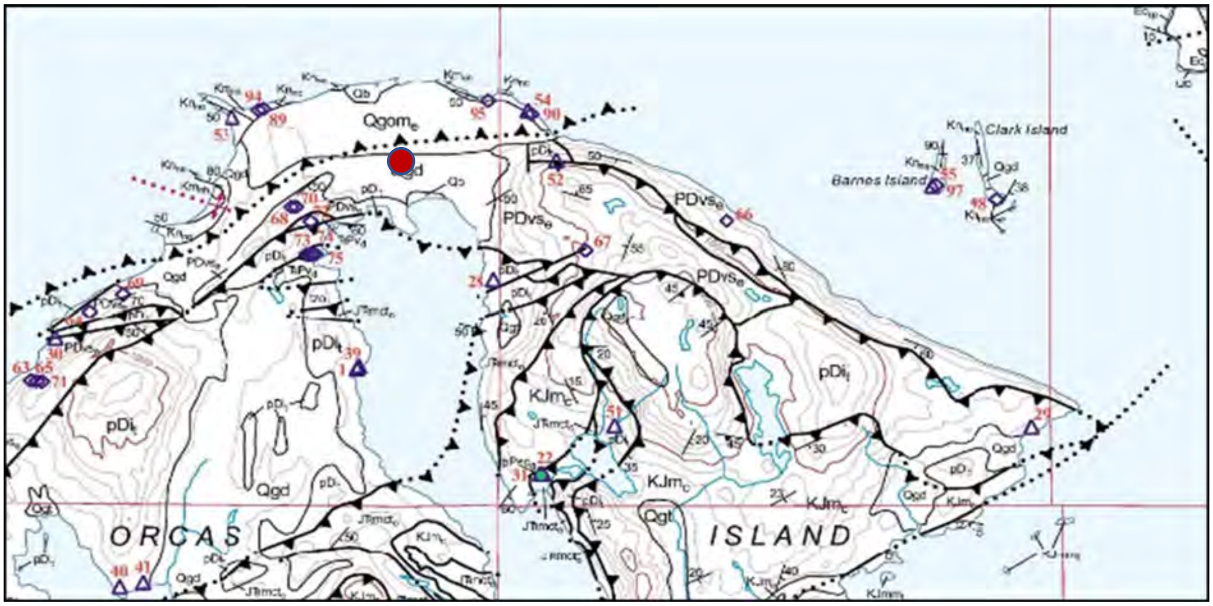


Image 7: Location of subject site shown in red on Geologic map of the Bellingham 1:100,000 quadrangle, Washington (Lapen, T.J., 2000).

<u>Turtleback Complex of McLellan (Unit pDi_t):</u> Metagabbro and rare pyroxenite, metaquartz diorite, metatonalite, metatrondhjemite, local orthogneiss, and metamorphosed basaltic to silicic dikes. Grain size ranges from fine to coarse. Metagabbro locally displays cumulate layering and pegmatitic textures. Meta-intrusive rocks are commonly statically recrystallized, however, Vance (1977) reports orthogneiss at one locality on the northwestern slope of Mount Constitution. Metagabbro is commonly the host rock for more silicic plutonic intrusives. All metaplutonic rocks are cut by variably metamorphosed basaltic to silicic dikes and are extensively recrystallized at

greenschist to albite-epidote amphibolite facies. They typically contain hornblende or actinolite, albite, epidote, chlorite, and quartz with other, variable accessory minerals.

Based on our review of the local geology, there are no mapped landslides within proximity of the project site. However, the site is located approximately 20 miles north from the Devil's Mountain Fault Zone (DMFZ). The DMFZ has been active as recently as 100 to 500 years ago and has the potential for a magnitude 7.5 or greater earthquake (Barrie, 2017). In addition, the site is approximately 10 miles southwest of the Sandy Point Fault, a northwest-southeast trending Holocene age fault considered active by the DNR. The Sandy Point Faults most recent earthquake occurred no more than 2,100 years before present and resulted in a vertical displacement of the Sandy Point terrace (Kelsey et. al 2010). In addition, a concealed, thrust fault extends along a generally east to west alignment just north of the subject area (Lapen, 2000), however this fault is not considered to be active by the Department of Natural Resources.

In general, the somewhat variable, glacially deposited materials encountered in our explorations appear to support the mapped geologic units, as described above. These deposits are considerably variable based on their unit descriptions and associated depositional environment. The observed bedrock knob in the northern portion of the site appears to be representative of the closely mapped East Sound Group of Brandon and Others (Unit PDvs_e). It should be noted that geologic maps are produced at regional scales and that, in general, some level of variation between mapped geology and site soils should generally be anticipated.

Groundwater

Groundwater was encountered within six of the twelve test pit explorations (TP-6, TP-8, TP-9, TP-10, TP-11, TP-12). In these explorations, groundwater was encountered as slow to moderate seepage at depths of between 3.5 and 5.5 feet BGS.

In our opinion, the groundwater observed within our test pit explorations is representative of perched groundwater and does not represent the regional water table. Perched groundwater conditions are expected to develop at the project site during the wet season and/or following periods of extended precipitation. Perched groundwater conditions occur above the regional groundwater table in the unsaturated zone and typically occur when loose, more permeable soil is underlain by denser, less permeable soil. The vertical movement of water through loose soils is restricted once a dense or less permeable soil is encountered at depth.

Based on a review of the Department of Ecology *Well Report Viewer*, a groundwater well for a single-family residence in the project vicinity (on North Beach Road) reported static groundwater levels around 75 feet BGS at the time of well installation.

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.

Groundwater levels are variable, and groundwater conditions will fluctuate depending on local subsurface conditions, precipitation, and changes in on-site and off-site use.

Web Soil Survey

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) *Web Soil Survey* website, one relevant soil unit, the Roche-Killebrew complex, 2 to 10 percent slopes, is present on the subject property. This soil is typically found in landforms such as hillslopes and are derived from a glacial drift over dense glaciomarine deposit parent materials. Based on their whole soil erosion “K” factor assigned by the NRCS, of 0.55, these soils are considered to present a **severe** susceptibility to erosion. Values of the erosion factor “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. The land capability classification for this soil unit (irrigated and nonirrigated) is **3w.**

GEOLOGIC HAZARDS

According to San Juan County Code (SJCC) section 18.20.070, Geologically Hazardous Areas are defined as *areas that because of their susceptibility to erosion, sliding, earthquake, or other geological events are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns.* In SJCC section 18.35.60, county code goes on to define Category 1 Landslide and Other Hazards, Category II Erosion, Landslide and Other Hazards, and Category III Seismic Hazards.

Considering the documented topographic and geologic conditions, the project site is not considered to contain Category I or II geologically hazardous areas as defined by SJCC. However, according to SJCC, all of San Juan County is considered to present seismic hazards. Our findings and recommendations with respect to this potential hazard are presented in the subsequent section.

Seismic Hazards

The entire property is classified as a Category III seismic hazard because it is located within the Seismic Design Category D1, which states that site slopes may be unstable during a seismic event. In accordance with SJCC 18.35.065(C) Category III Protection Standards, “Development activities are required to conform to the applicable provisions of the International Building Code which contains structural safeguards to reduce the risk from seismic activity.”

The Pacific Northwest is seismically active. Large Cascadia subduction zone earthquakes with possible magnitudes of 8 or 9 could produce ground shaking events with the potential to significantly impact the subject property. Cascadia subduction zone earthquakes have occurred 6 times in the last 3,500 years with the most recent taking place in 1700, approximately 322 years ago. They have been determined to have an average reoccurrence interval of approximately 300 to 700 years (Atwater and Haley, 1997). The property may be impacted by other local and regional fault movements and earthquake activity as well because it is located approximately 20 miles north of the Devil's Mountain Fault Zone (DMFZ). According to the published literature, the DMFZ has been active as recent as 100 to 500 years ago and has the potential for a magnitude 7.5 or greater earthquake (Barrie, 2017).

We recommend that the design team utilize seismic design standards per the IBC such that the planned structures, including nonstructural components that are permanently attached to supports, be designed to resist the effects of earthquake motions. However, it should be noted that no amount of engineering can completely mitigate or prevent ground instability. Mitigation is intended to make the risk posed by a potential earthquake that is present on site less and it should not be interpreted that mitigation is representative of eliminating any and all risk that might be present on the site.

Liquefaction Hazard Potential

Liquefaction is defined as a significant rise in pore water pressure within a soil mass caused by earthquake-induced cyclic shaking. The shear strength of liquefiable soil is reduced during large and/or long duration earthquakes as the soil consistency approaches that of semi-solid slurry. Liquefaction can result in significant and widespread structural damage if not properly mitigated. Deposits of loose, granular soil below the groundwater table are most susceptible to liquefaction. Damage caused by foundation rotation, lateral spreading, and other ground movements can result from soil liquefaction.

Based on a review of information obtained from the Washington State Department of Natural Resources (DNR) *Geologic Information Portal*, the subject site is classified as having a "**very low to low**" liquefaction susceptibility (Palmer et al., 2004). However, this map only provides an estimate of the likelihood that soil will liquefy as a result of an earthquake and is meant as a general guide to indicate areas potentially susceptible to liquefaction. Due to the presence of the generally fine grained, hard glacial soils below the project site, we generally agree with the low liquefaction susceptibility rating. Thus, no specific liquefaction hazard mitigation is recommended. Based on the seismic design category the design team should implement the applicable seismic design elements presented in the IBC and IRC, as required.

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the data collected during this investigation, it is GeoTest's 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.

Subsurface explorations performed as part of this study generally encountered native soil conditions consisting of a relatively thin layer of loose topsoil (commonly between 0.5 and 1 foot in thickness) over variable thicknesses of weathered glacial deposits (undifferentiated) over glacial deposits (undifferentiated) to the terminal depths of our explorations. Uncontrolled fill soils were observed to depths of roughly 2.5 feet BGS in exploration TP-6. Thicker deposits of uncontrolled fill materials could also be encountered below the existing structures, as these areas were not explored during our site investigation.

GeoTest recommends that the topsoil and uncontrolled fill soils (if present) be removed from below building and roadway footprints to expose native, inorganic soils at depth. GeoTest generally anticipates that about 0.5 to 1 foot of stripping will be needed to remove near-surface, organic soils, and to facilitate structural fill placement below building footprint and roadway areas. However, the removal of up to 2.5 feet of uncontrolled fill material should be anticipated to reach firm and unyielding native soils within the vicinity of TP-6. Once competent native soils have been exposed, GeoTest recommends that the subgrade surface be compacted to a firm and unyielding condition with an appropriate piece of construction equipment. Remedially compacted, medium dense (or denser) weathered and unweathered glacial deposits (undifferentiated) are considered suitable to provide support for the planned structures. Further recommendations regarding the placement and compaction of structural fill can be found in the *Fill and Compaction* section of this report.

Based on the subject property’s location, we have identified potential Seismic Hazards, as defined by the San Juan Code, to be present across the development site. We recommend that the design team utilize seismic design standards per the IBC / IRC such that the planned structure, including nonstructural components that are permanently attached to building’s supports, be designed to resist the effects of earthquake motions.

The native weathered and unweathered glacial deposits (undifferentiated) encountered at shallow depths in our explorations were variable based on location and recurrently displayed very dense densities / stiff to hard consistencies. These deposits commonly contained fines contents between roughly 25 and 84 percent. In addition, perched groundwater conditions were encountered in various locations across the site at depths of between 3.5 to 5.5 feet BGS. In our opinion the native undifferentiated glacial deposits, and/or the presence of perched groundwater, constitutes the presence of a “hydraulic restriction layer” as defined by the Washington State Department of Ecology *Stormwater Management Manual for Western Washington* (SMMWW), dated 2019. Thus, the conventional infiltration of stormwater does not appear to be feasible at the project site. Although granular soils were encountered to limited depths in TP-7, TP-8, and TP-9, these soils are not expected to be laterally continuous below the site and were underlain by fine grained dense deposits in two of the three locations. Due to the generally restrictive, near surface conditions and limited presence and lateral extent of granular soil conditions, the use of LID stormwater infiltration systems is also generally not considered to be feasible at the project site. GeoTest expects that stormwater will be managed by an engineered detention vault, pond or other approved means, once the design progresses past the conceptual phase.

Site Preparation and Earthwork

GeoTest assumes that all buildings may be demolished at the project site to facilitate the proposed construction. We expect that 0.5 to 1 foot of stripping will be needed across the majority of the site to remove the near surface topsoil deposits; however increased stripping depths should be anticipated in areas currently occupied by development as well as in the vicinity of TP-6, where uncontrolled fill was observed to a depth of 2.5 feet BGS. The portions of the site proposed for foundation(s), floor slabs, roadway or sidewalk development should be prepared by removing existing fill (if present), topsoil, deleterious material, and significant accumulations of organics from the area to be developed. Prior to placement of any foundation elements or structural fill, the exposed native subgrade under all areas to be occupied by soil-supported floor slabs, spread, or continuous foundations or roadways should be recompacted to a firm and unyielding condition.

We recommend that qualified geotechnical personnel be retained to document contact with firm and unyielding conditions below proposed foundation elements. If possible, verification of these conditions should be accomplished through proof rolling. 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. Areas exhibiting significant deflection, pumping, or over-saturation that cannot be readily 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. Further, we generally recommend that major earthworks take place during the dry summer months due to the nature of the soils and groundwater encountered.

During periods of wet weather, proof rolling could damage the exposed subgrade. Under these conditions, qualified geotechnical personnel should observe subgrade conditions to determine if proof rolling is feasible. In some locations, on-site proof rolling may not be feasible due to depth or the location of the excavation. In these circumstances, we recommend that verification of subgrade conditions be performed using soil probe or Dynamic Cone Penetrometer methods to verify firm and unyielding conditions.

Fill and Compaction

Structural fill used to obtain final elevations for footings, soil-supported floor slabs and flatworks must be properly placed and compacted. In most cases, any non-organic, predominantly granular soil may be used for fill 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 content, or construction debris is not suitable for reuse as structural fill and should be properly disposed off-site or placed in non-structural areas.

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 Soils

The native undifferentiated glacial drift materials could be reused in limited capacities. However, our experience working with these types of soils has shown that compaction to industry-standard levels may be very difficult or impossible to obtain because of elevated moisture content. Overall, these soils were variable in gradation and contained between 5 and 30 percent in-situ moisture content based on our laboratory testing. It should also be noted that attempting to use these materials during inclement weather is unlikely to result in adequate compaction due to the moisture sensitivity of these materials. Storing or stockpiling silty or clayey soils may prevent rainfall from further increasing moisture contents of the material but covering soil stockpiles will not dry back or moisture condition the stockpiles during extended periods of rainfall. The contractor should also be made aware that native materials can degrade after initial placement if native silty soil is not adequately protected. We generally recommend that the use of native borrow fill materials be limited to pond berm applications and that native materials only be utilized during periods of extended dry weather.

In some locations, native materials contain high quantities of silt and clay and generally appear to meet the Soil Gradation Specification for Compacted Till Liners as presented in the current SMMWW. Thus, these materials may be viable for reuse in low-permeability liner applications for stormwater detention facilities, which could be needed at the project site. If utilized for this application, oversize gravel may need to be screened from the naturally occurring glacial deposits (undifferentiated).

If reuse of native soils as structural fill is desired, we highly recommend a meeting between the owner, design team, contractor and GeoTest to properly plan and discuss moisture control, aeration, and compaction techniques prior to the start of construction. All parties should be aware that reusing on-site materials as structural fill will require significant efforts to segregate similar materials and to moisture condition them before, during, and after initial placement and compaction.

Imported Structural Fill

GeoTest recommends that imported structural fill consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run), or well-graded crushed rock. We recommend structural fill for dry weather construction be similar to Washington State Department of Transportation (WSDOT) Standard Specification 9-03.14(2) for

"Select Borrow" with the added requirement that 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. If a proposed material does not meet the referenced WSDOT specification, GeoTest should be allowed to review the material prior to its importation.

Accordingly, GeoTest recommends that imported structural fill for wet weather construction be similar to WSDOT Standard Specification 9-03.14(1) for "Gravel Borrow" with the added requirement that no more than 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.

The owner may elect to import different materials to the project site based on limited availability on Orcas Island. If this is the case, the civil engineer and GeoTest should be allowed to review material gradations and comment on their suitability for use at the project site based on the proposed use.

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 with appropriate equipment. 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 (Modified Proctor). 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

Fine-grained near surface soils, such as those present on-site, are particularly susceptible to degradation during wet weather. As a result, it may be difficult to control the moisture content of site soils during the wet season. If construction takes place during wet weather, GeoTest recommends that structural fill consist of imported, clean, well-graded sandy gravel or gravelly sand 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 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 native soil deposits underlying the site generally appear to support the mapped 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

Shallow conventional spread or isolated foundations are suitable to provide support for the proposed structures provided the following recommendations are incorporated into the project design. We recommend continuous or isolated spread footings be founded on remedially compacted and approved native soils or compacted structural fill placed directly over remedially compacted and approved native soil for uniform support. Qualified geotechnical personnel must confirm that suitable bearing conditions have been reached prior to placement of structural fill or foundation formwork.

To provide proper support, GeoTest recommends that existing fill, flatworks, foundations, hardscapes, uncontrolled fill materials and/or loose, soft or wet native soils which cannot be readily compacted be removed from beneath the building foundation area(s) and be replaced with properly compacted structural fill as described in the *Fill and Compaction* section of this report.

Localized overexcavation, if necessary, can be backfilled to the design footing elevation with structural fill or controlled density fill (CDF). In areas requiring overexcavation to competent native soil using structural fill as backfill, the limits of the overexcavation should extend laterally beyond the edge of each side of the footing a distance equal to the depth of the excavation below the base of the footing. If CDF is used to backfill the overexcavation, the limits of the overexcavation need only extend a nominal distance beyond the width of the footing. In addition, GeoTest recommends that foundation elements for the proposed structure bear entirely on similar soil conditions to help prevent differential settlement from occurring.

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, a net allowable bearing capacity of up to 2,000 pounds per square foot (psf) may be utilized. This capacity assumes that all unsuitable fill soils, deleterious materials and topsoils are removed from below the foundation elements.

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

Conventional slab-on-grade floor construction is feasible for the planned site improvements. Floor slabs should be supported on compacted structural fill placed over properly prepared native soil following fill and topsoil removal. Prior to placement of the new structural fill, the native soil should be proof-rolled or otherwise verified as suitable as recommended in the *Site Preparation and Earthwork* section of this report.

We recommend that all topsoil, uncontrolled fill (if present) and disturbed, native material be removed from below the proposed slab areas and that floor slabs be supported on at least 6 inches of clear crushed rock over properly prepared native soil or properly placed and compacted structural fill. Prior to placement of the structural fill or clear crushed rock, the native soil should be remedially compacted to a firm and unyielding condition and verified as suitable 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 that will act as a capillary break. Capillary break materials generally consist of ¾ to 1 ¼ inch clear crushed rock with no fines. The purpose of this gravel layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer. Other supporting structural fill should consist of materials recommended in the *Imported Structural Fill* section of this report. To help reduce the potential for water vapor migration through floor slabs, a continuous 10 to 15-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. American Concrete Institute (ACI) guidelines suggest that the slab may be poured directly on the vapor barrier. If moisture control within the building is critical, we recommend a representative of GeoTest observe the vapor barrier to confirm that joints and penetrations have been properly sealed.

Exterior concrete slabs-on-grade, such as for parking and sidewalks, do not require capillary break (clean gravel); however, long-term performance will be enhanced if exterior slabs are placed on a layer of clean, durable, well-draining granular material as recommended herein.

A Subgrade Modulus (k) of 200 pounds per cubic inch (pci) is recommended for use in design of concrete slab elements. This value is assuming site preparations prior to slab installation follow the minimum soil preparation measures recommendation above, including recompaction of existing native soil if required.

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 & Wall Drain Sections* (Figures 4A and

4B) 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 Tencate™ Mirafi™ 140N (or industry equivalent). 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 the development of foundation and site drainage parameters. GeoTest's recommendations 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 or retaining 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 is allowed to 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 40 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 60 pcf for structural fill in at-rest conditions.

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.

For structures designed using the seismic design provisions of the 2018 International Building Code, GeoTest recommends that foundation walls include a seismic surcharge in addition to the equivalent fluid densities presented above. We recommend that a seismic surcharge of approximately 8*H (where H is the height of the wall in feet) be used for design purposes, applied to the mid part of the wall. This surcharge assumes that the wall is allowed to rotate or yield. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the wall. If the wall is restrained, GeoTest should be contacted so that we can provide a revised seismic surcharge pressure.

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 275 pounds per cubic foot. The recommended value includes a safety factor of about 1.5 and is based on the assumption 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 values also assume drained conditions that will prevent the buildup of hydrostatic pressure in the compacted fill. Foundation 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 plans 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 structural fill 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. 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 accomplished in the generally granular, near surface, weathered and unweathered glacial deposits (undifferentiated) are commonly classified, according to WAC 296-155-66401, as a Type C soil and may be sloped as steep as 1.5:1 (Horizontal: Vertical). All soils are classified as Type C soil in the presence of groundwater seepage. 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. All permanent slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction. Permanent slope inclinations proposed in the presence of water (potential stormwater ponds) should be designed for permanent inclinations of 3H:1V.

Utilities

Utility trenches must be properly backfilled and compacted to reduce cracking or localized loss of foundation, slab, or pavement support. Trench backfill in improved areas (beneath structures, pavements, sidewalks, etc.) should consist of structural fill as defined in the *Fill and Compaction* section of this report. Trench backfill should be placed and compacted in general accordance with the recommendations presented in the *Fill and Compaction* section of this report.

Surcharge loads on trench support systems due to construction equipment, stockpiled material, and vehicle traffic should be included in the design of any anticipated shoring system. The contractor should implement measures to prevent surface water runoff from entering trenches and excavations. In addition, vibration as a result of construction activity and traffic may cause caving of the trench walls.

The contractor is responsible for trench configurations. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored by the contractor during excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring. If groundwater or groundwater seepage is present, and the trench is not properly dewatered, the soil within the trench zone may be prone to caving, channeling, and running. Trench widths may be substantially wider than under dewatered conditions.

Pavement Subgrade Preparation

Based on our experience in San Juan County, we anticipate that gravel roads may be preferred over paved roads. GeoTest recommends that pavement sections be founded on suitably prepared, firm and unyielding, native soils, or compacted structural fill placed directly over approved native subgrade. The native subgrade should be prepared in accordance with the *Site Preparation and Earthwork* section of this report. Site grading plans should include provisions for the sloping of subgrade soils in the proposed pavement areas so that passive drainage of the pavement section(s) can proceed uninterrupted during the life of the project. The below discussion represent typical pavement sections used at similar projects in the site vicinity. The final pavement design is to be determined by the project civil engineer.

Gravel Surfaced Road Sections – Light Duty

If gravel surfaced roadways are preferred in areas designed for light vehicle parking and lower traffic areas, we recommend a standard, or “light duty” gravel section 8” of base course (CSBC) meeting the criteria set forth in the Washington State Department of Transportation (WSDOT) Standard Specification 9-03.9[3].

Flexible Pavement Sections – Light Duty

If utilized within light vehicle parking and lower traffic areas, we recommend a standard, or “light duty”, pavement section that consists of 2.5 inches of Class ½-inch HMA asphalt above 2 inches of crushed surfacing top course (CSTC) meeting criteria set forth in the Washington State Department of Transportation (WSDOT) Standard Specification 9-03.9[3]. The base material for the pavement section should consist of 6 inches of crushed surface base course (CSBC). This would result in a total of 8 inches of rock (CSTC and CSBC, or Gravel Borrow) underlying the asphalt.

Flexible Pavement Sections – Heavy Duty

Fire truck and general heavy access or high-volume lanes will require a thicker asphalt section and should be designed using a paving section consisting of 4 inches of Class ½-inch HMA asphalt above 2 inches of CSTC meeting criteria set forth in the WSDOT Standard Specification 9-03.9[3]. The base material for the road section should consist of 8 inches of CSBC. This would result in a total of 10 inches of rock (CSTC and CSBC) underlying the asphalt.

Concrete Hardscape Sections

Concrete pavements could be used for sidewalks and other features such as parking or access areas. Design of concrete pavements is a function of concrete strength, reinforcement steel, and the anticipated loading conditions for the roads. For design purposes, a vertical modulus of subgrade reaction of 200 pounds per cubic inch (pci) should be expected for concrete elements constructed over properly placed and compacted structural fill over native soil. GeoTest expects that concrete pavement sections, if utilized, will be at least 4 inches thick and be founded on a minimum of 8 inches of compacted CSBC. The design of concrete access and parking areas will need to be performed by a structural engineer. GeoTest recommends that subgrade soils supporting concrete pavement sections include minor grade changes to allow for passive drainage away from the pavement.

GeoTest is available to further consult, review, or modify our pavement section recommendations based on further discussion with the project team and owner. The above pavement sections are initial recommendations and may be accepted or modified by the site Civil Engineer based on the actual finished site grading elevations or the owner's preferences.

Stormwater Infiltration Feasibility

The native weathered and unweathered glacial deposits (undifferentiated) encountered at shallow depths in our explorations were variable based on location and recurrently displayed very dense densities / stiff to hard consistencies. These deposits commonly contained fines contents between roughly 25 and 84 percent. In addition, perched groundwater conditions were encountered in various locations across the site at depths of between 3.5 to 5.5 feet BGS. In our opinion, the native undifferentiated glacial deposits and/or the presence of perched groundwater constitutes the presence of a "hydraulic restriction layer" as defined by the Washington State Department of Ecology *Stormwater Management Manual for Western Washington* (SMMWW), dated 2019. Thus, the conventional infiltration of stormwater does not appear to be feasible at the project site. Although granular soils were encountered to limited depths in TP-7, TP-8, and TP-9, these soils are not expected to be laterally continuous below the site and were underlain by fine grained dense deposits in two of the three locations. Due to the generally restrictive, near surface conditions and limited presence and lateral extent of granular soil conditions, the use of LID stormwater infiltration systems is also generally not considered to be feasible at the project site. GeoTest expects that stormwater will be managed by an engineered detention vault, pond or other approved means once the design progresses past the conceptual phase.

Stormwater Treatment

Considerable quantities of near surface topsoil and weathered soils will be generated from the planned construction. The reuse of on-site topsoil is often the most sustainable and cost-effective method for on or off-site pollutant treatment purposes. Cation exchange capacities, organic contents, and pH of site subsurface soils were also tested to determine possible pollutant treatment suitability.

Table 1: Cation Exchange Capacity, Organic Content, and pH Laboratory Test Results					
Test Pit ID	**Sample Depth (ft)**	**Geologic Unit**	**Cation Exchange Capacity (meq/100 grams)**	**Organic Content (%)**	**pH**
TP-1	0.5	Topsoil	21.6	10.75	6.0
TP-4	0.25	Topsoil	14.7	5.85	6.0
TP-7	1.0	W. Undifferentiated Glacial Deposit	9.6	2.60	6.3
TP-10	1.0	W. Undifferentiated Glacial Deposit	8.1	1.53	5.3
Method			EPA 9081	ASTM D2974	SM 4500-H^+ B

Cation exchange capacity, organic content, and pH tests were performed by Northwest Agricultural Consultants on four soil samples collected from the explorations performed for this project. A summary of the laboratory test results is presented in Table 1, above.

Suitability for onsite pollutant treatment is determined in accordance with Site Suitability Criteria 6 of the SMMWW. 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 1, the native topsoil and weathered undifferentiated glacial drift deposits encountered across the site appear to be suitable for stormwater treatment purposes.

On-site soils can be amended by mixing higher silt content soils or adding mulch (or other admixtures) to elevate the cation exchange capacity and organic contents. On-site amended soil requires additional testing to confirm compliance with ecological regulations. GeoTest is available to perform additional laboratory testing as part of an expanded scope of services if the soil is to be amended. Alternatively, the Owner may elect to import amended soils with the desired properties for planned treatment facilities.

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 structural fill placement, compaction activities and subgrade preparation operations 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. In the event that 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 Orcas Community Land Trust and their design consultants for specific application to the design of the proposed affordable housing development to be located on Patch Patch Lane in Eastsound, 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 indicate 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 and conclusions 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 future construction that differ from those contained within this report, GeoTest should be allowed to review our report 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 contained herein.

The future prospective earthwork contractor is responsible for performing 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 2A	Site and Exploration Plan
	Figure 2B	Site Plan

Figure 3	Bare Earth Imagery
Figure 4A	Conceptual Footing and Wall Drain Section (Slab on Grade)
Figure 4B	Conceptual Footing and Wall Drain Section (Crawl Space)
Figure 5	Soil Classification System and Key
Figures 6-11	Exploration Logs
Figures 12-14	Laboratory Test Results
Attachment	Report Limitations and Guidelines for Its Use (4 Pages) Northwest Agricultural Consultants Test Results (1 Page)

REFERENCES

American Society of Civil Engineers (ASCE). 2017. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures.* ASCE/SEI 7-16.

American Society for Testing and Materials (ASTM). (2012). ASTM D1557-12e1, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.* West Conshohocken, PA: ASTM International.

American Society for Testing and Materials (ASTM). *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).* ASTM D2487 – 17e1.

American Society for Testing and Materials (ASTM). *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).* ASTM D2488 – 17e1.

Atwater, B.F. and Haley, E. H., (1997) *Recurrence Intervals for Great Earthquakes of the Past 3,500 Years at Northeastern Willapa Bay, Washington.* USGS Survey Professional Paper 1576.

Barrie, J.V., Greene, H.G., (2017). *The Devil Mountain Fault Zone: An active Cascadia upper plate zone of deformation, Pacific Northwest of North America* (pp. 228-241) (Sedimentary Geology, Volume 364).

Gariepy, D., Graul, C. Heye, A., Howie, D., Labib, F. & Song, K. (n.d.) 2019. *Stormwater Management Manual for Western Washington* (2019 SMMWW) (pp. 1-1108) (United States, Washington Department of Ecology).

Google Earth Pro™ (n.d.) Retrieved September 2024, from https://www.google.com/earth/.

International Building Code (IBC), 2018. International Code Council.

Kelsey, H.M., Sherrod, B.L., Blakely, R.J., Pratt, T.L., Haugerud, R.A. (2010). *Active Faulting in the Bellingham Forearc Basin: North-South Shortening at the Northern End of the Cascadia Subduction Zone*, NEHRP Final Technical Report, USGS Award Number: G09AP00043.

San Juan County Code – Geologically Hazardous Areas §§ 18.35.050-18.35.070 (2021).

San Juan County Polaris Property Search (n.d.) Retrieved September 2024, from https://sjcgis.maps.arcgis.com.

USDA *Web Soil Survey*. Retrieved May 2022, from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

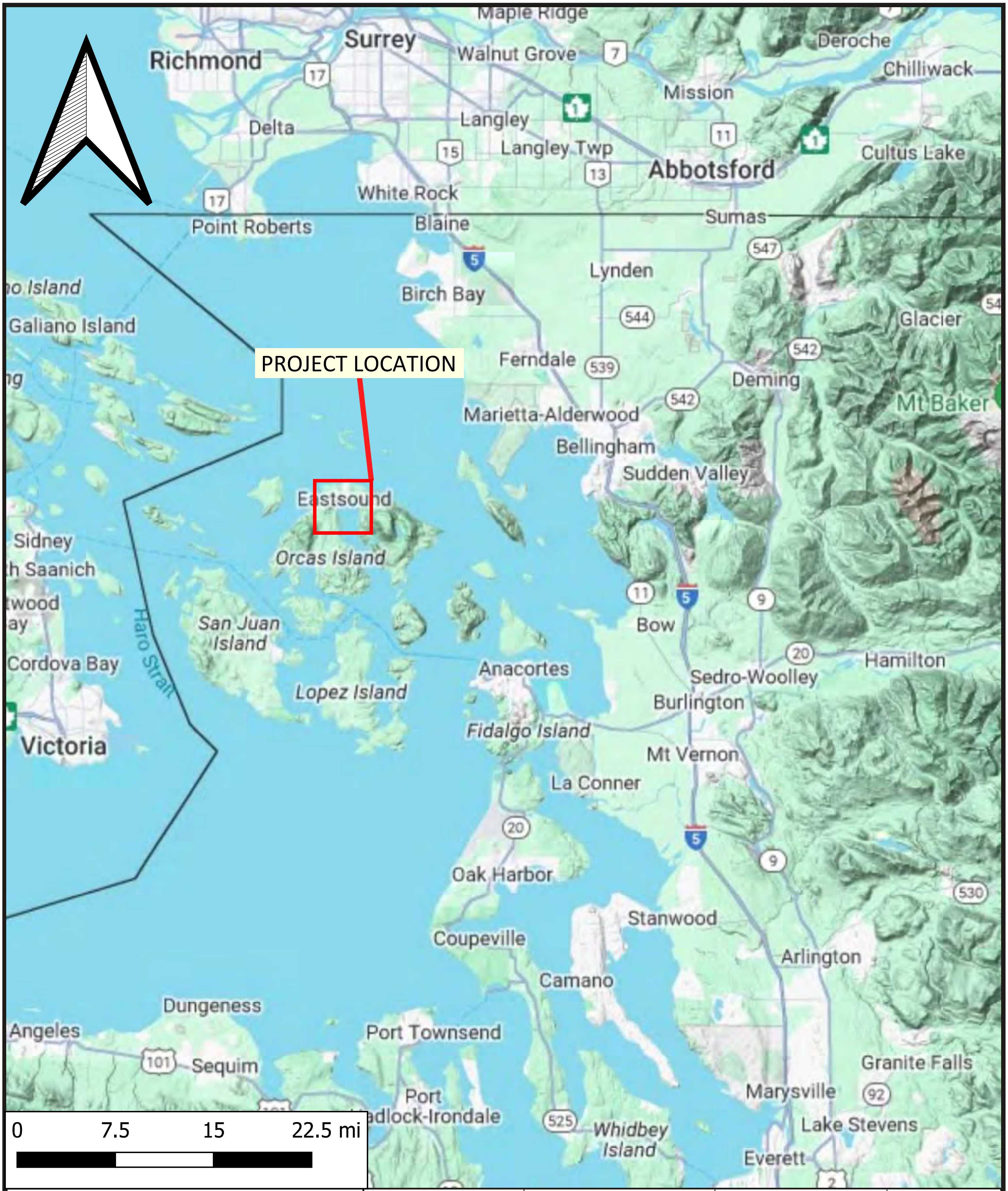
Washington Administrative Code (WAC). (2020). *WAC 296-155-6640,* Retrieved September 2024, from https://app.leg.wa.gov/wac/default.aspx?cite=296-155-66403.

Washington Geologic Information Portal, Washington State Department of Natural Resources – Online Web Services, Retrieved September 2024, from https://geologyportal.dnr.wa.gov.

Washington State Department of Ecology. *Well Log Viewer.* Retrieved September 2024, from https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/.

Washington State Department of Transportation/Americal Public Works Association Washington State Chapter. 2020. *Standard Specifications for Road, Bridge, and Municipal Construction M 41-10.*

Washington Lidar Portal. (n.d.). Retrieved September 2024 from http://lidarportal.dnr.wa.gov/.



Date: 7-30-2024 | By: JV | Scale: As Shown

Project **24-1958**

VICINITY MAP

Pea Patch Property

55 Pea Patch Lane

Orcas Island, Washington

Figure 1

GEOTEST An RMA Company


REFERENCED DRAWING: ESRI Satellite using QGIS 3.34.5-Prizren

Date: 7-30-2024	By: JV	Scale: As Shown

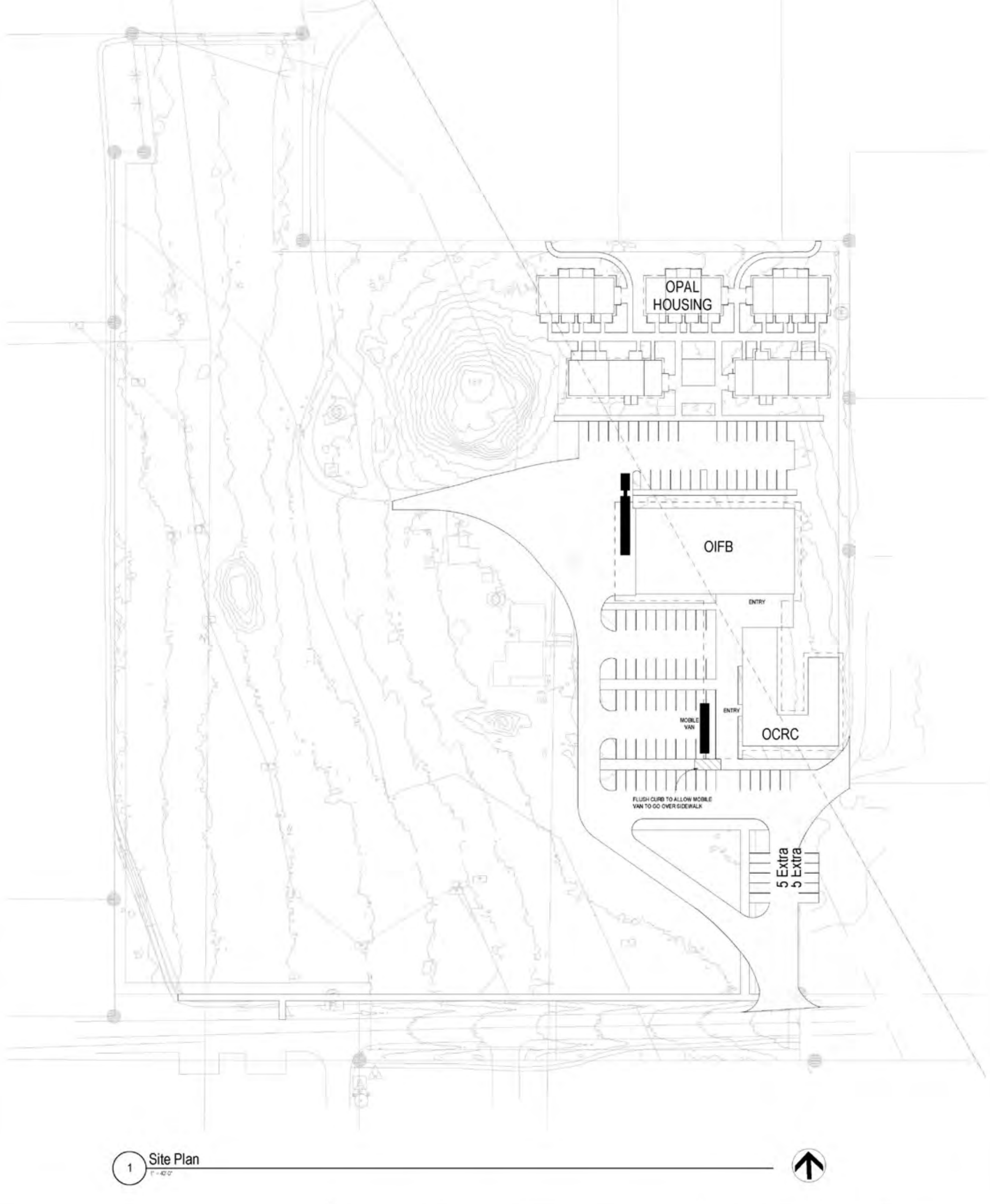
SITE AND EXPLORATION PLAN

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Project
24-1958

Figure
2A

Site Plan Provided by Client



Date: 9-4-24	By: HS	Scale:NTS

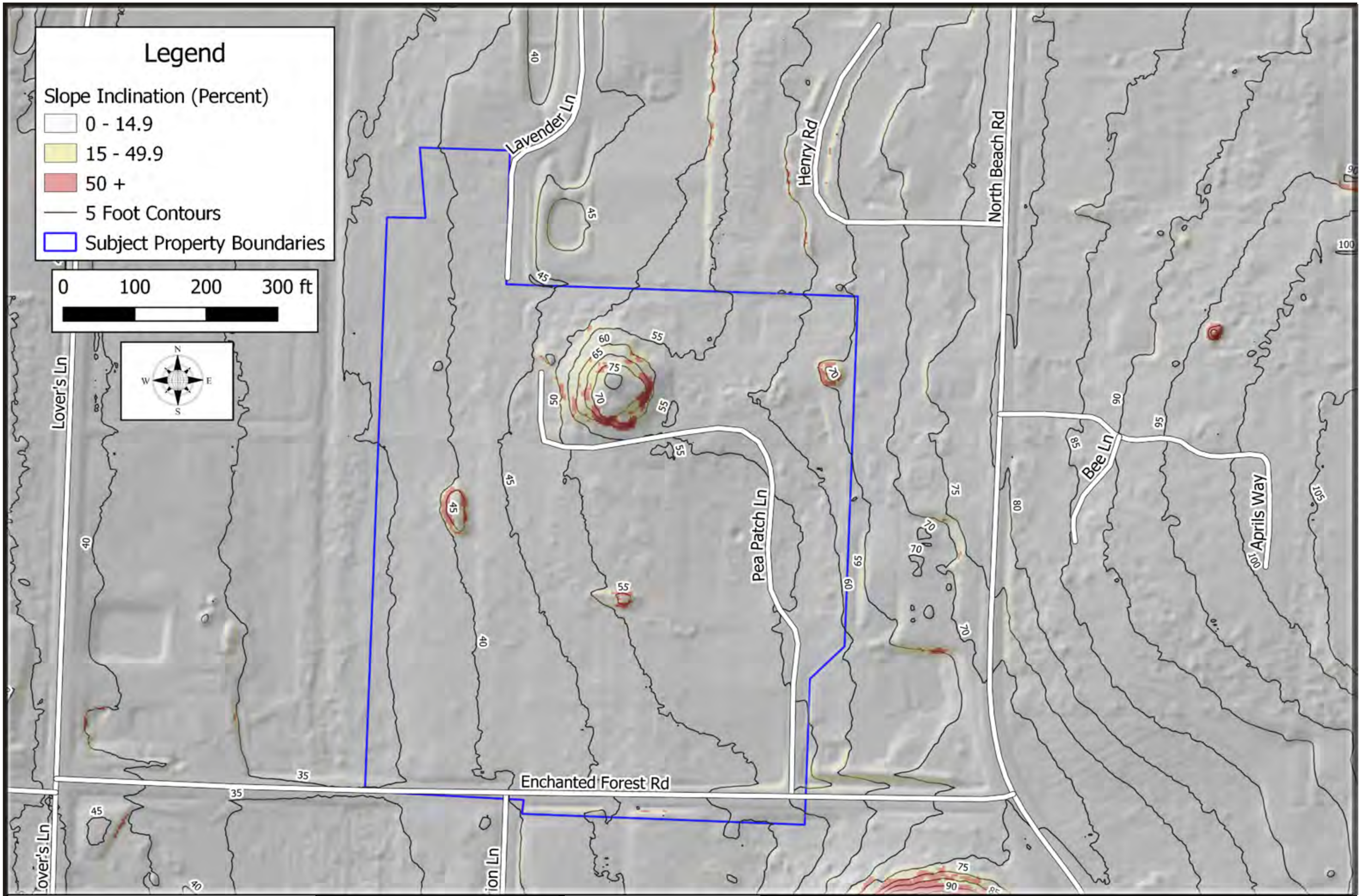
SITE PLAN

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Project
24-1958

Figure
2B

GEOTEST
An RMA Company



Data Source(s):

Parcels and Roadways : SJC Parcels

Elevation and Hillshade: Derived from San Juan 2019 datset Accessed from WA LidarPortal using Qgis 3.4.15-Madeira

GEOTEST
An RMA Company

Date: 9.4.24.
By: HS
Scale: As Shown

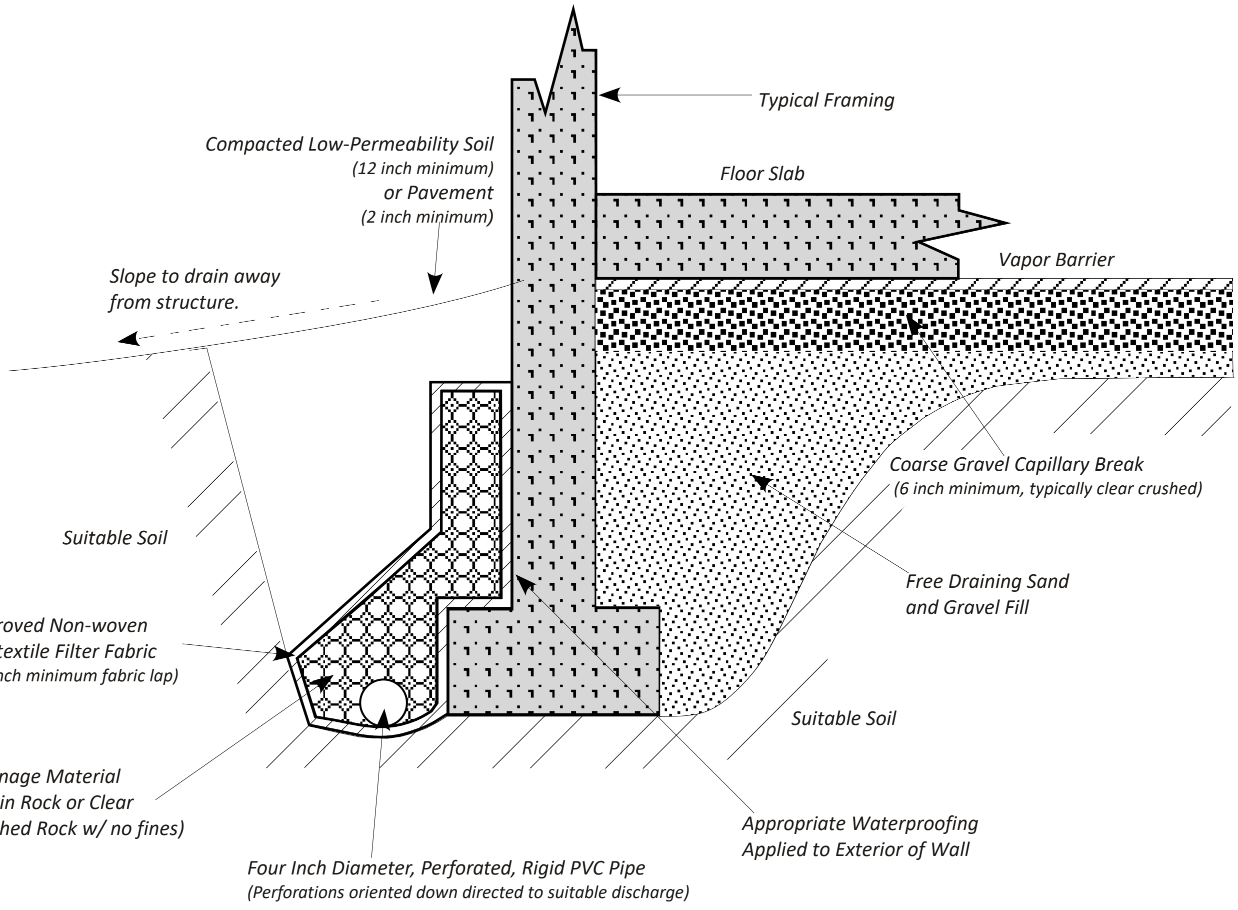
Project
24-1958

Figure
3

BARE EARTH IMAGERY

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

CONCEPTUAL FOOTINGS WITH INTERIOR SLAB-ON-GRADE



Notes:

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).

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.

This footing drain detail may need to be modified from this conceptual drawing to fit the dimensions of the planned footing and slab configuration.

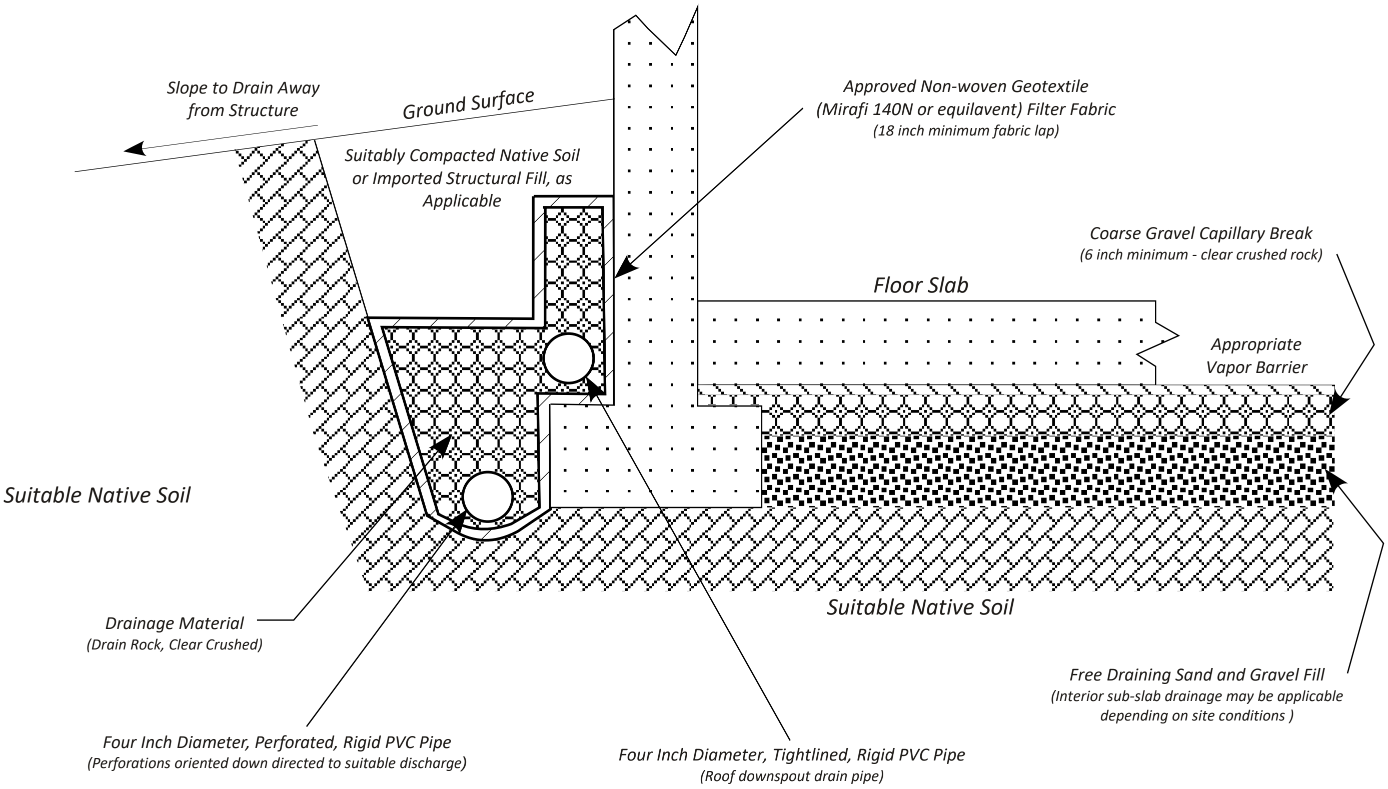
GEOTEST
An RMA Company

Date: 4-20-23	By: HS	Scale: None	Project
			24-1958

CONCEPTUAL FOOTING & WALL DRAIN SECTION
PEA PATCH PROPERTY
55 PEA PATCH LANE
ORCAS ISLAND, WASHINGTON

Figure
4A

CONCEPTUAL SHALLOW FOOTINGS WITH INTERIOR SLAB-ON-GRADE AND DOWNSPOUT DRAIN



Notes:

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).

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

This footing drain detail may need to be modified from this conceptual drawing to fit the dimensions of the planned footing and slab configuration.

GEOTEST
An RMA Company

Date: 7-30-2024
By: JV
Scale: Shown

CONCEPTUAL FOOTING & WALL DRAIN SECTION
PEA PATCH PROPERTY
55 PEA PATCH LANE
ORCAS ISLAND, WASHINGTON

Project
24-1958

Figure
4B

Soil Classification System

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

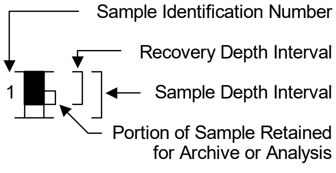
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT	■	**AC** or **PC**	Asphalt concrete pavement or Portland cement pavement
ROCK	▩	**RK**	Rock (See Rock Classification)
WOOD	▩	**WD**	Wood, lumber, wood chips
DEBRIS	▩	**DB**	Construction debris, garbage

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

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
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

Groundwater

∇ ATD	Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

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

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Soil Classification System and Key

Figure
5

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): ~64 Excavated By: Island Excavation, Inc.	
0					SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
	1	d			SM	Medium dense, orange-brown, dry, gravelly, very silty SAND with occasional organics, trace cobbles (Weathered Glacial Deposits, Undifferentiated)	
2	2	d					
4	3	d	W = 10 GS		SM	Dense, brown, damp, gravelly, silty SAND, occasional rootlets, orange mottling, trace cobbles (Glacial Deposits, Undifferentiated)	
6	4	d				GeoTest observed an increase in relative density to very dense and a decrease in orange mottling below 5.5 feet. GeoTest observed a decrease in silt content below 6.5 feet.	
8	5	d					

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

Excavation terminated at planned depth.

TP-2

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): ~63 Excavated By: Island Excavation, Inc.	
0					SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
	6	d			SM	Medium dense, light brown to orange-brown, damp, gravelly, silty SAND with occasional organics, orange mottling (Weathered Glacial Deposits, Undifferentiated)	
	7	d					
2	8	d					
4	9	d				GeoTest observed an increase in relative density to dense and an increase in cobble and boulder content below 4.5 feet.	
6					SM	Very dense, gray-brown, damp, slightly gravelly, very silty SAND, trace cobbles, blocky fracturing (Glacial Deposits, undifferentiated)	
	10	d					
8	11	d					

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

Excavation terminated at planned depth.

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.
4. Approximate elevation obtained from CalTopo intereactive web portal.

GEOTEST
An RMA Company

Pea Patch Property 55 Pea Patch Lane Orcas Island, Washington	Log of Test Pits	Figure 6

TP-3

SAMPLE DATA | **SOIL PROFILE** | **GROUNDWATER**

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~66
Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Soil Profile	Groundwater
0					SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
					SM	Medium dense, light brown, dry, silty, very gravelly SAND with occasional organics (Weathered Glacial Deposits, undifferentiated)	
2					SM	Medium dense, orange-brown, damp, slightly gravelly, very silty SAND with occasional organics (Weathered Glacial Deposits, undifferentiated)	
4					SP-SM	Medium dense, dark brown to brown, damp to moist, slightly silty, very gravelly SAND with occasional organics, trace cobbles (Glacial Deposits, undifferentiated)	
6	12	d	W = 4 GS				
	13	d			SM	Very dense, gray-brown, damp, gravelly, very silty SAND with trace cobbles (Glacial Deposits, undifferentiated)	
8						Excavation terminated at planned depth.	

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

TP-4

SAMPLE DATA | **SOIL PROFILE** | **GROUNDWATER**

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~64
Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Soil Profile	Groundwater
0	14	d			SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
	15	d			SM	Loose to medium dense, orange-brown, dry, gravelly, very silty SAND with occasional organics, oxidized (Weathered Glacial Deposits, undifferentiated)	
2	16	d					
					SM	Medium dense, brown to gray-brown, damp, gravelly SAND, trace cobble to boulders (Glacial Deposits, undifferentiated) GeoTest observed an increase in relative density to dense below 3.5 feet.	
4					SM	Very dense, gray-brown, damp, slightly gravelly, very silty SAND, trace cobbles (Glacial Deposits, undifferentiated) GeoTest observed an increase in boulder content below 7 feet.	
6	17	d					
8						Excavation terminated at planned depth.	

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 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.
4. Approximate elevation obtained from CalTopo intereactive web portal.

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Log of Test Pits

Figure
7

TP-5

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~61
Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	SOIL PROFILE	GROUNDWATER
0				SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
				SM	Medium dense to dense, light brown to tan, dry, slightly gravelly, very silty SAND with occasional organics, moderate orange mottling, trace cobbles to boulder (Weathered Glacial Deposits, undifferentiated)	
2	18	d				
				SM	Very dense, gray brown, damp, very silty SAND, trace cobble to boulders (Glacial Deposits, undifferentiated)	
4	19	d	W = 8 GS			
6						

Test Pit Completed 07/31/24
Total Depth of Test Pit = 6.0 ft.

Excavation terminated due to machine refusal.

TP-6

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~54
Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	SOIL PROFILE	GROUNDWATER
0				SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	
				SM	Medium dense, brown, damp, gravelly, very silty SAND with numerous organics, deleterious wood debris (Fill)	
2	20	d				
				SM	Medium dense, light brown to orange-brown, damp to moist, silty, gravelly SAND with numerous organics, moderate orange mottling, trace cobbles (Weathered Glacial Deposits, undifferentiated)	
4	21	d				
				SM	Very dense, blue-gray, wet, gravelly, very silty SAND, trace cobbles to boulders, trace rootlets (Glacial Deposits, undifferentiated)	Slight Groundwater Seepage at 5.5 ft BGS
6	22	d				
8	23	d				

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

Excavation terminated at planned depth.

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.
4. Approximate elevation obtained from CalTopo intereactive web portal.

GEOTEST
An RMA Company

Pea Patch Property 55 Pea Patch Lane Orcas Island, Washington	Log of Test Pits	Figure 8

TP-7

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~56
Excavated By: Island Excavation, Inc.

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol		
0					SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	Groundwater not encountered.
	24	d			SM	Medium dense, orange-brown, dry, gravelly, very silty SAND with numerous organics, trace cobbles (Weathered Glacial Deposits, undifferentiated)	
2	25	d	W = 5 GS		SP	Medium dense, gray-brown to brown, gravelly SAND, moderate orange mottling, trace cobbles to boulders (Glacial Deposits, undifferentiated)	
4							
6	26	d			SM	Very dense, gray-brown, moist, gravelly, very silty SAND, trace cobbles to boulders (Glacial Deposits, undifferentiated)	
8						Excavation terminated at planned depth.	

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

TP-8

Excavation Method: Tracked Excavator
Ground Elevation (ft): ~52
Excavated By: Island Excavation, Inc.

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol		
0	27	d			GP	Dense to very dense, gray, dry, sandy GRAVEL (Road Base) GeoTest observed geotextile stabilization fabric at 1.5 feet.	
2	28	d	W = 9 GS		SP	Medium dense, orange-brown, damp, SAND, orange mottling, trace cobbles (Weathered Glacial Deposits, undifferentiated)	
4					SP	Medium dense, brown, moist to wet, very gravelly SAND, trace cobbles (Glacial Deposits, undifferentiated)	Slight Groundwater Seepage at 4.0 ft BGS
6	29	d					
8	30	d				Excavation terminated at planned depth.	

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 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.
4. Approximate elevation obtained from CalTopo intereactive web portal.

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Log of Test Pits

Figure
9

TP-9

SAMPLE DATA

SOIL PROFILE

Excavation Method: Tracked Excavator

Ground Elevation (ft): ~53

Excavated By: Island Excavation, Inc.

GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data
	31	d	
	32	d	W = 7 GS
6	33	d	AL
	34	d	W = 30 GS

Graphic Symbol / USCS Symbol	Description
SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)
SM	Medium dense, orange-brown, dry, gravelly, silty SAND with numerous organics (Weathered Glacial Deposits, undifferentiated)
SP	Medium dense, orange-brown to brown, damp, gravelly SAND with occasional organics, orange mottling, trace cobbles (Glacial Deposits, undifferentiated)
CL	Soft to medium stiff, blue-gray, moist, sandy CLAY (Glacial Deposits, undifferentiated) PP= 0.5 tsf

Slight to Moderate Groundwater Seepage at 5.5 ft BGS

Excavation terminated at planned depth.

Test Pit Completed 07/31/24
Total Depth of Test Pit = 9.3 ft.

TP-10

SAMPLE DATA

SOIL PROFILE

Excavation Method: Tracked Excavator

Ground Elevation (ft): ~49

Excavated By: Island Excavation, Inc.

GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data
	35	d	
2	36	d	
	37	d	W = 20 GS
	38	d	

Graphic Symbol / USCS Symbol	Description
SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)
SM	Medium dense, light brown ot orange-brown, dry, gravelly, very silty SAND with numerous organics (Weathered Glacial Deposits, undifferentiated)
SP-SM	Medium dense, orange-brown, damp, slightly silty, slightly gravelly, SAND with occasional organics (Weathered Glacial Deposits, undifferentiated)
ML	Very stiff to hard, gray, damp to moist, slightly gravelly, sandy SILT, orange mottling (Weathered Glacial Deposits, undifferentiated)
SM	Very dense, dark brown to gray, damp, slighty gravelly, very silty SAND, trace cobbles to boulders (Glacial Deposits, undifferentiated)

Slight Groundwater Seepage at 4.0 ft BGS

Excavation terminated due to machine refusal

Test Pit Completed 07/31/24
Total Depth of Test Pit = 6.0 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.
4. Approximate elevation obtained from CalTopo intereactive web portal.

GEOTEST
An RMA Company

Pea Patch Property 55 Pea Patch Lane Orcas Island, Washington	Log of Test Pits	Figure 10

TP-11

Excavation Method: Tracked Excavator

Ground Elevation (ft): ~56

Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	SOIL PROFILE	GROUNDWATER
0				SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	
				SM	Medium dense to dense, light brown, dry, slightly gravelly, very silty SAND with numerous organics (Weathered Glacial Deposits, undifferentiated)	
2 4				SM	Medium dense, gray-brown, damp, gravelly, silty SAND with occasional organics, moderate orange mottling, trace cobbles (Weathered Glacial Deposits, undifferentiated)	Slight Groundwater Seepage at 4.25 ft BGS.
6 8	39	d		SM	Very dense, dark brown to gray, damp, slighty gravelly, very silty SAND, trace cobbles to boulders (Glacial Deposits, undifferentiated)	

Excavation terminated at planned depth.

Test Pit Completed 07/31/24
Total Depth of Test Pit = 8.0 ft.

TP-12

Excavation Method: Tracked Excavator

Ground Elevation (ft): ~52

Excavated By: Island Excavation, Inc.

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	SOIL PROFILE	GROUNDWATER
0				SM	Loose, dark brown, damp, gravelly, silty SAND with numerous organics (Topsoil)	
2				SM	Medium dense, light brown to orange-brown, dry, gravelly, silty SAND with numerous organics (Weathered Glacial Deposits, undifferentiated)	
				SM	Medium dense, gray-brown, damp, slightly gravelly, silty SAND with occasional organics, orange mottling (Weathered Glacial Deposits, undifferentiated)	
4				SP	Medium dense, brown, moist, very gravelly SAND, trace cobbles (Glacial Deposits, undifferentiated)	Slight Groundwater Seepage at 3.5 ft BGS.
6				SM	Very dense, dark brown to gray, damp, slighty gravelly, very silty SAND, trace cobbles to boulders (Glacial Deposits, undifferentiated)	

Excavation terminated at planned depth.

Test Pit Completed 07/31/24
Total Depth of Test Pit = 6.0 ft.

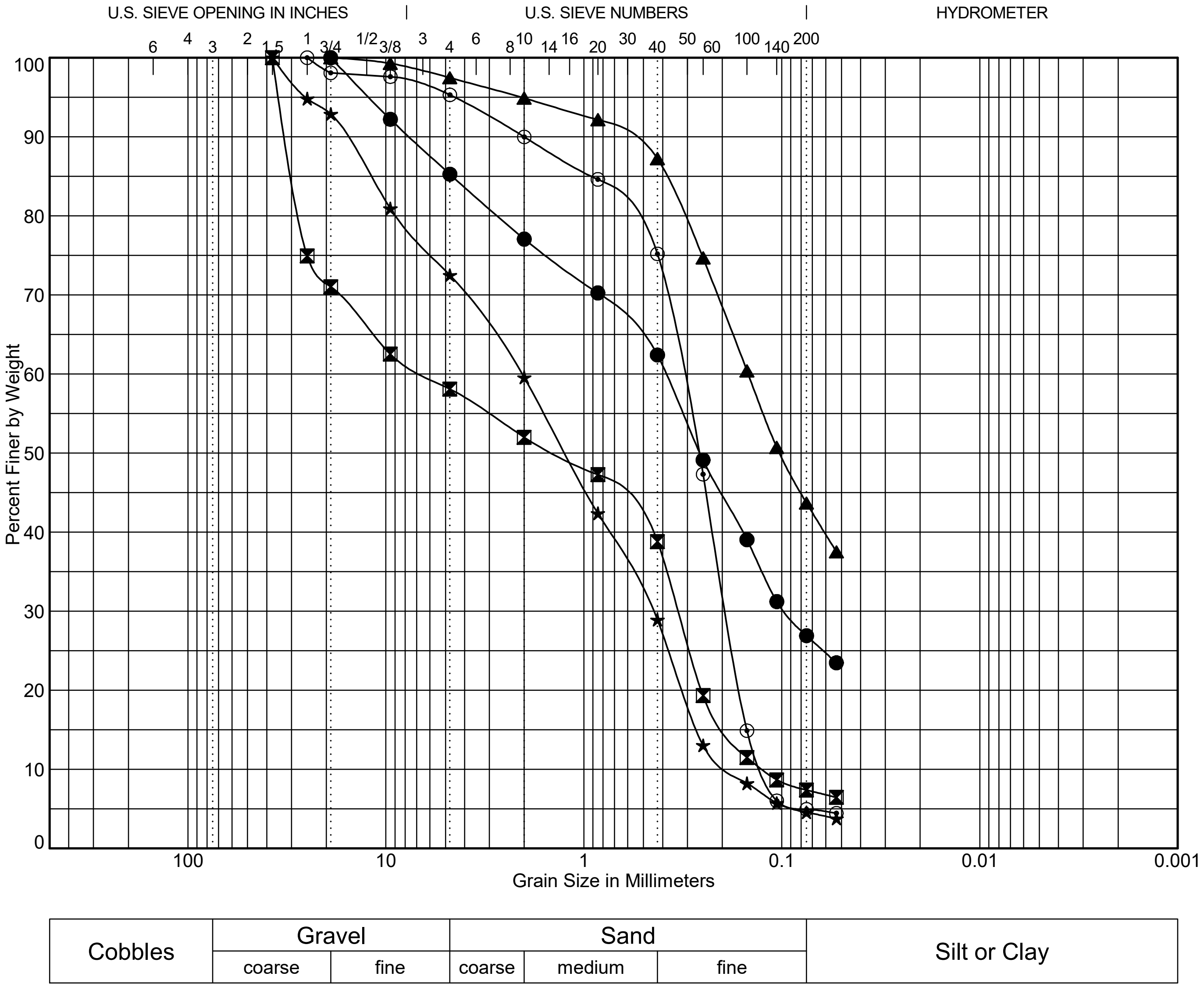
Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.
4. Approximate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

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Log of Test Pits

Figure
11



Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	TP-1	3.8	Gravelly, silty SAND (SM)					
⧗	TP-3	6.0	Slightly silty, very gravelly SAND (SP-SM)				0.14	51.29
▲	TP-5	4.0	Very silty SAND (SM)					
★	TP-7	3.0	Gravelly SAND (SP)				0.54	11.38
⊙	TP-8	2.5	SAND (SP)				0.92	2.57

Point		Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	TP-1	3.8	7.621	0.386	0.259	0.096		0.0	14.7	8.2	14.7	35.5	26.9
⧗	TP-3	6.0	31.898	6.405	1.395	0.334	0.125	29.0	12.9	6.1	13.2	31.4	7.4
▲	TP-5	4.0	0.627	0.148	0.102			0.0	2.5	2.6	7.7	43.6	43.7
★	TP-7	3.0	16.078	2.061	1.243	0.45	0.181	7.1	20.4	12.9	30.6	24.3	4.6
⊙	TP-8	2.5	2.006	0.318	0.263	0.19	0.124	1.9	2.8	5.3	14.8	70.2	4.9

$C_c = D_{30}^2/(D_{60} * D_{10})$ To be well graded: $1 < C_c < 3$ and

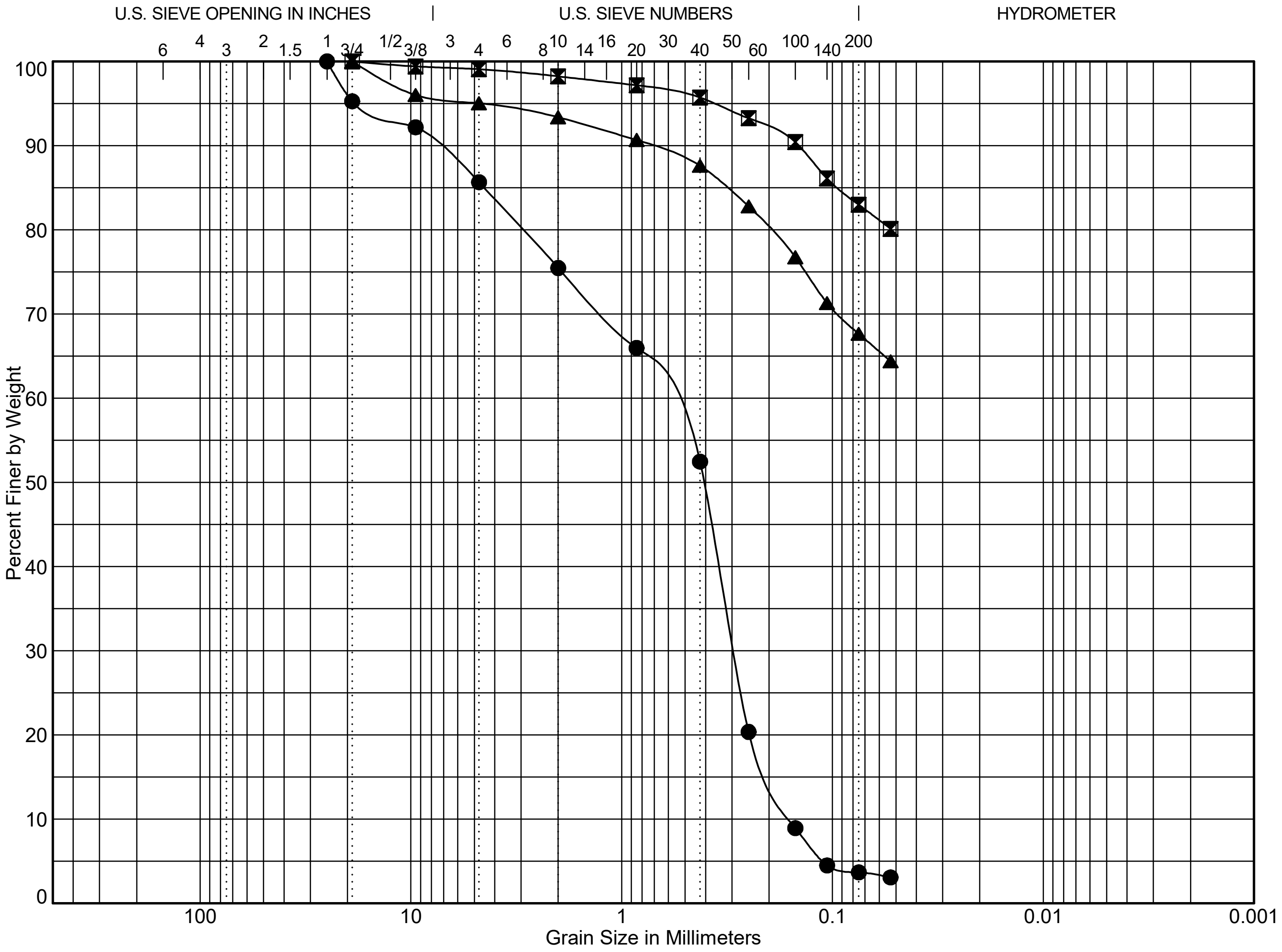
$C_u = D_{60}/D_{10}$ $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Grain Size Test Data

Figure
12



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Point	Depth	Classification	LL	PL	PI	C_c	C_u
●	TP-9	3.0	Gravelly SAND (SP)				0.87	3.98
⧗	TP-9	9.3	Sandy CLAY (CL)					
▲	TP-10	3.0	Slightly gravelly, sandy SILT (ML)					

	Point	Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	TP-9	3.0	7.543	0.626	0.408	0.293	0.157	4.7	9.6	10.2	23.0	48.8	3.7
⧗	TP-9	9.3	0.145					0.0	0.9	0.9	2.5	12.7	83.0
▲	TP-10	3.0	0.731					0.0	5.0	1.7	5.8	20.0	67.6

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

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

To be well graded: $1 < C_c < 3$ and

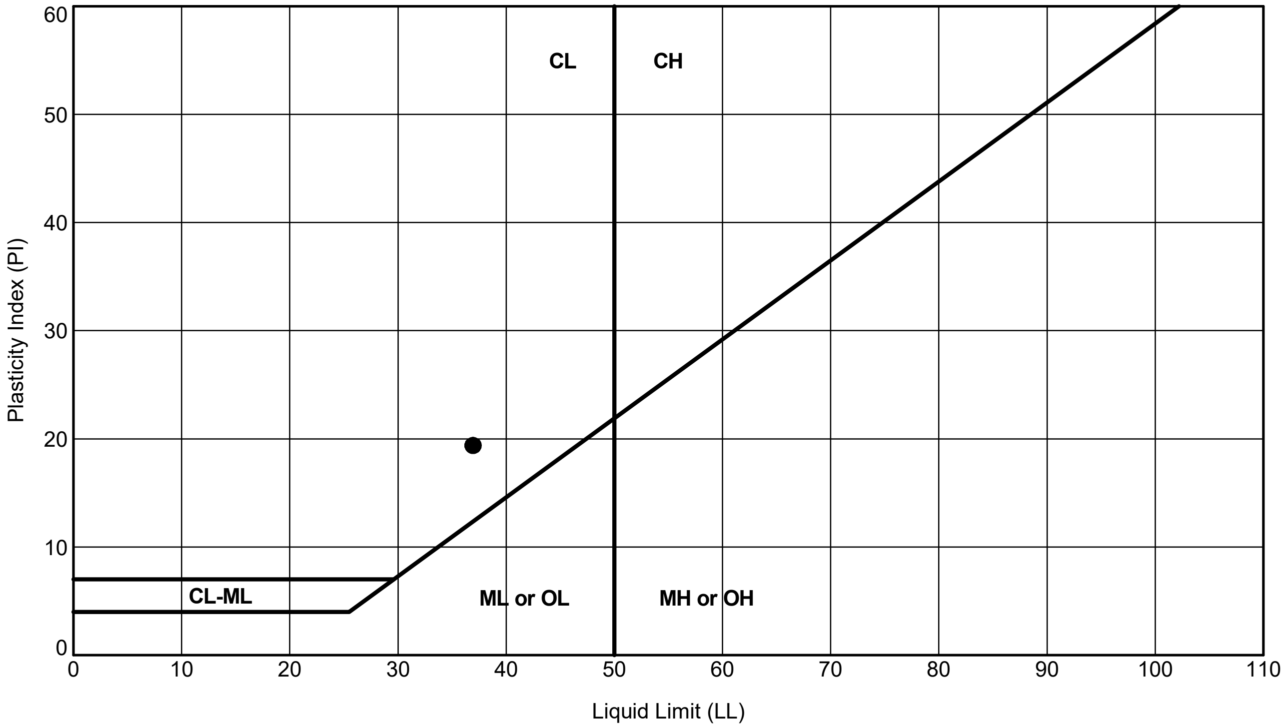
$C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST
An RMA Company

Pea Patch Property
55 Pea Patch Lane
Orcas Island, Washington

Grain Size Test Data

Figure
13



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	TP-9	33	6.0	37	18	19		Sandy CLAY	CL

ASTM D 4318 Test Method

Pea Patch Property 55 Pea Patch Lane Orcas Island, Washington	Plasticity Chart	Figure 14

Northwest Agricultural
Consultants

2545 W Falls Avenue
Kennewick, WA 99336
509.783.7450
www.nwag.com
lab@nwag.com

PAP-Accredited
NAPT

GeoTest Services Inc.
741 Marine Drive
Bellingham, WA 98225

Report: 69299-1-1
Date: August 08, 2024
Project No: 00-241958-0
Project Name: Pea Patch

Sample ID	pH	Organic Matter	Cation Exchange Capacity
TP-1 @ 0.5’	6.0	10.75 %	21.6 meq/100g
TP-4 @ 0.25’	6.0	5.85 %	14.7 meq/100g
TP-7 @ 1.0’	6.3	2.60 %	9.6 meq/100g
TP-10 @ 1.0’	5.3	1.53 %	8.1 meq/100g
Method	**SM 4500-H$^+$ B**	**ASTM D2974**	**EPA 9081**

REPORT LIMITATIONS AND GUIDELINES FOR ITS USE[1]

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.

---

[1] Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

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.

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.

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 preformed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.