Report of Geotechnical Engineering Services

Parklands II Short Plat

Camas, Washington

June 9, 2026

Geotechnical ■ Environmental ■ Special Inspections

Columbia West

Engineering, Inc



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June 9, 2026

MAS1A LLC
3405 NW McMaster Drive
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Attn: Jon Ellsworth

Re: Report of Geotechnical Engineering Services
Parklands II Short Plat
NW Camas Meadows Drive
Camas, Washington
CWE Project: MAS1A-1-01-1

Columbia West Engineering, Inc. (Columbia West) is pleased to present this report of geotechnical engineering services for the proposed Parklands II Short Plat project in Camas, Washington. Our services were conducted in accordance with our proposal dated May 14, 2026.

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

Sincerely,

Michael C. King, PE
Senior Project Engineer

Daniel E. Lehto, PE, GE
Principal Engineer



Signed 06/09/2026

MCK:DEL:kat
Attachments
Document ID: MAS1A-1-01-1-060926-geor.docx

EXECUTIVE SUMMARY

This section provides a summary of the geotechnical considerations associated with the proposed Parklands II Short Plat project in Camas, 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 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. Extended wet weather construction may significantly affect earthwork productivity and increase the need for imported stabilization material.

- Partially cemented sandstone was encountered as shallow as approximately 3 feet BGS in test pit TP-4 and exhibited increased excavation resistance compared to the surrounding soil. In addition, conglomerate deposits are mapped in the site vicinity and may be encountered at shallow depths across portions of the site. Excavation difficulty may increase where cemented sandstone or conglomerate deposits are encountered, and specialized excavation methods may be required in localized areas.

- Permanent slopes should not be constructed steeper than 2H:1V. Foundations located above slope crests should maintain a minimum 10-foot horizontal setback measured from the outside edge of the foundation to the face of the slope.

- Due to the sloping topography and fine-grained soil encountered at the site, foundation drains are recommended for structures at the site.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

1.0 INTRODUCTION 1
2.0 BACKGROUND 1
3.0 PURPOSE AND SCOPE 1
4.0 SITE CONDITIONS 2
4.1 Geology 2
4.2 Surface Conditions 3
4.3 Subsurface Conditions 3
4.4 Seismic Hazards 4
5.0 DESIGN 5
5.1 Shallow Foundation Support 5
5.2 Seismic Design Criteria 7
5.3 Permanent Slopes 7
5.4 Retaining Structures 8
5.5 Drainage 9
5.6 Pavement 10
6.0 CONSTRUCTION 11
6.1 Site Preparation 11
6.2 Construction Traffic and Staging 12
6.3 Slope Construction and Drainage 13
6.4 Excavation 13
6.5 Construction Dewatering 14
6.6 Materials 15
6.7 Erosion Control 20
7.0 OBSERVATION OF CONSTRUCTION 20
8.0 LIMITATIONS 20

REFERENCES 22

FIGURES
Vicinity Map Figure 1
Site Plan Figure 2
Typical Minimum Foundation Slope Setback Detail Figure 3
Surcharge-Induced Lateral Earth Pressures Figure 4
Typical Perforated Drainpipe Trench Detail Figure 5
Typical Cut and Fill Slope Cross Section Figure 6

TABLE OF CONTENTS

APPENDICES
Appendix A
Field Explorations A-1
Exploration Legend
Soil Classification System
Test Pit Logs
Appendix B
Document Limitations and Important Information B-1

ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
AOS	apparent opening size
ASCE	American Society of Civil Engineers
ASTM	ASTM International
BGS	below ground surface
CSZ	Cascadia Subduction Zone
ESAL	equivalent single axle load
g	gravitational acceleration (32.2 feet/second^2)
HDPE	high-density polyethylene
HMA	hot mix asphalt
H:V	horizontal to vertical
IBC	International Building Code
km	kilometer(s)
MCE	maximum considered earthquake
M_W	moment magnitude
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
PVC	polyvinyl chloride
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSS	Washington Standard Specifications for Road, Bridge, and Municipal Construction (2026)

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
PARKLANDS II SHORT PLAT
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West is pleased to submit this geotechnical engineering report for the proposed Parklands II Short Plat project in Camas, Washington. The 3.25-acre site is located east of the intersection of NW Camas Meadows Drive and NW Pittock Place. The site is shown relative to surrounding physical features on Figure 1. Existing site conditions are shown on Figure 2. Abbreviations and acronyms used herein are defined immediately following the Table of Contents.

The project includes subdividing the parcel to support up to eight single-family residential building lots. Improvements are also expected to consist of utility infrastructure, public and private AC-paved roadways, and stormwater management facilities. Based on the existing site topography and correspondence with the design team, we expect the site will be graded to support terraced development and cuts and fills on the order of approximately 5 feet each are anticipated. We estimate 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

In 2015, Columbia West performed geotechnical engineering services for the Parklands at Camas Meadows development and prepared a geotechnical report (Columbia West 2015). At that time, the development plan consisted of detached single-family residential lots and commercial parcels located along the NW Camas Meadows Drive frontage.

Site development, including mass grading, utility installation, roadway construction, and preparation of the commercial parcels, were completed between 2017 and 2018. Columbia West provided construction observation and testing services during portions of site development and documented the completed grading and earthwork operations within the project area.

Based on Columbia West's understanding, the commercial parcels have remained substantially unchanged since completion of site development. Significant grading, construction, or other site alterations within the subject parcels have not been identified since the original infrastructure improvements were completed.

The current exploration program was performed to evaluate whether subsurface conditions within the subject parcels remain generally consistent with those observed during the previous geotechnical study and prior site development.

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 provided and 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 field staff.
- Conducted a subsurface exploration program that included the following:
  - Excavated six test pits to depths between 7 and 12 feet BGS
- Collected soil samples from the explorations and maintained a log of subsurface conditions encountered.
- Prepared this geotechnical engineering report that summarizes our explorations 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
  - Exploration logs
  - 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 east portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

The near-surface geologic units mapped across the site include gravel facies (Qfg), hyaloclastite sandstone (Tfth), and conglomerate (QTc). The Qfg unit generally consists of unconsolidated to weakly cemented gravelly deposits containing sand, gravel, cobbles, and occasional boulders. The Tfth unit consists of sandstone and conglomeratic deposits derived primarily from basaltic volcanic debris and commonly includes dense to very dense sand and gravel with occasional cemented zones. The QTc unit consists of unconsolidated to semi-consolidated pebble- to boulder-sized conglomerate with a sandy matrix. These geologic units are generally characterized by variable cementation, weathering, excavation conditions, and groundwater occurrence and may result in significant variation in subsurface conditions across the site.

The Web Soil Survey identifies the site as being predominantly underlain by Hesson clay loam (USDA 2026). These mapped soils generally consist of fine-grained silty clay loam to clay loam deposits derived from weathered volcanic materials. Hesson soils commonly exhibit moderate to high fines content and are generally consistent with the fine-grained soil encountered during our field explorations.

4.2 SURFACE CONDITIONS

The 3.25-acre site is generally open and grassy, remaining in its apparent post-construction condition. Site terrain is generally gently sloped with engineered north-facing slopes traversing portions of the central and north areas of the site. The site is bounded by NW Camas Meadows Drive to the south, forested land to the north, and residential development to the east and west.

4.3 SUBSURFACE CONDITIONS

4.3.1 General

Subsurface conditions at the site were explored by excavating six test pits (TP-1 through TP-6) to depths between 7 and 12 feet BGS. The exploration locations are shown on Figure 2. A description of our field exploration program and the exploration logs are presented in Appendix A. A summary of the subsurface conditions is presented below.

4.3.2 Soil Conditions

4.3.2.1 Topsoil and Root Zone

The surficial layer of soil covering the majority of the site consists of grass roots and a topsoil zone. The topsoil zone is generally 6 inches thick and consists of silty gravel with trace organics and variable proportions of cobbles. The root zone is generally 4 inches thick.

4.3.2.2 Engineered Fill

Engineered structural fill was observed below the topsoil layer in all test pit locations. The fill observed generally consists of silty gravel with variable proportions of cobbles and organics. The fill observed appeared generally consistent with the engineered structural fill observed and tested during prior site development.

4.3.2.3 Native Soil

Native soil encountered during our explorations generally consists of fine-grained and granular soils consistent with the mapped geologic units in the site vicinity. The observed subsurface conditions were generally consistent with soil encountered during the previous geotechnical investigation and those observed during prior site development completed between 2017 and 2018.

4.3.3 Groundwater

Perched groundwater seepage was observed in test pit TP-2 at a depth of 5 feet BGS. The observed rate of seepage was slow to moderate. Localized perched groundwater conditions may be present within discontinuous zones where relatively permeable soil overlies lower permeability soil. Groundwater levels are often subject to seasonal variation and may rise during extended periods of increased precipitation.

4.4 SEISMIC HAZARDS

4.4.1 Seismic Setting

4.4.1.1 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.

4.4.1.2 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:

- 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+.
- 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.

4.4.1.3 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 1 provides information on local faults close to the site.

Table 1. Nearest Mapped Crustal Faults

Source	Closest Mapped Distance[1] (km)	Mapped Length[1] (km)
Lacamas Lake fault	0.7	24
Grant Butte fault	14	10
East Bank fault	19	29
Portland Hills fault	21	49

1. Based on mapping by USGS (2026)

4.4.2 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.

4.4.3 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 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 is a significant structural design consideration and will primarily be controlled by site grading and floor slab loading. Provided the subgrade soil is prepared as

described in Section 6.1 (Site Preparation), we anticipate total static foundation settlement will be less than approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately 0.5 inch over a span of 50 feet.

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 300 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 the face of descending slopes and groundwater remains below the bases of 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 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 2.

Table 2. ASCE 7-16 Seismic Design Parameters[1]

Parameter	Short Period (T_s)	1-Second Period (T_1)
MCE spectral response acceleration, S	S_S = 0.807 g	S_1 = 0.353 g
Site class	D	
Site coefficient, F	F_a = 1.177	F_v = 1.94
Adjusted spectral response acceleration, S_M	S_{MS} = 0.950 g	S_{M1} = 0.694 g
Design spectral response acceleration, S_D	S_{DS} = 0.634 g	S_{D1} = 0.463 g

1. S_{M1} and S_{D1} must be increased by 50 percent per ASCE 7-16 Supplement 3 Section 11.4.8 Exception 1 or else a ground motion hazard analysis is required.

According to Section 11.4.8 of ASCE 7-16, a ground motion hazard analysis may be required to determine S_{D1}, unless seismic design parameters are determined in accordance with the exceptions defined in that section. Exception 1 of Supplement 3 to ASCE 7-16 indicates a ground motion analysis is not required for structures on Site Class D sites with S_1 greater than or equal to 0.2 where the S_{M1} and S_{D1} values are increased by 50 percent. Columbia West recommends the project structural engineer evaluate these requirements and exceptions to determine if the parameters for Site Class D provided in Table 2 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 tops of cut and fill slopes. Foundations should maintain a minimum 10-foot horizontal setback measured from the outside edge of the foundation to the face of the slope. 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 wall contains level backfill. Re-evaluation of our recommendations will be required on a case-by-case basis 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 if applicable. Wall foundation construction and bearing capacity should adhere to the specifications in Section 5.1 (Shallow Foundation Support).

Permanent retaining walls that are not restrained from rotation, are drained, and are retaining undisturbed native soil should be designed for active earth pressures using an equivalent fluid pressure of 39 pcf. Walls retaining undisturbed native soil that are restrained from rotation should be designed for an at-rest equivalent fluid pressure of 64 pcf. For walls with imported well-drained granular backfill meeting the specifications in WSS 9-03.12(2) – Gravel Backfill for Walls, active and at-rest equivalent fluid pressures of 34 pcf and 54 pcf, respectively, are applicable.

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. Seismic lateral earth pressures for walls retaining level backfill may be calculated assuming an equivalent fluid weight of 13 pcf for walls free to rotate or 27 pcf for walls that are restrained against rotation. The result of the triangular distribution increasing with depth should be applied at a height of 0.34H above the base of the wall, where H is the wall height. The seismic earth pressure force should be superimposed with static active earth pressure.

5.4.3 Backfill and Drainage

The above design parameters have been provided assuming 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 backs of the walls to within 1 foot of finished grade. The drain rock and drainage geotextile fabric should meet specifications in Section 6.6 (Materials). The perforated collector pipes should discharge at appropriate locations away from the bases of the walls. The discharge pipes should not be tied directly into stormwater drain systems, unless measures are taken to prevent backflow into the drainage systems of the walls.

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 construction of flatwork adjacent to retaining walls be postponed at least four weeks after backfilling the walls, 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 surfaces 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 Subdrains

Subdrains consisting of a trench backfilled with drain rock and a perforated pipe should also be considered if portions of the site are cut below surrounding grades. If encountered in cut areas, shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and subsurface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drainpipe trench detail is presented on Figure 5.

If site grading and improvements include cuts greater than 10 feet, there may be a greater potential of encountering subsurface seepage or springs, which may need to be captured and conveyed to an approved location as described above. Columbia West should be contacted to review site grading plans when cut and fill volumes and locations are determined.

If installed during site improvement activities, drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seepage become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations during and after construction if additional groundwater seepage become evident.

5.5.4 Foundation Drains

Due to the sloping topography and the potential for localized perched groundwater conditions within the fine-grained soil, perimeter building foundation drains should be considered for structures at the site. Foundation drains are generally not necessary on the down-slope sides 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 the specifications 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 Camas standards. Based on our explorations, an AASHTO soil classification of A-5 should be used for design of public roadways.

We have provided pavement sections for private automobile-only parking and drive aisles that may 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 3. Material properties and compaction recommendations for AC and aggregate base are presented in Section 6.6 (Materials).

Table 3. Recommended AC Pavement Sections Constructed over Native Soil or Engineered Fill

Traffic	ESALs	AC[1] (inches)	Aggregate Base[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. All thicknesses are intended to be the minimum acceptable.

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 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 Topsoil Zone

An approximately 6-inch-thick topsoil zone was observed throughout the site. Topsoil zones typically have lower densities and contain slightly higher organic contents. The topsoil zone generally exhibits low strength and does not provide adequate support for structural improvements. We recommend improving the topsoil zone during site preparation where it will not be removed by site cuts.

In all structural fill, pavement, and improvement areas, the soil in topsoil 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 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 thicknesses for pavement areas are intended to support post-construction design traffic loads and are 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).

As an alternative to thickened crushed rock sections, haul roads and staging areas may be constructed using cement-amended subgrade overlain by a crushed rock wearing surface. If this approach is used, the thickness of granular material in staging areas and along haul roads can typically be reduced to between 6 and 9 inches. This recommendation is based on an assumed minimum unconfined compressive strength of 100 psi for subgrade amended to a depth of 12 to 16 inches. The actual thickness of the amended material and imported granular material will depend on the contractor's means and methods and should be the contractor's responsibility. Cement amendment is discussed in Section 6.6 (Materials). Due to the plasticity of the near-surface soil, at least two passes with a tiller should be assumed to adequately mix the cement with the on-site soil.

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 and 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 6. 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 generally be capable of performing the anticipated site excavations. Based on our explorations, the subsurface profile generally consists of silty gravel underlain by dense granular soil. Perched groundwater seepage was observed in test pit TP-2 at a depth of 5 feet BGS.

Bedrock was not encountered in the test pits completed for this study. However, partially cemented sandstone was encountered in TP-4 at a depth of approximately 3 feet BGS. The sandstone exhibits increased excavation resistance compared to the overlying soil and may locally increase excavation difficulty. In addition, geologic mapping indicates conglomerate deposits may be present within portions of the site. If encountered during grading, utility construction, or foundation excavations, conglomerate and cemented sandstone may require heavier excavation equipment, ripping, hydraulic rock breaking, or other specialized excavation methods. Excavation conditions are expected to vary across the site depending on the distribution and continuity of these materials.

Temporary excavation sidewalls in the near-surface fine-grained soil may temporarily stand near vertical to depths of approximately 4 feet in relatively dry and stable conditions; however, localized sloughing or instability may occur depending on actual moisture conditions encountered during construction. Open cut excavation techniques may be feasible for deeper excavations, provided side slopes are laid back to a stable inclination. Excavation slopes should be flattened if excessive sloughing, raveling, seepage, or other unstable conditions are encountered.

Localized excavation difficulty should be anticipated where weathered or competent basalt is encountered. The contractor should anticipate variable excavation conditions across the site.

Shoring may be required where open cut excavations are not feasible or where excavations are located adjacent to existing or proposed improvements. Localized dewatering measures may be necessary if groundwater seepage or perched water conditions are encountered during construction. The contractor should be responsible for selecting appropriate excavation support, dewatering methods, and construction procedures based on actual field conditions encountered during construction.

All excavations should be performed in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes anticipated excavation conditions, the contractor remains responsible for selecting excavation and dewatering methods, monitoring 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 in 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 base of a utility excavation, 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 should 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 it is adequately dried or moisture conditioned to achieve recommended compaction specifications. Based on experience, we anticipate the moisture content of the on-soil will generally be above the optimum moisture content required to meet compaction requirements 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 the 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 compacted with a smooth-drum roller operating without vibratory action.

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 tops 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 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

Drainage 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 on City of Camas roadways should be in conformance with City of Camas requirements.

AC on private roadways 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 inches 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 Clark County 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 AC paving must take place during cold weather construction as defined above, the contractor and design team should discuss options for minimizing risk of pavement serviceability.

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 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 the 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, the 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 on-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 not drain well 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 in 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 in 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 B.

♦ ♦ ♦

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
Senior Project Engineer

Daniel E. Lehto, PE, GE
Principal Engineer

REFERENCES

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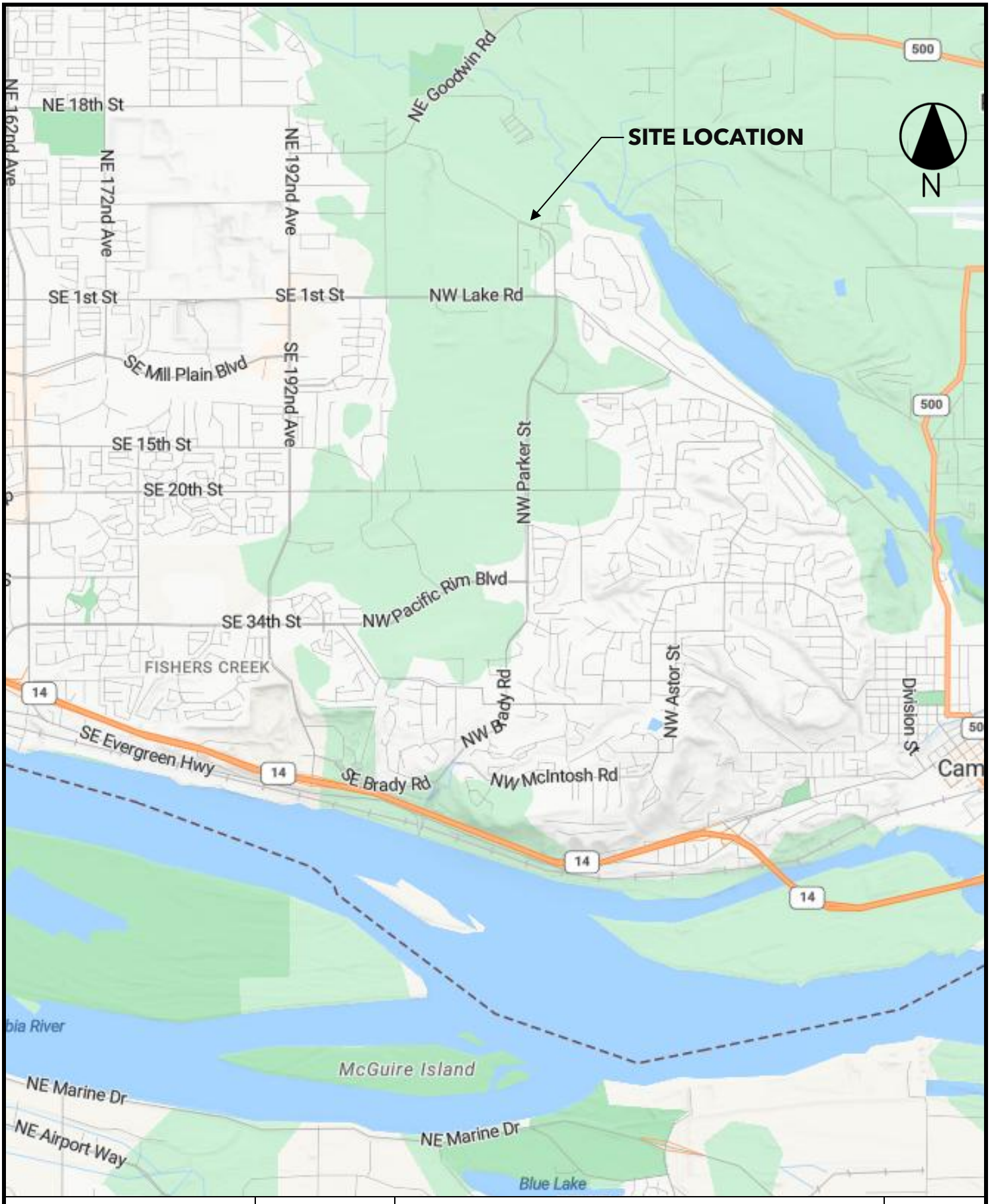
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FIGURES



Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	PROJECT NO.: MAS1A-1-01-1 JUNE 2026	VICINITY MAP PARKLANDS II SHORT PLAT CAMAS, WASHINGTON	FIGURE 1



LEGEND

- SITE BOUNDARY
- TEST PIT

N

0 75 150 300

SCALE IN FEET

NOTES:
1. AERIAL PHOTO SOURCED FROM GOOGLE EARTH.
2. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
3. REFER TO REPORT TEXT FOR EXPLORATION DESCRIPTIONS.

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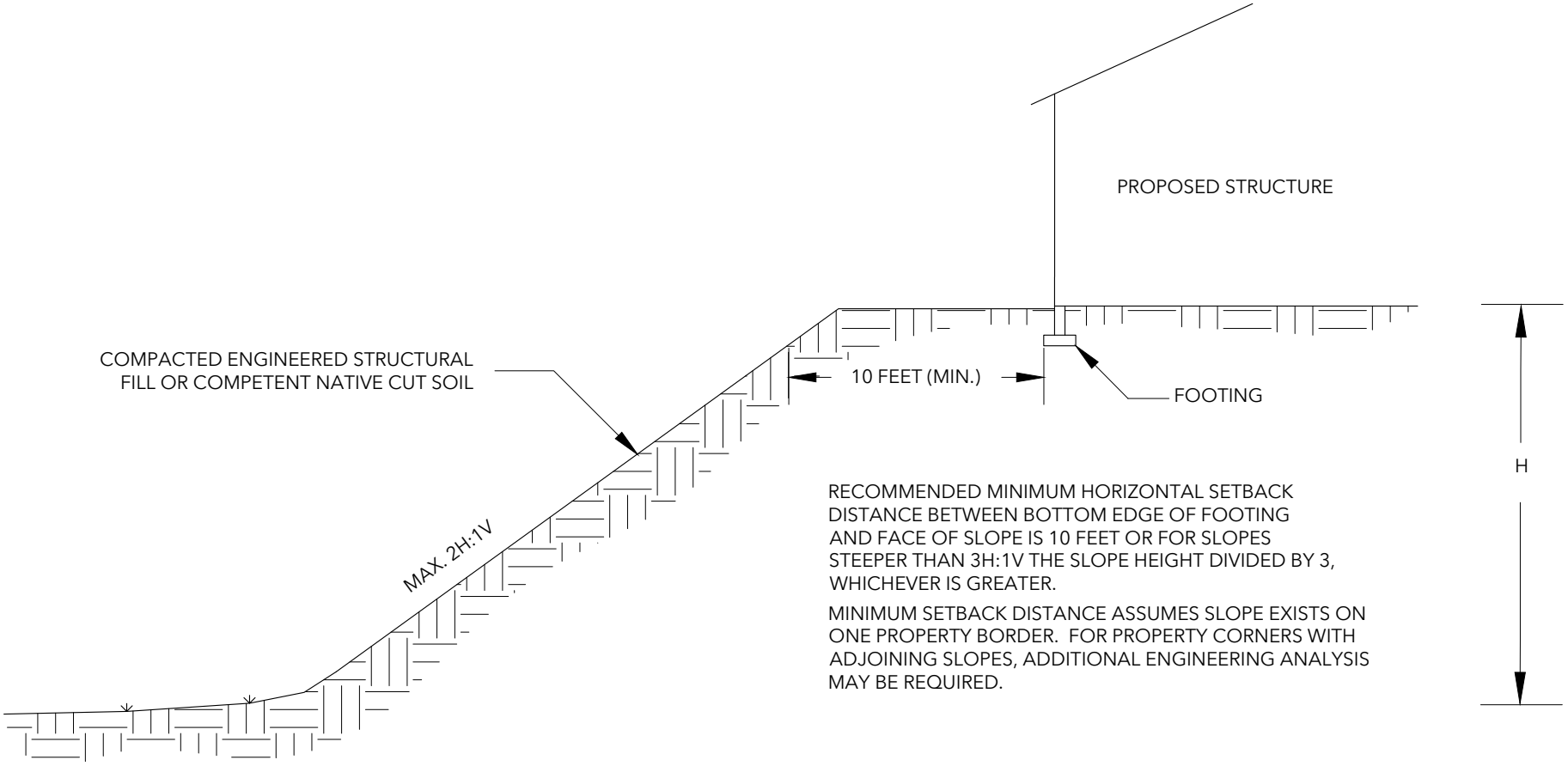
PARKLANDS II SHORT PLAT
CAMAS, WASHINGTON

SITE PLAN

PROJECT NO.:
MAS1A-1-01-1

JUNE 2026

FIGURE
2



RECOMMENDED MINIMUM HORIZONTAL SETBACK DISTANCE BETWEEN BOTTOM EDGE OF FOOTING AND FACE OF SLOPE IS 10 FEET OR FOR SLOPES STEEPER THAN 3H:1V THE SLOPE HEIGHT DIVIDED BY 3, WHICHEVER IS GREATER.

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

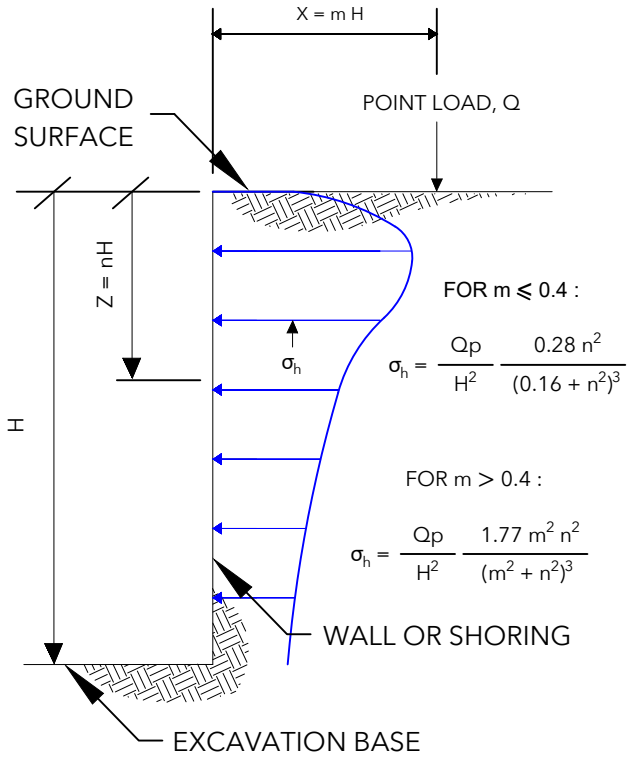
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TYPICAL MINIMUM FOUNDATION SLOPE SETBACK DETAIL

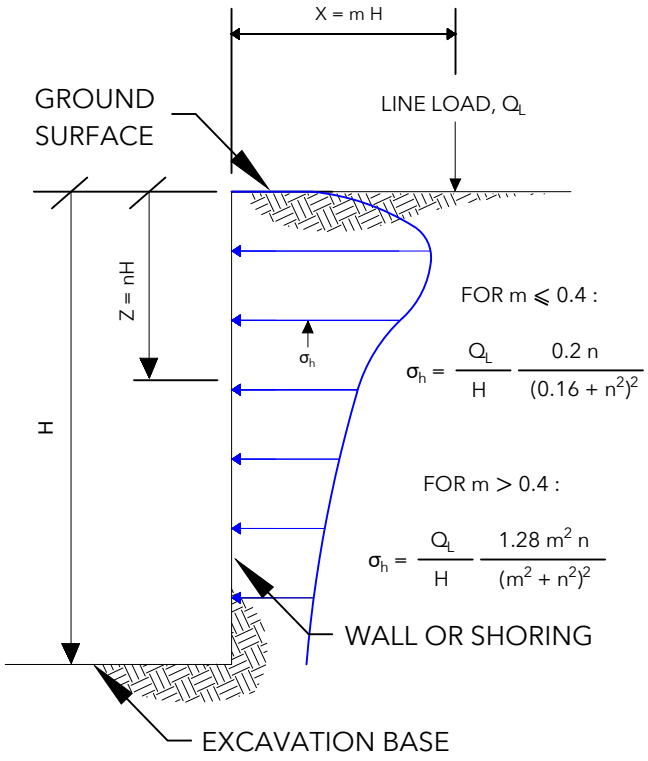
NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL AND MAY NOT BE SITE-SPECIFIC.

FIGURE 3

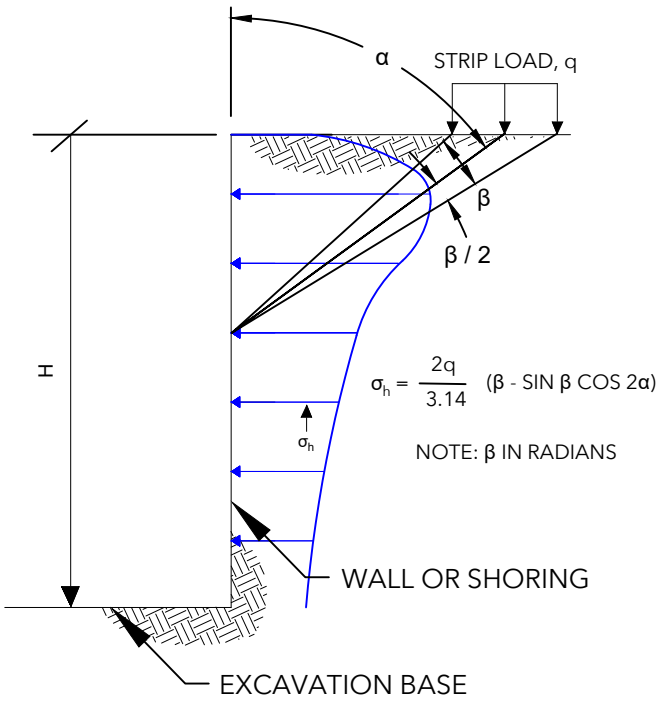
VERTICAL POINT LOAD



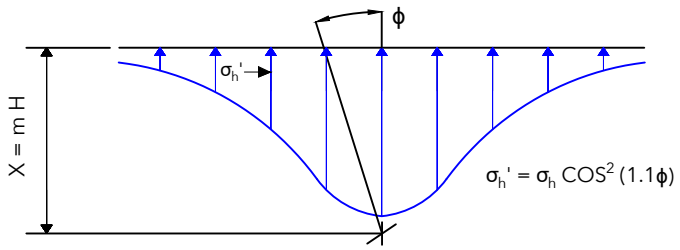
LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL

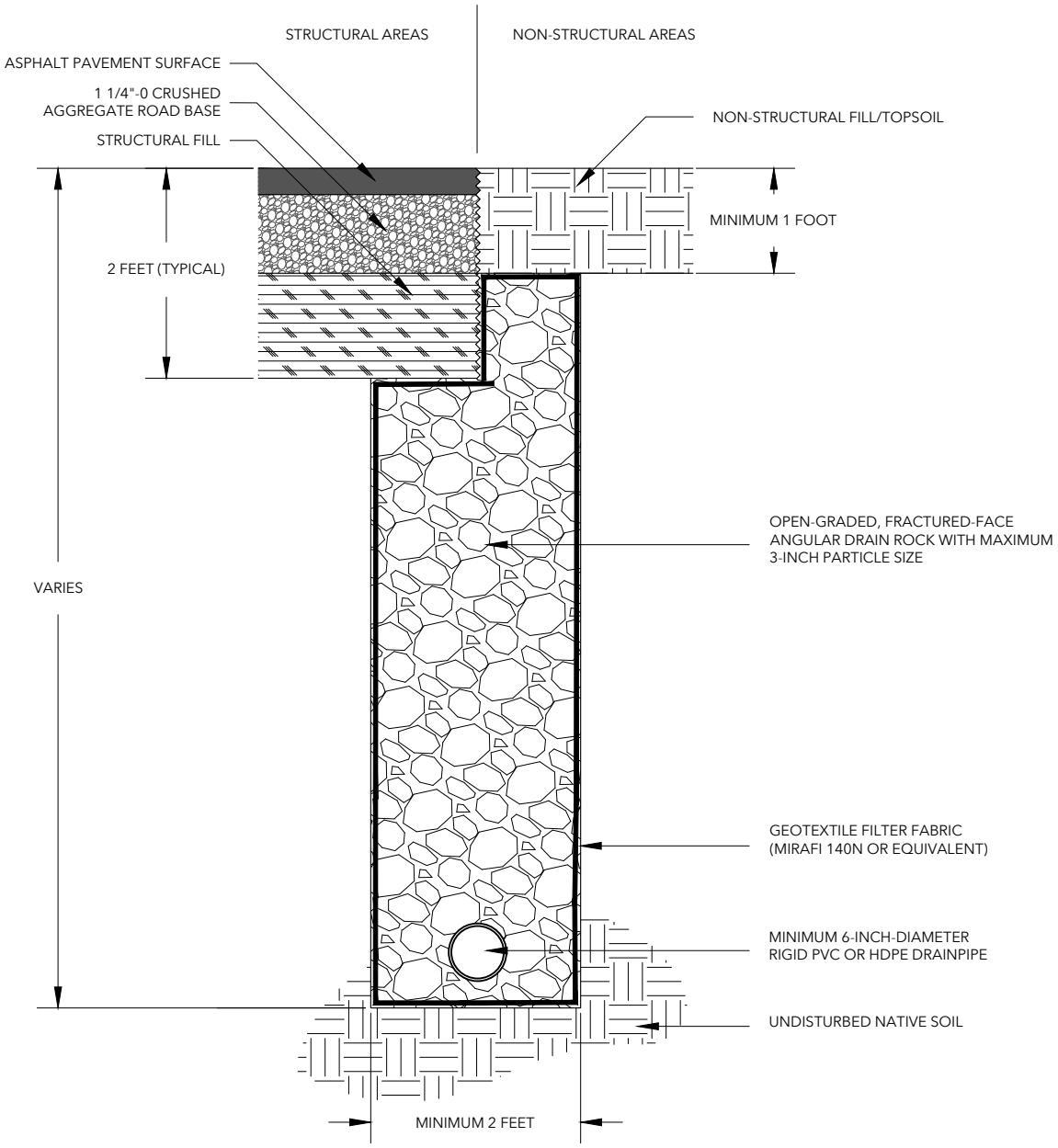


VERTICAL POINT LOAD HORIZONTAL PRESSURE DISTRIBUTION



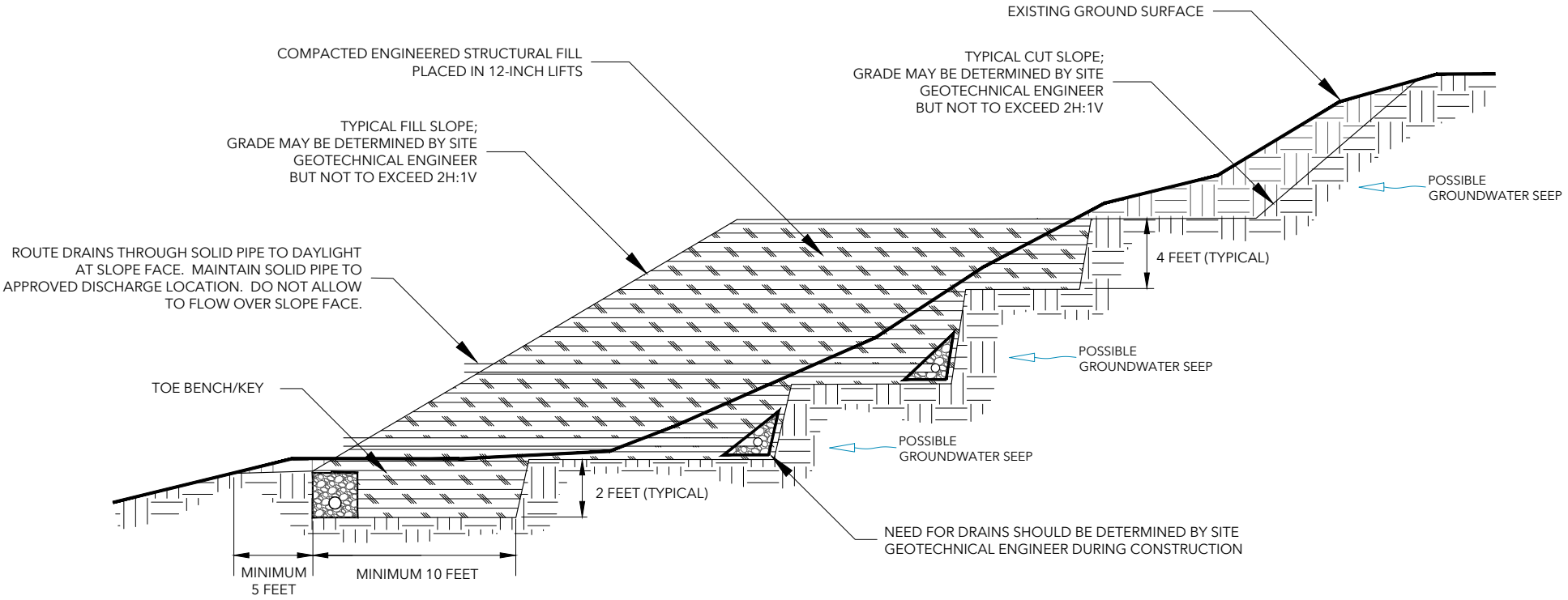
NOTES:

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.



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE SITE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE-SPECIFIC SOIL CONDITIONS.

Geotechnical ■ Environmental ■ Special Inspections Columbia West Engineering, Inc	TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL AND MAY NOT BE SITE-SPECIFIC.	FIGURE 5

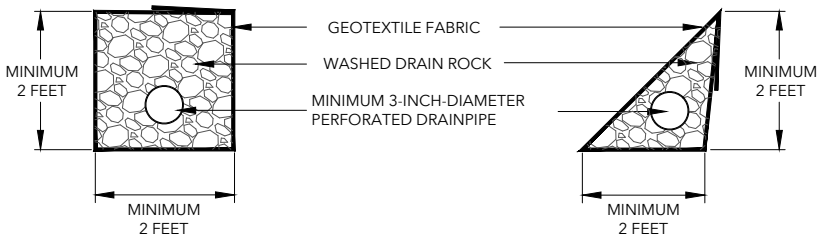


DRAIN SPECIFICATIONS

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.

TYPICAL DRAIN SECTION DETAIL



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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 6

APPENDIX A

APPENDIX A
FIELD EXPLORATIONS

GENERAL

We explored subsurface conditions at the site by excavating six test pits (TP-1 through TP-6) to depths between 7 and 12 feet BGS. Excavation services were provided by L&S Contractors of Yacolt, Washington, on May 28, 2026, using a track-mounted excavator. The explorations were continuously logged by a qualified member of Columbia West's staff. The exploration logs are presented in this appendix.

The approximate 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

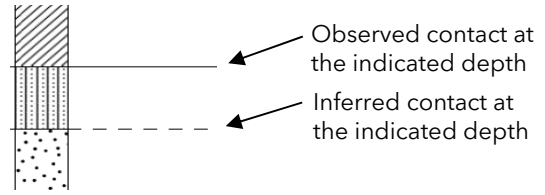
Representative disturbed samples of soil observed in the test pit explorations were collected from the test pit walls and bases using the excavator bucket. Sampling methods and intervals are shown on the exploration logs.

SOIL CLASSIFICATION

Descriptions of sampling methods and the abbreviations used on the exploration logs are presented on the "Exploration Legend" and the soil samples were classified in the field in accordance with the "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

SAMPLING METHOD	DESCRIPTION
SPT	Sample collected from the indicated depth in general accordance with ASTM D1586, *Standard Test Method Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils,* using an SPT sampler and 140-pound hammer
SH	Sample collected from the indicated depth in general accordance with ASTM D1587, *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes,* using a thin-walled Shelby tube, or in general accordance with ASTM D6519, *Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler,* using a thin-walled tube
D&M	Sample collected from the indicated depth in general accordance with ASTM D3550, *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils,* using a Dames & Moore sampler and 140-pound hammer or pushed
CSS	Sample collected from the indicated depth in general accordance with ASTM D3550, *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils,* using a 3-inch-outside diameter California split-spoon sampler and 140-pound hammer
DP	Sample collected from the indicated depth in general accordance with ASTM D6282, *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations,* using a direct-push soil sampler
GRAB	Grab sample collected from the indicated depth
CORE	Pavement or rock core interval at the indicated depth



GEOTECHNICAL ABBREVIATIONS			
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
ENVIRONMENTAL ABBREVIATIONS			
CA	Sample submitted for chemical analysis	ND	Not detected
		NS	No sheen
PID	Photoionization detector headspace analysis	SS	Slight sheen
		MS	Moderate sheen
ppm	Parts per million	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 FINE-GRAINED 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 COARSE-GRAINED 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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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-1

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 8:02 AM
LOGGED BY N. Casas
TIME COMPLETED 8:24 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Dense, brown silty GRAVEL with cobbles, moist, gravel is fine to coarse and subangular, cobbles are approximately 5-10% (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Dense, brown silty GRAVEL with cobbles, moist, gravel is fine to coarse and subangular, cobbles are approximately 5-10% - **FILL**.	Grab	TP1.1			
			3.5					
			Loose to medium dense, dark brown-black silty GRAVEL, trace organics (roots), wet, gravel is fine to coarse and subangular. 4.5	Grab	TP1.2			
5	GM		Medium dense to dense, brown silty GRAVEL with sand, moist, gravel is fine to coarse and subrounded, sand is fine to coarse. Without organics at 5 feet. 8.0					Slight organic odor; likely remnant organics from the previously stripped topsoil layer.
			Exploration completed at 8 feet.					
10								

GROUNDWATER: Not observed

CAVING: Minor at 5 feet

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TEST PIT NUMBER: TP-2

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 8:28 AM
LOGGED BY N. Casas
TIME COMPLETED 8:47 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Medium dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subangular (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Medium dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subangular - **FILL**. 4.0	Grab	TP2.1			
5	GM		Loose to medium dense, dark brown-black silty GRAVEL, wet, gravel is fine to coarse and subangular. 5.0	Grab	TP2.2			Slight organic odor; likely remnant organics from the previously stripped topsoil layer.
			Dense, brown silty GRAVEL, moist, gravel is fine to coarse and subrounded. 8.0					
			Exploration completed at 8 feet.					
10								

GROUNDWATER: Slow to moderate seepage at 5 feet (perched)

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-3

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 8:49 AM
LOGGED BY N. Casas
TIME COMPLETED 9:05 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subangular (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subangular - **FILL**. With cobbles, cobbles are approximately 5-10% at 1 foot. Without cobbles and organics at 3 feet. 4.0					
5	ML		Medium stiff, brown SILT with sand, gravel, and cobbles, moist, sand is fine to coarse, gravel is fine to coarse and subrounded. 9.0	Grab	TP3.1			
			Exploration completed at 9 feet.					
10								

GROUNDWATER: Not observed
CAVING: Not observed

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Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT NUMBER: TP-4

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 9:06 AM
LOGGED BY N. Casas
TIME COMPLETED 9:38 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subrounded (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subrounded - **FILL**.					
			With cobbles, without organics, cobbles are approximately 5-10% at 2 feet.	Grab	TP4.1			
			Without cobbles at 3 feet. 3.0					
			Very dense, light brown silty SAND with gravel, moist, sand is fine to coarse, gravel is fine to coarse and subrounded, strong cementation.	Grab	TP4.2			
5	SM		7.0					
			Exploration completed at 7 feet.					
10								

GROUNDWATER: Not observed

CAVING: Not observed

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Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT NUMBER: TP-5

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 9:42 AM
LOGGED BY N. Casas
TIME COMPLETED 10:09 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subrounded (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Dense, brown silty GRAVEL, trace organics, moist, gravel is fine to coarse and subrounded - **FILL**. With cobbles, without organics, cobbles are approximately 5-10% at 2 feet. 5.0					
5	GM		Loose to medium dense, dark brown silty GRAVEL, trace organics (roots), moist, gravel is fine to coarse and subangular. With cobbles, cobbles are approximately 10-20% at 6 feet. Without cobbles at 8 feet. 10.0	Grab	TP5.1			Slight organic odor; likely remnant organics from the previously stripped topsoil layer.
10			Dense, brown silty GRAVEL, moist, gravel is fine to coarse and subrounded. 11.0	Grab	TP5.2			
			Exploration completed at 11 feet.					

GROUNDWATER: Not observed

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-6

PROJECT NAME Parklands II Short Plat
CLIENT MAS1A LLC
PROJECT NO. MAS1A-1-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/28/2026
EQUIPMENT CAT 307E2, 3-foot toothed bucket
TIME STARTED 10:11 AM
LOGGED BY N. Casas
TIME COMPLETED 10:40 AM

DEPTH (ft)	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE ID	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
			Dense, brown silty GRAVEL with cobbles, trace organics, moist, gravel is fine to coarse and subrounded, cobbles are approximately 5-10% (6 inches of topsoil, 4-inch-thick root zone). 0.5					
			Dense, brown silty GRAVEL with cobbles, trace organics, moist, gravel is fine to coarse and subrounded, cobbles are approximately 5-10% - **FILL**. 4.0	Grab	TP6.1			
5	GM		Loose to medium dense, dark brown-black silty GRAVEL with cobbles, trace organics (roots), moist, gravel is fine to coarse and subangular, cobbles are approximately 5-10%.	Grab	TP6.2			Slight organic odor; likely remnant organics from the previously stripped topsoil layer.
			Without cobbles and organics at 8 feet. 9.0					
10			Dense, brown silty GRAVEL, moist, gravel is fine to coarse and subrounded. 12.0					
			Exploration completed at 12 feet.					

GROUNDWATER: Not observed

CAVING: Not observed

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APPENDIX B

APPENDIX B
DOCUMENT LIMITATIONS AND IMPORTANT INFORMATION

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This document has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and consulting and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This document 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 document 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 document, it may not be valid. Columbia West cannot accept responsibility for use of this document 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.

Document Conclusions and Preliminary Nature

This document should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soil based on conditions observed during site exploration. The exploration and associated laboratory testing of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the site. 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 exploration logs. This document 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 document is based on observations 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. Document conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the site. Groundwater conditions, if presented in this document, reflect observed conditions at the time of exploration. 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 document is necessary. Even slight variations in site or subsurface conditions may produce impacts to the performance of structures 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 document.

Therefore, this document 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 soil is exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this document or future performance of structures if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

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Uncontaminated samples of soil or rock collected in connection with this document will be retained for 30 days. Retention of such samples beyond 30 days will occur only at client's request and in return for payment of incurred storage charges. All contaminated or environmentally impacted material or samples are the sole property of the client. Client maintains responsibility for proper disposal.

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Geotechnical documents, 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 document is usually less than that necessary for contractor's needs. Contractors should be advised of these document limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this document, but should rely on 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 purpose of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

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