Report of Geotechnical Engineering Services

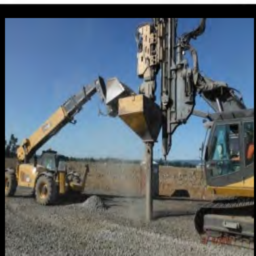
Manning Meadows Subdivision

La Center, Washington

January 16, 2025

Geotechnical ■ Environmental ■ Special Inspections

Columbia West
Engineering, Inc

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January 16, 2025

LGI Homes
12951 Bel-Red Road, Suite 150
Bellevue, WA 98005

Re: Report of Geotechnical Engineering Services
Manning Meadows Subdivision
1819 NE 339th Street
La Center, Washington
CWE Project: LGI-14-01-1

Columbia West Engineering, Inc. (Columbia West) is pleased to present this report of geotechnical engineering services for the proposed Manning Meadows Subdivision in La Center, Washington. Our services were conducted in accordance with our proposal dated November 27, 2024.

We appreciate the opportunity to work on the project. Please contact us if you have any questions regarding this report.

Sincerely,

Michael C. King, PE
Project Engineer

Shawn M. Dimke, PE
Principal Engineer

MICHAEL C. KING
STATE OF WASHINGTON
23022061
REGISTERED
PROFESSIONAL ENGINEER

Signed 01/16/2025

MCK:SMD:kat
Attachments
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EXECUTIVE SUMMARY

This section provides a summary of the geotechnical considerations associated with the proposed residential development in La Center, Washington. This summary is an overview and the report should be referenced for a thorough discussion of subsurface conditions and geotechnical recommendations for the project.

- The proposed lightly loaded residential structures can be supported by conventional spread footings bearing on firm soil as described in the report.
- The moisture content of the native soil at the time of exploration was considerably higher than the optimum moisture content required for compaction. Depending on the time of year, significant drying will likely be required before using the on-site clay and fine-grained soil as structural fill. Accordingly, the on-site clay and fine-grained soil can typically only be placed as structural fill during the dry summer months.
- The on-site soil will generally provide poor support for construction equipment during the wet construction season. Subgrade protection during construction will be important. Granular haul roads and working pads should be employed if earthwork occurs during the wet season or when the subgrade is wet of optimum moisture content.
- An approximately 12- to 18-inch-thick tilled zone was encountered at the site. Proper stripping operations will remove some of the tilled zones. The tilled zones not removed from cuts and site stripping will need to be removed or stabilized. Scarification and compaction of the tilled zones will likely not be possible, unless completed during the dry summer period. Removal and replacement of the tilled zones with granular material or cement amendment will be necessary if stabilization through moisture conditioning is not possible.
- Based on soil and groundwater conditions and the results of infiltration testing, on-site infiltration systems are not feasible at the site.
- Due to the sloping topography, predominantly clay subsurface soil, and perched groundwater encountered in our test pits, perimeter building foundation drains are recommended for all structures at the site.

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ABBREVIATIONS AND ACRONYMS

AC	asphalt concrete
AOS	apparent opening size
ASCE	American Society of Civil Engineers
ASTM	ASTM International
BGS	below ground surface
CSZ	Cascadia subduction zone
ESA	environmental site assessment
ESAL	equivalent single-axle load
g	gravitational acceleration (32.2 feet/second^2)
HMA	hot mix asphalt
H:V	horizontal to vertical
IBC	International Building Code
in/hr	inch(es) per hour
km	kilometers
MCE	maximum considered earthquake
M_W	moment magnitude
NRCS	Natural Resources Conservation Service
OSHA	Occupational Safety and Health Administration
pcf	pounds per cubic foot
pci	pounds per cubic inch
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSS	Washington Standard Specifications for Road, Bridge, and Municipal Construction (2024)
WWHM	Western Washington Hydrology Model

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
MANNING MEADOWS SUBDIVISION
LA CENTER, WASHINGTON

1.0 INTRODUCTION

Columbia West is pleased to submit this geotechnical engineering report for the proposed residential development in La Center, Washington. The approximately 9.83-acre site is located at 1819 NE 339th Street. The site is shown relative to surrounding physical features on Figure 1. Figure 2 shows the existing conditions at the site. Abbreviations and acronyms used herein are defined immediately following the Table of Contents.

The project includes the construction of approximately 100 residential lots. Improvements are also expected to consist of utility infrastructure, public and private AC-paved roadways, and stormwater management facilities. Grading plans were not finalized at the time of this report; however, based on the anticipated terraced-lot design, we expect cuts and fills to be on the order of 5 to 10 feet. We estimate that column and wall loads will not exceed 20 kips and 4 kips per lineal foot, respectively. Slab loads are not expected to exceed 100 psf.

2.0 BACKGROUND

Columbia West recently prepared a Phase I ESA for the site (Columbia West 2014). The site is currently partially developed with a single-family residence and associated outbuildings in the north portion of the site. The remainder of the site is undeveloped, and review of historical aerial photographs indicates the area was traditionally used for agricultural purposes. The Phase I ESA identified two septic systems and a decommissioned well at the site.

3.0 PURPOSE AND SCOPE

The purpose of our services was to provide geotechnical engineering recommendations for the proposed project. The specific scope of our services included the following:

- Reviewed information available in Columbia West's files for the site vicinity.
- Coordinated and managed the field exploration program, which included locating utilities, coordinating site access, and scheduling subcontractors and Columbia West's field staff.
- Conducted a subsurface exploration program that included the following:
  - Excavated nine test pits to depths between 14 and 15 feet BGS
- Collected geotechnical soil samples from the explorations and maintained a log of subsurface conditions encountered.
- Performed a laboratory testing program that consisted of the following tests:
  - Nineteen moisture content determinations in general accordance with ASTM D2216
  - Six particle-size analyses in general accordance with ASTM D1140
  - Two Atterberg limits tests in general accordance with ASTM D4318
  - One organic content test in general accordance with ASTM D2974

- Prepared this geotechnical engineering report that summarizes our explorations, laboratory testing, and analyses and provides geotechnical design criteria and construction recommendations for the proposed development, which includes the following:
  - Summary of subsurface conditions at the site
  - Recommendations for foundation support
  - Recommendations for floor slab subgrade preparation
  - Recommendations for retaining walls, including lateral earth pressures, backfill, compaction, and drainage
  - Recommendations for site preparation, including grading and drainage, stripping depths, fill type for imported material, compaction criteria, trench excavation and backfill, use of on-site soil, and wet/dry weather earthwork
  - Recommendations for managing groundwater conditions that may affect the performance of structures and site improvements
  - Recommendations for pavement design and construction
  - Seismic design coefficients in accordance with the 2021 IBC

4.0 SITE CONDITIONS

4.1 GEOLOGY

The site is located within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Puget Sound Lowland constitute highland areas, and depressed structural zones form sediment-filled basins. The site is located in the north portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

The near-surface geologic unit is mapped as Pleistocene- to Pliocene-aged, semi-consolidated, pebble- to cobble-sized sedimentary Conglomerate with sandy and silty facies (QTc).

The USDA NRCS Web Soil Survey identifies the surface soil as Gee silt loam. Although soil conditions may vary from the broad NRCS descriptions, Gee soils are generally fine textured with low permeability and low to moderate shear strength. Gee soils exhibit a slight erosion hazard based primarily on slope grade.

4.2 SURFACE CONDITIONS

The approximately 9.83-acre site is currently occupied with a residential structure and garage in the north portion. Apart from the residential structure, the site is generally open and grassy. Mature tree growth is present along the northwestern site boundary.

4.3 SUBSURFACE CONDITIONS

4.3.1 General

Subsurface conditions at the site were explored by excavating nine test pits (TP-1 through TP-9) to depths between 14 and 15 feet BGS. The exploration locations are shown on Figure 2. A description of our field explorations and the exploration logs are presented in Appendix A. A description of our laboratory testing program and the testing results are presented in Appendix B. A summary of the subsurface conditions is presented below.

4.3.2 Soil Conditions

4.3.2.1 Root Zone and Topsoil/Tilled Zone

The surficial layer of soil covering the majority of the site consists of grass roots and a tilled zone. The tilled zone is generally 12 to 18 inches thick and consists of clay with sand and trace organics. The tilled zone generally contains a 3- to 4-inch-thick root zone.

4.3.2.2 Alluvium

Alluvial clay and silt were encountered beneath the tilled zone and extend to the maximum depths explored, except for test pit TP-4. The clay and silt are medium stiff and generally exhibit low plasticity. Laboratory testing indicates the moisture content of the soil varied between 29 and 55 percent at the time exploration and fines contents ranging from 76 to 88 percent for the tested samples.

4.3.2.3 Gravel

Dense clayey gravel was observed below the surficial clay in test pit TP-4 at a depth of 13 feet BGS. The tested moisture content of the gravel was 6 percent at the time of exploration. The gravel observed is likely related to the mapped dense sedimentary Conglomerate member.

4.3.3 Groundwater

Perched groundwater was observed in most test pit explorations at depths between 2 and 12 feet BGS. The observed rate of seepage generally ranges from slow to moderate; however, rapid seepage was observed in test pit TP-2 at a depth of 10 feet BGS. Perched water is likely to be present in isolated, discontinuous zones below the ground surface and particularly where more permeable soil is present above lower permeable soil. Groundwater levels are often subject to seasonal variation and may rise during extended periods of increased precipitation.

4.4 INFILTRATION TESTING

Infiltration testing was completed in two of the test pits to assist in the evaluation of stormwater management facilities for the project. The infiltration testing was conducted in general accordance with the recommendations for the encased falling head method per the *Clark County Stormwater Manual* (Clark County 2021). Table 1 summarizes our infiltration testing results and fines content determinations. The exploration logs and the laboratory testing results are presented in Appendices A and B, respectively.

Table 1. Infiltration Testing Results

Location	Depth (feet BGS)	Soil Type	Fines Content[1] (percent)	Coefficient of Permeability, k (in/hr)
TP-1	2	CLAY	82	Negligible
TP-1	5	CLAY	84	Negligible
TP-2	2	CLAY	81	Negligible
TP-2	5	CLAY	76	Negligible

1. Fines content: percent passing U.S. Standard No. 200 sieve

As indicated in Table 1, near-surface infiltration rates were negligible in the tested locations. Based on review of Table 7-2 of the USDA hydrologic soil group criteria (USDA 2009), Appendix 2-A of the 2021 *Clark County Stormwater Manual*, and the *Clark County WWHM Soil Groupings* memorandum (Otak, Inc. 2010), the near-surface native soil meets the classification criteria for WWHM Soil Group 4. Based on the near-surface soil at the site and the results of testing, on-site infiltration systems are not feasible.

4.5 SEISMIC HAZARDS

4.5.1 Seismic Setting

4.5.1.1 Earthquake Sources

Three scenario earthquakes were considered for this study consistent with the local seismic setting. Two of the possible earthquake sources are associated with the CSZ, and the third event is a shallow, local crustal earthquake that could occur in the North American Plate. The three earthquake scenarios are discussed below.

4.5.1.2 Regional Events

The CSZ is the region where the Juan de Fuca Plate is being subducted beneath the North American Plate. This subduction is occurring in the coastal region between Vancouver Island and northern California. Evidence has accumulated suggesting that this subduction zone has generated eight great earthquakes in the last 4,000 years, with the most recent event occurring approximately 300 years ago (Weaver and Shedlock 1991). The fault trace is mapped approximately 50 to 120 km off the Washington Coast.

Two types of subduction zone earthquakes are possible and considered in this study:

1. An interface event earthquake on the seismogenic part of the interface between the Juan de Fuca Plate and the North American Plate on the CSZ. This source is capable of generating earthquakes with a M_W of 9.0+.
2. A deep intraplate earthquake on the seismogenic part of the subducting Juan de Fuca Plate. These events typically occur at depths of between 30 and 60 km. This source is capable of generating an event with a M_W of up to 8.0.

4.5.1.3 Local Events

A significant earthquake could occur on a local fault near the site within the design life of the development. Such an event would cause ground shaking at the site that could be more intense than the CSZ events, although the duration would be shorter. Table 2 provides information on local faults close to the site.

Table 2. Nearest Mapped Crustal Faults

Source	Closest Mapped Distance[1] (km)	Mapped Length[1] (km)
Lacamas Lake fault	23	24
Portland Hills fault	28	49

1. Based on mapping by USGS (2018)

4.5.2 Seismic Settlement

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles. Granular soil, which relies on interparticle friction for strength, undergoes a loss of strength until the excess pore pressures dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Silty soil with low plasticity can be susceptible to strain softening under relatively higher levels of ground shaking. Strain-softened soil has volumetric strains much smaller than liquefiable soil due to matrix effects. Based on the results of our subsurface explorations and review of groundwater mapping, liquefaction is not considered a hazard at the site.

4.5.3 Lateral Spreading

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. Liquefied soil adjacent to an open face can flow toward the open face, resulting in lateral ground displacement. Due to the low risk for liquefaction potential at the site, lateral spreading is not considered a hazard at the site.

5.0 DESIGN

Based on our subsurface explorations, laboratory testing, and analysis, the proposed development is generally compatible with the surface and subsurface soil, provided the recommendations presented in this report are incorporated into design and implemented during construction.

5.1 SHALLOW FOUNDATION SUPPORT

Based on the foundation loads in Section 1.0 (Introduction), the proposed buildings can be supported by conventional spread footings bearing on firm, native soil or engineered structural fill underlain by firm, native soil.

Foundations should not be supported by topsoil/buried topsoil or undocumented fill material. If encountered, these materials should be removed and replaced with structural fill/granular pads. If footings are constructed during wet weather conditions or when the footing subgrade soil is above its optimum moisture content, we recommend placing and compacting a thin layer of crushed rock (typically 2 to 4 inches) meeting the requirements for imported granular material described in Section 6.6.1 (Structural Fill) over the exposed subgrade soil.

5.1.1 Dimensions and Capacity

Continuous perimeter wall and isolated spread footings should have minimum widths of 16 and 20 inches, respectively. The bases of exterior footings should bear at least 18 inches below the lowest adjacent exterior grade. The bases of interior footings should bear at least 12 inches below the base of the floor slab.

Footings bearing on subgrade prepared as recommended above should be sized based on an allowable bearing pressure of 2,000 psf. As the allowable bearing pressure is a net bearing pressure, the weight of the footing and associated backfill may be ignored when calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and is typically increased by one-third for transient lateral forces such as seismic or wind.

5.1.2 Static Settlement

Foundation settlement tolerances should be provided to the design-build contractor who will design the ground improvement to meet the project requirements. Foundation static settlement tolerances for most structures is 1 inch of total settlement and 0.5 inch of differential settlement between similarly loads footings.

5.1.3 Resistance to Sliding

Lateral foundation loads can be resisted by passive earth pressure on the sides of footings and by friction at the bases of footings. Our analysis indicates the available passive earth pressure for footings confined by native soil or engineered structural fill is 325 pcf. Typically, the movement required to develop the available passive resistance may be relatively large; therefore, we recommend using a reduced passive equivalent fluid pressure of 250 pcf. The upper 12 inches of soil should be neglected when calculating passive pressure resistance. The recommended passive pressure resistance assumes that a minimum horizontal clearance of 10 feet is maintained between the footing face and adjacent down-gradient slopes and that groundwater remains below the bases of the footings.

The estimated unfactored coefficient of friction between in-situ native soil or engineered structural fill and in-place poured concrete is 0.35. The estimated unfactored coefficient of friction between compacted crushed aggregate and in-place poured concrete is 0.45.

5.1.4 Subgrade Observation

Footing and floor subgrade soil should be evaluated by Columbia West prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report. Subgrade observation should confirm that all disturbed material, organic material, unsuitable fill, remnant topsoil zones, and softened subgrade (if present) have been removed. Over excavation of footing subgrade soil may be required to remove deleterious material, particularly if footings are constructed during wet weather conditions. Footing excavations should be backfilled with compacted granular pads.

5.1.5 Floor Slabs

Floor slabs can be supported on firm, competent, native soil or engineered structural fill underlain by firm, native soil prepared as described in this report. Disturbed soil and unsuitable fill in proposed slab locations, if encountered, should be removed and replaced with structural fill.

To reduce slab shifting and moisture transmission, slabs should be underlain by at least 6 inches of compacted crushed aggregate. Geotextile may be used below the crushed aggregate layer to increase subgrade support. Recommendations for floor slab aggregate base and subgrade geotextile are discussed in Section 6.6 (Materials).

Slab thickness and reinforcement should be designed by an experienced structural engineer in accordance with anticipated loads. Concrete floor slabs with maximum loads of 100 psf may be designed assuming a modulus of subgrade reaction, k, of 150 pci for slabs-on-grade constructed on subgrade prepared as recommended in this report.

Flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives. Many flooring manufacturers will warrant their product only if a vapor barrier is installed according to their recommendations. Selection and design of an appropriate vapor barrier, if needed, should be based on discussions among members of the design team.

5.2 SEISMIC DESIGN CRITERIA

Seismic design for the proposed structures is governed by ASCE 7-16. Based on review of geologic mapping and the results of our subsurface explorations, seismic design parameters for Site Class D are presented for the site in Table 3.

Table 3. ASCE 7-16 Seismic Design Parameters

Parameter	Short Period (T_s)	1 Second Period (T_1)
MCE spectral response acceleration, S	S_S = 0.798 g	S_1 = 0.375 g
Site class	D	
Site coefficient, F	F_a = 1.2	F_v = 1.975
Adjusted spectral response acceleration, S_M	S_{MS} = 0.957 g	S_{M1} = 0.741 g
Design spectral response acceleration, S_D	S_{DS} = 0.638 g	S_{D1} = 0.496 g

ASCE 7-16 Section 11.4.8 requires a site-specific seismic hazard evaluation in accordance with Section 21.2 for structures on Site Class D sites with S_1 greater than or equal to 0.2 g (S_1 at the site is 0.375 g). Exception 2 of ASCE 7-16 Section 11.4.8 indicates a site-specific seismic hazard evaluation is not required for structures on Site Class D sites with S_1 greater to or equal 0.2 g, provided the value of the seismic response coefficient C_S is determined by Eq. (12.8-2) for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \geq T > 1.5T_s$ or Eq. (12.8-4) for $T > T_L$. We anticipate the buildings will meet these requirements, but if Exception 2 is not applicable, a site-specific seismic hazard evaluation will be required. Columbia West recommends the project structural engineer evaluate these requirements and exceptions to determine if the parameters for Site Class D provided in Table 3 can be used for design or if a site-specific seismic hazard evaluation is required.

5.3 PERMANENT SLOPES

Permanent cut and fill slopes should not exceed 2H:1V. Slopes that will be maintained by mowing and slopes that will be below the potential inundation depth for stormwater detention ponds should not be constructed steeper than 3H:1V. Access roads and pavement should be located at least 5 feet from the top of cut and fill slopes. The horizontal setback should be increased to 10 feet for foundations. A minimum slope setback detail for structures is presented on Figure 3.

The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the slope face.

5.4 RETAINING STRUCTURES

5.4.1 General

Retaining walls may be constructed at the site. Our retaining wall design recommendations are based on the following assumptions: (1) the walls consist of conventional, cantilevered retaining walls, (2) the walls are less than 10 feet in height, (3) the backfill is drained, and (4) the retained soil has a slope flatter than 4H:1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

5.4.2 Wall Design Parameters

Lateral earth pressures should be considered during design of retaining walls and below-grade structures. Hydrostatic pressure and additional surcharge loading should also be considered. Wall foundation construction and bearing capacity should adhere to specifications provided in Section 5.1 (Shallow Foundation Support).

Permanent retaining walls that are not restrained from rotation should be designed for active earth pressures using an equivalent fluid pressure of 35 pcf. Walls that are restrained from rotation should be designed for an at-rest equivalent fluid pressure of 55 pcf. Additional lateral earth pressures caused by surcharge loads (i.e., loads from construction, traffic, and adjacent structures) should be calculated based on the equations presented on Figure 4.

Provided the walls can yield a small amount from seismic loading, a superimposed seismic lateral force should be calculated based on a dynamic force of $7H^2$ pounds per lineal foot of wall, where H is the height of the wall in feet. The force should be applied as a uniformly distributed load with the resultant located at 0.5H from the base of the wall.

5.4.3 Backfill and Drainage

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

A minimum 6-inch-diameter, perforated collector pipe should be placed at the bases of the walls. The pipe should be embedded in a minimum 2-foot-wide zone of angular drain rock that is wrapped in a drainage geotextile fabric and extends up the back of the wall to within 1 foot of the finished grade. The drain rock and drainage geotextile fabric should meet specifications provided in Section 6.6 (Materials). The perforated collector pipes should discharge at an appropriate location away from the base of the wall. The discharge pipes should not be tied directly into stormwater drain systems, unless measures are taken to prevent backflow into the drainage system of the wall.

Backfill placed behind the walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of retaining wall select backfill placed and compacted in conformance with Section 6.6.1 (Structural Fill).

Settlement of up to 1 percent of the wall height commonly occurs immediately adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of flatwork 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.

5.5 DRAINAGE

5.5.1 Temporary

During work 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 site, the contractor should keep all pads and subgrade free of ponding water.

5.5.2 Surface

The ground surface at finished pads should be sloped away from their edges at a minimum 2 percent gradient for a distance of at least 5 feet. Roof drainage from buildings should be directed into solid, smooth-walled drainage pipes that carry the collected water to the storm drain system.

5.5.3 Foundation Drains

Due to the sloping topography and subsurface conditions, perimeter building foundation drains are recommended for all structures at the site. Foundation drains are not necessary on the down-slope side of buildings constructed on slopes. Foundation drains should consist of a filter fabric-wrapped, drain rock-filled trench that extends at least 12 inches below the lowest adjacent grade (i.e., slab subgrade elevation). A perforated pipe should be placed at the base to collect water that gathers in the drain rock. The drain rock and filter fabric should meet specifications outlined in Section 6.6 (Materials). Discharge for footing drains should not be tied directly into the stormwater drainage system, unless mechanisms are installed to prevent backflow.

5.6 PAVEMENT

5.6.1 General

We recommend that public roadways for the subdivision be constructed in accordance with City of La Center standards. We have provided pavement sections for private automobile-only parking and drive aisles that will also service heavy vehicle traffic (i.e., garbage trucks, semi-trucks, etc.). Our pavement recommendations are based on the following design parameters and assumptions:

- The subgrade consists of firm, undisturbed, native soil or a minimum of 12 inches of subgrade soil directly below the pavement sections are compacted to at least 92 percent of maximum dry density, as determined by ASTM D1557.
- Resilient moduli for subgrade soil and aggregate base materials were assumed to be 4,000 psi and 20,000 psi, respectively.
- Pavement design life of 20 years with no expected traffic growth.
- Initial and terminal serviceability indices of 4.2 and 2.0, respectively.
- Structural coefficients of 0.42 and 0.10 for the AC and aggregate base, respectively.
- Reliability of 75 percent and standard deviation of 0.45.

- Truck traffic consists of two- and three-axle vehicles, such as delivery trucks.
- Pavement may be exposed to a fire apparatus load of 75,000 pounds on an infrequent basis.

If any of these assumptions are incorrect, Columbia West should be contacted with the appropriate information so that the pavement designs can be revised.

5.6.2 AC Pavement Design Sections

Based on the traffic assumptions stated above, we recommend the AC pavement sections presented in Table 4. Material properties and compaction recommendations for AC and aggregate base are presented in Section 6.6 (Materials).

Table 4. Recommended AC Pavement Sections Constructed over Native Soil or Engineered Fill

Traffic	ESALs	AC Thickness (inches)	Aggregate Base Thickness[1] (inches)
Drive aisles with limited trucks (up to five trucks per day)	25,000	3	9*
Automobile parking (no trucks)	5,000	2.5	8*

1. Aggregate base thickness can be decreased to 4 inches if the subgrade is cement amended to a minimum depth of 12 inches with a minimum unconfined compressive strength of 100 psi.

5.6.3 Construction Considerations

Recommended pavement section thicknesses are intended to be minimum acceptable values and do not include construction traffic loading. The recommendations assume that pavement construction will be completed during an extended period of warm, dry weather. Wet weather construction may require an increased thickness of aggregate base as discussed in Section 6.2 (Construction Traffic and Staging). Construction traffic should be limited to dedicated haul roads or non-structural, unpaved portions of the site. Construction traffic should not be permitted on new pavement, unless accounted for in the pavement design section.

6.0 CONSTRUCTION

6.1 SITE PREPARATION

6.1.1 General

Site grading should be performed in accordance with the requirements specified in the 2021 IBC, Chapter 18 and Appendix J, with exceptions noted in this report. Site preparation should be observed and documented by Columbia West.

6.1.2 Demolition

Where required, demolition includes removal of structural features that may be at the site. Abandoned foundations and utilities, if present, will need to be removed and the resulting excavations backfilled. Utility lines should be completely removed or, with prior approval, grouted full if left in place. Excavations left from demolition and removal of existing structures should be backfilled with compacted structural fill in accordance with the recommendations in Section 6.6.1 (Structural Fill).

6.1.3 Stripping and Grubbing

Where encountered, existing root zones should be stripped and removed from all areas to receive new structural improvements. Based on our explorations, the average depth of stripping will be approximately 4 inches for most of the site. Increased stripping depths may be anticipated in areas with thicker vegetation and shrubs. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported offsite for disposal or used in landscaped areas.

6.1.4 Tilled Zone

An approximately 12- to 18-inch-thick tilled zone was observed throughout the site. Tilled zones typically have lower densities and contain slightly higher organic contents. The tilled zone generally exhibits low strength and does not provide adequate subgrade support for foundation elements or pavement. We recommend improving the tilled zone during site preparation where it will not be removed by site cuts.

In all structural fill, pavement, and improvement areas, the soil in tilled zones should be removed and replaced with structural fill or scarified and compacted in place. Scarification and compaction of the subgrade may be the most economical option for subgrade improvement; however, it will likely only be possible during extended dry periods and following moisture conditioning of the soil. As discussed further on in this report, cement amendment is an option for conditioning the soil for use as structural fill during periods of wet weather or when drying the soil is not an option.

6.1.5 Test Pit Locations

The test pit excavations were backfilled using the relatively minimal compactive effort of the excavator bucket. Soft spots can be expected at these locations. We recommend this relatively uncompacted soil be removed from the test pits to a depth of 3 feet below finished subgrade. 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.

6.1.6 Subgrade Evaluation

Upon completion of stripping and prior to the placement of structural fill or pavement improvements, exposed subgrade soil should be evaluated by proof rolling with a fully loaded dump truck or similar heavy, rubber-tired construction equipment. When the subgrade is too wet for proof rolling or access with a truck is not possible, a foundation probe may be used to identify areas of soft, loose, or unsuitable soil. Columbia West should perform subgrade evaluation. If soft or yielding subgrade areas are identified during evaluation, we recommend the subgrade be over excavated and backfilled with compacted imported granular fill.

6.2 CONSTRUCTION TRAFFIC AND STAGING

The near-surface fine-grained soil may be disturbed during construction. If not carefully executed, site preparation, utility trench work, and roadway excavation can create extensive soft areas and significant repair costs can result. Earthwork planning, regardless of the time of year, should include considerations for minimizing subgrade disturbance.

If construction occurs during or extends into the wet season or if the moisture content of the surficial soil is more than a couple percentage points above optimum, site stripping and cutting may need to be accomplished using track-mounted equipment. Likewise, the use of granular haul roads and staging areas will be necessary for support of construction traffic during the rainy season or when the moisture content of the surficial soil is more than a few percentage points above optimum.

The aggregate base thickness for pavement areas is intended to support post-construction design traffic loads and is not designed to support construction traffic. Moreover, if construction is planned for periods when the subgrade soil is wet, staging and haul roads with increased thicknesses of aggregate base will be required. The amount of staging and haul road areas, as well as the required thickness of granular material, will vary with the contractor's sequencing of a project and type/frequency of construction equipment and should, therefore, be the responsibility of the contractor. Based on our experience, between 12 and 18 inches of imported granular material are generally required in staging areas and between 18 and 24 inches in haul road areas. The contractor should also be responsible for selecting the type of material for construction of haul roads and staging areas. A geotextile fabric can be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic to help prevent silt migration into the aggregate base. The imported granular material, stabilization material, and geotextile fabric should meet the specifications in Section 6.6 (Materials).

Project stakeholders should understand that wet weather construction is risky and costly. Proper construction methods and techniques are critical to overall project integrity and should be observed and documented by Columbia West.

6.3 SLOPE CONSTRUCTION AND DRAINAGE

Fill slopes should consist of structural fill material as discussed in Section 6.6.1 (Structural Fill). Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes with grades of 3H:1V or steeper should also be overbuilt by at least 3 feet and cut back to finish grade. A typical fill slope cross section is shown on Figure 5. Drainage implementations, including subdrains or perforated drainpipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. The extent, depth, and location of drainage may be determined in the field by Columbia West during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion. Fill slopes should be overbuilt, compacted, and trimmed at least 2 feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

6.4 EXCAVATION

Conventional earthmoving equipment in proper working condition should be capable of making necessary site excavations. Temporary excavation sidewalls should maintain a vertical cut to a depth of approximately 4 feet BGS in the near-surface silt, provided groundwater seepage is not present in the sidewalls. In sandy soil, excavations will likely slough and cave, even at shallow depths. Open-cut excavation techniques may be used to excavate trenches between 4 and 8 feet deep, provided the walls of the excavation are cut at a maximum slope of 1.5H:1V and groundwater seepage does not occur. Excavation side slopes should be reduced to a stable inclination if excessive sloughing or raveling occurs.

Shoring may be required if open-cut excavations are not feasible. As a wide variety of shoring and dewatering systems are available, we recommend that the contractor be responsible for selecting the appropriate shoring and dewatering systems. If box shoring is used, the contractor should understand it is a safety feature used to protect workers and does not prevent caving. If excavations are left open, caving of the sidewalls may occur. The presence of caved material will limit the ability to properly backfill and compact trenches. The contractor should be prepared to fill voids between the box shoring and the sidewalls of the trenches with sand or gravel before caving occurs.

Temporary excavation sidewalls should maintain a vertical cut to a depth of approximately 4 feet in the native soil, provided groundwater seepage is not present in the sidewalls. Open-cut excavation techniques may be used to excavate trenches between 4 and 8 feet deep, provided the walls of the excavation are cut at a maximum slope of 1H:1V and groundwater seepage is not present. Excavation slopes should be reduced to 1.5H:1V or 2H:1V if excessive sloughing or raveling occurs.

Shoring may be required if open-cut excavations are not feasible or if excavations are proposed adjacent to existing infrastructure and improvements. A wide variety of shoring and dewatering systems are available, and we recommend that the contractor be responsible for selecting the appropriate shoring and dewatering systems.

All excavations should be made in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes certain approaches to excavation and dewatering, the contract documents should specify that the contractor is responsible for selecting the excavation and dewatering methods, monitoring the excavations for safety, and providing shoring (as required) to protect personnel and adjacent structural elements.

6.5 CONSTRUCTION DEWATERING

The contractor should be responsible for temporary drainage of surface water, perched water, and groundwater. Dewatering should be performed to the extent necessary to prevent standing water and/or erosion of exposed site soil. During rough and finished grading of building pad areas, the contractor should keep all footing excavations and slab subgrade soil free of standing water.

The need for dewatering will depend on the time of year and depth of excavations. If perched groundwater is encountered, pumping from a sump located within the trench may be effective in dewatering localized sections of trench. However, this method is unlikely to prove effective in dewatering long sections of trench or large excavations. In addition, the sidewalls of trench excavations will need to be flattened or shored if seepage is encountered. We note that these recommendations are for guidance only. Dewatering of excavations is the sole responsibility of the contractor, as the contractor is in the best position to select these systems based on their means and methods.

If groundwater is present at the bases of utility excavations, we recommend placing a minimum of 12 inches of stabilization material at the base of the excavation. The actual thickness of stabilization material should be determined at the time of construction based on observed field conditions. Trench stabilization material should be placed in one lift and compacted until well keyed. Stabilization material and geotextile fabric should meet the requirements in Section 6.6 (Materials).

6.6 MATERIALS

6.6.1 Structural Fill

6.6.1.1 General

Areas proposed for fill placement should be appropriately prepared as described in Section 6.1 (Site Preparation). Engineered fill placement should be observed by Columbia West. Compaction of engineered structural fill should be verified by proof rolling or nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed for each vertical foot of engineered fill placed.

Various materials may be acceptable for use as structural fill. Structural fill should be free of organic material or other unsuitable material and meet the specifications provided in the following sections. Representative samples of proposed engineered structural fill should be submitted for laboratory testing and approval by Columbia West prior to placement. All structural fill should be free of organic material and have a particle size of less than 6 inches.

6.6.1.2 On-Site Soil

The on-site soil is suitable for use as structural fill if adequately dried or moisture conditioned to achieve recommended compaction specifications. Based on laboratory testing, we anticipate that the moisture content of the soil will generally be above the optimum moisture content required to meet compaction requirements for the on-site soil and drying of the soil will be necessary. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill. It will be difficult, if not impossible, to adequately compact on-site soil during the rainy season or during prolonged periods of rainfall.

On-site soil used as structural fill should be placed in loose lifts not exceeding 8 inches thick and compacted using standard conventional compaction equipment. The soil moisture content should be within a few percentage points of optimum conditions. The soil should be compacted to at least 92 percent of maximum dry density as determined by ASTM D1557.

The on-site soil will likely expand during excavation and transport and consolidate during compaction. Development of site-specific expansion and consolidation factors is beyond the scope of this study. We can provide site-specific factors upon request.

6.6.1.3 Imported Granular Material

Imported granular material should consist of pit- or quarry-run rock, crushed rock, or crushed gravel and sand meeting the specifications in WSS 9-03.14(1) – Gravel Borrow. Imported granular material should be placed in loose lifts not exceeding 12 inches thick and compacted to at least 95 percent of maximum dry density as determined by ASTM D1557. During wet weather conditions or where wet subgrade conditions are present, the initial loose lift of granular fill should be approximately 18 inches thick and should be compacted with a smooth-drum roller operating in static mode.

6.6.1.4 Stabilization Material

Stabilization material should consist of durable, 4- or 6-inch-minus pit- or quarry-run rock, crushed rock, or crushed gravel and sand that is free of organic material and other deleterious material. The material should have a maximum particle size of 6 inches with less than 5 percent by dry weight passing the U.S. Standard No. 4 sieve. The material should have at least two mechanically fractured faces.

Stabilization material should be placed in loose lifts between 12 and 24 inches thick and compacted to a firm, unyielding condition. Equipment with vibratory action should not be used when compacting stabilization material over wet, fine-grained soil. If stabilization material is used to stabilize soft subgrade below pavement or construction haul roads, a subgrade geotextile should be placed as a separation barrier between the soil subgrade and stabilization material.

6.6.1.5 Trench Backfill

Trench backfill placed below, adjacent to, and up to at least 12 inches above utility lines (i.e., the pipe zone) should consist of well-graded granular material meeting the specifications in WSS 9-03.12(3) – Gravel Backfill for Pipe Zone Bedding. Pipe zone backfill should be compacted to at least 90 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

Within structural areas (below pavement and building pads), trench backfill above the pipe zone should consist of WSS 9-03.19 – Bank Run Gravel for Trench Backfill or WSS 9-03.14(2) – Select Borrow with a maximum particle size of 2½ inches. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). Remaining trench backfill should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

Outside of structural areas, trench backfill placed above the pipe zone should be compacted to at least 90 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

6.6.1.6 Retaining Wall Backfill
Backfill material placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of free-draining granular material meeting the specifications in WSS 9-03.12(2) – Gravel Backfill for Walls. The wall backfill should be separated from structural fill, native soil, and/or topsoil using a geotextile fabric that meets the specifications provided below for drainage geotextiles.

Wall backfill located within a horizontal distance of 3 feet from the face of a retaining wall should be compacted to 90 percent of maximum dry density as determined by ASTM D1557. Backfill placed within 3 feet of the wall should be compacted in loose lifts less than 6 inches thick using hand-operated tamping equipment (such as a jumping jack or vibratory plate compactor). Remaining wall backfill should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

6.6.1.7 Retaining Wall Leveling Pad
Crushed aggregate used as a leveling pad for retaining wall footings should consist of 1¼-inch-minus crushed aggregate meeting the specifications in WSS 9-03.9(3) – Crushed Surfacing. The leveling pad material should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

6.6.1.8 Floor Slab and Pavement Aggregate Base
Aggregate base for building floor slabs and pavement should consist of 1¼-inch-minus crushed aggregate meeting the specifications in WSS 9-03.9(3) – Crushed Surfacing. Slab aggregate base should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

6.6.1.9 Drain Rock
Drain rock should consist of angular, granular material with a maximum particle size of 2 inches. The material should be free of roots, organic material, and other unsuitable material; should have less than 2 percent fines by dry weight; and should have at least two mechanically fractured faces. Drain rock should be compacted to a well-keyed, firm condition.

6.6.2 Geotextile Fabric
6.6.2.1 Subgrade Geotextile
Subgrade geotextile should meet the specifications in WSS 9-33.2(1), Table 3, Geotextile for Separation or Soil Stabilization. The geotextile should be installed in accordance with the manufacturer's recommendations. A minimum initial aggregate base lift of 6 inches is required over geotextiles. All stabilization material should be underlain by a subgrade geotextile.

6.6.2.2 Drainage Geotextile
Subgrade geotextile should meet the specifications in WSS 9-33.2(1), Table 2, Geotextile for Underground Drainage Filtration Properties. The AOS should be between U.S. Standard No. 70 and No. 100 sieves. The geotextile should be installed in accordance with the manufacturer's recommendations. A minimum initial aggregate base lift of 6 inches is required over geotextiles.

6.6.3 Pavement

6.6.3.1 AC

AC should consist of HMA Class ½" adhering to the specifications in WSS 9-03.8(6) – HMA Proportions of Materials. The asphalt binder should consist of PG 58-22 meeting the specifications in WSS 9-02.1(4) – Performance Graded (PG) Asphalt Binder. Asphalt should be compacted to 91 percent of the theoretical maximum density as determined by ASTM D2041. Minimum and maximum AC lift thicknesses should be 2 and 3 inches, respectively. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with WSS and City of La Center specifications.

6.6.3.2 Cold Weather Paving Considerations

In general, AC paving is not recommended during cold weather (temperatures less than 40 degrees Fahrenheit). Compacting under these conditions can result in low compaction and premature pavement distress.

Each AC mix design has a recommended compaction temperature range that is specific for the particular AC binder used. In colder temperatures, it is more difficult to maintain the temperature of the AC mix as it can lose heat while stored in the delivery truck, as it is placed, and in the time between placement and compaction. In Washington, the AC surface temperature during paving should be at least 40 degrees Fahrenheit for lift thickness greater than 2.5 inches and at least 50 degrees Fahrenheit for lift thickness between 2 and 2.5 inches.

If paving activities must take place during cold weather construction as defined above, the project team should be consulted and a site meeting should be held to discuss ways to lessen low compaction risks.

6.6.4 Soil Amendment with Cement

The on-site soil can be amended with portland cement to obtain suitable properties for use as wet weather structural fill or subbase for pavement. The effectiveness of soil amendment is highly dependent on proper mixing techniques, soil moisture conditioning, and the quantity of cement. The quantity of cement applied during amendment should be based on an assumed dry unit weight of 100 pcf for the on-site soil.

6.6.4.1 Subbase Stabilization

Specific recommendations for soil amendment should be based on exposed site conditions at the time of construction. For preliminary design purposes, we recommend cement-amended subgrade for building pads and pavement subbase (below the aggregate base layer) achieve a target strength of 100 psi. The quantity of cement required to achieve the target strength will vary with moisture content and soil type. Laboratory testing of cement-amended soil should be used to confirm design expectations.

Based on our experience, the near-surface soil will require approximately 6 to 7 percent cement by weight to achieve the target strength of 100 psi. This cement percentage assumes that the soil moisture content does not exceed 25 percent at the time of amendment. If the soil moisture content is in the range of 25 to 35 percent, 7 to 8 percent cement by weight may be required to achieve the target strength. The amount of cement added to the soil at the time of construction should be based on observed field conditions and subgrade performance. During extended periods of dry weather, water may need to be applied during the amendment and tilling process to achieve the optimum moisture content required for compaction.

Cement amendment equipment should have balloon tires to minimize softening, rutting, and disturbance of the fine-grained site soil. A sheepsfoot or segmented pad roller with a minimum static weight of 40,000 pounds should be used for initial compaction. Rollers with vibratory action should not be used to compact fine-grained, cement-amended soil. Final compaction should be conducted with a smooth-drum roller with a minimum applied linear force of 700 pounds per inch. The amended soil should be compacted to at least 95 percent of maximum dry density as determined by ASTM D558.

Following cement amendment, a minimum curing time of four days is required prior to exposure to construction traffic. Construction traffic should not be allowed on unprotected, cement-amended subgrade. To protect cement-amended areas from damage, the finished surface should be covered with 4 to 6 inches of imported granular material. The protective layer of crushed rock often becomes contaminated with soil during construction, particularly in staging and haul road areas. Contaminated aggregate, where present, should be removed and replaced with clean crushed aggregate prior to construction of pavement or other permanent site improvements supported by aggregate base.

Cement amendment should not be attempted during moderate to heavy precipitation or when the ambient air temperature is below 40 degrees Fahrenheit. Cement should not be placed in areas of standing water or where saturated subgrade conditions exist.

6.6.4.2 Cement-Amended Structural Fill

If adequate compaction is not achievable with on-site soil due to moisture or weather conditions, the soil may be cement amended and placed as general structural fill. Prior to placement of cement-amended fill, subgrade soil should be prepared as described in Section 6.1 (Site Preparation). Where multiple lifts of cement-amended fill are necessary to meet finished grade, consecutive lifts may be placed immediately following amendment and compaction of the underlying lift. However, where the final lift of cement-amended fill will serve as building pad or pavement subbase material, the four-day cure period as discussed above is recommended.

6.6.4.3 Testing and Construction Observation

Cement amendment of the site soil should be observed and tested by Columbia West to document conformance with design recommendations. Cement spread rate should be verified by measuring the spread area relative to the weight of cement used or with a pan sample test conducted at one random location per lift per 20,000 square feet of cement-amended fill. Amendment depth should be verified through excavation of a small test pit and measurement at one random location per lift of cement-amended fill. Adequate compaction and moisture content should be verified by conducting nuclear gauge density testing at a frequency of approximately one test per 5,000 square feet of cement-amended fill in accordance with ASTM D6938. When amending pavement subgrade, at least one representative sample should be collected per day of cement amendment, cured for seven days, and tested for unconfined compressive strength in accordance with ASTM D1633. The tested samples should have a minimum seven-day, unconfined compressive strength of 100 psi.

6.6.4.4 Drainage Considerations

Cement-amended soil will be poorly drained and will not be suitable for planting areas. The material may also be difficult to excavate with light-duty equipment. Proposed landscape areas should not be cement amended, unless accommodations are made for drainage and planting. Cement amendment within building pad areas should consider the potential for trapped water below the floor slab. Columbia West should be consulted to provide appropriate recommendations if cement amendment is proposed within building pad areas. Cement amendment should not be used if runoff during construction cannot be directed away from adjacent wetlands. Cement amendment runoff should be collected, monitored, and treated, if necessary, in accordance with applicable regulations prior to being discharged.

6.7 EROSION CONTROL

Soil at this site is susceptible to erosion by wind and water; therefore, erosion control measures should be carefully planned and installed before construction begins. Surface water runoff should be collected and directed away from sloped areas to prevent water from running down the slope face. Measures that can be employed to reduce erosion include the use of silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads. All erosion control methods should be in accordance with local jurisdiction standards.

7.0 OBSERVATION OF CONSTRUCTION

Satisfactory pavement, earthwork, and foundation performance depends to a large degree on the quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Columbia West should be retained to observe subgrade preparation, fill placement, foundation excavations, drainage system installation, and pavement placement and to review laboratory compaction and field moisture-density information.

Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

8.0 LIMITATIONS

We have prepared this report for use by the addressee and members of the design and construction team for the proposed project. This report is subject to the limitations expressed in Appendix C.

♦ ♦ ♦

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

Sincerely,

Michael C. King, PE
Project Engineer

Shawn M. Dimke, PE
Principal Engineer

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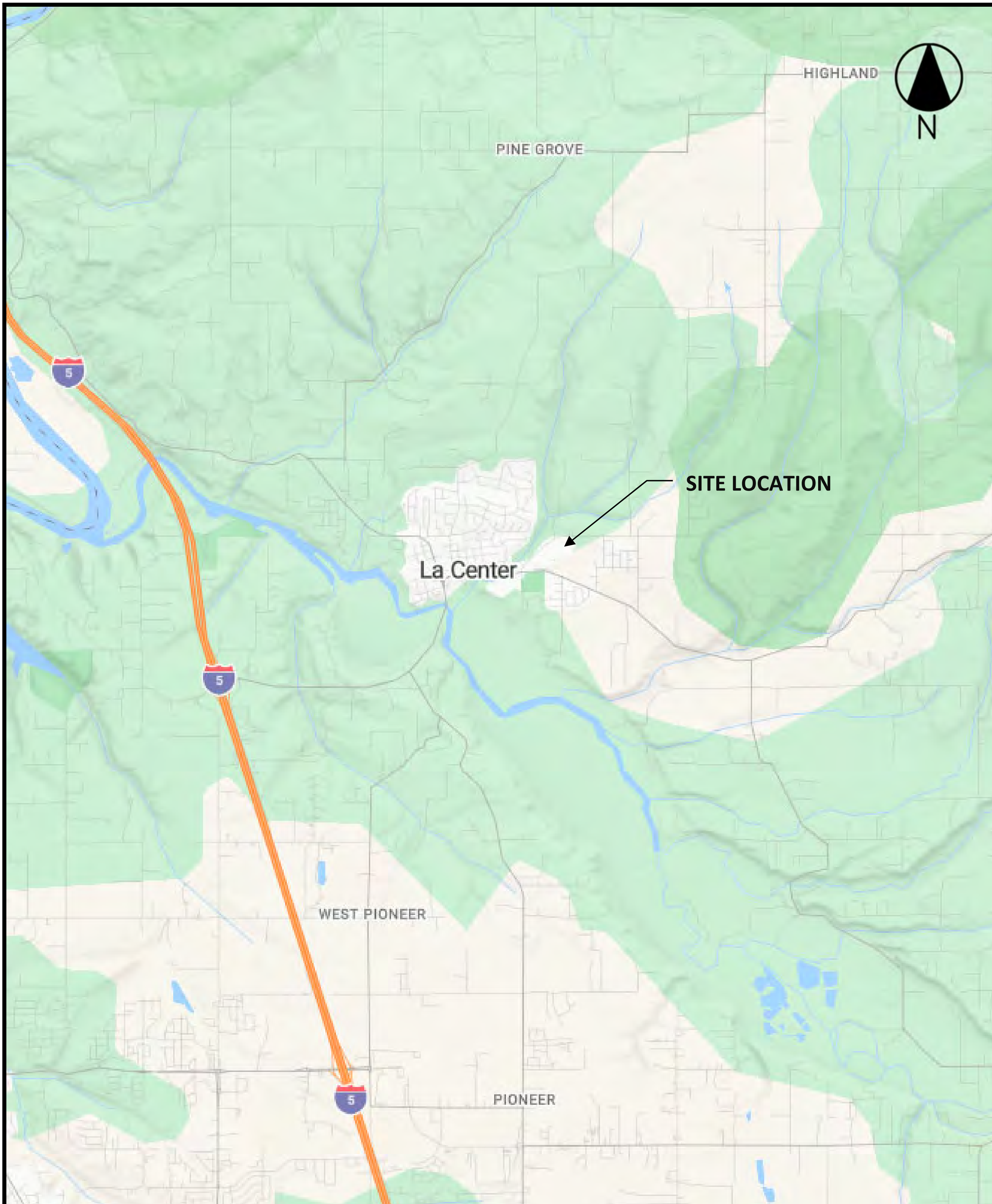
FIGURES



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Columbia West Engineering, Inc

PROJECT NO.:
LGI-14-01-1

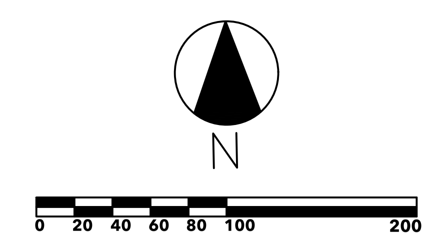
JANUARY 2025

VICINITY MAP
MANNING MEADOWS SUBDIVISION
LA CENTER, WASHINGTON

FIGURE
1

LEGEND

- SITE BOUNDARY
- TEST PIT
- K UNFACTORED COEFFICIENT OF PERMEABILITY, IN/HR



NOTES:
1. AERIAL PHOTO SOURCED FROM GOOGLE EARTH.
2. PRELIMINARY SITE PLAN PREPARED BY PLS ENGINEERING.
3. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
4. REFER TO REPORT TEXT FOR EXPLORATION

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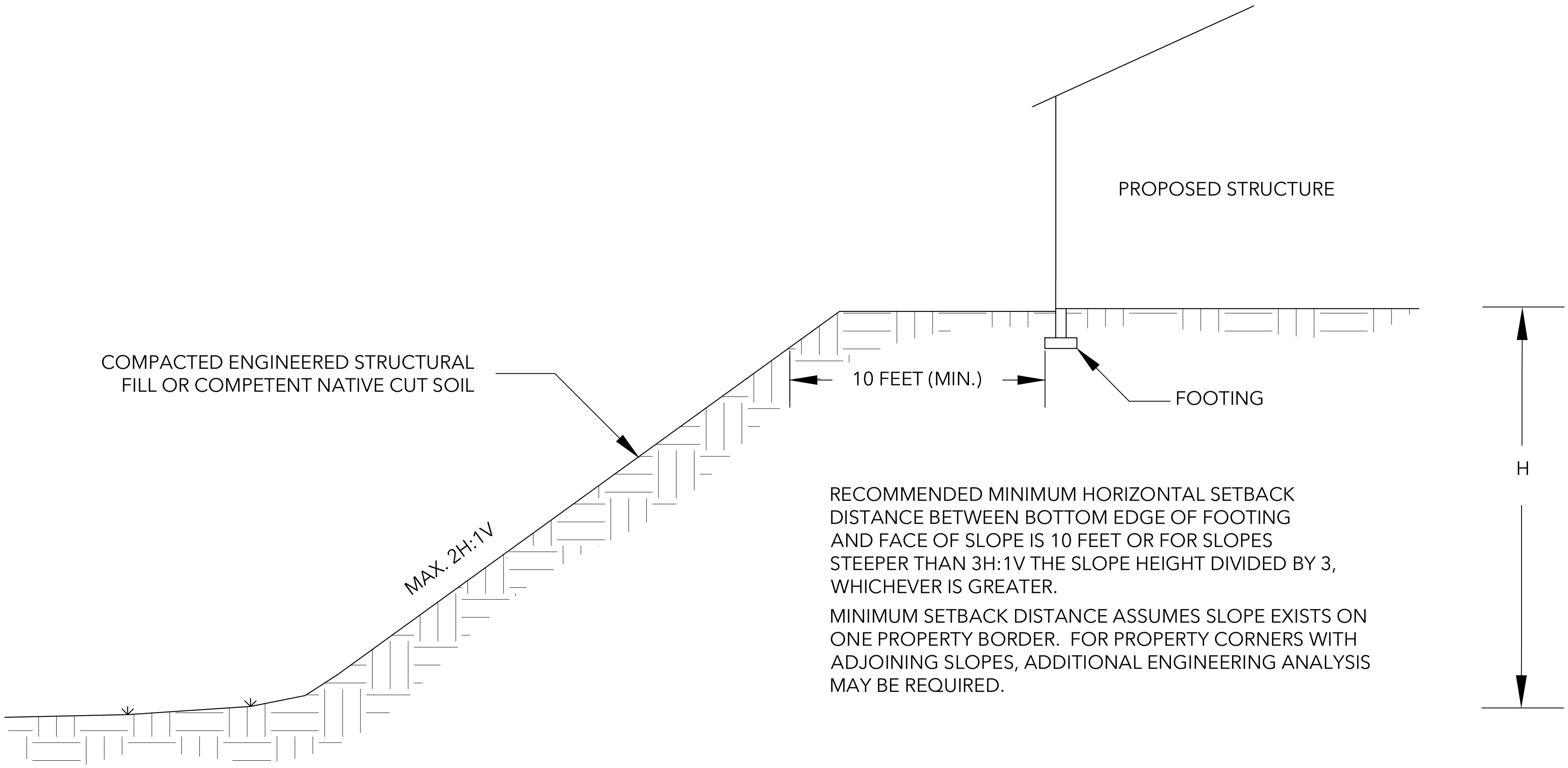
MANNING MEADOWS SUBDIVISION
LA CENTER, WASHINGTON
1819 NE 339TH STREET

SITE PLAN

PROJECT NO: LGI-14-01-1

JANUARY 2025

FIGURE 2



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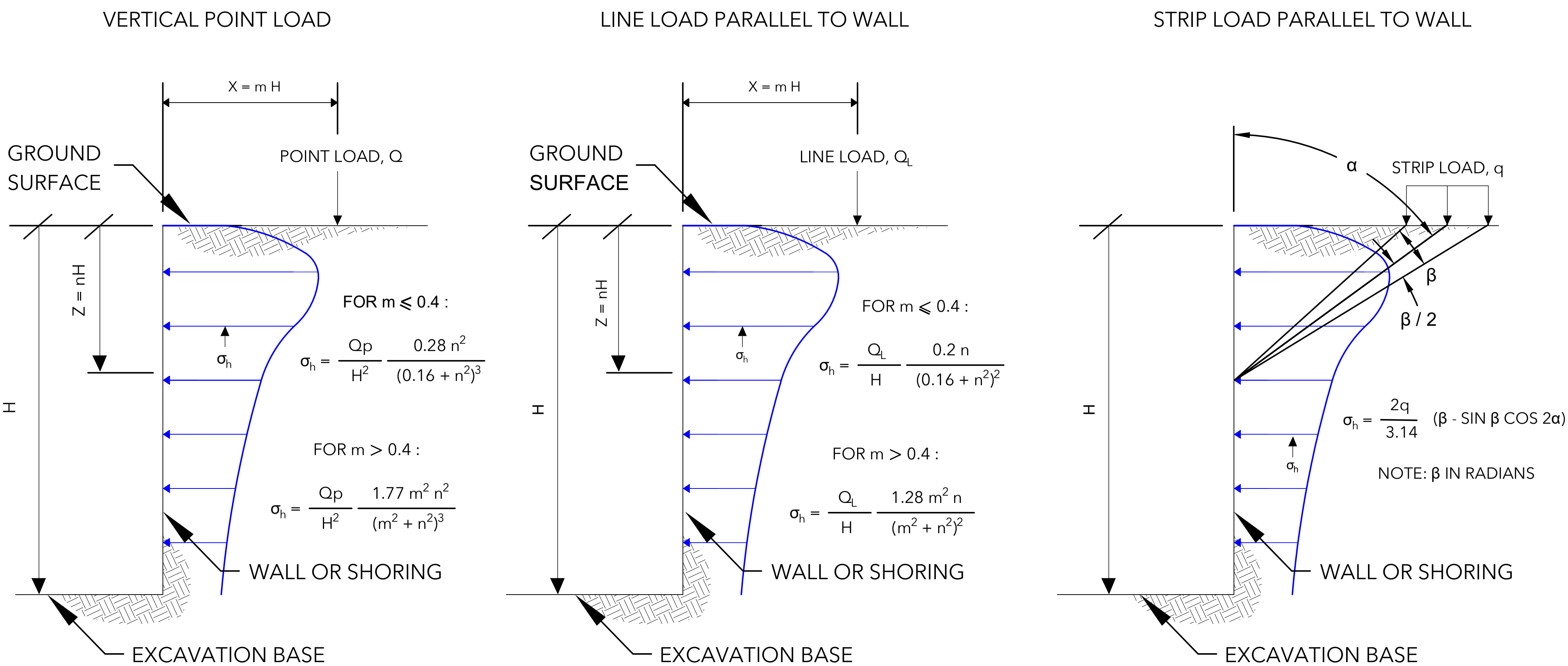
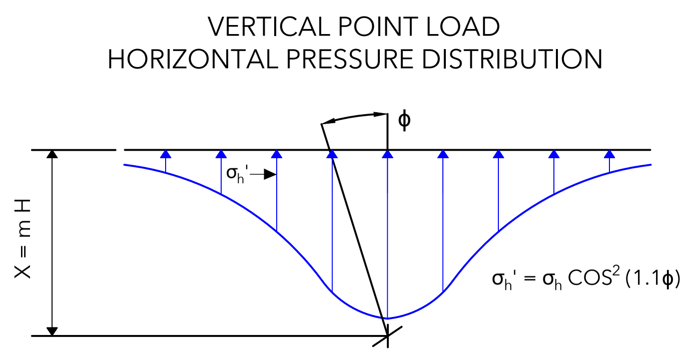
TYPICAL MINIMUM FOUNDATION
SLOPE SETBACK DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL AND MAY NOT BE SITE-SPECIFIC.

FIGURE 3





NOTES:

1. FIGURE SHOULD BE USED JOINTLY WITH RECOMMENDATIONS PRESENTED IN THE REPORT TEXT.
2. LATERAL EARTH PRESSURES ASSUME RIGID WALLS WITH BACKFILL MATERIALS HAVING A POISSON'S RATIO OF 0.5.
3. TOTAL LATERAL EARTH PRESSURES RESULTING FROM COMBINED LOADS MAY BE CALCULATED USING SUPERPOSITION.
4. DRAWING IS NOT TO SCALE.

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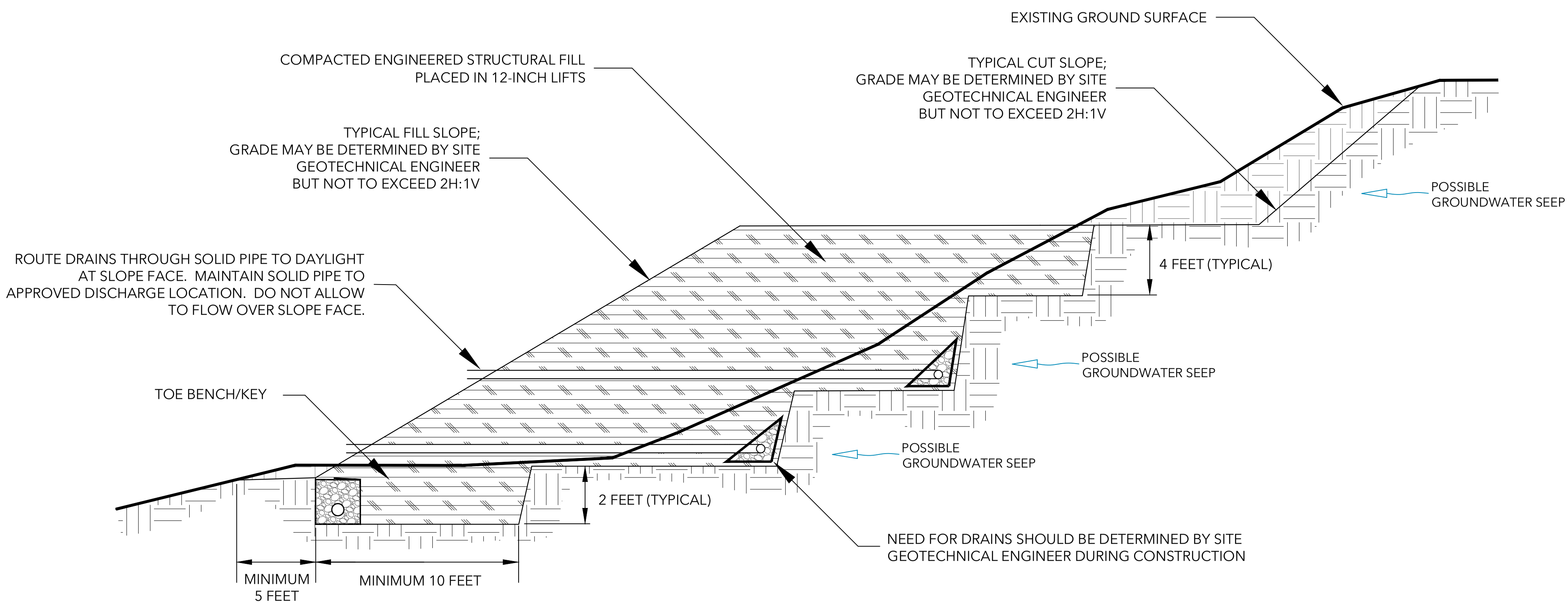
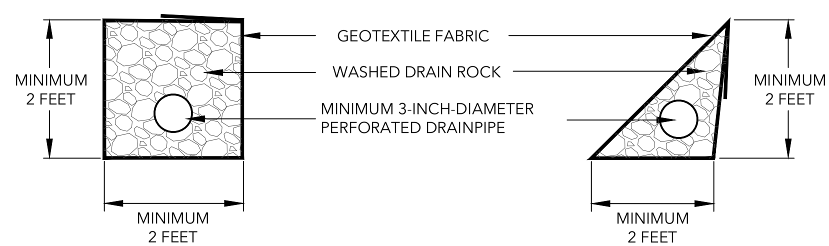
SURCHARGE-INDUCED LATERAL EARTH PRESSURES

FIGURE 4



TYPICAL DRAIN SECTION DETAIL



DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN U.S. STANDARD NO. 70 AND NO. 100 SIEVES.

WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE U.S. STANDARD NO. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

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TYPICAL CUT AND FILL SLOPE CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL CUT AND FILL SLOPE CROSS SECTION AND MAY NOT BE SITE-SPECIFIC.

FIGURE 5

APPENDIX A

APPENDIX A
FIELD EXPLORATIONS

GENERAL

We explored subsurface conditions at the site by excavating nine test pits (TP-1 through TP-9) to depths between 14 and 15 feet BGS. Excavation services were provided by L&S Contracting LLC of Yacolt, Washington, on December 12, 2024, using a track-mounted excavator. The explorations were logged on a full-time basis by Columbia West personnel. The exploration logs are presented in this appendix.

The exploration locations are shown on Figure 2. The exploration locations were determined in the field by pacing or measuring from existing site features. This information should be considered accurate only to the degree implied by the methods used.

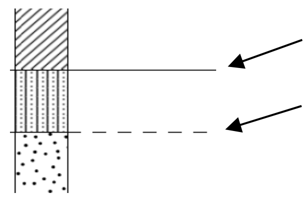
SOIL SAMPLING

Representative disturbed samples of soil observed in the test pit explorations were collected from the test pit walls and base using the excavator bucket. Sampling methods and intervals are shown on the exploration logs.

SOIL CLASSIFICATION

The soil samples were classified in the field in accordance with the "Exploration Legend" and "Soil Classification System," which are presented in this appendix. The exploration logs indicate the depths at which the soil characteristics change, although the change could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

EXPLORATION LEGEND

<table>
<tr><th>SAMPLER TYPE</th><th colspan="2">DESCRIPTION</th></tr>
<tr><td>SPT</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D1586, Standard Penetration Test and Split-Barrel Sampling of Soils</td></tr>
<tr><td>SH</td><td colspan="2">Sample collected from the indicated depth using thin-wall Shelby tube in general accordance with ASTM D1587, Thin-Walled Tube Sampling of Fine-Grained Soils</td></tr>
<tr><td>D&M</td><td colspan="2">Sample collected from the indicated depth using Dames & Moore sampler and 140-pound hammer or pushed</td></tr>
<tr><td>CSS</td><td colspan="2">Sample collected from the indicated depth using 3-inch-outside diameter California split-spoon sampler and 140-pound hammer</td></tr>
<tr><td>GRAB</td><td>Grab sample collected from the indicated depth</td><td rowspan="2"></td></tr>
<tr><td>CORE</td><td>Pavement or rock core interval at the indicated depth</td></tr>
</table>

GEOTECHNICAL ABBREVIATIONS AND ACRONYMS			
ATT	Atterberg Limits	PP	Pocket Penetrometer
CBR	California Bearing Ratio	P200	Percent Passing No. 200 Sieve
CON	Consolidation Test	RES	Resilient Modulus
DD	Dry Density	SIEV	Sieve Analysis
DS	Direct Shear	TS	Torvane Shear
HYD	Hydrometer	tsf	Tons per Square Foot
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	UU	Unconsolidated Undrained Triaxial Test
NP	Non-Plastic	VS	Vane Shear
OC	Organic Content	WD	Wet Density
P	Pushed Sample		

ENVIRONMENTAL ABBREVIATIONS AND ACRONYMS			
CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
ppm	Parts per Million	MS	Moderate Sheen
		HS	Heavy Sheen

SOIL CLASSIFICATION SYSTEM

PARTICLE-SIZE CLASSIFICATION

COMPONENT	ASTM / USCS		AASHTO	
	Size Range	Sieve Size Range	Size Range	Sieve Size Range
Boulders	Greater than 300 mm	Greater than 12 inches	--	--
Cobbles	75 mm to 300 mm	3 inches to 12 inches	Greater than 75 mm	Greater than 3 inches
Gravel	75 mm to 4.75 mm	3 inches to No. 4 sieve	75 mm to 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm to 19.0 mm	3 inches to 3/4-inch sieve	--	--
Fine	19.0 mm to 4.75 mm	3/4-inch to No. 4 sieve	--	--
Sand	4.75 mm to 0.075 mm	No. 4 to No. 200 sieve	2.00 mm to 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm to 2.00 mm	No. 4 to No. 10 sieve	2.00 mm to 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm to 0.425 mm	No. 10 to No. 40 sieve	--	--
Fine	0.425 mm to 0.075 mm	No. 40 to No. 200 sieve	0.425 mm to 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	Less than 0.075 mm	Passing No. 200 sieve	Less than 0.075 mm	Passing No. 200 sieve

CONSISTENCY FOR COHESIVE SOIL

CONSISTENCY	SPT N-VALUE (blows per foot)	D&M N-VALUE (blows per foot)	POCKET PENETROMETER (unconfined compressive strength [tsf])
Very soft	0 to 2	0 to 3	Less than 0.25
Soft	2 to 4	3 to 6	0.25 to 0.5
Medium stiff	4 to 8	6 to 12	0.5 to 1.0
Stiff	8 to 15	12 to 25	1.0 to 2.0
Very stiff	15 to 30	25 to 65	2.0 to 4.0
Hard	Greater than 30	Greater than 30	Greater than 4.0

RELATIVE DENSITY FOR GRANULAR SOIL

RELATIVE DENSITY	SPT N-VALUE (blows per foot)	D&M N-VALUE (blows per foot)
Very loose	0 to 4	0 to 11
Loose	4 to 10	11 to 26
Medium dense	10 to 30	26 to 74
Dense	30 to 50	74 to 120
Very dense	Greater than 50	Greater than 120

MOISTURE DESIGNATIONS

TERM	FIELD IDENTIFICATION
Dry	Very low moisture, dry to touch
Moist	Damp, color appears darkened, without visible moisture, cohesive soil will clump, sand will bulk
Wet	Visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Percent	SILT AND CLAY IN		Percent	SAND AND GRAVEL IN		Percent	SECONDARY MATERIAL
	Fine-Grained Soil	Coarse-Grained Soil		Fine-Grained Soil	Coarse-Grained Soil		Organics and Man-Made Debris
< 5	trace	trace	< 5	trace	trace	< 4	trace
5 - 12	minor	with	5 - 15	minor	minor	4 - 12	some
> 12	some	silty/clayey	15 - 30	with	with		
			> 30	sandy/gravelly	with		

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TEST PIT NUMBER: TP-1

PROJECT NAME Manning Meadows Subdivision **CLIENT** LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren **PROJECT LOCATION** La Center, Washington
CONTRACTOR L&S Contracting LLC **EQUIPMENT** CAT 307E
CAVING Not observed **DATE COMPLETED** 12/12/2024
GROUNDWATER Slow seepage at 3 and 6 feet **TIME STARTED** 8:21 AM **TIME COMPLETED** 12:20 PM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	FINES (%)	REMARKS
0–1.0					Soft, brown CLAY with sand, trace organics, moist (12-inch-thick tilled zone, 3-inch-thick root zone). 1.0					
1.0–15.0				CL	Medium stiff, brown-gray CLAY with sand, moist, low plasticity, sand is fine.					
	▬	TP1.1				1.0	29	35-23-12	82	Infiltration test at 2 feet.
						1.0				
5	▬	TP1.2					34		84	Infiltration test at 5 feet.
10										
	▬	TP1.3			Brown-orange, trace gravel, gravel is fine at 11.5 feet.		37			
15					15.0					

Test pit completed at 15 feet.

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TEST PIT NUMBER: TP-2

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER See remarks
TIME STARTED 8:58 AM **TIME COMPLETED** 12:20 PM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0–1.3					Soft, brown CLAY with sand, trace organics, moist (15-inch-thick tilled zone, 3-inch-thick root zone). 1.3				
1.3–15.0				CL	Medium stiff, brown-gray CLAY with sand, moist, sand is fine.				
	▬	TP2.1				0.5	33	81	Infiltration test at 2 feet. Slow seepage at 2 feet.
						0.5			
5	▬	TP2.2					55	76	Infiltration test at 5 feet. Moderate seepage at 5 feet.
10									Rapid seepage at 10 feet.
	▬	TP2.3					40		
15					15.0				

Test pit completed at 15 feet.

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TEST PIT NUMBER: TP-3

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Not observed
TIME STARTED 9:27 AM **TIME COMPLETED** 9:48 AM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	FINES (%)	REMARKS
0–1.5					Soft, brown SILT with sand, trace organics, moist (18-inch-thick tilled zone, 3-inch-thick root zone). 1.5					
1.5–6.0				ML	Medium stiff, brown-gray-orange SILT, some clay, minor sand, moist, low plasticity, sand is fine. 6.0	0.5				
	▬	TP3.1				0.5		40-27-13		
6.0–15.0				CL	Medium stiff, brown CLAY with sand, moist, sand is fine. 15.0					
	▬	TP3.2					38			
	▬	TP3.3					31		79	
15					Test pit completed at 15 feet.					

TEST PIT NUMBER: TP-4

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PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Slow seepage at 5 and 10 feet
TIME STARTED 9:51 AM **TIME COMPLETED** 10:15 AM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	% Organic Material	REMARKS
	▬	TP4.1			Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 3-inch-thick root zone). 1.5		30	3.6	
					Medium stiff, gray-brown-orange CLAY, minor sand, moist, sand is fine.	0.5			
						0.5			
5					Brown at 5 feet.				
	▬	TP4.2					31		
10	▬	TP4.3			Brown-gray at 10 feet. 13.0		30		
	▬	TP4.4		GC	Dense, brown clayey GRAVEL, moist, gravel is fine to coarse and rounded. 14.0		6		
15					Test pit completed at 14 feet.				

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TEST PIT NUMBER: TP-5

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Slow seepage at 4 and 12 feet
TIME STARTED 10:17 AM **TIME COMPLETED** 10:50 AM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.5					Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 4-inch-thick root zone). 1.5			
1.5–14.0				CL	Medium stiff, brown CLAY, minor sand, moist, sand is fine. 14.0	0.5 0.5		
					Test pit completed at 14 feet.			

Depth scale: 5, 10, 15

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TEST PIT NUMBER: TP-6

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Slow seepage at 7 feet
TIME STARTED 10:51 AM **TIME COMPLETED** 11:13 AM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0–1.5					Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 4-inch-thick root zone). 1.5				
1.5–15.0				CL	Medium stiff, brown-gray CLAY, minor sand, moist, sand is fine. 15.0	1.0			
	▬	TP6.1					36		
						1.0			
5									
	▬	TP6.2					36		
10									
	▬	TP6.3					30	88	
15					Test pit completed at 15 feet.				

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TEST PIT NUMBER: TP-7

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Slow seepage at 6 feet
TIME STARTED 11:21 AM **TIME COMPLETED** 11:48 AM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.5					Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 4-inch-thick root zone). 1.5			
1.5–14.0				CL	Medium stiff, brown CLAY, minor sand, moist, sand is fine. 14.0	1.0		
	▬	TP7.1				1.0	33	
	▬	TP7.2					33	
					Test pit completed at 14 feet.			

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TEST PIT NUMBER: TP-8

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER See remarks
TIME STARTED 11:49 AM **TIME COMPLETED** 12:13 PM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.5	▬	TP8.1			Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 4-inch-thick root zone). 1.5			
1.5–14.0					Medium stiff, brown-gray-orange CLAY, minor sand, moist, sand is fine.	1.0		
						1.0		
					Brown at 4 feet.			
5								
	▬	TP8.2		CL			32	
								Slow seepage at 8 feet.
10								
								Moderate seepage at 12 feet.
					14.0			
15					Test pit completed at 14 feet.			

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TEST PIT NUMBER: TP-9

PROJECT NAME Manning Meadows Subdivision
CLIENT LGI Homes
PROJECT NO. LGI-14-01-1 **LOGGED BY** E. Uren
PROJECT LOCATION La Center, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E
CAVING Not observed
DATE COMPLETED 12/12/2024
GROUNDWATER Slow seepage at 11 feet
TIME STARTED 12:21 PM **TIME COMPLETED** 12:45 PM

DEPTH (ft)	SAMPLE GRAPHIC	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.3					Soft, brown CLAY with sand, trace organics, moist (18-inch-thick tilled zone, 3-inch-thick root zone). 1.3			
1.3–14.0				CL	Medium stiff, brown-gray CLAY, minor sand, moist, sand is fine. 14.0	1.0		
	▬	TP9.1					34	
						1.0		
10	▬	TP9.2					31	
14.0					Test pit completed at 14 feet.			

APPENDIX B

APPENDIX B
LABORATORY TESTING

GENERAL

Laboratory testing was conducted on select soil samples to confirm field classifications and determine the index engineering properties and strength characteristics. The laboratory classifications are shown on the exploration logs if those classifications differed from the field classifications. The locations of the tested samples are shown on the exploration logs. Descriptions of the tests are presented below, and results of the testing are presented in this appendix.

PARTICLE-SIZE ANALYSIS

Particle-size analysis was completed on select soil samples in general accordance with ASTM D1140 (P200). This test is a quantitative determination of the percent passing the U.S. Standard No. 200 sieve by dry weight.

MOISTURE CONTENT

The natural moisture content of select soil samples was determined in general accordance with ASTM D2216. The natural moisture content is a ratio of the weight of the water to dry soil in a test sample and is expressed as a percentage.

ATTERBERG LIMITS TESTING

Atterberg limits (plastic and liquid limits) testing was performed on select soil samples in general accordance with ASTM D4318. The plastic limit is defined as the moisture content where the soil becomes brittle. The liquid limit is defined as the moisture content where the soil begins to act similar to a liquid. The plasticity index is the difference between the liquid and plastic limits.

ORGANIC CONTENT TESTING

Organic content testing was completed on a select soil sample in general accordance with ASTM D2974. The moisture content of the sample was determined by drying the sample in a standard drying oven and is expressed as a percentage of the sample weight. The organic content is determined by igniting the oven-dried sample in a muffle furnace. The resulting substance is ash, which is expressed as a percentage of the oven-dried sample.

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MOISTURE CONTENT, PERCENT PASSING NO. 200 SIEVE BY WASHING

PROJECT	CLIENT	PROJECT NO.	
Manning Meadows Subdivision 1819 NE 339th Street La Center, Washington	LGI Homes 700 Washington Street, Suite 200 Vancouver, WA 98660	LGI-14-01-1	
		ISSUE DATE 12/30/24	PAGE 1 of 2
		DATE SAMPLED 12/12/24	SAMPLED BY E. Uren

LABORATORY TEST DATA

TEST PROCEDURE
ASTM D2216 - Method A, ASTM D1140

LAB ID	CONTAINER MASS (g)	MOIST MASS + CONTAINER (g)	DRY MASS + CONTAINER (g)	AFTER WASH DRY MASS + CONTAINER (g)	FIELD ID	SAMPLE DEPTH (ft)	PERCENT MOISTURE CONTENT	PERCENT PASSING NO. 200 SIEVE
S24-2373	540.89	845.79	776.82	583.64	TP1.1	2	29%	82%
S24-2374	537.38	829.08	755.27	571.28	TP1.2	5	34%	84%
S24-2375	381.89	1,430.52	1,148.62	-	TP1.3	12	37%	-
S24-2376	579.12	892.74	815.07	623.90	TP2.1	2	33%	81%
S24-2377	548.47	1,083.64	893.33	631.21	TP2.2	5	55%	76%
S24-2378	87.56	312.35	248.64	-	TP2.3	13	40%	-
S24-2380	87.62	325.08	259.70	-	TP3.2	8	38%	-
S24-2381	542.53	827.06	759.80	588.60	TP3.3	14	31%	79%
S24-2383	87.55	298.22	248.03	-	TP4.2	6	31%	-
S24-2384	87.69	308.34	257.81	-	TP4.3	10	30%	-
S24-2385	866.50	3,799.50	3,626.88	-	TP4.4	13	6%	-
S24-2386	86.70	354.19	283.46	-	TP6.1	3	36%	-
S24-2387	87.42	308.66	249.79	-	TP6.2	6	36%	-
S24-2388	556.08	887.47	810.21	587.83	TP6.3	13	30%	88%
S24-2389	87.97	298.82	246.68	-	TP7.1	4	33%	-
S24-2390	86.86	335.60	273.95	-	TP7.2	12	33%	-

NOTES:	DATE TESTED	TESTED BY
Sample weight received for Lab ID: S24-2385 did not meet the minimum size requirements; entire sample used for analysis.	12/19/24	M. Scherette

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MOISTURE CONTENT, PERCENT PASSING NO. 200 SIEVE BY WASHING

PROJECT	CLIENT	PROJECT NO.	
Manning Meadows Subdivision 1819 NE 339th Street La Center, Washington	LGI Homes 700 Washington Street, Suite 200 Vancouver, WA 98660	LGI-14-01-1	
		ISSUE DATE: 12/30/24	PAGE: 2 of 2
		DATE SAMPLED: 12/12/24	SAMPLED BY: E. Uren

LABORATORY TEST DATA

TEST PROCEDURE
ASTM D2216 - Method A, ASTM D1140

LAB ID	CONTAINER MASS (g)	MOIST MASS + CONTAINER (g)	DRY MASS + CONTAINER (g)	AFTER WASH DRY MASS + CONTAINER (g)	FIELD ID	SAMPLE DEPTH (ft)	PERCENT MOISTURE CONTENT	PERCENT PASSING NO. 200 SIEVE
S24-2391	87.82	310.66	256.33	-	TP8.2	7	32%	-
S24-2392	87.74	340.06	276.29	-	TP9.1	3	34%	-
S24-2393	86.60	323.76	268.20	-	TP9.2	10	31%	-

NOTES:
Sample weight received for Lab ID: S24-2385 did not meet the minimum size requirements; entire sample used for analysis.

DATE TESTED: 12/19/24
TESTED BY: M. Scherette

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	
Manning Meadows Subdivision 1819 NE 339th Street La Center, Washington	LGI Homes 700 Washington Street, Suite 200 Vancouver, WA 98660	LGI-14-01-1	
		ISSUE DATE 12/30/24	PAGE 1 of 1
		LAB ID S24-2373	FIELD ID TP1.1
		DATE SAMPLED 12/12/24	SAMPLED BY E. Uren

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit TP-1 depth = 2 feet	no data provided

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318 - Method A

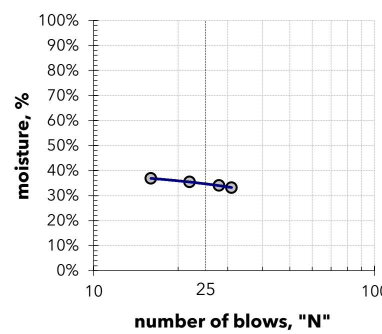
ATTERBERG LIMITS

liquid limit =	35
plastic limit =	23
plasticity index =	12

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	34.06	33.14	32.23	34.26
dry soil + pan weight, g =	30.81	30.06	29.28	30.65
pan weight, g =	21.00	21.02	20.97	20.84
N (blows) =	31	28	22	16
moisture, % =	33.1 %	34.1 %	35.5 %	36.8 %

LIQUID LIMIT



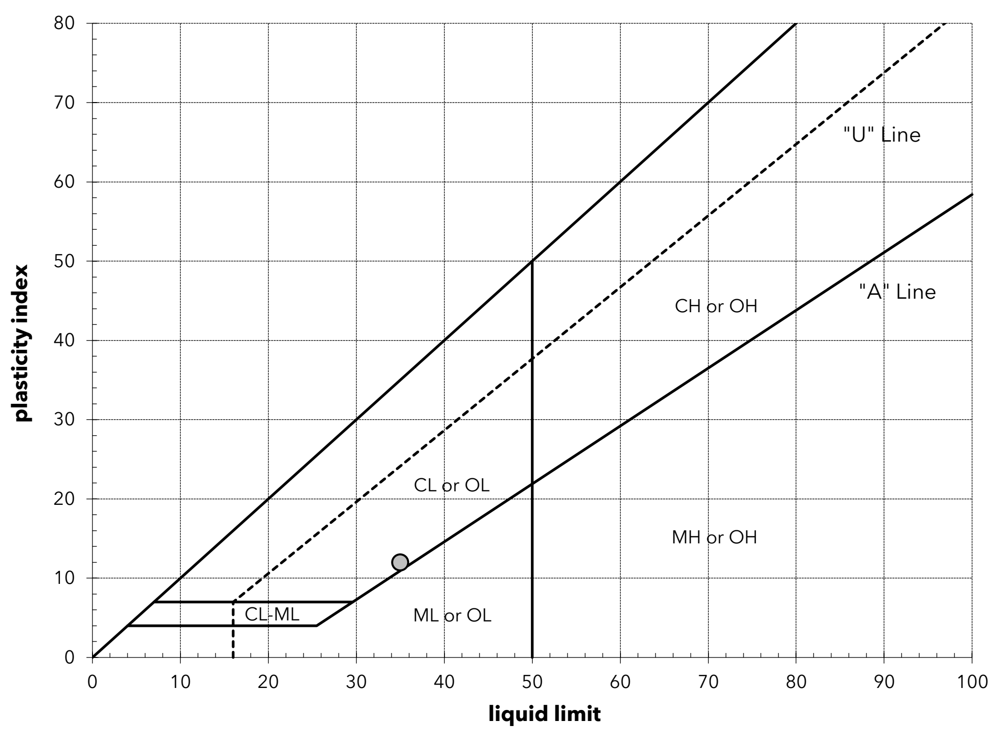
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	28.11	28.38		
dry soil + pan weight, g =	26.78	27.02		
pan weight, g =	20.87	21.02		
moisture, % =	22.5 %	22.7 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	n/a
% sand =	n/a
% silt and clay =	n/a
% silt =	n/a
% clay =	n/a
moisture content =	29%

DATE TESTED	TESTED BY
12/27/24	K. Summers

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	
Manning Meadows Subdivision 1819 NE 339th Street La Center, Washington	LGI Homes 700 Washington Street, Suite 200 Vancouver, WA 98660	LGI-14-01-1	
		ISSUE DATE 12/30/24	PAGE 1 of 1
		LAB ID S24-2379	FIELD ID TP3.1
		DATE SAMPLED 12/12/24	SAMPLED BY E. Uren

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
SILT	Test Pit TP-3 depth = 4 feet	no data provided

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318 - Method A

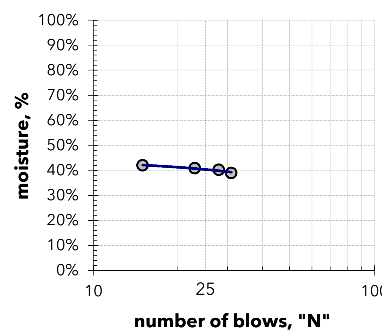
ATTERBERG LIMITS

liquid limit =	40
plastic limit =	27
plasticity index =	13

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	30.66	30.39	30.15	30.48
dry soil + pan weight, g =	27.95	27.69	27.50	27.63
pan weight, g =	20.99	20.96	21.01	20.84
N (blows) =	31	28	23	15
moisture, % =	38.9 %	40.1 %	40.8 %	42.0 %

LIQUID LIMIT



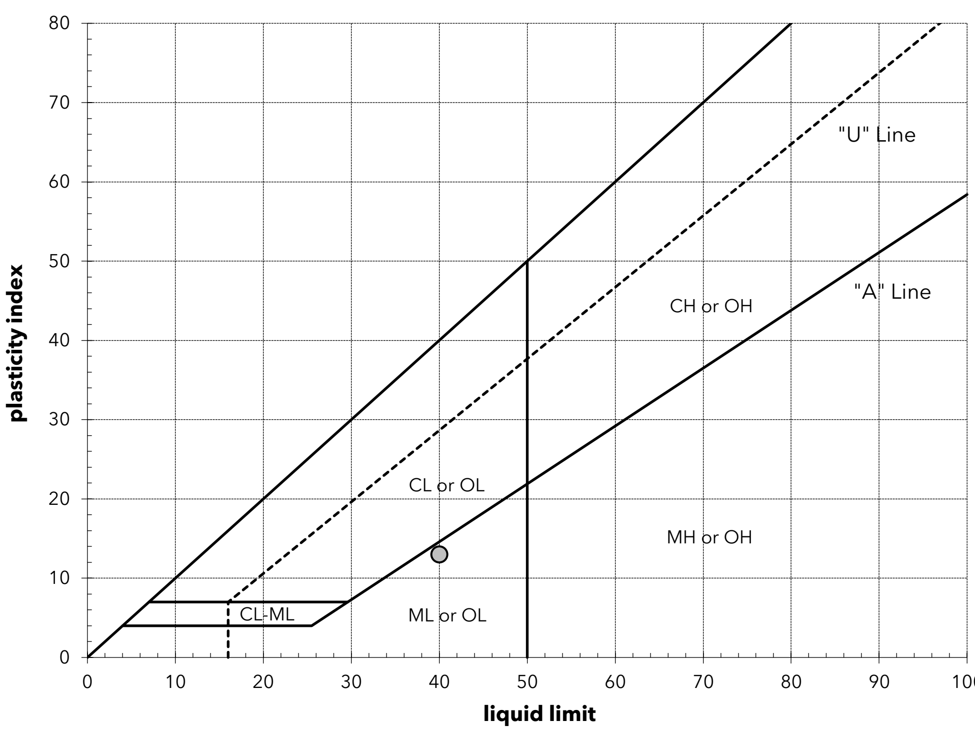
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	28.47	28.92		
dry soil + pan weight, g =	26.84	27.22		
pan weight, g =	20.87	21.04		
moisture, % =	27.3 %	27.5 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	n/a
% sand =	n/a
% silt and clay =	n/a
% silt =	n/a
% clay =	n/a
moisture content =	n/a

DATE TESTED	TESTED BY
12/26/24	C. Lillie

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Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

ORGANIC CONTENT TEST REPORT

PROJECT	CLIENT	PROJECT NO.	
Manning Meadows Subdivision 1819 NE 339th Street La Center, Washington	LGI Homes 700 Washington Street, Suite 200 Vancouver, WA 98660	LGI-14-01-1	
		ISSUE DATE 12/30/24	PAGE 1 of 1
		DATE SAMPLED 12/12/24	SAMPLED BY E. Uren

LABORATORY TEST DATA

TEST PROCEDURE
ASTM D2974 - Method A (Furnace Temperature = 440°C)

LAB ID	WET MASS OF SPECIMEN (g)	OVEN DRY MASS OF SPECIMEN (g)	ASHED MASS OF SPECIMEN (g)	TIME IN FURNACE (hrs)	FIELD ID	SAMPLE DEPTH (ft)	PERCENT MOISTURE CONTENT (oven-dried)	PERCENT ASH	PERCENT ORGANIC MATTER
S24-2382	50.02	38.34	36.97	14.25	TP4.1	0.5	30%	96.4%	3.6%

NOTES:	DATE TESTED	TESTED BY
	12/19/24	M. Scherette

COLUMBIA WEST ENGINEERING, INC. authorized signature

APPENDIX C

APPENDIX C
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction Observation

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then, only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled Report Ownership. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

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Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.