



## **REPORT OF GEOTECHNICAL ENGINEERING SERVICES**

Vista View Apartments  
2075 NE 240<sup>th</sup> Avenue  
Wood Village, Oregon

For  
Prime Realty Investors, LLC  
September 6, 2019

GeoDesign Project: Fairway-1-01



September 6, 2019

Prime Realty Investors, LLC  
c/o First West Realty  
3561 NE 215<sup>th</sup> Court  
Fairview, OR 97024

Attention: Les Bick

**Report of Geotechnical Engineering Services**

Vista View Apartments  
2075 NE 240<sup>th</sup> Avenue  
Wood Village, Oregon  
GeoDesign Project: Fairway-1-01

GeoDesign, Inc. is pleased to submit this report of geotechnical engineering services for the proposed Vista View Apartments located at 2075 NE 240<sup>th</sup> Avenue in Wood Village, Oregon. This report presents a description of our services and site conditions, a summary of field explorations and laboratory testing, and recommendations for use in design and construction of the proposed development. Our services for this project were conducted in accordance with our proposal dated April 26, 2019.

We appreciate the opportunity to be of continued service to you. Please contact us if you have questions regarding this report.

Sincerely,

GeoDesign, Inc.

A handwritten signature in blue ink, appearing to read "Brett A. Shipton".

Brett A. Shipton, P.E., G.E.  
Principal Engineer

cc: Norm Faris, Valar Engineering (via email only)

JLM:BAS:kt

Attachments

One copy submitted (via email only)

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## ACRONYMS AND ABBREVIATIONS

|       |                                                             |
|-------|-------------------------------------------------------------|
| AC    | asphalt concrete                                            |
| ASCE  | American Society of Civil Engineers                         |
| ASTM  | American Society for Testing and Materials                  |
| BGS   | below ground surface                                        |
| g     | gravitational acceleration (32.2 feet/second <sup>2</sup> ) |
| H:V   | horizontal to vertical                                      |
| IBC   | International Building Code                                 |
| ksf   | kips per square foot                                        |
| MCE   | maximum considered earthquake                               |
| MSL   | mean sea level                                              |
| OSHA  | Occupational Safety and Health Administration               |
| OSSC  | Oregon Standard Specifications for Construction (2018)      |
| pcf   | pounds per cubic foot                                       |
| pci   | pounds per cubic inch                                       |
| psf   | pounds per square foot                                      |
| psi   | pounds per square inch                                      |
| SOSSC | State of Oregon Structural Specialty Code                   |
| SPT   | standard penetration test                                   |
| USGS  | U.S. Geological Survey                                      |

## 1.0 INTRODUCTION

GeoDesign, Inc. is pleased to submit this report of geotechnical engineering services for the proposed Vista View Apartments located at 2075 NE 240<sup>th</sup> Avenue in Wood Village, Oregon. Figure 1 shows the site relative to existing topographic and physical features. Figure 2 shows the proposed site layout and the approximate locations of our explorations. Acronyms and abbreviations used herein are defined above, immediately following the Table of Contents.

## 2.0 PROJECT UNDERSTANDING

The proposed development consists of an apartment building with 61 residential units totaling a floor area of approximately 61,000 square feet. The apartment building will encompass most of the 0.76-acre site and will include three stories of wood-framed construction over two levels of partially below-grade parking. Both levels of parking will have a combined capacity of 92 parking stalls. Site cuts up to 20 feet will be required to construct the parking levels. Based on provided preliminary site plans, we understand that site fills will be less than a few feet.

Based on correspondence with Valar Engineering, we understand that maximum column and wall loads of the building will be approximately 400 kips and 20 kips per lineal foot, respectively. The parking garage slab loads are expected to be no greater than 250 psf.

## 3.0 PURPOSE AND SCOPE

The purpose of our services was to characterize subsurface conditions and provide geotechnical engineering recommendations for use in design and construction of the proposed development. Specifically, we performed the following tasks:

- Reviewed readily available, published geologic data and our in-house files for existing information on subsurface conditions in the site vicinity.
- Conducted a subsurface exploration program that consisted of the following:
  - Drilled five borings to practical refusal on boulders and dense gravel at depths between 3.0 and 20.4 feet BGS.
  - Excavated four test pits to depths between 5.0 and 16.0 feet BGS.
- Maintained continuous logs of the explorations and collected soil samples at representative intervals.
- Conducted a laboratory testing program that consisted of the following:
  - Nine moisture content determinations in general accordance with ASTM D2216
  - Two particle-size analyses in general accordance with ASTM C117 and ASTM D1140
- Provided recommendations for site preparation and grading, including temporary and permanent slopes, fill placement criteria, suitability of on-site soil for fill, subgrade preparation, and wet weather earthwork.
- Provided recommendations for temporary shoring for excavation of below-grade levels.
- Provided foundation support recommendations for the proposed structure, including preferred foundation type, allowable bearing capacity, and lateral resistance parameters.
- Provided recommendations for preparation of floor slab subgrade.

- Provided recommendations for use in design of conventional retaining walls, including backfill and drainage requirements and lateral earth pressures.
- Provided general recommendations for site drainage.
- Provided seismic design recommendations in accordance with the procedures outlined in the 2012 IBC and 2014 SOSSC.
- Prepared this geotechnical engineering report that presents our findings, conclusions, and recommendations.

## **4.0 SITE CONDITIONS**

### **4.1 SURFACE CONDITIONS**

The approximately 0.76-acre site consists of Tax Lot 1701 of Multnomah County Tax Map 1N3E27D. The site is bound by an industrial property to the north, NE 240<sup>th</sup> Avenue to the east, NE Halsey Street to the south, and an apartment complex to the west. Land use in the vicinity of the site is mixed residential and industrial.

The site is currently undeveloped and is mostly covered with grass and low-lying brush vegetation. Blackberry brambles and medium-sized trees are located along the west perimeter of the site. An approximately 1,200-square-foot gravel pad occupies the south portion of the site. The topography of the site slopes downward to the north with site elevations on the order of 134 to 137 feet above MSL on the southeast and southwest corners, respectively, to 117 feet above MSL near the north site perimeter.

### **4.2 SUBSURFACE CONDITIONS**

We explored subsurface conditions at the site by drilling five borings (B-1 through B-5) and excavating four test pits (TP-1 through TP-4). Generally, we experienced difficult drilling conditions at all boring locations. The borings met refusal in boulders and dense gravel at depths between 3.0 and 20.4 feet BGS. Test pits were added to our scope to extend our observations of the subsurface conditions to greater depths in locations where borings met refusal. Difficult excavation conditions were encountered in the test pits due to the presence of boulders and dense gravel. The locations of our explorations are shown on Figure 2. The details of our exploration program and laboratory analyses are summarized in the Appendix.

In general, we encountered a layer of coarse-grained flood deposits consisting of silty sand with gravel, cobbles, and boulders overlying a dense gravel unit. A layer of undocumented fill ranging in thickness from 1 foot to 2 feet was encountered just below the ground surface. We encountered an approximate 3- to 4-inch-thick root zone in all our explorations. The following sections provide a summary of the soil units encountered.

#### **4.2.1 Fill**

Undocumented fill was encountered to depths between 1 foot and 2 feet BGS. The undocumented fill consists primarily of silty and sandy soil with trace amounts of organics. In test pit TP-4, metal and AC debris were observed to be mixed in the fill. Laboratory testing of a select sample indicates the undocumented fill had an in-place moisture content of approximately 9 percent at the time of our explorations.

#### **4.2.2 Coarse-Grained Flood Deposits**

We encountered coarse-grained flood deposits consisting of loose to medium dense, silty sand with gravel, cobbles, and boulders beneath the fill. The coarse-grained flood deposits were observed to extend to depths between 9 and 13 feet BGS. Drill resistance was very strong through the cobbles and boulders of this unit, which are mostly composed of relatively fresh basalt that resulted in practical refusal of borings B-2 through B-4 at depths between 3 and 4.1 feet BGS. Laboratory analyses indicate the moisture content of the coarse-grained flood deposits ranges from 8 to 20 percent at the time of our exploration.

Boulders up to 6 feet in diameter were encountered in test pit TP-2 and are assumed to be distributed throughout the unit in a matrix of silt and sand. In our experience, boulders larger than those observed during our exploration are present in this unit.

#### **4.2.3 Dense Gravel**

A dense gravel unit was encountered beneath the fill and coarse-grained unit. The gravel unit consists of gravel with varying amounts of silt, sand, and cobbles and appears to have zones of varying amounts of cementation. Geologic maps indicate that the upper portion of the Troutdale Formation extends near the ground surface in the site area.<sup>1</sup> The Troutdale Formation is a deposit of dense, cemented gravel and is likely what was encountered in our explorations. The unit typically has high strength and very low compressibility characteristics.

#### **4.2.4 Groundwater**

We did not encounter groundwater in our explorations. Data suggests the local groundwater table is located at a depth of approximately 60 feet BGS (70 feet above MSL).<sup>2</sup> The depth to groundwater may fluctuate below the site in response to seasonal changes and other factors not observed during this study.

### **5.0 CONCLUSIONS**

Based on our review of analyses and available information, it is our opinion that the site can be developed as proposed. In our opinion, the following factors will have an impact on design and construction of the proposed development:

- The proposed structure can be supported on conventional shallow footings bearing on the underlying coarse-grained flood deposits and gravel unit at the site or on structural fill overlying firm native soil. Boulders capable of creating eccentric concentrated loading on the base of footings are present in the coarse-grained flood deposits. Accordingly, we recommend the bottom of footings be separated from boulders by a minimum distance of 12 inches through installation of granular pads.

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<sup>1</sup> Evarts, R.C., and O'Connor, J.E., 2008, Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon, U.S. Geological Survey Scientific Investigations Map 3017

<sup>2</sup> Snyder, Daniel T., 2008. Estimated Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area. Prepared in cooperation with the City of Portland, the City of Gresham, Clackamas County's Water Environment Services, and Multnomah County. U.S. Geological Survey Scientific Investigations Report 2008-5059.

- Boulders within the coarse-grained unit may prevent excavation using conventional earthwork equipment or may fall along property boundaries, which may prohibit complete removal of the boulder. The contractor should anticipate removal and chipping of large boulders in the excavations.
- Based on site constraints and the proposed footprint of the structure, shoring systems will be required to safely maintain the building excavation. As excavation will be difficult in the coarse-grained flood deposits, it may be possible to decrease the exposed height of the shoring system by using temporary slopes above the retaining walls.

The following sections present specific recommendations for use in design and construction of the proposed development.

## **6.0 SITE DEVELOPMENT RECOMMENDATIONS**

### **6.1 SITE PREPARATION**

#### **6.1.1 Demolition**

Demolition includes complete removal of existing site improvements. Underground vaults, tanks, manholes, drain tiles, and other subsurface structures should be removed in areas of new foundation elements. Utility lines can be completely removed when extending under footings or grouted full if left in place, with prior authorization, in other structural areas. Soil disturbed during demolition should be removed and replaced in accordance with the recommendations in the "Structural Fill" section.

Material generated during demolition should be transported off site for disposal or stockpiled in areas designated by the owner. In general, this material will not be suitable for re-use as engineered fill.

#### **6.1.2 Grubbing and Stripping**

The existing root zone should be stripped and removed from the site in all proposed building and pavement areas. Based on our explorations, the depth of stripping will be between 3 and 4 inches. Greater stripping depths may be required to remove localized zones of loose or organic soil. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or used in landscaped areas.

Trees and shrubs should be removed from the planned development area. Root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used to remove the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

#### **6.1.3 Subgrade Preparation and Evaluation**

Following stripping and site cutting, and prior to placing fill or building improvements, the exposed subgrade should be evaluated by proof rolling. The subgrade should be proof rolled with a fully loaded dump truck or similar heavy, rubber tire construction equipment to identify soft,



loose, or unsuitable areas. A member of our geotechnical staff should observe proof rolling to evaluate yielding of the ground surface. Soft or loose zones identified during proof rolling should be excavated and replaced with compacted structural fill. Areas that appear too wet or soft to support proof rolling equipment should be prepared in accordance with recommendations for wet weather construction provided in the "Wet Weather Considerations" section.

#### **6.1.4 Test Pit Locations**

The test pit excavations were backfilled using minimal compactive effort of the excavator bucket. Soft or loose areas can be expected at these locations. Where site cuts do not extend to the bottom of the test pit excavations, we recommend that this relatively uncompacted soil be removed from the test pits to a depth of 3 feet below finished subgrade and replaced with structural fill. If a test pit is located within 10 feet of a footing, we recommend full-depth removal of the uncompacted soil. The resulting excavation should be brought back to grade with structural fill.

### **6.2 WET WEATHER CONSIDERATIONS**

The silty soil at the site is easily disturbed during the wet season. Haul roads and working blankets will be necessary for support of construction traffic during the rainy season or when the moisture content of the subgrade soil is more than a few percentage points above optimum. To minimize the cost associated with the repair of disturbed subgrade, we recommend that the subgrade in these areas be protected from construction traffic. Subgrade protection can be accomplished by constructing granular haul roads and working blankets or preventing traffic from driving across sensitive subgrade.

The contractor has control of the construction schedule and equipment and, therefore, should be responsible for selecting the appropriate thicknesses for haul roads and working blankets. Based on our experience, a 12-inch-thick blanket should be sufficient for light staging areas and an 18-inch-thick blanket for areas subject to heavy construction traffic. The thicknesses of haul roads and areas with repeated heavy construction traffic typically needs to be increased to between 18 to 24 inches. The material used to construct haul roads and staging areas should be selected by the contractor.

### **6.3 EXCAVATION**

We understand that excavations for the below-grade levels will be on the order of 20 feet BGS in the south portion of the site and a few feet in the north portion. Conventional earthmoving equipment in proper working condition will have difficulty making necessary excavations for site cuts and utilities in the coarse-grained flood deposits and underlying gravel unit. The contractor should be prepared to use rock chipping equipment and other specialized tools during excavation.

#### **6.3.1 Boulders**

We anticipate that much of the coarse-grained unit can be excavated using conventional earthmoving equipment, but boulders of significant size should be expected. We encountered boulders up to 6 feet in diameter in our subsurface explorations, and boulders of similar or larger size are assumed to be distributed throughout the unit. Removal of boulders using

hydraulic rock breaking equipment may be necessary when boulders are encountered, particularly along the edges of the proposed excavation area where boulders may extend through the face of the shoring.

The coarse-grained flood deposits and gravel unit may be prone to raveling, and shoring will be required to maintain vertical excavation walls. In our opinion, a soldier pile shoring system is preferred for the subsurface conditions observed at the site. Geotechnical parameters for use in shoring design are provided in “Cantilevered Shoring” and “Tieback Soldier Pile Shoring” sections.

### **6.3.2 Construction Dewatering**

Groundwater is anticipated to be located at a depth of approximately 60 feet BGS at the site; however, perched groundwater could be encountered during excavation, especially during the rainy season. We anticipate that dewatering can be accomplished by pumping from sumps located within the excavation. Water generated during dewatering operations should be pumped to a suitable disposal point.

### **6.3.3 Safety**

Excavations should be made in accordance with applicable OSHA and state regulations. While this report describes certain approaches to excavation and dewatering, the contractor should be responsible for selecting excavation and dewatering methods, monitoring the excavations for safety, and providing shoring as required to protect personnel and adjacent utilities and structures.

## **6.4 CANTILEVER SHORING**

Temporary support for shallow excavations, or one level below grade, at the site can be provided by installing soldier piles with timber lagging or cantilevered shoring. Cantilevered shoring should be designed to resist an active lateral earth pressure that has an equivalent fluid pressure of 35 pcf, with an available passive earth pressure at the inside base of the excavation of 450 pcf above the level of groundwater according to Figure 3. The passive earth pressure can be applied over 3 pile diameters and the active earth pressure below the base of the excavation is applied over 1 pile diameter. These values do not include surcharge-induced earth pressures. The values on Figure 4 can be used to compute surcharge-induced lateral earth pressures. The lateral earth pressures listed above are unfactored. For temporary shoring a factor of safety of 1.3 should be applied to the passive earth pressure.

The above equivalent fluid pressures do not include effects from surcharge loads. We recommend a vertical live load of 250 psf be applied at the surface of the retained soil where the wall shoring retains roadways. Surcharge-induced lateral earth pressures can be calculated in accordance with Figure 4. If the surface at the top of the shoring is sloped back to a broken slope condition, the recommended lateral earth pressures should be increased as indicated in Table 1.

**Table 1. Recommended Lateral Earth Pressure Increases from Inclined Backfill  
(Cantilever Retaining Wall)**

| Inclination at Top of Shoring<br>(H:V) | Percent Increase<br>in Lateral Earth Pressure<br>(percent) <sup>1</sup> |
|----------------------------------------|-------------------------------------------------------------------------|
| 1.5:1                                  | 170                                                                     |
| 2:1                                    | 145                                                                     |

1. Assumes retained broken slope backfill is less than 5 feet in height.

## 6.5 TIEBACK SOLDIER PILE SHORING

A tieback shoring system may be used for support of below-grade excavations. The shoring systems should be designed to support surcharge loading imposed by adjacent roadways and structures. Our geotechnical recommendations for use in design and construction of the soldier pile shoring systems are provided in the following sections.

### 6.5.1 Lateral Earth Pressures

Soldier pile shoring systems with tieback anchors should be designed using the lateral earth pressures provided on Figure 3. These pressures will allow moderate relaxation of the shoring toward the excavation causing ground surface settlement. Based on our experience, settlement on the order of 1 inch can be expected adjacent to the shoring. We anticipate that settlement will become negligible at a distance of approximately 15 feet from the wall. Surcharge-induced lateral earth pressures should be computed using the methods provided on Figure 4.

If the surface at the top of the shoring is sloped back to a broken slope condition, the recommended lateral earth pressures on Figure 3 should be increased as indicated in Table 2.

**Table 2. Recommended Lateral Earth Pressure Increases from Inclined Backfill  
(Braced Retaining Wall)**

| Inclination at Top of Shoring<br>(H:V) | Increase in Lateral Earth Pressure<br>(psf) <sup>1</sup> |
|----------------------------------------|----------------------------------------------------------|
| 1.5:1                                  | 18H                                                      |
| 2:1                                    | 10H                                                      |

1. Assumes retained broken slope backfill is less than 5 feet in height.

### 6.5.2 Soldier Piles

Structural design of the soldier piles should consider the lateral earth pressures discussed above. In addition, the soldier piles will be subject to compressive forces as a result of the downward component of the tieback anchor loads. We recommend a minimum soldier pile embedment of 10 feet below the base of the excavation. We recommend an allowable end bearing capacity of 10 ksf for piles embedded at least 5 feet below the excavation base. In addition, we recommend

that structural concrete be used at the tip of each soldier pile. In our experience, this is achievable by using grout that has a compressive strength of 1,000 psi. These values should be verified by the structural engineer designing the shoring.

We encountered cobbles and boulders in the coarse-grained flood deposits during our explorations, which will likely be present where soldier piles are located. The contractor should expect to encounter cobbles and boulders during installation of the soldier piles and tieback anchors. We recommend that the bid documents include a contingency for removing and drilling through boulders.

### **6.5.3 Lagging**

Lagging should be designed to resist horizontal earth pressures equal to one-half of the earth pressures used to design the shoring system in areas where soldier pile spacing is less than 4B (where B is the pile width).

Lagging pressures can increase temporarily when the anchors are tested, particularly in the lagging near the elevation of the anchor. This effect on the lagging is reduced for systems that use walers or if a testing beam is used that spans to adjacent piles.

Soldier pile and lagging walls will likely consist of pressure-treated lumber or shotcrete. We recommend prompt and careful installation of lagging to maintain the integrity of the excavation, particularly in areas of seepage or raveling granular soil. All voids behind the lagging should be backfilled with permeable soil or a porous slurry. We recommend a maximum 4-foot, unsupported, exposed face during wall construction.

### **6.5.4 Tieback Anchors**

The bonded zone for the tieback anchors should be maintained outside of the “unbonded zone for anchors” shown on Figure 3. We anticipate that the tieback anchors will be capable of achieving an ultimate bond strength of between 3 and 8 ksf, depending on the method of construction. A variety of methods are available for construction of tieback anchors. Therefore, we recommend that the contractor be responsible for selecting the appropriate bonded length and installation methods to achieve the required anchor capacity. Tieback anchors should be locked off at 100 percent of the design load.

Prior to installing production anchors, we recommend that performance tests be conducted on a minimum of two anchors. The purpose of these tests is to verify the installation procedure selected by the contractor before several anchors are installed. Performance tests should be performed to 150 percent of the design load and in accordance with the guidelines provided in *Recommendations for Rock and Soils Anchors*<sup>3</sup>.

We recommend that proof tests be conducted on all production anchors in accordance with the guidelines presented in *Recommendations for Prestressed Rock and Soil Anchors*. The anchors should be proof tested to at least 133 percent of the design load.

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<sup>3</sup> Post-Tensioning Institute, 2014. *Recommendations for Prestressed Rock and Soil Anchors*, Fifth Edition, Post Tensioning Institute, Phoenix, Arizona.

We encountered cobbles and boulders in the coarse-grained flood deposits, which will be exposed in most of the excavation walls. The contractor bid documents should include a contingency for drilling through and removing boulders that extend through the surface defined by the lagging.

#### **6.5.5 Other Considerations**

The proposed excavation is located near existing structures and improvements. We recommend that adjacent improvements be surveyed and existing cracks measured prior to, during, and after construction of the proposed building. We also recommend that the condition of nearby structures be photographed prior to excavation. If settlement or damage is observed in adjacent structures, GeoDesign should be contacted to provide additional recommendations.

#### **6.6 TEMPORARY SLOPES**

We understand that temporary slopes may be used above the basement shoring. Where construction slopes are possible, excavation side slopes less than 5 feet high should be no steeper than 1.5H:1V, provided perched groundwater is not present. If slopes greater than 5 feet high are required, GeoDesign should be contacted to make additional recommendations. We recommend a minimum horizontal distance of 2 feet from the edge of the existing improvements to the top of the temporary slope. The cut slopes should be covered with sheet plastic to prevent erosion during rainy weather and excessive drying during the summer months. If sloughing or instability is observed, the slope should be flattened or the cut supported by shoring.

#### **6.7 STRUCTURAL FILL**

Structural fill includes fill beneath foundations, slabs, pavement, other areas intended to support structures, or within the influence zones of structures. Structural fill should be free of organic matter and other deleterious material and, in general, should consist of particles no larger than 3 inches in diameter. Recommendations for suitable fill materials are provided in the following sections.

##### **6.7.1 On-Site Native Soil**

The on-site native soil will be suitable for use as structural fill only if it can be moisture conditioned. Based on our experience, the on-site silty soil is sensitive to small changes in moisture content and may be difficult to compact adequately during wet weather or when their moisture content is more than a few percentage points above optimum. This soil may require extensive drying if it is used as structural fill. We recommend using imported granular material for structural fill if the moisture content of the on-site soil cannot be reduced.

##### **6.7.2 Imported Granular Material**

Imported granular material should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand that is fairly well graded between coarse and fine and has less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve. All granular material must be durable such that there is no degradation of the material during and after installation as structural fill. The percentage of fines can be increased to 12 percent if the fill is placed during dry weather and provided the fill material is moisture conditioned, as necessary, for proper compaction.

### 6.7.3 Pipe Bedding

Utility trench backfill for bedding and in the pipe zone should consist of well-graded granular material with a maximum particle size of  $\frac{3}{4}$ -inch and less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve, or as required by the pipe manufacturer.

### 6.7.4 Drain Rock

Drain rock should consist of open-graded, angular, granular material with a maximum particle size of 2 inches. The material should be free of roots, organic matter, and other unsuitable material and have less than 2 percent by dry weight passing the U.S. Standard No. 200 sieve (washed analysis).

## 6.8 FILL PLACEMENT AND COMPACTION

Fill soil should be compacted at a moisture content that is near optimum. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction.

Fill and backfill material should be placed in uniform, horizontal lifts and compacted with appropriate equipment. The maximum lift thickness will vary depending on the material and compaction equipment used but should generally not exceed the loose thicknesses provided in Table 3. Fill material should be compacted in accordance with the compaction criteria provided in Table 4.

**Table 3. Recommended Uncompacted Lift Thickness**

| Compaction Equipment                               | Recommended Uncompacted Lift Thickness<br>(inches) |                                                                                     |                                                                  |
|----------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------|
|                                                    | Silty Soil                                         | Granular and Crushed<br>Rock Maximum<br>Particle Size<br>$\leq 1\frac{1}{2}$ Inches | Crushed Rock<br>Maximum Particle<br>Size $> 1\frac{1}{2}$ Inches |
| Hand Tools:<br>Plate Compactor and<br>Jumping Jack | 4 to 8                                             | 4 to 8                                                                              | Not Recommended                                                  |
| Rubber Tire Equipment                              | 6 to 8                                             | 10 to 12                                                                            | 6 to 8                                                           |
| Light Roller                                       | 8 to 10                                            | 10 to 12                                                                            | 8 to 10                                                          |
| Heavy Roller                                       | 10 to 12                                           | 12 to 18                                                                            | 12 to 16                                                         |
| Hoe Pack Equipment                                 | 12 to 16                                           | 18 to 24                                                                            | 12 to 16                                                         |

The above table is based on our experience and is intended to serve only as a guideline. The information provided in this table should not be included in the project specifications.

**Table 4. Compaction Criteria**

| Fill Type               | Compaction Requirements in Structural Zones             |                                         |                        |
|-------------------------|---------------------------------------------------------|-----------------------------------------|------------------------|
|                         | Percent Maximum Dry Density<br>Determined by ASTM D1557 |                                         |                        |
|                         | 0 to 2 Feet Below<br>Subgrade<br>(percent)              | > 2 Feet Below<br>Subgrade<br>(percent) | Pipe Zone<br>(percent) |
| Area Fill               | 95                                                      | 92                                      | -----                  |
| Aggregate Bases         | 95                                                      | 95                                      | -----                  |
| Trench Backfill         | 95 <sup>1</sup>                                         | 92 <sup>1</sup>                         | 90 <sup>3</sup>        |
| Retaining Wall Backfill | 95 <sup>2</sup>                                         | 92 <sup>2</sup>                         | -----                  |

1. Trench backfill above the pipe zone in nonstructural areas should be compacted to 85 percent or as recommended by the pipe manufacturer.
2. Should be reduced to 90 percent within a horizontal distance of 3 feet from the retaining wall.
3. Should be reduced to 90 percent within a horizontal distance of 3 feet from the retaining wall or as recommended by the pipe manufacturer.

#### **6.8.1 Area Fills**

Imported fill placed to raise site grades should be placed on a prepared subgrade that consists of firm, inorganic site soil or compacted fill. The fill material should be placed in uniform horizontal lifts and compacted to the recommended minimum density provided in Table 4.

#### **6.8.2 Aggregate Base**

Aggregate base materials under building floor slabs and pavement should be placed on a prepared subgrade that consists of firm, inorganic native soil or compacted fill. Aggregate base material should consist of imported  $\frac{3}{4}$ - or 1½-inch-minus granular material as described in the “Structural Fill” section that meets the requirements in OSSC 00641 (Aggregate Subbase, Base, and Shoulders). Aggregate base material should be placed in uniform, horizontal lifts and compacted to the recommended minimum density provided in Table 4.

#### **6.8.3 Trench Backfill**

Trench backfill in structural areas should consist of imported granular material as described in the “Structural Fill” section and be compacted to the minimum density provided in Table 4. Pipe bedding and fill in the pipe zone should be compacted to the minimum density presented in Table 4 or as recommended by the pipe manufacturer.

#### **6.8.4 Retaining Wall Backfill**

Retaining wall backfill should be compacted to the recommended minimum density provided in Table 4. Backfill within 2 horizontal feet of the wall should consist of drain rock as described in the “Structural Fill” section. Wall backfill within 3 horizontal feet of the wall should be placed in uniform, horizontal lifts and compacted to a lesser density of 90 percent of the maximum density, as determined by ASTM D1557, to reduce the effect of compaction-induced stresses against the retaining wall.

Settlement of up to 1 percent of the wall height commonly occurs immediately adjacent to retaining walls as the walls rotate and develop lateral active earth pressures. Consequently, we recommend that flatwork (slabs, sidewalks, or pavement) placed adjacent to retaining walls be postponed at least four weeks following wall construction, unless survey data indicates that settlement is complete prior to that time.

#### **6.9 PERMANENT CUT AND FILL SLOPES**

Permanent cut and fill slopes in the site soil should be inclined no steeper than 2H:1V. We recommend that slopes that are to be mowed not exceed 3H:1V. Buildings, access roads, and pavement should be set back a minimum of 5 feet from the crest of any such slopes. The base of all footings should be located a minimum distance of 5 feet from the face of slopes.

#### **6.10 EROSION CONTROL**

The on-site silty soil is moderately susceptible to erosion. Consequently, we recommend that slopes be covered with an appropriate erosion control product if construction occurs during periods of wet weather. We recommend that all slope surfaces be planted as soon as practical to minimize erosion. Surface water runoff should be collected and directed away from slopes to prevent water from running down the slope face. Erosion control measures (such as straw bales, sediment fences, and temporary detention and settling basins) should be used in accordance with local and state ordinances.

### **7.0 DESIGN RECOMMENDATIONS**

#### **7.1 FOUNDATION SUPPORT**

We understand that two levels of partially below-grade parking are proposed across the site and that site cuts for the below-grade levels will range between 2 and 20 feet BGS in the north and south portions, respectively. Based on our explorations, site cuts for below-grade parking levels in the south portion of the site should extend into the dense gravel unit; whereas, the north portion of the building will likely be situated above the coarse-grained flood deposits. Both soil units should be capable of supporting the proposed building on conventional shallow footings. All footings should be located a minimum distance of 5 feet from the face of slopes. For areas adjacent to existing slopes, this can be accomplished by embedding the footing to an adequate depth.

To prevent eccentric concentrated loading from boulders on the base of footings, we recommend that all footings founded on the coarse-grained flood deposits be supported on granular pads with a minimum thickness of 12 inches. Our recommendations for use in foundation design and construction are provided in the following sections.

##### **7.1.1 Conventional Shallow Footings**

###### **7.1.1.1 Granular Pads**

Granular pads placed beneath footings should consist of imported granular material meeting the recommendations provided in the "Imported Granular Material" section. Granular pads should be placed in lifts with a maximum uncompacted thickness of 12 inches and compacted to not less



than 95 percent of the maximum dry density, as determined by ASTM D1557. The perimeter of granular pads should extend a minimum of 6 inches beyond the margins of the footing for every foot excavated below the footing base.

#### **7.1.1.2    *Bearing Capacity***

We recommend that footings founded on the coarse-grained flood deposits be sized based on an allowable bearing pressure of 4,000 psf. For footings bearing on the dense gravel unit, we recommend an allowable bearing pressure of 8,000 psf be used in design. These are net bearing pressures; the weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressures apply to the total of dead plus long-term live loads and may be doubled when considering earthquake or wind loads.

Continuous wall and spread footings should be at least 18 and 24 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the lowest adjacent final grade. The bottom of interior footings should be placed at least 12 inches below the base of the floor slab.

#### **7.1.1.3    *Settlement***

For foundations designed in accordance with the recommendations provided above, total post-construction settlement is expected to be less than or equal to 1 inch. Differential settlement between similarly loaded footings is expected to be less than ½ inch.

#### **7.1.1.4    *Lateral Resistance***

Lateral loads on footings can be resisted by passive earth pressure on the sides of the footings and by friction on the base of the footings. The available passive earth pressure for footings confined by native soil and structural fill is 350 pcf. Adjacent floor slabs, pavement, or the upper 12-inch depth of adjacent, unpaved areas should not be considered when calculating passive resistance. We recommend an allowable friction coefficient of 0.40 for footings founded on granular pads and directly on the dense gravel.

#### **7.1.1.5    *Construction Considerations***

Neat-cut, formed footing excavations may slough material during placement of reinforcement steel prior to concrete placement. This material should be removed prior to pouring footings. Excessive sloughing will require that footing excavations be laid back, formed, or shored. Footing excavations adjacent to the existing building foundations should be maintained a sufficient distance from footings or supported by temporary shoring as discussed previously.

All footing and floor slab subgrades should be evaluated by the project geotechnical engineer or their representative to confirm suitable bearing conditions. Observations should also confirm that all loose or soft material, organics, unsuitable fill, prior topsoil zones, and softened subgrades (if present) have been removed. Localized deepening of footing excavations may be required to penetrate deleterious material.

### **7.2    *SLABS ON GRADE***

A modulus of subgrade reaction of 175 pci can be used for design of the floor slabs, provided that the subgrade is prepared in accordance with the recommendations presented in the “Site

Development Recommendations” section. We recommend that the floor slab be supported on at least 6 inches of crushed rock to aid as a capillary break. The crushed rock should consist of imported crushed, angular rock less than ¾-inch in diameter that is fairly well graded between coarse and fine and has less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve. The crushed rock should be placed and compacted as previously recommended for aggregate base.

### **7.3 DRAINAGE CONSIDERATIONS**

#### **7.3.1 Temporary**

During grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface. During rough and finished grading of the building site, the contractor should keep all footing excavations and building pads free of water.

#### **7.3.2 Surface**

The finished ground surface around building should be sloped away from its foundation at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an appropriate stormwater system. Trapped planter areas should not be created adjacent to the building without providing means for positive drainage (i.e., swales or catch basins).

### **7.4 SEISMIC CONSIDERATIONS**

#### **7.4.1 IBC Design Parameters**

Oregon currently enforces the 2014 SOSSC, which refers to ASCE 7-10. We expect that Oregon will adopt the 2019 SOSSC in October 2019, which refers to ASCE 7-16. Table 5 presents the site design coefficients prescribed by ASCE 7-10 for the site and Table 6 presents design coefficients prescribed by ASCE 7-16. Based on the subsurface conditions encountered, Site Class is C should be assumed.

**Table 5. Seismic Design Parameters – ASCE 7-10**

| <b>Parameter</b>                                           | <b>Short Period<br/>(<math>T_s = 0.2</math> second)</b> | <b>1 Second Period<br/>(<math>T_1 = 1.0</math> second)</b> |
|------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------|
| MCE Spectral Acceleration, $S$                             | $S_s = 0.923$ g                                         | $S_1 = 0.384$ g                                            |
| Site Class                                                 | C                                                       |                                                            |
| Site Coefficient, $F$                                      | $F_a = 1.031$                                           | $F_v = 1.416$                                              |
| Adjusted Spectral Acceleration, $S_M$                      | $S_{MS} = 0.951$ g                                      | $S_{M1} = 0.544$ g                                         |
| Design Spectral Response<br>Acceleration Parameters, $S_D$ | $S_{DS} = 0.634$ g                                      | $S_{D1} = 0.362$ g                                         |

**Table 6. Seismic Design Parameters – ASCE 7-16**

| Parameter                                                  | Short Period<br>( $T_s = 0.2$ second) | 1 Second Period<br>( $T_1 = 1.0$ second) |
|------------------------------------------------------------|---------------------------------------|------------------------------------------|
| MCE Spectral Acceleration, $S$                             | $S_s = 0.863$ g                       | $S_1 = 0.366$ g                          |
| Site Class                                                 | C                                     |                                          |
| Site Coefficient, $F$                                      | $F_a = 1.200$                         | $F_v = 1.500$                            |
| Adjusted Spectral Acceleration, $S_M$                      | $S_{MS} = 1.035$ g                    | $S_{M1} = 0.548$ g                       |
| Design Spectral Response<br>Acceleration Parameters, $S_D$ | $S_{DS} = 0.690$ g                    | $S_{D1} = 0.366$ g                       |

#### 7.4.2 Liquefaction and Lateral Spreading

Liquefaction is a phenomenon caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. The excessive buildup of pore water pressure results in the sudden loss of shear strength in a soil. Granular soil, which relies on inter-particle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. In general, loose, saturated sandy soil with low silt and clay content is the most susceptible to liquefaction. Based on the groundwater conditions and soil properties encountered at the site, we do not anticipate liquefaction to be a site hazard.

Lateral spreading is a liquefaction-related seismic hazard and occurs on gently sloping or flat sites underlain by liquefiable sediment adjacent to an open face, such as a riverbank. Since liquefaction is not considered a hazard, we conclude that the risk of lateral spreading occurring at the site is low.

#### 7.4.3 Surface Fault Rupture

The closest mapped faults to the site are the Grant Butte fault and a fault that is part of the Damascus-Tickle Creek fault zone. Both faults are mapped approximately 2.7 miles to the south.<sup>4</sup> Since faults are not mapped beneath the site, we conclude that the probability of surface fault rupture beneath the site is low.

### 7.5 RETAINING WALL RECOMMENDATIONS

#### 7.5.1 Lateral Earth Pressures

Permanent braced retaining walls should be designed to resist the lateral earth pressures induced on the shoring. These earth pressures should be determined using Figures 3 and 4. Permanent retaining walls free to rotate slightly around the base should be designed for cantilever active earth pressures using an equivalent fluid unit weight of 35 pcf. This value is based on the following assumptions: (1) the walls will not be restrained against rotation, (2) the

<sup>4</sup> USGS, 2019. Quaternary Fault and Fold Database for the United States. Accessed on August 14, 2019 from USGS website: <https://earthquake.usgs.gov/hazards/qfaults/>.

backfill is level, (3) the backfill consists of granular material, (4) the backfill is drained, and (5) the wall is less than 15 feet in height. If retaining walls are restrained against rotation during backfilling, they should be designed for an at-rest earth pressure of 55 pcf.

Seismic lateral forces can be calculated using a dynamic force equal to  $7.5H^2$  pounds per linear foot of wall, where H is the wall height. The seismic force should be applied as a distributed load with the centroid located at 0.6 H from the wall base. Footings for retaining walls should be designed as recommended for shallow foundations.

### **7.5.2 Drainage and Backfill**

The above design parameters have been provided assuming that back-of-wall drains will be installed to prevent build-up of hydrostatic pressures behind all walls. If a drainage system is not installed, our office should be contacted for revised design forces.

A minimum 24-inch-wide zone of drain rock extending from the base of the wall to within 6 inches of finished grade should be placed against the back of all retaining walls. The drain rock should meet the requirements provided in the "Structural Fill" section. Perforated collector pipes should be embedded at the base of the drain rock. The drain rock should be separated from the retained soil with geofabric meeting the specifications provided in OSSC 00350 (Geosynthetic Installation) and OSSC 02320 (Geosynthetics). The perforated collector pipes should discharge at an appropriate location away from the base of the wall. The discharge pipe(s) should not be tied directly into stormwater drain systems, unless measures are taken to prevent backflow into the wall's drainage system.

The wall backfill should be compacted to a minimum of 92 percent of the maximum dry density, as determined by ASTM D1557. However, backfill located within a horizontal distance of 3 feet from retaining walls should only be compacted to approximately 90 percent of the maximum dry density, as determined by ASTM D1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (e.g., jumping jack or vibratory plate compactors). If flatwork (e.g., sidewalks or pavement) will be placed atop the wall backfill, we recommend that the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D1557.

Settlement up to 1 percent of the wall height commonly occurs adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of improvements adjacent to retaining walls be postponed at least four weeks after backfilling of the wall, unless survey data indicates that settlement is complete prior to that time.

## **8.0 OBSERVATION OF CONSTRUCTION**

Satisfactory earthwork and foundation performance depend to a large degree on the quality of construction. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated. In addition,

sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications.

## **9.0 LIMITATIONS**

We have prepared this report for use by Prime Realty Investors, LLC and other members of the design and construction team for the proposed development. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions and are not applicable to other sites.

Soil explorations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during excavation and construction, re-evaluation will be necessary.

The site development plans and design details were not finalized at the time this report was prepared. When the design has been finalized and if there are changes in the site grades or location, configuration, design loads, or type of construction, the conclusions and recommendations presented may not be applicable. If design changes are made, we should be retained to review our conclusions and recommendations and to provide a written evaluation or modification.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design.

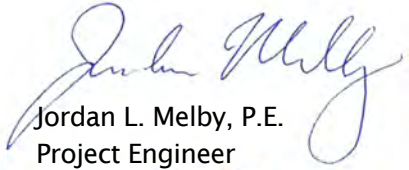
Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

◆ ◆ ◆

We appreciate the opportunity to be of continued service to you. Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

GeoDesign, Inc.

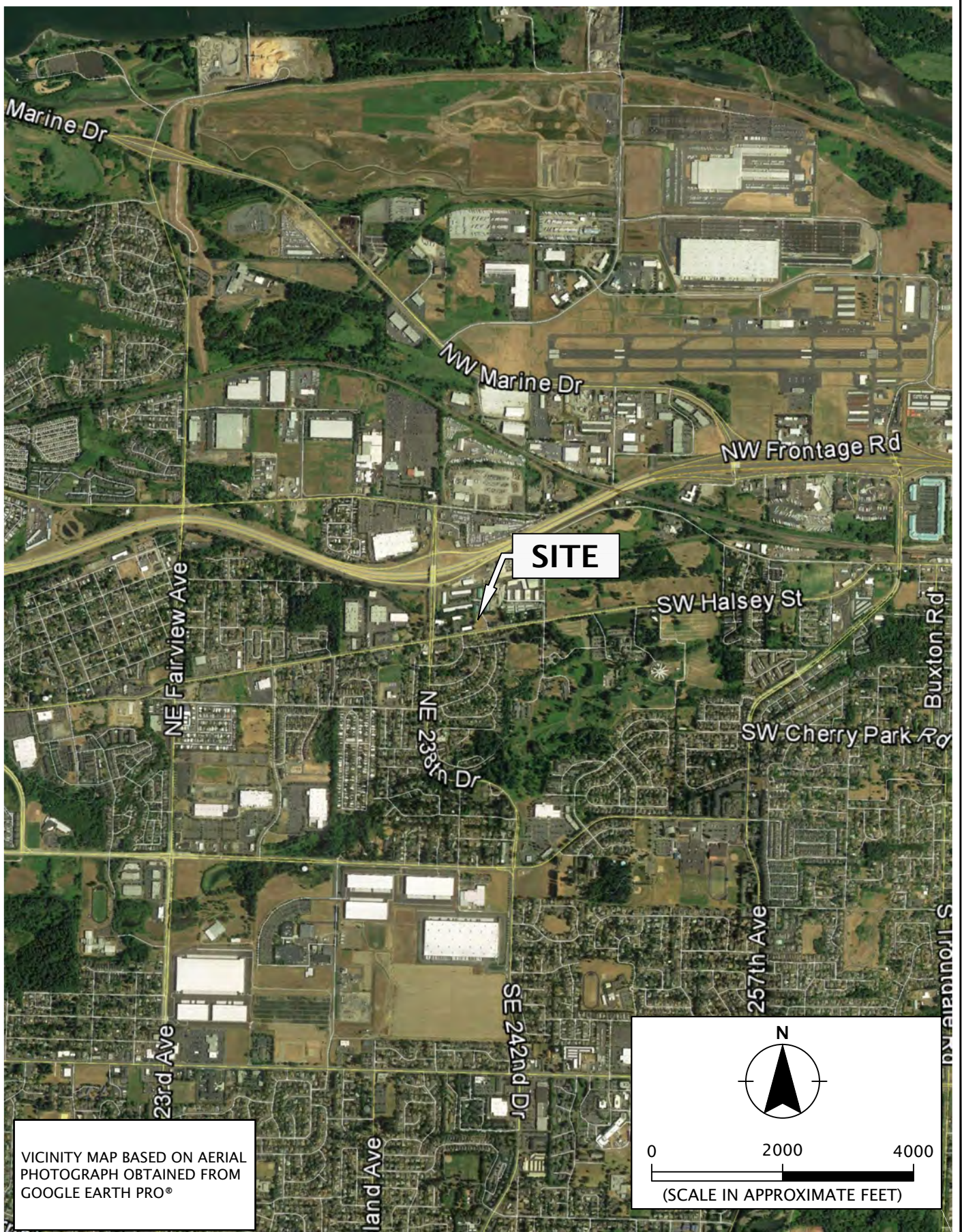
  
Jordan L. Melby, P.E.  
Project Engineer

  
Brett A. Shipton, P.E., G.E.  
Principal Engineer



## FIGURES





**GEODESIGN INC**  
 9450 SW Commerce Circle - Suite 300  
 Wilsonville OR 97070  
 503.968.8787 www.geodesigninc.com

FAIRWAY-1-01

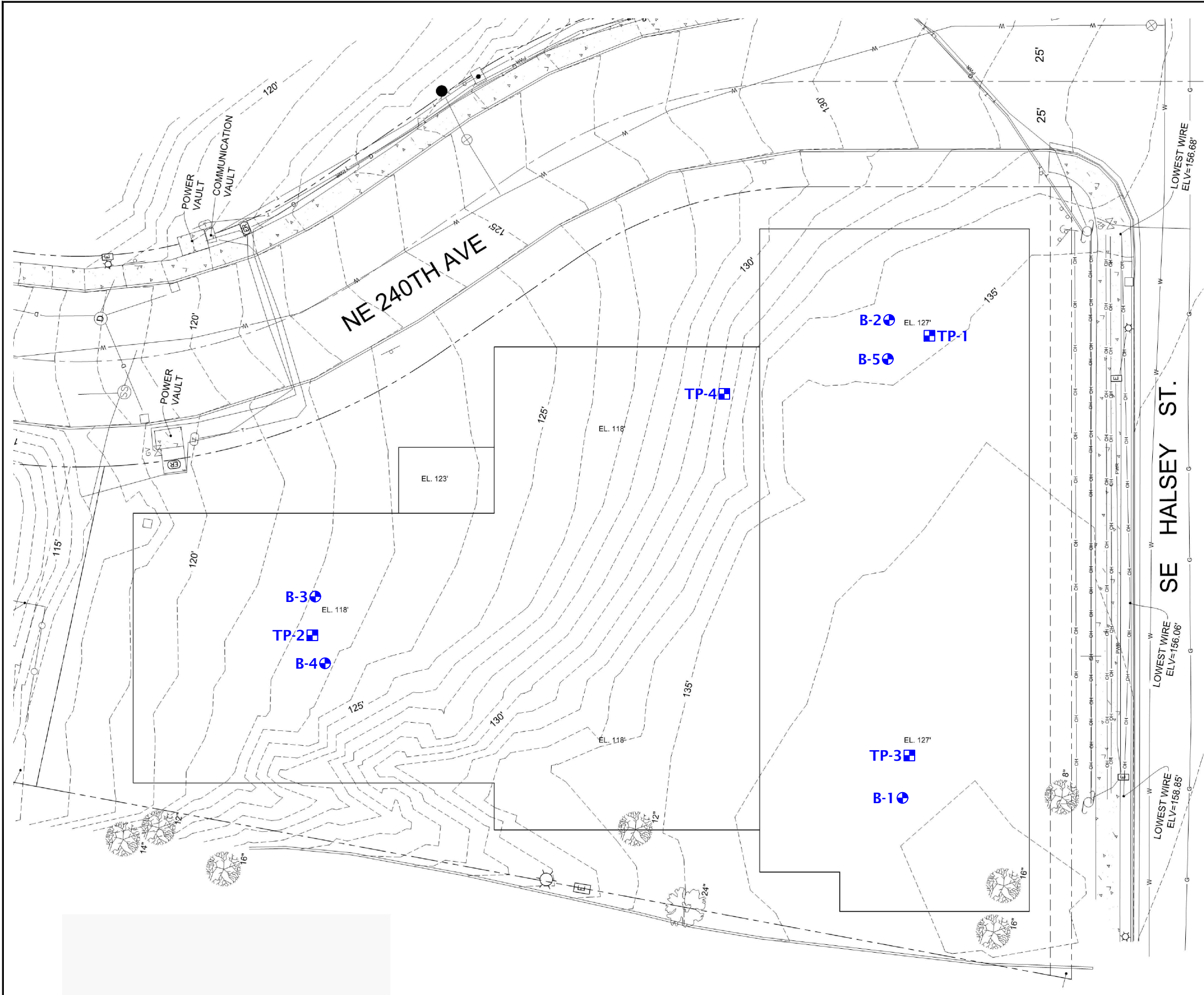
SEPTEMBER 2019

VICINITY MAP

VISTA VIEW APARTMENTS  
 WOOD VILLAGE, OR

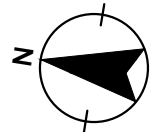
FIGURE 1





LEGEND:

- B-1 BORING
- TP-1 TEST PIT



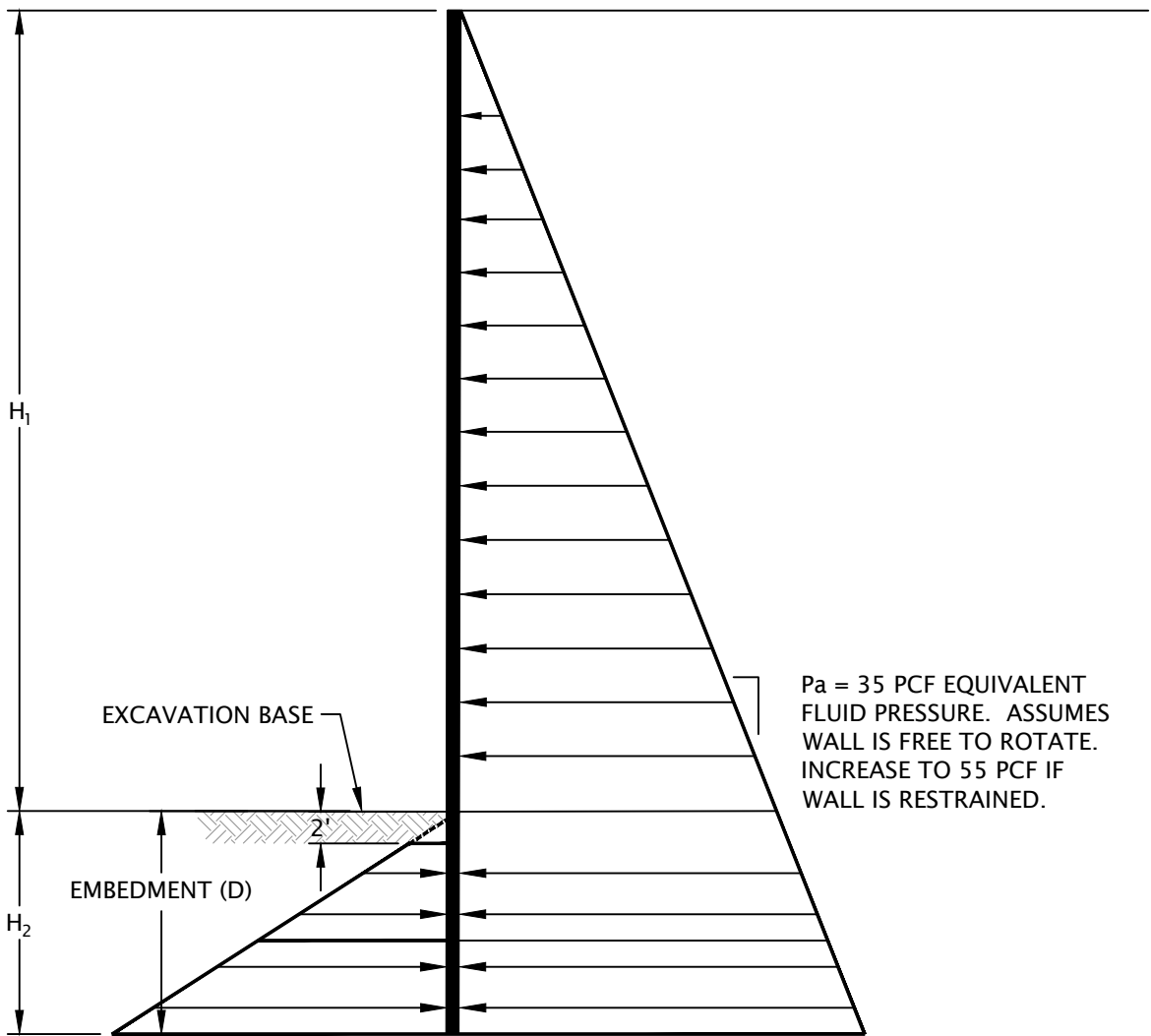
0 25 50  
(SCALE IN FEET)

SITE PLAN BASED ON IMAGE OF SHEET A109 SITE  
MASS GRADING DATED OCTOBER 25, 2018  
PREPARED BY DOUG CIRCOSTA, ARCHITECT

|                                                                                                                               |                |                                           |          |
|-------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------|----------|
| GEODESIGN <sup>INC.</sup><br>9450 SW Commerce Circle - Suite 300<br>Wilsonville OR 97070<br>503.968.8787 www.geodesigninc.com | FAIRWAY-1-01   | SITE PLAN                                 | FIGURE 2 |
|                                                                                                                               | SEPTEMBER 2019 | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |          |

Printed By: mmiller | Print Date: 9/5/2019 4:22:27 PM  
File Name: J:\E-L\Fairway\Fairway-1-01\Figures\CAD\Fairway-1-01-DET01.dwg | Layout: FIGURE 3

**RECOMMENDED DESIGN PARAMETERS FOR  
CANTILEVERED WALL**



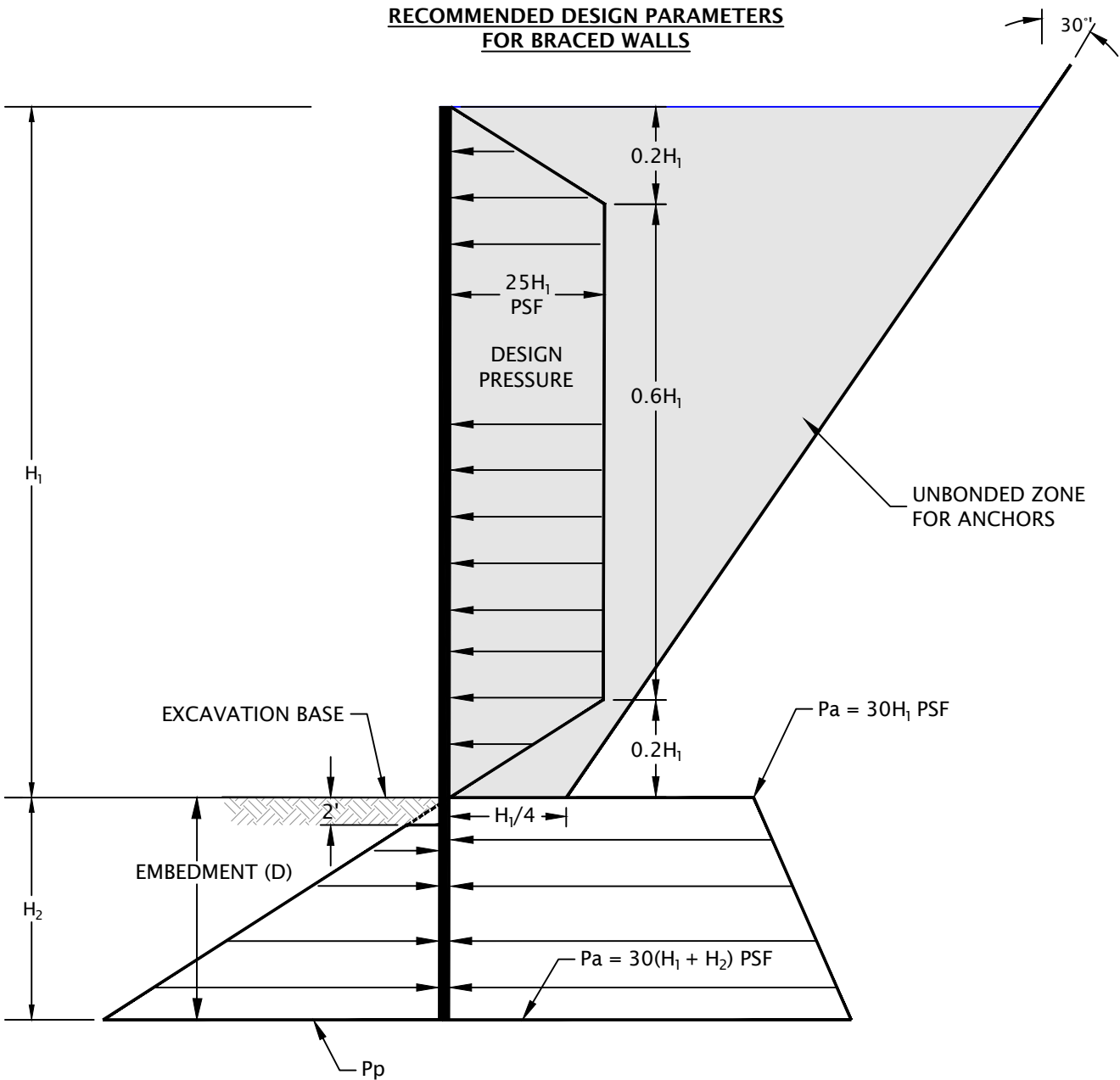
**EXPLANATION:**

$P_p = 450 H_2$  PCF  
 $H_1$  = HEIGHT OF EXPOSED SOLDIER PILE IN FEET  
PASSIVE PRESSURE ACTS OVER 3X THE PILE WIDTH.  
ACTIVE PRESSURE ACTS OVER 1X THE PILE WIDTH BELOW EXCAVATION BASE.

**NOTES:**

- FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
- LATERAL EARTH PRESSURE ASSUMES WATER WILL BE MAINTAINED BELOW THE BASE OF THE EXCAVATION.
- THE LATERAL EARTH PRESSURES ARE UNFACTORED.
- PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
- ASSUMES WALL IS EMBEDDED IN DENSE GRAVEL.
- ASSUMES RETAINED SOIL IS LEVEL.
- ASSUMES GROUNDWATER IS LOCATED A MINIMUM OF 3B BELOW EARTH RETENTION SYSTEM, WHERE B IS THE FOOTING WIDTH OR PILE DIAMETER.
- FIGURE SHOULD BE USED IN CONJUNCTION WITH REPORT TEXT.

**RECOMMENDED DESIGN PARAMETERS  
FOR BRACED WALLS**

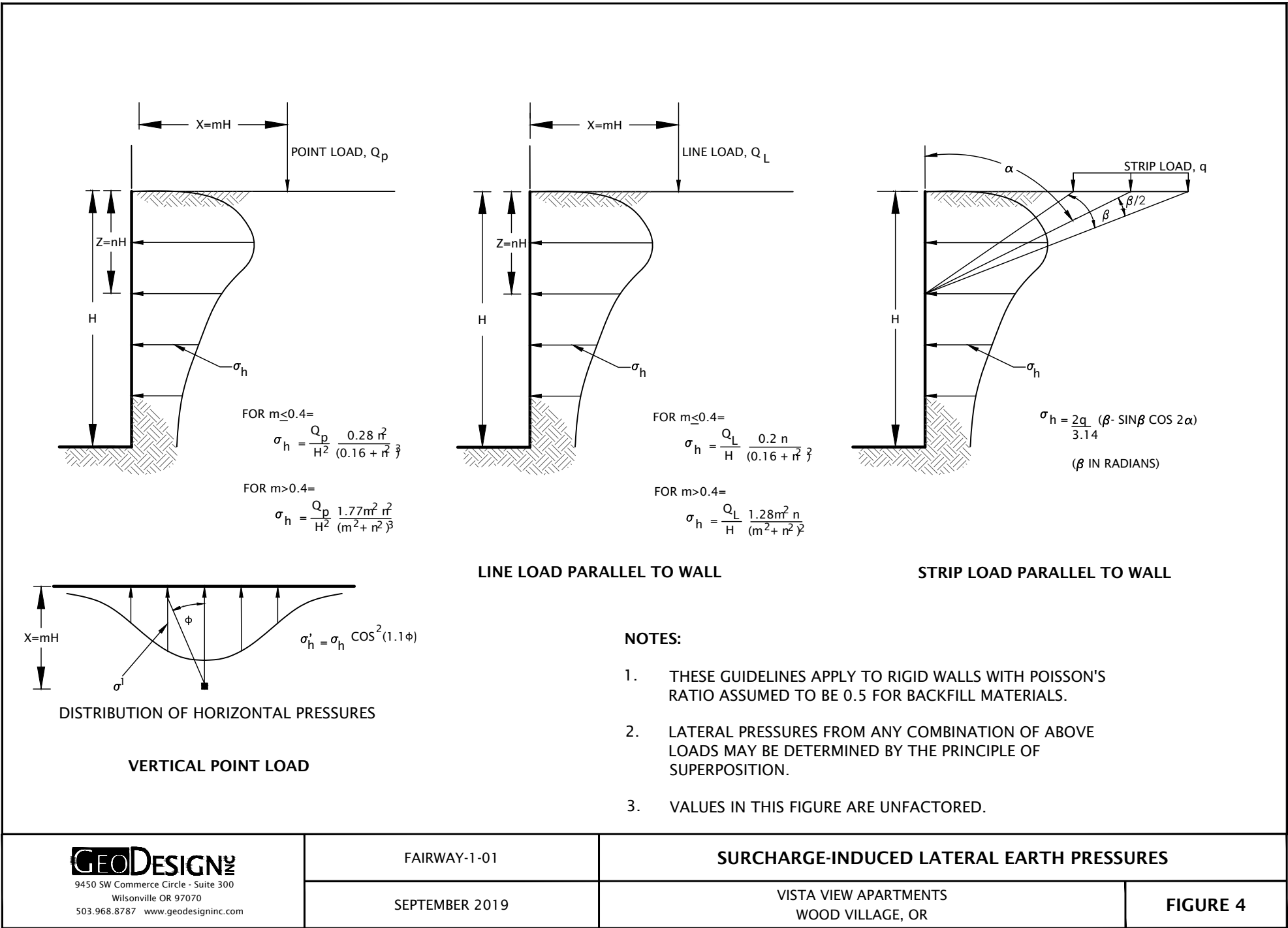


**EXPLANATION:**

$P_p = 450 H_2$  PCF GRAVEL (ABOVE GROUNDWATER)  
 $H_1$  = HEIGHT OF EXPOSED SOLDIER PILE IN FEET  
PASSIVE PRESSURE ACTS OVER 3X THE PILE WIDTH.  
ACTIVE PRESSURE ACTS OVER 1X THE PILE WIDTH BELOW THE EXCAVATION BASE.

**NOTES:**

- FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
- TIEBACKS SHOULD BE LOCKED OFF AT 100 PERCENT OF DESIGN LOAD.
- THE LATERAL EARTH PRESSURES ARE UNFACTORED.
- PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
- ASSUMES WALL IS EMBEDDED IN DENSE GRAVEL.
- ASSUMES RETAINED SOIL IS LEVEL.
- ASSUMES GROUNDWATER IS LOCATED A MINIMUM OF 3B BELOW EARTH RETENTION SYSTEM, WHERE B IS THE FOOTING WIDTH OR PILE DIAMETER.
- FIGURE SHOULD BE USED IN CONJUNCTION WITH REPORT TEXT.



## APPENDIX

## **APPENDIX**

### **FIELD EXPLORATIONS**

#### ***GENERAL***

We explored subsurface conditions at the site by drilling five borings (B-1 through B-5) to depths between 3 and 20.4 feet BGS and excavating four test pits (TP-1 through TP-4) to depths between 5 and 16 feet BGS. Figure 2 shows the approximate locations of our explorations. The borings were completed by Western States Soils Conservation, Inc. of Hubbard, Oregon, on July 22, 2019 using mud rotary drilling techniques. The test pits were completed by Dan J. Fischer Excavating Inc. of Forest Grove, Oregon, on August 1, 2019 using a trackhoe. The exploration logs are presented in this appendix.

The locations of the explorations were determined in the field by pacing from existing site features. This information should be considered accurate to the degree implied by the method used.

#### ***SOIL SAMPLING***

Samples were collected from the borings using 1½- and 3-inch-inside diameter split-spoon (SPT) samplers in general accordance with ASTM D1586. The split-spoon samplers were driven into the soil with a 140-pound hammer free-falling 30 inches. The samplers were driven a total distance of 18 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the exploration logs, unless otherwise noted. Grab samples were collected from the test pit walls and/or base using the backhoe bucket and bagged for transport to our laboratory. Sampler methods and intervals are shown on the exploration logs.

The average efficiency of the automatic SPT hammer used by Western States Soil Conservation, Inc. was 82.2 percent. The calibration testing results are presented at the end of this appendix.

#### ***SOIL CLASSIFICATION***

The soil samples were classified in the field in accordance with the “Exploration Key” (Table A-1) and “Soil Classification System” (Table A-2), which are presented in this appendix. The exploration logs indicate the depths at which the soil characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

### **LABORATORY TESTING**

#### ***CLASSIFICATION***

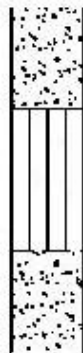
The soil samples were classified in the laboratory to confirm field classifications. The laboratory classifications are shown on the exploration logs if those classifications differed from the field classifications.

***MOISTURE CONTENT***

We determined the natural moisture content of select soil samples in general accordance with ASTM D2216. The natural moisture content is a ratio of the weight of the water to the dry weight of soil in a test sample expressed as a percentage. The test results are presented in this appendix.

***PARTICLE-SIZE ANALYSIS***

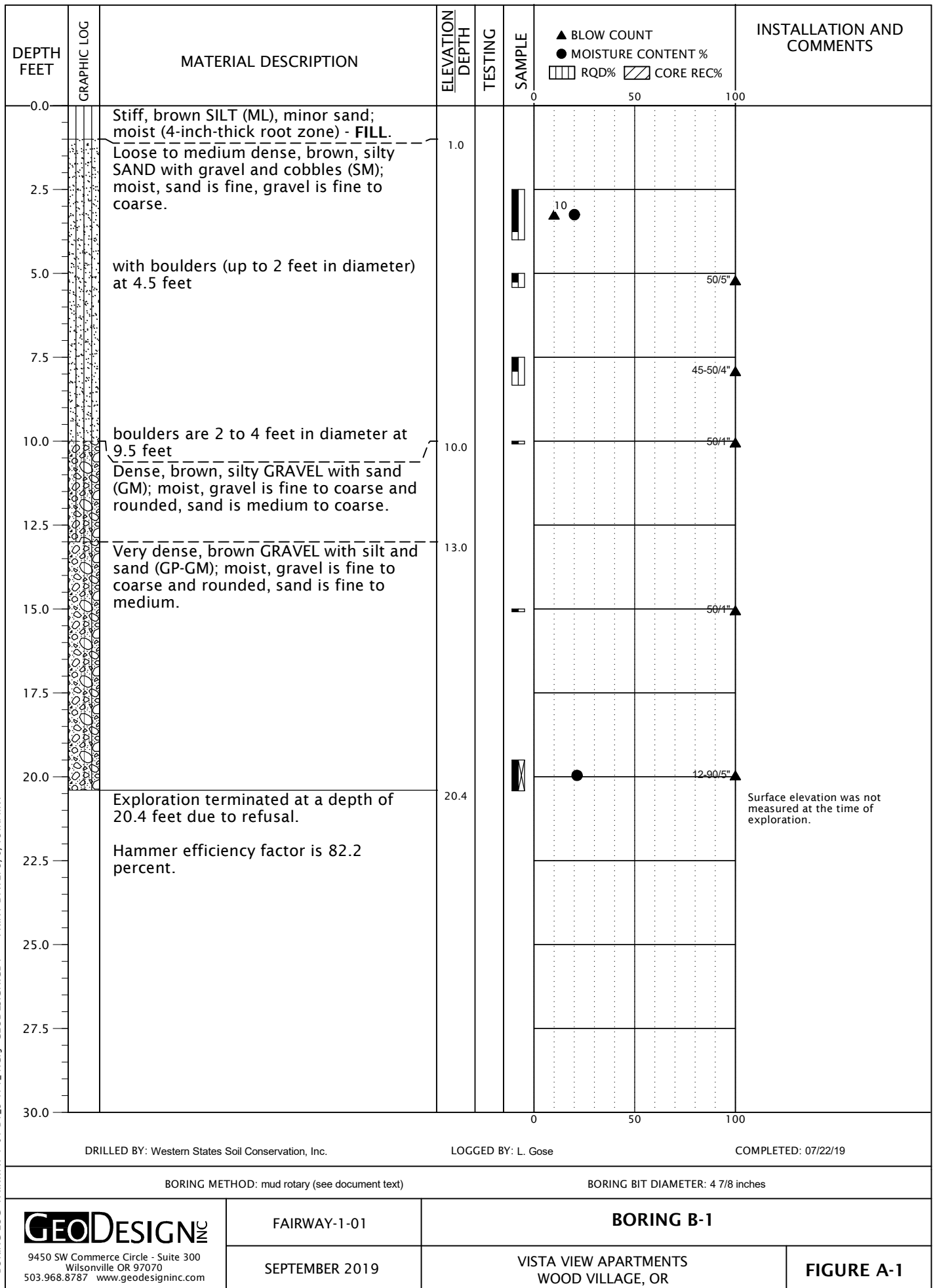
Particle-size analysis was performed on select soil samples to determine the distribution of soil particle sizes in general accordance with ASTM C117 and ASTM D1140. This test determines the weight of soil particles that pass the U.S. Standard No. 200 sieve expressed as a percentage of the dry weight of the sample. The test results are presented in this appendix.

| SYMBOL                                                                                                                                                                                  | SAMPLING DESCRIPTION                                                                                                              |                        |                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------|
|                                                                                                        | Location of sample collected in general accordance with ASTM D1586 using Standard Penetration Test with recovery                  |                        |                                             |
|                                                                                                        | Location of sample collected using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D1587 with recovery |                        |                                             |
|                                                                                                        | Location of sample collected using Dames & Moore sampler and 300-pound hammer or pushed with recovery                             |                        |                                             |
|                                                                                                        | Location of sample collected using Dames & Moore sampler and 140-pound hammer or pushed with recovery                             |                        |                                             |
|                                                                                                        | Location of sample collected using 3-inch-O.D. California split-spoon sampler and 140-pound hammer with recovery                  |                        |                                             |
|                                                                                                        | Location of grab sample                                                                                                           |                        |                                             |
|                                                                                                        | Rock coring interval                                                                                                              |                        |                                             |
|                                                                                                        | Water level during drilling                                                                                                       |                        |                                             |
|                                                                                                       | Water level taken on date shown                                                                                                   |                        |                                             |
| <div>Graphic Log of Soil and Rock Types</div>                                                         |                                                                                                                                   |                        |                                             |
| <b>GEOTECHNICAL TESTING EXPLANATIONS</b>                                                                                                                                                |                                                                                                                                   |                        |                                             |
| ATT                                                                                                                                                                                     | Atterberg Limits                                                                                                                  | P                      | Pushed Sample                               |
| CBR                                                                                                                                                                                     | California Bearing Ratio                                                                                                          | PP                     | Pocket Penetrometer                         |
| CON                                                                                                                                                                                     | Consolidation                                                                                                                     | P200                   | Percent Passing U.S. Standard No. 200 Sieve |
| DD                                                                                                                                                                                      | Dry Density                                                                                                                       |                        |                                             |
| DS                                                                                                                                                                                      | Direct Shear                                                                                                                      | RES                    | Resilient Modulus                           |
| HYD                                                                                                                                                                                     | Hydrometer Gradation                                                                                                              | SIEV                   | Sieve Gradation                             |
| MC                                                                                                                                                                                      | Moisture Content                                                                                                                  | TOR                    | Torvane                                     |
| MD                                                                                                                                                                                      | Moisture-Density Relationship                                                                                                     | UC                     | Unconfined Compressive Strength             |
| NP                                                                                                                                                                                      | Non-Plastic                                                                                                                       | VS                     | Vane Shear                                  |
| OC                                                                                                                                                                                      | Organic Content                                                                                                                   | kPa                    | Kilopascal                                  |
| <b>ENVIRONMENTAL TESTING EXPLANATIONS</b>                                                                                                                                               |                                                                                                                                   |                        |                                             |
| CA                                                                                                                                                                                      | Sample Submitted for Chemical Analysis                                                                                            | ND                     | Not Detected                                |
| P                                                                                                                                                                                       | Pushed Sample                                                                                                                     | NS                     | No Visible Sheen                            |
| PID                                                                                                                                                                                     | Photoionization Detector Headspace Analysis                                                                                       | SS                     | Slight Sheen                                |
|                                                                                                                                                                                         |                                                                                                                                   | MS                     | Moderate Sheen                              |
| ppm                                                                                                                                                                                     | Parts per Million                                                                                                                 | HS                     | Heavy Sheen                                 |
| <br>9450 SW Commerce Circle - Suite 300<br>Wilsonville OR 97070<br>503.968.8787 www.geodesigninc.com |                                                                                                                                   | <b>EXPLORATION KEY</b> |                                             |
|                                                                                                                                                                                         |                                                                                                                                   | <b>TABLE A-1</b>       |                                             |

| RELATIVE DENSITY - COARSE-GRAINED SOIL                                                                                                                                                  |                                                                          |                                                                                          |                                                              |                                       |           |                     |                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------|-----------|---------------------|---------------------|
| Relative Density                                                                                                                                                                        | Standard Penetration Resistance                                          | Dames & Moore Sampler (140-pound hammer)                                                 | Dames & Moore Sampler (300-pound hammer)                     |                                       |           |                     |                     |
| Very Loose                                                                                                                                                                              | 0 - 4                                                                    | 0 - 11                                                                                   | 0 - 4                                                        |                                       |           |                     |                     |
| Loose                                                                                                                                                                                   | 4 - 10                                                                   | 11 - 26                                                                                  | 4 - 10                                                       |                                       |           |                     |                     |
| Medium Dense                                                                                                                                                                            | 10 - 30                                                                  | 26 - 74                                                                                  | 10 - 30                                                      |                                       |           |                     |                     |
| Dense                                                                                                                                                                                   | 30 - 50                                                                  | 74 - 120                                                                                 | 30 - 47                                                      |                                       |           |                     |                     |
| Very Dense                                                                                                                                                                              | More than 50                                                             | More than 120                                                                            | More than 47                                                 |                                       |           |                     |                     |
| CONSISTENCY - FINE-GRAINED SOIL                                                                                                                                                         |                                                                          |                                                                                          |                                                              |                                       |           |                     |                     |
| Consistency                                                                                                                                                                             | Standard Penetration Resistance                                          | Dames & Moore Sampler (140-pound hammer)                                                 | Dames & Moore Sampler (300-pound hammer)                     | Unconfined Compressive Strength (tsf) |           |                     |                     |
| Very Soft                                                                                                                                                                               | Less than 2                                                              | Less than 3                                                                              | Less than 2                                                  | Less than 0.25                        |           |                     |                     |
| Soft                                                                                                                                                                                    | 2 - 4                                                                    | 3 - 6                                                                                    | 2 - 5                                                        | 0.25 - 0.50                           |           |                     |                     |
| Medium Stiff                                                                                                                                                                            | 4 - 8                                                                    | 6 - 12                                                                                   | 5 - 9                                                        | 0.50 - 1.0                            |           |                     |                     |
| Stiff                                                                                                                                                                                   | 8 - 15                                                                   | 12 - 25                                                                                  | 9 - 19                                                       | 1.0 - 2.0                             |           |                     |                     |
| Very Stiff                                                                                                                                                                              | 15 - 30                                                                  | 25 - 65                                                                                  | 19 - 31                                                      | 2.0 - 4.0                             |           |                     |                     |
| Hard                                                                                                                                                                                    | More than 30                                                             | More than 65                                                                             | More than 31                                                 | More than 4.0                         |           |                     |                     |
| PRIMARY SOIL DIVISIONS                                                                                                                                                                  |                                                                          |                                                                                          | GROUP SYMBOL                                                 | GROUP NAME                            |           |                     |                     |
| COARSE-GRAINED SOIL<br><br>(more than 50% retained on No. 200 sieve)                                                                                                                    | GRAVEL<br><br>(more than 50% of coarse fraction retained on No. 4 sieve) | CLEAN GRAVEL (< 5% fines)                                                                | GW or GP                                                     | GRAVEL                                |           |                     |                     |
|                                                                                                                                                                                         |                                                                          | GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)                                                 | GW-GM or GP-GM                                               | GRAVEL with silt                      |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | GW-GC or GP-GC                                               | GRAVEL with clay                      |           |                     |                     |
|                                                                                                                                                                                         |                                                                          | GRAVEL WITH FINES (> 12% fines)                                                          | GM                                                           | silty GRAVEL                          |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | GC                                                           | clayey GRAVEL                         |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | GC-GM                                                        | silty, clayey GRAVEL                  |           |                     |                     |
|                                                                                                                                                                                         | SAND<br><br>(50% or more of coarse fraction passing No. 4 sieve)         | CLEAN SAND (<5% fines)                                                                   | SW or SP                                                     | SAND                                  |           |                     |                     |
|                                                                                                                                                                                         |                                                                          | SAND WITH FINES (≥ 5% and ≤ 12% fines)                                                   | SW-SM or SP-SM                                               | SAND with silt                        |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | SW-SC or SP-SC                                               | SAND with clay                        |           |                     |                     |
|                                                                                                                                                                                         |                                                                          | SAND WITH FINES (> 12% fines)                                                            | SM                                                           | silty SAND                            |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | SC                                                           | clayey SAND                           |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | SC-SM                                                        | silty, clayey SAND                    |           |                     |                     |
|                                                                                                                                                                                         |                                                                          |                                                                                          | FINE-GRAINED SOIL<br><br>(50% or more passing No. 200 sieve) | Liquid limit less than 50             | ML        | SILT                |                     |
| CL                                                                                                                                                                                      |                                                                          | CLAY                                                                                     |                                                              |                                       |           |                     |                     |
| CL-ML                                                                                                                                                                                   | silty CLAY                                                               |                                                                                          |                                                              |                                       |           |                     |                     |
| OL                                                                                                                                                                                      | ORGANIC SILT or ORGANIC CLAY                                             |                                                                                          |                                                              |                                       |           |                     |                     |
| Liquid limit 50 or greater                                                                                                                                                              | MH                                                                       | SILT                                                                                     |                                                              |                                       |           |                     |                     |
|                                                                                                                                                                                         | CH                                                                       | CLAY                                                                                     |                                                              |                                       |           |                     |                     |
|                                                                                                                                                                                         | OH                                                                       | ORGANIC SILT or ORGANIC CLAY                                                             |                                                              |                                       |           |                     |                     |
|                                                                                                                                                                                         | HIGHLY ORGANIC SOIL                                                      |                                                                                          |                                                              | PT                                    | PEAT      |                     |                     |
| MOISTURE CLASSIFICATION                                                                                                                                                                 |                                                                          | ADDITIONAL CONSTITUENTS                                                                  |                                                              |                                       |           |                     |                     |
| Term                                                                                                                                                                                    | Field Test                                                               | Secondary granular components or other materials such as organics, man-made debris, etc. |                                                              |                                       |           |                     |                     |
|                                                                                                                                                                                         |                                                                          | Percent                                                                                  | Silt and Clay In:                                            |                                       | Percent   | Sand and Gravel In: |                     |
|                                                                                                                                                                                         | Fine-Grained Soil                                                        |                                                                                          | Coarse-Grained Soil                                          |                                       |           | Fine-Grained Soil   | Coarse-Grained Soil |
| dry                                                                                                                                                                                     | very low moisture, dry to touch                                          |                                                                                          |                                                              |                                       |           |                     |                     |
| moist                                                                                                                                                                                   | damp, without visible moisture                                           | < 5                                                                                      | trace                                                        | trace                                 | < 5       | trace               | trace               |
|                                                                                                                                                                                         |                                                                          | 5 - 12                                                                                   | minor                                                        | with                                  | 5 - 15    | minor               | minor               |
| wet                                                                                                                                                                                     | visible free water, usually saturated                                    | > 12                                                                                     | some                                                         | silty/clayey                          | 15 - 30   | with                | with                |
|                                                                                                                                                                                         |                                                                          |                                                                                          |                                                              |                                       | > 30      | sandy/gravelly      | Indicate %          |
| <br>9450 SW Commerce Circle - Suite 300<br>Wilsonville OR 97070<br>503.968.8787 www.geodesigninc.com |                                                                          | SOIL CLASSIFICATION SYSTEM                                                               |                                                              |                                       | TABLE A-2 |                     |                     |



BORING LOG FAIRWAY-1-01-B1\_5-TP1\_4.GPJ GEODESIGN.GDT PRINT DATE: 9/6/19 KM:KT



BORING LOG FAIRWAY-1-01-B1\_5-TP1\_4.GPJ GEODESIGN.GDT PRINT DATE: 9/6/19:KM:KT

| DEPTH<br>FEET                                                                                                            | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                     | ELEVATION<br>DEPTH                        | TESTING | SAMPLE | ▲ BLOW COUNT<br>● MOISTURE CONTENT %<br>RQD% CORE REC% | INSTALLATION AND<br>COMMENTS |
|--------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------|--------|--------------------------------------------------------|------------------------------|
| 0.0                                                                                                                      |             |                                                                                                                          |                                           |         | 0      | 0                                                      |                              |
| 1.0                                                                                                                      |             | Loose, light brown, silty SAND (SM), trace organics; dry to moist, sand is fine (4-inch-thick root zone) - <b>FILL</b> . | 1.0                                       |         |        |                                                        |                              |
| 2.5                                                                                                                      |             | Loose to medium dense, brown, silty SAND with gravel and boulders (SM); moist, sand is fine.                             |                                           |         |        |                                                        |                              |
| 4.1                                                                                                                      |             | Exploration terminated at a depth of 4.1 feet due to refusal on boulder.                                                 | 4.1                                       |         |        |                                                        |                              |
| 5.0                                                                                                                      |             | Hammer efficiency factor is 82.2 percent.                                                                                |                                           |         |        |                                                        |                              |
| 7.5                                                                                                                      |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 10.0                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 12.5                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 15.0                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 17.5                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 20.0                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 22.5                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 25.0                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 27.5                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| 30.0                                                                                                                     |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| DRILLED BY: Western States Soil Conservation, Inc.           LOGGED BY: L. Gose           COMPLETED: 07/22/19            |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| BORING METHOD: mud rotary (see document text)           BORING BIT DIAMETER: 4 7/8 inches                                |             |                                                                                                                          |                                           |         |        |                                                        |                              |
| <b>GEODESIGN INC</b><br>9450 SW Commerce Circle - Suite 300<br>Wilsonville OR 97070<br>503.968.8787 www.geodesigninc.com |             | FAIRWAY-1-01                                                                                                             | BORING B-2                                |         |        |                                                        |                              |
|                                                                                                                          |             | SEPTEMBER 2019                                                                                                           | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |         |        |                                                        | FIGURE A-2                   |

BORING LOG FAIRWAY-1-01-B1\_5-TP1\_4.GPJ GEODESIGN.GDT PRINT DATE: 9/6/19:KM:KT

| DEPTH FEET                                                                                                               | GRAPHIC LOG | MATERIAL DESCRIPTION                                                            | ELEVATION DEPTH                           | TESTING | SAMPLE | ▲ BLOW COUNT<br>● MOISTURE CONTENT %<br>RQD% CORE REC% | INSTALLATION AND COMMENTS |
|--------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------|-------------------------------------------|---------|--------|--------------------------------------------------------|---------------------------|
| 0.0                                                                                                                      |             | Medium stiff, brown SILT with sand (ML); moist (4-inch-thick root zone) - FILL. |                                           |         |        |                                                        |                           |
| 2.5                                                                                                                      |             | Medium dense, brown, silty SAND with boulders (SM); moist, sand is fine.        | 1.5                                       |         |        |                                                        |                           |
| 3.0                                                                                                                      |             | Exploration terminated at a depth of 3.0 feet due to refusal on boulder.        | 3.0                                       |         |        |                                                        |                           |
| 5.0                                                                                                                      |             | Hammer efficiency factor is 82.2 percent.                                       |                                           |         |        |                                                        |                           |
| 7.5                                                                                                                      |             |                                                                                 |                                           |         |        |                                                        |                           |
| 10.0                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 12.5                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 15.0                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 17.5                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 20.0                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 22.5                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 25.0                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 27.5                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| 30.0                                                                                                                     |             |                                                                                 |                                           |         |        |                                                        |                           |
| DRILLED BY: Western States Soil Conservation, Inc.           LOGGED BY: L. Gose           COMPLETED: 07/22/19            |             |                                                                                 |                                           |         |        |                                                        |                           |
| BORING METHOD: mud rotary (see document text)           BORING BIT DIAMETER: 4 7/8 inches                                |             |                                                                                 |                                           |         |        |                                                        |                           |
| <b>GEODESIGN INC</b><br>9450 SW Commerce Circle - Suite 300<br>Wilsonville OR 97070<br>503.968.8787 www.geodesigninc.com |             | FAIRWAY-1-01                                                                    | BORING B-3                                |         |        |                                                        |                           |
|                                                                                                                          |             | SEPTEMBER 2019                                                                  | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |         |        |                                                        | FIGURE A-3                |

BORING LOG FAIRWAY-1-01-B1\_5-TP1\_4.GPJ GEODESIGN.GDT PRINT DATE: 9/6/19 KM:KT

| DEPTH<br>FEET                                                                                                                                                                            | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                                                        | ELEVATION<br>DEPTH | TESTING                                   | SAMPLE                            | ▲ BLOW COUNT<br>● MOISTURE CONTENT %<br>RQD% CORE REC% |    | INSTALLATION AND<br>COMMENTS |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------|-----------------------------------|--------------------------------------------------------|----|------------------------------|
| 0.0                                                                                                                                                                                      |             |                                                                                                                                                             |                    |                                           |                                   | 0                                                      | 50 | 100                          |
| 2.5                                                                                                                                                                                      |             | Medium stiff, brown SILT with sand (ML); moist (4-inch-thick root zone) - FILL.<br>Medium dense, brown, silty SAND with boulders (SM); moist, sand is fine. | 1.5                |                                           |                                   |                                                        |    |                              |
| 3.1                                                                                                                                                                                      |             | Exploration terminated at a depth of 3.1 feet due to refusal on boulder.                                                                                    | 3.1                |                                           |                                   |                                                        |    |                              |
| 5.0                                                                                                                                                                                      |             | Hammer efficiency factor is 82.2 percent.                                                                                                                   |                    |                                           |                                   |                                                        |    |                              |
| 7.5                                                                                                                                                                                      |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 10.0                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 12.5                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 15.0                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 17.5                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 20.0                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 22.5                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 25.0                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 27.5                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| 30.0                                                                                                                                                                                     |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| DRILLED BY: Western States Soil Conservation, Inc. LOGGED BY: L. Gose COMPLETED: 07/22/19                                                                                                |             |                                                                                                                                                             |                    |                                           |                                   |                                                        |    |                              |
| BORING METHOD: mud rotary (see document text)                                                                                                                                            |             |                                                                                                                                                             |                    |                                           | BORING BIT DIAMETER: 4 7/8 inches |                                                        |    |                              |
| <br>9450 SW Commerce Circle - Suite 300<br>Wilsonville, OR 97070<br>503.968.8787 www.geodesigninc.com |             | FAIRWAY-1-01                                                                                                                                                |                    | BORING B-4                                |                                   |                                                        |    |                              |
|                                                                                                                                                                                          |             | SEPTEMBER 2019                                                                                                                                              |                    | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |                                   | FIGURE A-4                                             |    |                              |

BORING LOG FAIRWAY-1-01-B1\_5-TP1\_4.GPJ GEODESIGN.GDT PRINT DATE: 9/6/19:KM:KT

| DEPTH<br>FEET                                                                                                       | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                        | ELEVATION<br>DEPTH | TESTING             | SAMPLE | ▲ BLOW COUNT<br>● MOISTURE CONTENT %<br>RQD% CORE REC% |    |     | INSTALLATION AND<br>COMMENTS |
|---------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------|--------------------|---------------------|--------|--------------------------------------------------------|----|-----|------------------------------|
| 0.0                                                                                                                 |             |                                                                                                             |                    |                     |        | 0                                                      | 50 | 100 |                              |
| 1.0                                                                                                                 |             | Loose, brown, silty SAND (SM), trace organics; moist, sand is fine (4-inch-thick root zone) - <b>FILL</b> . | 1.0                |                     |        |                                                        |    |     |                              |
| 2.5                                                                                                                 |             | Loose to medium dense, brown, silty SAND with gravel and boulders (SM); moist, sand is fine.                |                    |                     |        |                                                        |    |     |                              |
| 4.1                                                                                                                 |             | Exploration terminated at a depth of 4.1 feet due to refusal on boulder.                                    | 4.1                |                     |        |                                                        |    |     |                              |
| 5.0                                                                                                                 |             | Hammer efficiency factor is 82.2 percent.                                                                   |                    |                     |        |                                                        |    |     |                              |
| 7.5                                                                                                                 |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 10.0                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 12.5                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 15.0                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 17.5                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 20.0                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 22.5                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 25.0                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 27.5                                                                                                                |             |                                                                                                             |                    |                     |        |                                                        |    |     |                              |
| 30.0                                                                                                                |             |                                                                                                             |                    |                     |        | 0                                                      | 50 | 100 |                              |
| DRILLED BY: Western States Soil Conservation, Inc.                                                                  |             | LOGGED BY: L. Gose                                                                                          |                    | COMPLETED: 07/22/19 |        |                                                        |    |     |                              |
| BORING METHOD: mud rotary (see document text)                                                                       |             | BORING BIT DIAMETER: 4 7/8 inches                                                                           |                    |                     |        |                                                        |    |     |                              |
| GEO DESIGN INC<br>9450 SW Commerce Circle - Suite 300<br>Wilsonville, OR 97070<br>503.968.8787 www.geodesigninc.com |             | FAIRWAY-1-01                                                                                                | BORING B-5         |                     |        |                                                        |    |     |                              |
| SEPTEMBER 2019                                                                                                      |             | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR                                                                   |                    |                     |        |                                                        |    |     | FIGURE A-5                   |

| DEPTH<br>FEET                                                                                                                       | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                                             | ELEVATION<br>DEPTH | TESTING                                   | SAMPLE | ● MOISTURE<br>CONTENT % | COMMENTS                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------|--------|-------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 0.0                                                                                                                                 |             |                                                                                                                                                  |                    |                                           |        | 050100                  |                                                                                                                              |
| 1.0                                                                                                                                 |             | Loose, brown, silty SAND (SM), trace organics; dry to moist, sand is fine (3-inch-thick root zone) - FILL.                                       |                    |                                           |        |                         |                                                                                                                              |
| 2.5                                                                                                                                 |             | Loose to medium dense, brown, silty SAND with gravel and boulders (SM); moist, sand is fine, boulders are approximately 3 to 4 feet in diameter. |                    | P200                                      | ☒      | ●                       | P200 = 32%<br><br>Concrete pipe at 3.0 feet.                                                                                 |
| 5.0                                                                                                                                 |             |                                                                                                                                                  |                    |                                           |        |                         | Minor caving observed at 5.0 feet.                                                                                           |
| 7.5                                                                                                                                 |             |                                                                                                                                                  |                    |                                           |        |                         |                                                                                                                              |
| 10.0                                                                                                                                |             | with cobbles at 10.0 feet                                                                                                                        |                    |                                           | ☒      |                         |                                                                                                                              |
| 11.0                                                                                                                                |             | Medium dense to dense, gray-brown, silty GRAVEL with sand (GM); wet, gravel is fine to coarse, sand is coarse.                                   |                    |                                           | ☒      | ●                       |                                                                                                                              |
| 12.5                                                                                                                                |             |                                                                                                                                                  |                    |                                           |        |                         |                                                                                                                              |
| 13.0                                                                                                                                |             | Dense, dark gray GRAVEL with silt, sand, and cobbles (GP-GM); wet, gravel is coarse, sand is coarse, weak to moderate cementation.               |                    |                                           | ☒      | ●                       |                                                                                                                              |
| 15.0                                                                                                                                |             |                                                                                                                                                  |                    |                                           |        |                         |                                                                                                                              |
| 16.0                                                                                                                                |             | Exploration terminated at a depth of 16.0 feet due to refusal on gravel.                                                                         |                    |                                           |        |                         | No groundwater seepage observed to the depth explored.<br><br>Surface elevation was not measured at the time of exploration. |
| 17.5                                                                                                                                |             |                                                                                                                                                  |                    |                                           |        |                         |                                                                                                                              |
| 20.0                                                                                                                                |             |                                                                                                                                                  |                    |                                           |        | 050100                  |                                                                                                                              |
| EXCAVATED BY: Dan J. Fischer Excavating, Inc.                                                                                       |             | LOGGED BY: Z. Rogers                                                                                                                             |                    | COMPLETED: 08/01/19                       |        |                         |                                                                                                                              |
| EXCAVATION METHOD: trackhoe (see document text)                                                                                     |             |                                                                                                                                                  |                    |                                           |        |                         |                                                                                                                              |
| <div>GEODESIGN</div> <div>9450 SW Commerce Circle - Suite 300<br/>Wilsonville, OR 97070<br/>503.968.8787 www.geodesigninc.com</div> |             | FAIRWAY-1-01                                                                                                                                     |                    | TEST PIT TP-1                             |        |                         |                                                                                                                              |
|                                                                                                                                     |             | SEPTEMBER 2019                                                                                                                                   |                    | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |        | FIGURE A-6              |                                                                                                                              |

| DEPTH<br>FEET | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                                             | ELEVATION<br>DEPTH | TESTING | SAMPLE | ● MOISTURE<br>CONTENT % | COMMENTS                                                                                                                     |
|---------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------|--------|-------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 0.0           |             | Medium stiff, brown SILT with sand (ML), trace organics (rootlets); moist, sand is fine (4-inch-thick root zone) - <b>FILL</b> .                 |                    | PP      |        |                         | PP = 0.75 tsf                                                                                                                |
| 1.5           |             | Loose to medium dense, brown, silty SAND with gravel and boulders (SM); moist, sand is fine, boulders are approximately 2 to 6 feet in diameter. | 1.5                |         |        |                         | Minor caving observed at 2.0 feet.                                                                                           |
| 2.5           |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |
| 5.0           |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |
| 7.5           |             | Dense, dark gray-brown, silty SAND with gravel and cobbles (SM); moist, sand is fine to medium, gravel is coarse.                                | 7.0                | P200    |        |                         | P200 = 28%                                                                                                                   |
| 9.0           |             | Dense, dark gray GRAVEL with silt and sand (GP-GM); moist, gravel is coarse, sand is coarse, weak to moderate cementation.                       | 9.0                |         |        |                         |                                                                                                                              |
| 10.0          |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |
| 12.5          |             | Exploration terminated at a depth of 12.5 feet due to refusal on gravel.                                                                         | 12.5               |         |        |                         | No groundwater seepage observed to the depth explored.<br><br>Surface elevation was not measured at the time of exploration. |
| 15.0          |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |
| 17.5          |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |
| 20.0          |             |                                                                                                                                                  |                    |         |        |                         |                                                                                                                              |

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: Z. Rogers

COMPLETED: 08/01/19

EXCAVATION METHOD: trackhoe (see document text)



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FAIRWAY-1-01

SEPTEMBER 2019

TEST PIT TP-2

VISTA VIEW APARTMENTS  
WOOD VILLAGE, OR

FIGURE A-7

| DEPTH<br>FEET                                                                                                                       | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                                                                                       | ELEVATION<br>DEPTH                        | TESTING             | SAMPLE | ● MOISTURE<br>CONTENT % | COMMENTS                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|--------|-------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 0.0                                                                                                                                 |             |                                                                                                                                                                                            |                                           |                     | 0      | 50                      | 100                                                                                                                          |
| 1.0                                                                                                                                 |             | Medium stiff, brown SILT with sand and gravel (ML), trace organics (rootlets); dry to moist, sand is medium, gravel is fine to coarse and rounded (4-inch-thick root zone) - <b>FILL</b> . |                                           |                     |        |                         |                                                                                                                              |
| 2.5                                                                                                                                 |             | Medium dense, brown, silty SAND with gravel, cobbles, and boulders (SM); moist, sand is fine, gravel is coarse, boulders are approximately 1 to 3 feet in diameter.                        |                                           |                     | ☒      | ●                       |                                                                                                                              |
| 5.0                                                                                                                                 |             | sand is fine to coarse, boulders are approximately 1 to 4 feet in diameter at 4.0 feet                                                                                                     |                                           |                     |        |                         |                                                                                                                              |
| 7.5                                                                                                                                 |             |                                                                                                                                                                                            |                                           |                     |        |                         | Minor to moderate caving observed at 7.0 feet.                                                                               |
| 10.0                                                                                                                                |             | Dense, brown, silty GRAVEL with sand, cobbles, and boulders (GM); moist, gravel is fine to coarse and rounded, sand is medium to coarse.                                                   | 10.0                                      |                     | ☒      |                         |                                                                                                                              |
| 12.5                                                                                                                                |             |                                                                                                                                                                                            |                                           |                     |        |                         |                                                                                                                              |
| 13.0                                                                                                                                |             | Dense, brown GRAVEL with silt and sand (GP-GM); moist to wet, gravel is fine to coarse and rounded, sand is medium to coarse.                                                              | 13.0                                      |                     | ☒      |                         |                                                                                                                              |
| 15.0                                                                                                                                |             | Exploration terminated at a depth of 15.0 feet due to refusal on gravel.                                                                                                                   | 15.0                                      |                     |        |                         | No groundwater seepage observed to the depth explored.<br><br>Surface elevation was not measured at the time of exploration. |
| 17.5                                                                                                                                |             |                                                                                                                                                                                            |                                           |                     |        |                         |                                                                                                                              |
| 20.0                                                                                                                                |             |                                                                                                                                                                                            |                                           |                     | 0      | 50                      | 100                                                                                                                          |
| EXCAVATED BY: Dan J. Fischer Excavating, Inc.                                                                                       |             | LOGGED BY: Z. Rogers                                                                                                                                                                       |                                           | COMPLETED: 08/01/19 |        |                         |                                                                                                                              |
| EXCAVATION METHOD: trackhoe (see document text)                                                                                     |             |                                                                                                                                                                                            |                                           |                     |        |                         |                                                                                                                              |
| <div>GEODESIGN</div> <div>9450 SW Commerce Circle - Suite 300<br/>Wilsonville, OR 97070<br/>503.968.8787 www.geodesigninc.com</div> |             | FAIRWAY-1-01                                                                                                                                                                               | TEST PIT TP-3                             |                     |        |                         |                                                                                                                              |
|                                                                                                                                     |             | SEPTEMBER 2019                                                                                                                                                                             | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |                     |        |                         | FIGURE A-8                                                                                                                   |



| DEPTH<br>FEET                                                                                                                                                                                                                                                                                                                                    | GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                                                                   | ELEVATION<br>DEPTH                        | TESTING | SAMPLE | ● MOISTURE<br>CONTENT % | COMMENTS                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------|--------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0.0                                                                                                                                                                                                                                                                                                                                              |             | Medium stiff, brown, sandy SILT with debris (ML); moist, sand is fine, debris consists of asphalt and metal (4-inch-thick root zone) - FILL.           |                                           |         |        | 050100                  |                                                                                                                                                                           |
| 2.5                                                                                                                                                                                                                                                                                                                                              |             | Medium dense, brown, silty SAND with gravel and boulders (SM); moist, gravel is rounded, sand is fine to medium, boulders are 2 to 4 feet in diameter. | 2.0                                       |         |        |                         | Buried asphalt concrete pavement at 2.0 feet.                                                                                                                             |
| 5.0                                                                                                                                                                                                                                                                                                                                              |             | Exploration completed at a depth of 5.0 feet.                                                                                                          | 5.0                                       |         |        |                         | No groundwater seepage observed to the depth explored.<br>No caving observed to the depth explored.<br><br>Surface elevation was not measured at the time of exploration. |
| 7.5                                                                                                                                                                                                                                                                                                                                              |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| 10.0                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| 12.5                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| 15.0                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| 17.5                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| 20.0                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                                        |                                           |         |        | 050100                  |                                                                                                                                                                           |
| EXCAVATED BY: Dan J. Fischer Excavating, Inc.                                                                                                                                                                                                                                                                                                    |             |                                                                                                                                                        | LOGGED BY: Z. Rogers                      |         |        | COMPLETED: 08/01/19     |                                                                                                                                                                           |
| EXCAVATION METHOD: trackhoe (see document text)                                                                                                                                                                                                                                                                                                  |             |                                                                                                                                                        |                                           |         |        |                         |                                                                                                                                                                           |
| <div><div><div><div><div><div><span></span></div><div><b>GEO</b></div></div><div><div><div><span></span></div><div><b>DESIGN</b></div></div><div><div><span></span></div><div><b>INC</b></div></div></div></div><div>9450 SW Commerce Circle - Suite 300<br/>Wilsonville, OR 97070<br/>503.968.8787 www.geodesigninc.com</div></div></div></div> |             | FAIRWAY-1-01                                                                                                                                           | TEST PIT TP-4                             |         |        |                         |                                                                                                                                                                           |
|                                                                                                                                                                                                                                                                                                                                                  |             | SEPTEMBER 2019                                                                                                                                         | VISTA VIEW APARTMENTS<br>WOOD VILLAGE, OR |         |        |                         | FIGURE A-9                                                                                                                                                                |

| SAMPLE INFORMATION    |                           |                     | MOISTURE<br>CONTENT<br>(PERCENT) | DRY<br>DENSITY<br>(PCF) | SIEVE               |                   |                   | ATTERBERG LIMITS |                  |                     |
|-----------------------|---------------------------|---------------------|----------------------------------|-------------------------|---------------------|-------------------|-------------------|------------------|------------------|---------------------|
| EXPLORATION<br>NUMBER | SAMPLE<br>DEPTH<br>(FEET) | ELEVATION<br>(FEET) |                                  |                         | GRAVEL<br>(PERCENT) | SAND<br>(PERCENT) | P200<br>(PERCENT) | LIQUID<br>LIMIT  | PLASTIC<br>LIMIT | PLASTICITY<br>INDEX |
| B-1                   | 2.5                       |                     | 20                               |                         |                     |                   |                   |                  |                  |                     |
| B-1                   | 19.5                      |                     | 21                               |                         |                     |                   |                   |                  |                  |                     |
| TP-1                  | 2.0                       |                     | 10                               |                         |                     |                   | 32                |                  |                  |                     |
| TP-1                  | 11.0                      |                     | 12                               |                         |                     |                   |                   |                  |                  |                     |
| TP-1                  | 13.0                      |                     | 7                                |                         |                     |                   |                   |                  |                  |                     |
| TP-2                  | 3.0                       |                     | 19                               |                         |                     |                   |                   |                  |                  |                     |
| TP-2                  | 7.0                       |                     | 14                               |                         |                     |                   | 28                |                  |                  |                     |
| TP-3                  | 3.0                       |                     | 8                                |                         |                     |                   |                   |                  |                  |                     |
| TP-4                  | 1.0                       |                     | 9                                |                         |                     |                   |                   |                  |                  |                     |



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FAIRWAY-1-01

SEPTEMBER 2019

## SUMMARY OF LABORATORY DATA

VISTA VIEW APARTMENTS  
WOOD VILLAGE, OR

FIGURE A-10

**Summary of SPT Test Results**

Project: WSSC-8-04, Test Date: 12/27/2018

EMX: Maximum Energy

|                                |                      |            |              | ETR: Energy Transfer Ratio - Rated |                     |
|--------------------------------|----------------------|------------|--------------|------------------------------------|---------------------|
| Start<br>Depth<br>ft           | Final<br>Depth<br>ft | N<br>Value | N60<br>Value | Average<br>EMX<br>ft-lb            | Average<br>ETR<br>% |
| 25.00                          | 26.50                | 0          | 0            | 0.00                               | 0.0                 |
| 30.00                          | 31.50                | 31         | 42           | 267.77                             | 76.5                |
| 35.00                          | 36.50                | 34         | 46           | 305.69                             | 87.3                |
| 40.00                          | 41.50                | 0          | 0            | 0.00                               | 0.0                 |
| <b>Overall Average Values:</b> |                      |            |              | 287.61                             | 82.2                |
| <b>Standard Deviation:</b>     |                      |            |              | 32.43                              | 9.3                 |
| <b>Overall Maximum Value:</b>  |                      |            |              | 387.60                             | 110.7               |
| <b>Overall Minimum Value:</b>  |                      |            |              | 234.46                             | 67.0                |

