Chinookan, LLC
Geotechnical Engineering Evaluation

Vineyard Vista Subdivision
Off NE North Fork Ave
La Center, Washington, 98629

True North Project No. 22-0389-1
December 1, 2023

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Chinookan, LLC
PO Box 886
La Center, Washington, 98629

Attn: Mr. Lincoln Wolverton

Subject: Geotechnical Engineering Evaluation
Vineyard Vista Subdivision
Off NE North Fork Ave
Clark County Parcel Nos. 258898000 & 258903000
True North Project # 22-0389-1

Dear Mr. Wolverton:

At your request, True North Geotechnical Services (True North) is providing you with this report summarizing our geotechnical services for the proposed new Vineyard Vista Subdivision residential development to be located at the above-mentioned address in La Center, Washington (site). The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development.

We have endeavored to prepare this report in accordance with generally accepted geotechnical engineering practices at the time we prepared it, for the exclusive use of Chinookan, LLC, the owner, and their agents, for specific application to this project. Use or reliance upon this report by a third party is at their own risk. True North does not make any representation or warranty, express or implied, to such other parties as to the accuracy or completeness of this report or the suitability of its use by such other parties for any purpose whatever, known or unknown, to True North.

Based on the results of our study, development of the site with the proposed buildings and associated roadways and utilities is feasible provided the recommendations in this report are included in the project design and implemented during construction. The chief geotechnical concerns of note associated with the project include maintaining proper setbacks from the steep slopes present within the northeastern portion of the site, ensuring proper cut and fill slope construction for the grading of the proposed new lots and roadway, and avoiding exposing any potentially expansive clays located in the southwest corner of the site.

The attached report includes a summary of our project understanding, geologic site reconnaissance, subsurface explorations, and our conclusions regarding the expected effect that the proposed lot development will have on the site.

PURPOSE AND SCOPE OF WORK

The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development. This report includes a summary of our project understanding, geologic site reconnaissance, subsurface exploration, our conclusions regarding the effects of the proposed lot development on the site, and recommendations for design and construction.

The following describes our specific scope of work that was completed:

- **Geologic Map and Literature Review**: We reviewed published geologic and geologic hazard mapping for the site.
- **Test Pit Excavations:** We completed five (5) test pit excavations on the property. The test pit excavations extended to depths ranging from about 10 to 12 feet below the ground surface (bgs).
- **Laboratory Testing:** Samples collected from the borings were returned to our office for further examination including classification in general accordance with the Unified Soil Classification, Visual-Manual Procedure. Select samples were subjected to laboratory testing, including natural moisture content analysis, and fines content analysis.
- **Analysis:** Data collected during the literature research, subsurface explorations, and laboratory testing were used to develop site-specific geotechnical design parameters and construction recommendations.
- **Report Preparation:** This Geotechnical Engineering Evaluation summarizes the results of our explorations and analyses, including information relating to the following:
    - Exploration logs and site plan with exploration locations
    - Laboratory test results
    - Summary of interpreted surface and subsurface conditions
    - Shallow foundation design recommendations
        - Minimum embedment and allowable bearing pressure
        - Estimated settlement
        - Sliding coefficient and passive earth pressure
    - Subsurface drainage requirements
    - Earthwork recommendations
        - Temporary and permanent slope inclinations
        - Structural fill materials and preparation
        - Suitability of native and on-site soils for reuse as structural fill
        - Wet weather/conditions consideration
    - Foundation, slab and pavement subgrade preparation recommendations
    - Flexible and rigid pavement design recommendations
    - Utility trench excavation and backfill recommendations for associated utilities
    - Seismic design criteria and design considerations

PROJECT UNDERSTANDING

True North understands that you are planning to subdivide two existing City of La Center/Clark County Tax Parcels, Nos. 63472946 and 258903000, comprising approximately 29.53 acres.

True North's current understanding of the proposed development is based on a review of Preliminary Grading and Stormwater plans for the project, prepared by The Wolfe Group, LLC, dated November, 2023. We understand that the proposed project consists of the subdivision of the existing lots into 84 new lots. The new lots will range in size from approximately 6000 to 10,000 square-feet, and will each accommodate one single-family home. The existing home and shop on the property will remain and has been property line adjusted into a new lot located at the southwest of the proposed development (see site plan). We understand that several new public roadways are planned to provide access to the lots from NE North Fork Avenue. In general, we understand that utilities are planned below the new roadways. The site with respect to existing nearby features is shown in the attached Vicinity Map, Figure 1. The location of our explorations with respect to existing site conditions and boundaries is shown on the attached Figure 2, Site and Exploration Plan.

We anticipate the future homes at all lots will have relatively short driveways to the new public roadways and will be supported by conventional concrete spread footings. We also understand that three open space tracts are planned at the site for community parks and critical areas protection, and stormwater management for all lots and streets aside from Lots 1 through 13 is planned at a storm facility, located in the center of the site, at the top of the existing gully. Stormwater from Lots 1 through 13 will be collected and routed to the existing storm system located below E 24th Circle, which runs along the southern site boundary. Based on our understanding of proposed development, we anticipate cuts and fills of up to 10 to 15 feet across the site. The purpose of our explorations was to evaluate subsurface conditions and provide geotechnical recommendations for design and construction, including site preparation and support of the proposed new development.

SITE CONDITIONS

Geologic Setting

The site is located in the eastern margin of the Portland Basin, a structural basin with basalt bedrock overlain by sediment associated with repeated glacial outburst flooding of the Columbia River and its tributaries. The last of these outburst flooding events, known as the Missoula Floods, occurred about 10,000 years ago. The flood deposits include layers of clay, silt, sand, and gravel. Some layers may include boulders up to 8 feet in diameter.

In the immediate vicinity of the site, the near surface soils are mapped as Pleistocene-age fine-grained catastrophic flood deposits (Qfs), consisting of clay, silt, and fine sands, underlain at depth by Eocene-age volcanic breccia.

Surface Conditions

The site consists of the above-mentioned parcels, which comprise approximately 29.53 acres located directly northwest of downtown La Center. The site is surrounded to the north and the east by undeveloped forest land, and to the west by agricultural fields. Directly south of the site is a subdivision of single-family residences.

The elevation at the site is variable, characterized by an east-west plateau in the approximate center of the site. To the south, the ground descends at a gradient of approximately 15 to 25 percent. To the north, the ground descends at a gradient of approximately 5 to 15 percent. There is a gully in the northeast of the site that descends from the plateau to Brezee Creek at a gradient of approximately 15 to 50 percent. The site ranges in elevation from about 350 feet above mean sea level (AMSL) at the lowest part of the gully to about 452 feet AMSL at the crest of the plateau. Approximately two-thirds of the site, in the northeast segment, southeastern corner, and along the southern property line is heavily forested with mature trees. The plateau had previously been developed for agricultural production, and several acres of mature grapevines are still present, but not in active production.

Subsurface Conditions

On September 28th and 29th, 2022, we visited the site to excavate five test pits (see attached Site Plan, Figure 2). The test pit explorations, designated TP-1 through TP-5, were excavated to maximum depths between about 9.5 and 12 feet bgs. The approximate test pit locations are shown on Figure 2. Descriptions of field and laboratory procedures and the interpreted exploration logs are included in Attachment A. The following is a generalized description of the subsurface units encountered in our explorations:

TOPSOIL:	Brown topsoil, with varying amounts of cobbles, organics and tree roots was observed at the surface in all our test pits, extending to depths ranging from about 6 to 18 inches bgs. In TP-1 and TP-2, topsoil was silty with some sand, in TP-4, topsoil exhibited trace sand.
Sandy/ Silty CLAY:	Red-brown Sandy/Silty CLAY (CL) with varying amounts and textures of sand was encountered just below the topsoil in TP-1 to TP-4, extending to varying depths of about 3 feet bgs in TP-1 to 8 to 9 feet bgs in TP-2, TP-3, and TP-4. The consistency of this layer was stiff to very stiff, generally increasing with depth. The moisture content of samples tested from this layer ranged from about 13 to 34 percent. The fines content of three samples from this layer in TP-2, TP-2, and TP-3 were 80, 81, and 89 percent, respectively. The plasticity index of a sample taken 3 feet bgs from TP-4 was found to be 17 percent.

Sandy SILT: Red-brown Sandy SILT (SM) with gravel and some cobbles was encountered just below the topsoil in TP-5, extending to a depth of about 10.5 feet bgs. The consistency of this layer was medium stiff to stiff. The moisture content of two samples tested from this layer ranged from 21 to 34 percent. The fines content of one sample taken from this layer in TP-5 was 44 percent. The plasticity index of a sample at 1.5 feet bgs was found to be 11 percent.

CLAY: Light gray to red CLAY (CL) was encountered below the sandy/silty clay in TP-1, TP-2, TP-3, and TP-4, extending to the termination depths of 10 to 12 feet in each exploration. Generally, the relative density of this layer was very stiff. The moisture content of samples tested from this layer ranged from about 17 to 34 percent. The fines content of three samples from this layer in TP-1, TP-3, and TP-4 were 84, 92, and 96 percent, respectively. A sample from TP-2 taken 2 feet bgs was found to have a plasticity index of 18 percent.

Clayey SAND: Yellow-black Clayey SAND (SC) with gravel and some cobbles was encountered below the silt layer in test pit TP-5, extending to the termination depth of about 12 feet bgs. In general, the relative density of this layer was dense. Atterberg Limit testing on a sample from this layer indicated this material to be non-plastic. The fines content of one sample from this layer in TP-5 was 18 percent.

Groundwater

Groundwater was not encountered at any of the five test pit exploration locations, which were excavated to depths of up to 12 feet bgs. Based on a review of nearby well logs as well as Clark County data, the static groundwater level at the property is mapped at about 60 to 100 feet bgs, although zones of isolated restrictive layers may occur, resulting in seasonally higher perched water levels at times.

Hydrologic Soil Properties

According to the USDA Web Soil Survey, four near-surface soils at the site have been identified: Hesson clay loam (HcB, HcD), Hesson gravelly clay loam (HgD), Hillsboro silt loam (HoB, HoG), and Olequa silty clay loam, heavy variant (OhF). These soils are generally classified as silty or clayey loam at the approximate test depths and are assigned the hydrologic soil groups “C”, “C”, “B”, and “C”, respectively, based on drainage and other properties, indicating the soils have a very low to moderately high capacity to transmit water.

For the purposes of the stormwater system design using the Western Washington Hydrologic Model (WWHM), it is our opinion, based on the results of our explorations, infiltration testing, and laboratory testing, that the native near-surface soil conditions observed in our explorations can generally be classified as Soil Group 3 (SG3).

Geologic Hazards

The following provides a geologic hazard review for the subject site. The geologic hazard review as based on our site reconnaissance and explorations, as well as a review of publicly available published literature and maps.

Slope Hazards:

Topography at the site varies significantly and is defined by the plateau running east to west through the approximate middle of the property. To the south of the plateau, slopes descend at a 10 to 25 percent gradient to the southern property line. To the north of the plateau, slopes descend gently to the northern property line at a gradient of 5 to 15 percent. In the northeast corner of the property, the slope descends sharply from the plateau at a 15 to 50 percent gradient towards the eastern property line and Brezee Creek.

The portions of the site where slope gradients exceed 40 percent should be considered geologically hazardous areas for steep slopes, in accordance with La Center Municipal Code (LCMC) 18.300. This encompasses a small portion of the northeastern corner of the site, where the plateau descends into the gully leading to Brezee Creek. As such, activities at the top of the slope should be subject to setbacks and restrictions, which are outlined in the Recommendations section of this report. See Figure 2 – Site Plan for more information.

Landslide Hazards:

Multiple mapped areas of potential instability exist on the site, notably along the gulley descending to Brezee Creek and along the entire southern parcel, where existing slopes were measured to be about 15 percent. Based on a review of Clark County Maps Online and the Washington Geologic Information Portal, there are no mapped historic or active landslides on the property or in the surrounding area. We were able to assess much of the native surficial soil conditions in the area of the site previously used for agricultural production, nearly all of the southern parcel, and much of the heavily wooded areas. What we observed showed no evidence of localized slumps, bulges, seeps, or springs that would indicate the possibility of unstable slopes on the property. Based on these observations, as well as our literature review, it is our opinion that no portions of the site constitute a landslide hazard in accordance with LCMC 18.300.

Expansive Soils:

Review of a Geotechnical Investigation Report prepared by Geotechnical Resources Incorporated, dated March 5, 1999, indicates the presence of expansive soils in the development to the south of this site's southern parcel. Specifically, near surface samples taken from an exploration completed just south of E 24th Circle were found to exhibit high plasticity and high shrink/swell potential. In our explorations, TP-2, TP-4 and TP-5 were the most closely adjacent to this area. Atterberg Limit testing performed on near-surface cohesive soils taken from these test pits resulted plastic indices of 18, 17, and 11 percent, respectively. These results suggest that the near-surface cohesive soils in the southern half of the site exhibit low plasticity. Based on these results, it is our opinion that the near-surface cohesive soils in the southern half of the site do not exhibit the same shrink/swell potential as was observed in the north of the Southview Heights Subdivision, and therefore do not pose a concern for the proposed development of the site. While there remains the potential for buried clay soils within the southwestern portions of the site, which may exhibit some expansion potential, the currently proposed grading plan does not propose any cuts into these areas that may result in exposing such moisture sensitive clays.

Seismic Hazards:
The following seismic hazards have been considered as part of our geologic hazards review for the project site:

Ground Motion Amplification: Based on a review of Clark County Maps Online, the site is designated as seismic Site Class “C”. Based on the presence of dense gravelly clay soils at shallow depths in our explorations, it is our opinion that Site Class “C” is indeed appropriate for use at the site. The seismic design parameters, in accordance with the 2018 IBC (with Washington State amendments), are summarized in Table 2.

Table 2. 2018 IBC Seismic Design Parameters

Location	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.801 g	S_1 = 0.377 g
Site Class	C	
Site Coefficient	F_a = 1.2	F_v = 1.5
Adjusted Spectral Acceleration	S_{MS} = 0.961 g	S_{M1} = 0.565 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.641 g	S_{D1} = 0.377 g

g – acceleration due to gravity

Liquefaction: Based on the relative density and grain size of the soils encountered in our explorations and the presence of bedrock at relatively shallow depths, we consider the potential for liquefaction settlement within the site boundaries to be low. Indeed, site is mapped as having a negligible to very low liquefaction susceptibility based on the Liquefaction Susceptibility Map of Clark County.

CONCLUSIONS AND RECOMMENDATIONS

Geotechnical Design and Construction Considerations

Based on the results of our Geotechnical Engineering Evaluation, development of the site with the proposed development is feasible provided the recommendations in this report are included in the project design and implemented during construction. As with any geotechnical evaluation, this investigation is meant to create a "broad brush" understanding of the subsurface conditions across the site. We recommend lot specific geotechnical explorations and recommendations if more detailed information is required/recommended for lot development that varies from our previously stated

The primary geotechnical concerns associated with the project are:

1. **Presence of moisture sensitive, clay soils.** In general, the soils at this site are classified as CL – low plasticity clay. Low plasticity clays (CL) have a low potential for shrink/swell provided the soils are maintained at the in-situ moisture content. However, clay soils are extremely moisture sensitive. As such, we recommend a minimum 3-inches of crushed rock structural fill having a fines content between 10 and 20 percent be placed below the home foundations. This "dirty" rock typically consists of screenings, reject rock, or crushed recycled concrete (preferred) with particle sizes less than 3 inches in diameter. The higher fines content serves to inhibit the flow of moisture through the new subgrade, thus keeping the underlying native soil at its in-situ moisture content, reducing the potential for subgrade softening.

   True North will need to assess the exposed subgrades and may recommend additional over-excavation and replacement with the higher fines content crushed rock described above, depending on the conditions revealed during construction. Further details regarding site preparation and foundation construction are described in the following sections of this report.

2. **Presence of steep slopes on south and east edges of development.** As stated above, steep slopes exist on the eastern and southern edges of the property. These slopes appear well vegetated and we did not note signs of slope instability in the areas able to be observed during our site explorations. An adequate setback of the footings or other structural elements from the steeper slopes will be required, which is described in detail in the "Geotechnical Slope Setbacks" section of this report.

   Along the southern boundaries of the site, as well as within limited other lots throughout the development, new cut and fill slopes will be graded to create the building pads for home construction. Where grading will take place on existing slopes steeper than 5H:1V, we have provided recommendations detailed in the "Cut and Fill Slopes" section of this report.

In summary, provided the recommendations in this report are adhered to, we do not foresee any major issues that would preclude the proposed development. The above-mentioned factors are listed to draw the attention of the reader to the issues to address during design and construction.

Site Preparation

After any surface and near surface water sources have been controlled, the construction areas should be cleared and stripped of organic matter, and other deleterious materials. Silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads should be used as required to reduce sediment transport during construction to acceptable levels.

Where present, existing topsoil, buried structures, and other disturbed surface materials should be stripped and removed from proposed development locations and for a five-foot-margin around such areas. Based on our explorations, the depth of stripping may range from 6 up to 18 inches, although greater stripping depths may be required if loose or soft materials or abandoned utilities or other embedded structures are encountered, or where mature trees and their associated roots are removed. Deleterious materials encountered during site preparation should be removed from the subgrade soils and hauled off site for disposal. Stripped material should be transported off site for disposal or stockpiled for use in landscaped areas. If stripping operations occur during wet weather, a generally greater stripping depth might be required in order to remove disturbed moisture sensitive soils; therefore, stripping is best performed during a period of dry weather.

Subgrade Verification

Following site preparation, including removal of all topsoil/till zone and compaction of the exposed subgrade and prior to placing aggregate base for the foundations, building pad, or pavement section, the exposed subgrade should be evaluated. The subgrades should be evaluated by qualified True North personnel using a steel foundation probe, proofroll, or other acceptable method. Unsuitable areas identified during the field evaluation should be re-compacted to or be excavated to firm ground and replaced with structural fill.

Wet/Freezing-Weather/Wet-Soil Conditions

Due to the presence of fine-grained silt and clay in the near-surface materials at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above the optimum moisture required for compaction. Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads may help reduce further damage to the pavement and disturbance of site soils. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic.

Excavations

Where required, temporary soil cuts associated with site excavations or regrading activities should be adequately sloped back to prevent sloughing and collapse, unless a shoring box or other suitable excavation side wall bracing is provided. It is the responsibility of the contractor to ensure that excavations are properly sloped or braced for worker safety protection, in accordance with OSHA safety guidelines.

Structural Fill

Structural fill includes any fill materials placed under footings, pavements, or driveways and backfill over the embedded mat foundation. Typical materials used for structural fill include: clean, well-graded sand and gravel; clean sand; crushed rock; controlled-density fill (CDF); lean-mix concrete; and various soil mixtures of silt, sand, and gravel. Use of the on-site soils as structural fill may be feasible, provided they are properly moisture conditioned prior to placement and compaction.

Imported granular structural fill should consist of angular pit or quarry run rock, crushed rock, or crushed gravel and sand that is fairly well graded between coarse and fine particle sizes. The fill should contain no organic matter or other deleterious materials, have a maximum particle size of one inch, and have less than 5 percent passing the U.S. No. 200 Sieve. In deep excavations, or where subgrade soils require stabilization, the particle size may be increased to four inches. The percentage of fines can be increased to 12 percent of the material passing the U.S. No. 200 Sieve if placed during dry weather and provided the fill material is moisture-conditioned, as necessary, for proper compaction. The material should be placed in lifts with a maximum uncompacted thickness of 12 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exist, the initial lift thickness may be increased to 24 inches and should be compacted by rolling with a smooth-drum, nonvibratory roller.

Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. Drainage implementations, including subdrains or perforated drain pipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by True North during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V without individual slope stability analysis. Fill slopes should be constructed by placing fill material in maximum 12-inch level lifts and horizontally benching where appropriate. Structural fill should be compacted to a minimum of 92 percent of the maximum dry density, as determined by ASTM D 1557. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by True North.

A typical cut and fill slope cross section is shown in Figure 4 of this report.

Geotechnical Slope Setback

To reduce the risk of slope instability at the site, we recommend that residential structures be set back from steeper slopes in accordance with the standards outlined in LCMC 18.300.070. Specifically, residential structures should be set back at the ratio of H/3, where H is equal to the total height of the slope. Without individual lot-specific evaluations, the setbacks will be approximately 10 to 20 feet from the steep slopes in the northeast corner of the site where they exceed 40 percent gradient. The limitation recommendation is intended to reduce potential for slope instability by limiting the dynamic and static loading resulting from construction and permanent structures.

The setback is based on the horizontal distance of the outside base of footings from the adjacent slope. With increased embedment of the footings, structures may be founded closer to the adjacent top of slope, providing the horizontal distance from the slope surface is maintained. Reduction of the setback from the top of the slope may also be achieved with embedded “daylight” basement style foundations, which may allow for structures places up to and even extending into the steeper slope areas, depending on a site specific evaluation prior to finalizing the home design.

To reduce the risk of slope instability, clearing, grading, soil stockpiling, utility installation and other major construction activities should not be permitted within the limitation area or along the slopes themselves. The probability for slope instability increases with disturbance or alteration of existing slope vegetation. The setback zone is not intended to be an undisturbed conservation area, and small disturbances such as minor landscaping or construction of decks or fences are acceptable. The recommendations provided are intended to address the geotechnical aspects of construction within the recommended limitation zones.

The limits of the steep slope hazard area, as well as approximate setback limits are shown in Figure 2. Actual slope limits and associated setbacks should be determined after completion of a site-specific topographic survey. We have included a typical slope setback figure for guidance as Figure 5 of this report.

Foundations

Once the site has been properly prepared as discussed above, the planned construction can be supported on a conventional shallow foundation system. All foundations should bear on a minimum 3-inches of “dirty” crushed rock structural fill placed atop native, firm and unyielding, undisturbed low plasticity clay. Continuous-wall and isolated-spread footings should be at least 12 and 24 inches wide, respectively. For frost protection, the footings should be founded at least 12 inches below the lowest adjacent grades or deeper if required by local building code. The footings should be founded below an imaginary line projected at a 1H:1V slope from the base of any adjacent, parallel utility trenches.

Footings should bear on the previously described structural fill placed in accordance with our recommendations. Footings should be sized for an allowable bearing capacity of 1,500 psf. We estimate post construction settlements will be less than one inch for our recommended allowable bearing capacity. We estimate that the differential settlement will be approximately half of the total settlement. Our recommended bearing capacity is based on limiting settlements and includes a minimum factor of safety of 3 against ultimate bearing failure.

Lateral loads acting on the foundations can be resisted by passive earth pressures on the sides of the foundation and by friction along the soil-rock-concrete interface at the base of the foundation. We recommend using an allowable passive earth pressure of 250 pounds per cubic foot (pcf) for foundations confined by the near-surface clayey sand, sandy gravel, or structural fill placed in accordance with our recommendations. We recommend an allowable coefficient of friction of 0.35 for foundations. In order to develop these capacities, concrete must be poured neat in excavations, the adjacent grade must be level, and the static ground water level must remain below the base of the footing throughout the year. The passive pressure within the upper foot of embedment should be neglected. These allowable lateral resistance values include a factor of safety of 1.5.

Slab-on-grade Floors

Satisfactory subgrade support for lightly-loaded building floor slabs can be obtained on the undisturbed native soil or on engineered structural fill. A subgrade modulus of 125 pounds per cubic inch may be used to design floor slabs.

A minimum 6-inch-thick layer of drain rock should be placed and compacted over the prepared subgrade to assist as a capillary break and blanket drain. The drain rock may include a capping layer of clean ¾ inch minus crushed rock that contains no more than 5% fines. The drain rock and capping rock should be placed in one lift and compacted until well-keyed, about 90% of the maximum dry density as determined by ASTM D698.

A vapor retarder manufactured for use beneath floor slabs should be installed according to the manufacturer’s recommendations. Careful attention should be made during construction to prevent perforating the retarder, and to seal edges and utility penetrations. We recommend following ACI 302.1, Chapter 3 with regard to installing a vapor retarder.

Site Retaining Walls

The two possible conditions regarding the ability of a wall to yield include the active and at-rest earth pressure cases. The active earth pressure case is applicable to a wall that is capable of yielding slightly away from the backfill by either sliding or rotating about its base. A conventional cantilevered retaining wall is an example of a wall that can develop the active earth pressure case by yielding. The at-rest earth pressure case is applicable to a wall that is considered to be relatively rigid and laterally supported at the top and bottom and therefore is unable to yield.

Based on our understanding of the proposed new development, we anticipate that the backfill area behind any embedded walls will be roughly horizontal and will be completely drained. For that case, yielding walls can be analyzed using an active earth pressure on the basis of a hydrostatic pressure distribution and an equivalent fluid unit weight of 40 psf per foot of depth. Correspondingly, non-yielding walls can be analyzed using an at-rest earth pressure on the basis of a hydrostatic pressure distribution and an equivalent fluid unit weight of 60 pcf.

A passive earth pressure of 250 pounds per cubic foot (pcf) may be used for the face of the footings, which has been reduced by a factor of 1.5 to account for the amount of deformation required to mobilize full passive resistance, and a coefficient of friction equal to 0.35 may be used when calculating resistance to sliding. The values presented above do not include a factor of safety (FS).

To account for seismic loading, the earth pressures should be increased by at least 40%. The resultant of the additional seismic force can be assumed to act at a distance of 0.6H measured up from the base of the wall, where H equals the overall height of the wall.

Pavement Design

The City of La Center has set standards for the minimum pavement sections for each design level category of public roadways, depending on the AASHTO classification of the expected subgrade conditions. The minimum section for both Local Access and Neighborhood Access streets with the anticipated AASHTO Class A-5 on-site soils is 4 inches of asphaltic concrete (AC) over 11 inches of crushed rock base (CRB). In our opinion, based on anticipated traffic volume and subgrade conditions, the minimum sections will provide a minimum 20-year service life with terminal serviceability within the AASHTO recommended range.

These recommended pavement sections are based on the assumption that the subgrade consists of firm structural fill or compacted native subgrade and that the pavement will be constructed during the dry summer months. Proofrolling should be used to evaluate pavement subgrade. Any soft areas disclosed by proofrolling will likely need to be reworked. Some contingency should be provided for the repair of any soft areas. If pavement construction is scheduled for the wet season, it will be necessary to increase the above-recommended base course sections.

AC and CRB materials should conform to WSDOT specifications. All CRB should be compacted to at least 95 percent of the modified proctor ASTM D-1557 laboratory test standard.

Permanent, properly installed drainage is also an essential aspect of pavement design and construction. All paved areas should have positive drainage to prevent ponding of surface water and saturation of the base course. This is particularly important in cut sections or at low points within the paved areas, such as around stormwater catch basins.

Drainage

The Contractor should be made responsible for temporary drainage of surface water and groundwater as necessary during construction to prevent standing water and/or erosion at the site.

As a matter of good construction practice, we recommend that perimeter drains be installed for all buildings. Perimeter drains should consist of perforated drainpipe embedded in a zone of free draining fill that is wrapped in a non-woven geotextile filter. The pipe should be connected to a tightline drainpipe leading to storm drain facilities. Foundation and crawl space drainage should be sloped to drain to a sump or low point drain outlet. Water should not be allowed to pond within crawl spaces. Roof drains should be connected to a tightline drainpipe leading to storm drain outlet facilities.

Water should not be allowed to “pond” or collect anywhere on the site. The ground surface around structures should be sloped to drain away from building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or other approved drainage areas. “Trapped” planting areas should not be created next to any buildings without providing means for drainage.

Soil Erosion

Site-specific erosion control measures should be implemented to address the maintenance of slopes or exposed areas. This may include silt fence, bio-filter bags, straw wattles, or other suitable methods. During construction, all exposed areas should be well compacted and protected from erosion. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or rip in localized areas to minimize erosion.

Finished slopes should be vegetated as soon as possible with erosion-resistant native grasses and plants. Once established, slope vegetation should be properly maintained. Concentrated water should be prevented from flowing over slope faces.

CONSTRUCTION OBSERVATIONS

Satisfactory earthwork performance depends on the quality of construction. Sufficient monitoring of the contractor’s activities is a key part in ensuring that work is completed in accordance with the construction drawings and specifications. We recommend that True North observe that the subsurface conditions observed during our site investigation are consistent with those encountered during construction, and that foundation subgrades are suitable for placement of structural fill, rebar, or concrete for the new structures.

The City of La Center and/or Clark County may require a final letter of geotechnical compliance before they will finalize a permit. If such a letter is required, a representative from True North MUST observe foundation subgrades PRIOR to concrete being poured for the foundation. If True North does not perform this observation, we cannot provide a final letter of geotechnical compliance, and a permit will not be eligible for final sign-off. It is the owner's responsibility to ensure that True North be notified in a timely manner (i.e., at least 48 hours prior to the required site observation) of the need for our services on site during construction.

LIMITATIONS

We have prepared this report for use by the owner/developer and other members of the design and construction team for the proposed Vineyard Vista Subdivision. The opinions and recommendations contained within this report are not intended to be construed as a warranty of subsurface conditions, but are forwarded to assist in the planning and design process. The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project, as derived from written and verbal information supplied to us by you.

The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project and potential future development, as derived from written and verbal information supplied to us by you. When the design has been finalized, we recommend that we review the design and specifications to see that our recommendations have been interpreted and implemented as intended. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

CLOSING

We appreciate the opportunity to be of service to you. If you have any questions, or if we can be of further assistance to you, please contact us at (360) 984-6584.

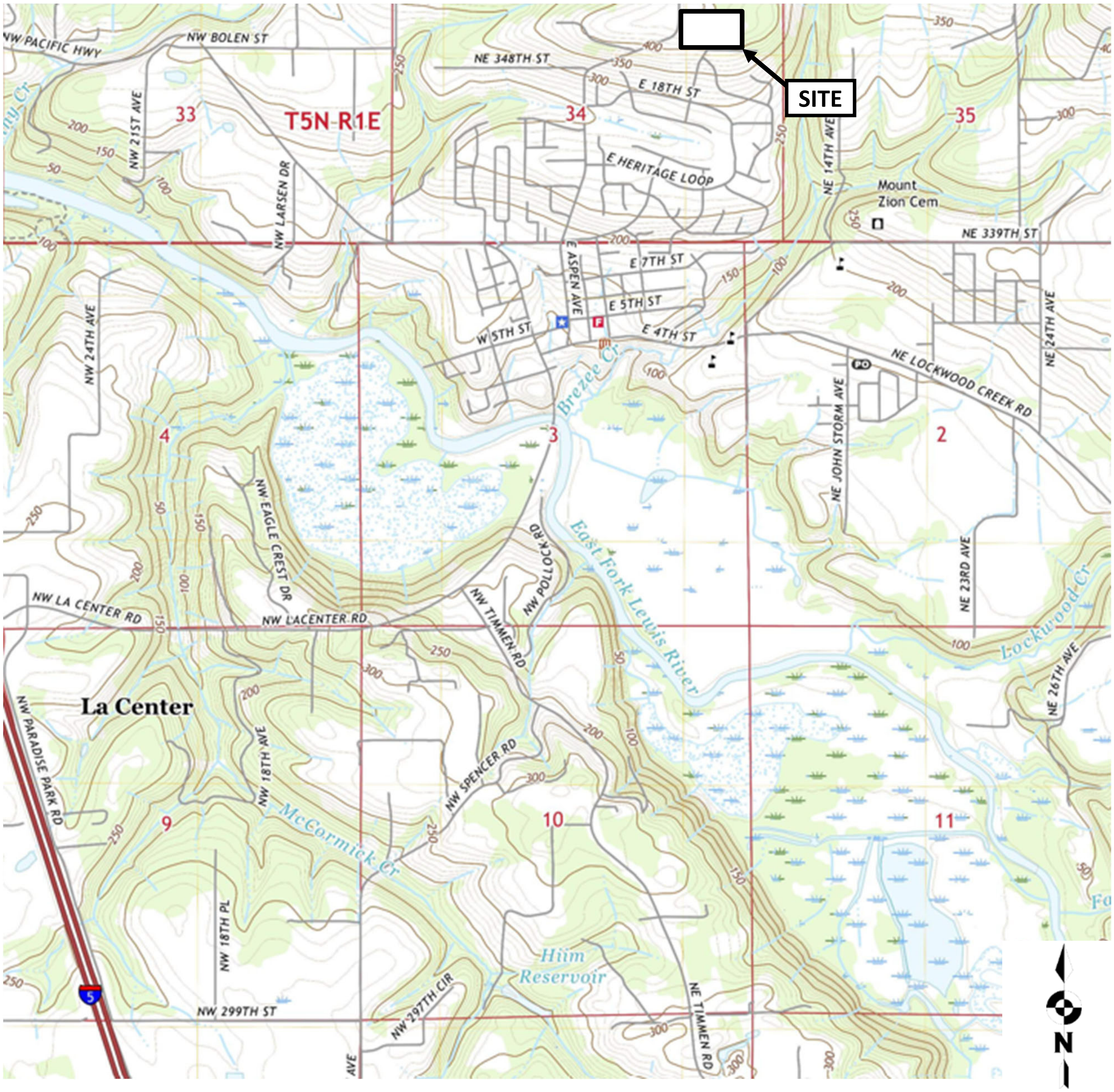
Respectfully Submitted,

TIMOTHY JAMES NORTH
STATE OF WASHINGTON
48620
REGISTERED PROFESSIONAL ENGINEER

Timothy J. North, P.E.
Geotechnical Engineer

Attachment:
- Figure 1 – Vicinity Map
- Figure 2 – Site Plan
- Figure 3 – Site Photographs
- Figure 4 – Typical Cut and Fill Slope Cross Section
- Figure 5 – Typical Slope Setback
- Appendix A – Field and Laboratory Procedures
- Test Pit Logs TP-1 through TP-5

FIGURES



Source: “Topographic Map of the Ridgefield Quadrangle, 7.5 minute series” 2020, United States Geological Survey (USGS).

TRUE NORTH GEOTECHNICAL	Chinookan, LLC Vineyard Vista Subdivision La Center, WA	Project # 22-0389-1
219 West 4th Street Vancouver, WA 98660 360-984-6584	December 2023	Figure 1 – Vicinity Map

Scale:
1" ≈ 250'

N

TP-1 Approximate Exploratory Test Pit Locations, September 28-29, 2022.

Source: Aerial & Topo – Clark County MapsOnline, accessed December 1, 2023.

TRUE NORTH ◆ GEOTECHNICAL ◆	Chinookan, LLC Vineyard Vista Subdivision La Center, WA	Project # 22-0389-1
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Photo 1. Looking northeast upslope from behind the existing barn towards the gully.

Photo 2. Excavating Test Pit 2.

TRUE NORTH GEOTECHNICAL	Chinookan, LLC Vineyard Vista Subdivision La Center, WA	Project # 22-0389-1
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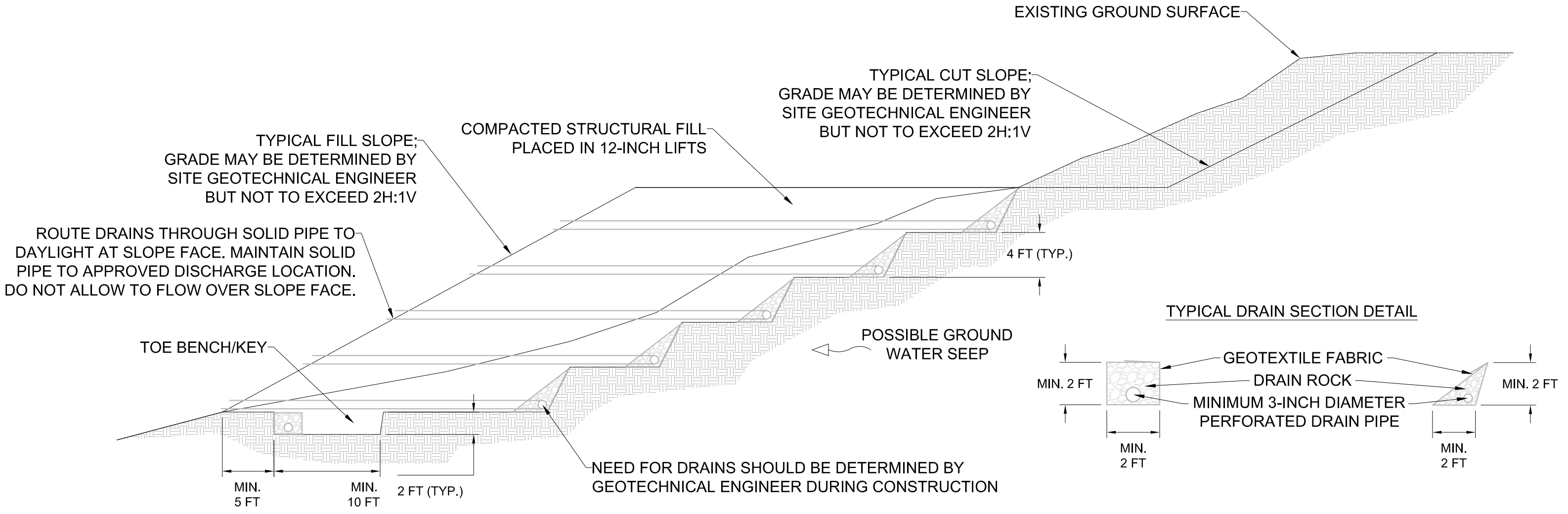
Photo 3. Excavation of Test Pit 3, just southwest of the gully.

Photo 4. Test Pit 1.

TRUE NORTH GEOTECHNICAL	Chinookan, LLC Vineyard Vista Subdivision La Center, WA	Project # 22-0389-1
219 West 4th Street Vancouver, WA 98660 360-984-6584	December 2023	Figure 3B – Site Photographs (2 of 2)



DRAIN SPECIFICATIONS

1. GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN NO. 70 AND NO. 100 SIEVE.
2. WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE NO. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

NOTES:

1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE
3. DRAWING REPRESENTS TYPICAL FILL AND CUT SLOPE SECTION, AND IS NOT SITE SPECIFIC.

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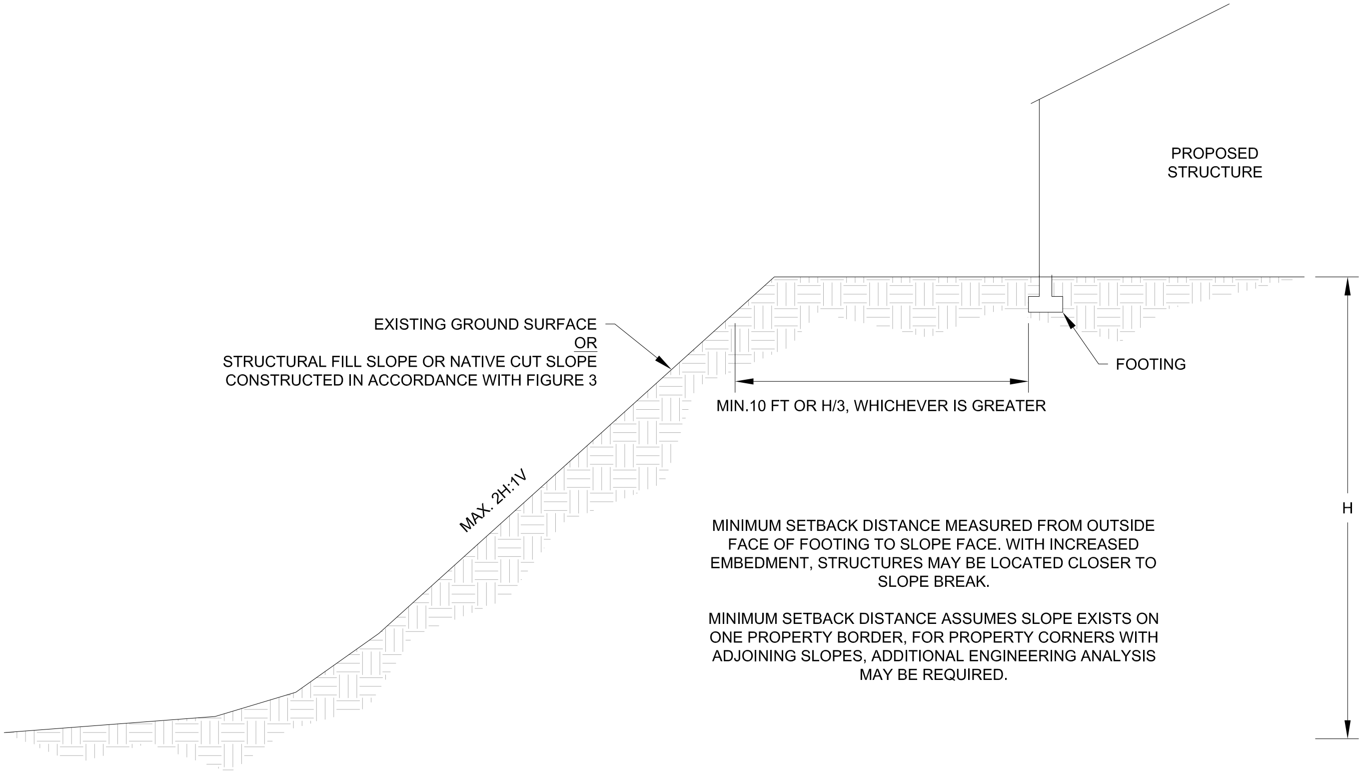
219 West 4th Street Vancouver, WA 98660 360-984-6584	December 2023	Figure 4 – Typical Cut and Fill Slope Cross-Section



MINIMUM SETBACK DISTANCE MEASURED FROM OUTSIDE FACE OF FOOTING TO SLOPE FACE. WITH INCREASED EMBEDMENT, STRUCTURES MAY BE LOCATED CLOSER TO SLOPE BREAK.

MINIMUM SETBACK DISTANCE ASSUMES SLOPE EXISTS ON ONE PROPERTY BORDER, FOR PROPERTY CORNERS WITH ADJOINING SLOPES, ADDITIONAL ENGINEERING ANALYSIS MAY BE REQUIRED.

NOTES:

1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE
3. DRAWING REPRESENTS TYPICAL SLOPE SECTION, AND IS NOT SITE SPECIFIC.

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APPENDIX A

Field Exploration Procedures
Laboratory Testing Procedures
Exploration Test Pit Logs

FIELD EXPLORATION PROCEDURES

General

We explored subsurface conditions at the site by excavating five test pits, designated TP-1 through TP-5, to depths ranging from about 9.5 to 12.0 feet bgs. The test pit explorations were excavated on September 28 and 29th, 2022 with a Deere 35G tracked mini excavator, owned and operated by Dan Tapani Excavating of Battle Ground, Washington. Upon completion, the test pits were backfilled with excavated soils tamped into place as best possible.

Soil Sampling

A True North representative observed subsurface explorations to record the soil, rock, and groundwater conditions encountered, and to obtain soil samples. Disturbed soil samples were obtained from the sidewalls of the excavation and the excavator bucket at selected depths throughout the explorations. Soil samples were sealed to retain moisture and returned to our laboratory for additional examination and testing.

Field Classification

The observed soils were classified initially on site in general accordance with ASTM D 2488 Description and Identification of Soils (Visual-Manual Procedure). Consistency, color, relative moisture, degree of plasticity, peculiar odors, and other distinguishing characteristics of the soil samples were noted. The terminology used is described in the key and glossary that follow.

Summary Exploration Logs

Results from the test pits are shown in the summary exploration logs. The left-hand portion of a log provides our interpretation of the soil encountered, sample depths, and groundwater information. The right-hand portion of a log shows the results of field and laboratory testing. Soil descriptions and interfaces between soil types shown in summary logs are interpretive, and actual transitions may be gradual.

LABORATORY TESTING PROCEDURES

Soil samples obtained during field explorations are examined in a laboratory, and representative samples may be selected for further testing. The testing program included visual-manual classification and natural moisture content testing.

Visual Manual Classification

Soil samples are classified in general accordance with guidelines presented in ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The physical characteristics of the samples are noted and the field classifications are modified, where necessary, in accordance with ASTM terminology, though certain terminology that incorporates current local engineering practice may be used. The term which best described the major portion of the sample is used to describe the soil type.

Natural Moisture Content

Natural moisture content is determined in general accordance with guidelines presented in ASTM D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

Fines Content

Fines content testing is performed in general accordance with guidelines presented in ASTM D1140, *Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No.200) Sieve in Soils by Washing*. The fines content is the fraction of soil that passes the U.S. Standard Number 200 Sieve. This sieve differentiates fines (silt and clay) from sand and gravel. Soil material that remains on the Number 200 sieve is sand and gravel. Material that passes the sieve is fines. The test is used to refine soil type.

Atterberg Limits

The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil. The behavior of fine-grained soil can change markedly at different water contents, and this analysis aids in soil classification. Atterberg Limits are determined in general accordance with guidelines presented in ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. A summary of the results of the Atterberg limits testing are shown in Figure A1.

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TABLE A1
Key to Test Pit and Boring Terminology and Symbols

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTION
			GRAPH	LETTER	
Coarse Grained Soils More Than 50% Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or No Fines)	○	GW	Well-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			⬡	GP	Poorly-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with Fines (Significant Percentage of FInes)	▥	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			▨	GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No. 4 Sieve	Clean Sands (Little or No Fines)	⁖	SW	Well-graded Sands, Gravelly Sands, Little or No Fines
			⁚	SP	Poorly-graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines (Significant Percentage of FInes)	▥	SM	Silty Sands, Sand-Silt Mixtures
			▨	SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More Than 50% Material Passing No. 200 Sieve	Silts and Clays	Liquid Limit Less than 50 percent	▥	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands, Clayey Silts
			▨	CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays
			▤	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit Greater than 50 percent	▥	MH	Inorganic Silts Micaceous or Diatomaceous Fine Sand or Silty Soils
			▨	CH	Inorganic Clays of High Plasticity, Fat Clays
			▨	OH	Organic Clays of Medium to High Plasticity, Organic Silts
			+	PT	Peat, Humus, Swamp Soils

Topsoil	⁘	Humus and Duff Layer
Fill	▩	Highly Variable Constituents

Relative Density of Coarse-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50+

Consistency of Fine-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 -8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	30 - 50
Very Hard	50+

Key to Sampler Type Symbols

G	☒	◫	▥	◧
Grab	SPT	Shelby Tube	Dames & Moore	Rock Core

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Project Name: Chinookan - Vineyard Vista Subdivision		TEST PIT LOG TP-1
Project Location: 34911 & 35011 NE North Fork Ave, La Center WA 98629		Project No.: 22-0389-1
Operator: Dan Tapani Excavating	Equipment: Mini excavator w 2' bucket	Date Started: 09/28/22
Logged By: LS	Checked By: TJN	Date Completed: 09/28/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
			⁙		Stiff light brown Sandy Silt TOPSOIL; heavily rooted with organics; dry to moist.			
1			⁙					PP = 2.5 tsf
2	G	S-1	▨	CL	Very stiff, tan CLAY with sand; sand medium coarse; clay low plasticity; dry to moist.	14		PP = 3.5 tsf Fines content = 87%
3			▨		Very stiff, light gray CLAY; low plasticity; blocky; strongly cemented; dry to moist.			PP = >4.0 tsf
	G	S-2	▨			17		
4			▨	CL				
5			▨					
6	G	S-3	▨		Very stiff tan CLAY with trace Sand; low plasticity; blocky; strongly cemented; dry to moist.	25		Fines content = 84%
7			▨	CL				
8	G	S-4	▨	CL	Very stiff, red-brown CLAY; low plasticity; blocky; very strongly cemented; dry to moist.	26		
9			▨					
10					Excavation terminated at 9.5 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
11								
12								
13								
14								
15								

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TEST PIT LOG TP-2

Project Name: Chinookan - Vineyard Vista Subdivision

Project Location: 34911 & 35011 NE North Fork Ave, La Center WA 98629

Project No.: 22-0389-1

Operator: Dan Tapani Excavating

Equipment: Mini excavator w 2' bucket

Date Started: 09/29/22

Logged By: LS

Checked By: TJN

Date Completed: 09/29/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
			⁘		Medium stiff light brown Silty TOPSOIL; moderately rooted with organics.			
1			▨		Very stiff, red-brown CLAY with Sand; few organics; strongly cemented and low plasticity; moist.			PP = 3.5 tsf
2	G	S-1	▨					PP = 4.5 tsf PI = 18%
			▨		sand content increasing with depth			
3			▨	CL				
4	G	S-2	▨			18		Fines content = 80%
5	G	S-3	▨		Very stiff red-tan Sandy CLAY; some brittle black gravel; clay strongly cemented, low plasticity; moist.	22		Fines content = 81%
6			▨					
7			▨	CL				
8			▨					
9			▨					
10	G	S-4	▨		Very stiff red Sandy CLAY; strongly cemented, low plasticity; moist.	30		
11			▨	CL				
12					Excavation terminated at 12.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
13								
14								
15								

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TEST PIT LOG TP-3

Project Name: Chinookan - Vineyard Vista Subdivision

Project Location: 34911 & 35011 NE North Fork Ave, La Center WA 98629

Project No.: 22-0389-1

Operator: Dan Tapani Excavating

Equipment: Mini excavator w 2' bucket

Date Started: 09/29/22

Logged By: LS

Checked By: TJN

Date Completed: 09/29/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
			⁘		Soft, dark brown TOPSOIL with organics; moist.			
1	G	S-1	▨		Stiff red-brown Silty CLAY with some organics and trace fine sand; trace cobbles; moderately cemented, low plasticity; dry to moist.	20		PP = 3.0 tsf Fines content = 85%
2			▨					PP = 3.5 tsf
3			▨					PP = 4.0 tsf
4	G	S-2	▨			24		Fines content = 89%
5			▨	CL	single lamination of yellow clay $\frac{1}{8}$" thick			
6			▨					
7			▨					
8			▨					
9	G	S-3	▨		Stiff, red CLAY; interbedded with layers of gray and tan clay; moderately cemented, low plasticity; moist.	34		Fines content = 96%
10	G	S-4	▨	CL				
11					Excavation terminated at 11.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
12								
13								
14								
15								

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TEST PIT LOG TP-4

Project Name	Chinookan - Vineyard Vista Subdivision		
Project Location	34911 & 35011 NE North Fork Ave, La Center WA 98629	Project No.	22-0389-1
Operator	Dan Tapani Excavating	Equipment	Mini excavator w 2' bucket
Date Started	09/28/22		
Logged By	LS	Checked By	TJN
Date Completed	09/28/22		

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
			⁙		Loose, dark brown TOPSOIL with trace sand; moist.			
1	G	S-1	▨	SC	Dense, red-brown Clayey SAND; some fine organics; fine sand; low plasticity; dry to moist.	13		PP = 3.0 tsf Fines content = 74%
2			▨		Stiff red-brown Sandy CLAY; some uniform cobbles; fine sand; low plasticity; moist.			PP = 3.5 tsf Fines content = 81%
3	G	S-2				28		PP = 3.5 tsf PI = 17%
4								PP = 4.0 tsf
				SC				
5								
6	G	S-3			some yellow brittle weathered stone, cobbles decreasing in frequency.			
7								
8			▨		Stiff yellow CLAY; some highly weathered brittle black and red basalt; weakly cemented, low plasticity; moist.			
9				CL				
10	G	S-4				37		Fines content = 92%
11	G	S-5			Excavation terminated at 11.0 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
12								
13								
14								
15								

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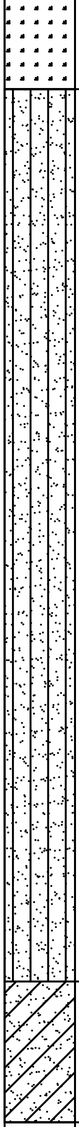
TEST PIT LOG TP-5

Project Name: Chinookan - Vineyard Vista Subdivision
Project Location: 34911 & 35011 NE North Fork Ave, La Center WA 98629
Project No.: 22-0389-1
Operator: Dan Tapani Excavating
Equipment: Mini excavator w 2' bucket
Date Started: 09/28/22
Logged By: LS
Checked By: TJN
Date Completed: 09/28/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
					Loose, brown TOPSOIL with cobbles; significant organics with diameter up to 1"; moist.			
1					Stiff red-brown Sandy SILT with gravel; some cobbles up to 8" in diameter; very fine sand; some organics to 4' depth; dry to moist.			PP = 2.0 tsf
2	G	S-1						PI = 11% PP = 3.0 tsf
3								PP = 3.25 tsf
	G	S-2				21		
4								PP = 3.5 tsf
5					Bed of gravel and fine cobbles weakly cemented in yellow-gray clay with black mottling			
6				SM				
7	G	S-3				34		Fines content = 44%
8								
9								
10								
11	G	S-4		SC	Dense, yellow-black Clayey SAND with gravel; some cobbles; medium sand; low plasticity; moist.	19		Fines content = 18%
12					Excavation terminated at 12 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
13								
14								
15								