GEOTECHNICAL ENGINEERING STUDY

Proposed 2531 NE 3rd Avenue Subdivision
2531 NE 3rd Avenue
Camas, Clark County, WA 98607

Prepared for:

DD&C, LLC
418 Date Street
Vancouver, WA 98660

Prepared By:

Seth A. Chandlee
Project Manager

Paul Williams, PE
Project Engineer

Project No. G0941800
{August 2018}

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Soil and Water Technologies, Inc.

Geotechnical & Environmental Consultants

DD&C, LLC.
418 Date Street
Vancouver, WA 98661

August 21st, 2018
G0941800

Attention: Bryan Desgrosellier

Hello Bryan,

We are pleased to submit our report titled "Geotechnical Engineering Study with Infiltration Testing, Proposed 2531 NE 3rd Avenue Subdivision located at 2531 NE 3rd Avenue, Camas, Clark County, Washington." This report presents the results of our field exploration, selective laboratory tests, and engineering analyses.

Based on the results of this study, it is our opinion that construction of the proposed residential development is feasible from a geotechnical standpoint, provided recommendations presented in this report are included in the project design.

We appreciate the opportunity to have been of service to you and look forward to working with you in the future. Should you have any questions about the content of this report, or if we can be of further assistance, please call.

Respectfully Submitted,
Soil and Water Technologies, Inc.

PAUL WILLIAMS
STATE OF WASHINGTON
43138
REGISTERED
PROFESSIONAL ENGINEER
8/21/18

Seth A. Chandlee
Project Manager

Paul Williams, PE
Project Engineer

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INTRODUCTION

General

This report presents the results of the geotechnical engineering study completed by Soil and Water Technologies, Inc. (SWT) for the proposed 2531 NE 3rd Avenue Subdivision located in Camas, Clark County, Washington. The general location of the site is shown on the *Vicinity Map, Figure 1.* Our approximate exploratory test pit locations are shown in relation to the site on the *Site Plan, Figure 2.*

The purpose of this study is to explore and evaluate subsurface conditions at the site and provide geotechnical recommendations for the proposed construction based on the soil conditions encountered. These recommendations include site specific geotechnical parameters for foundation support, earthwork grading, utility trench backfill, roadway construction, drainage, erosion control and a seismic hazard evaluation.

Project Description

Based on the preliminary site plan information provided by DD&C, LLC, it is our understanding that the approximate one-acre property will be developed into a total of twelve (12) residential building lots. The project will also include associated underground utilities, an asphalt paved roadway, stormwater management facilities and a park area. Although no specific grading plan was available at the time of our study, we anticipate that earthwork cuts/fills will range from approximately one to four feet (1-4') in thickness across the site. The proposed residences will most likely be constructed with wood frames, suspended floors and slab on grade garage floors.

At the time this report was written, specific structural design loads were not available. However, based on our experience with similar projects, we anticipate that wall loads will be approximately seven hundred to one thousand five hundred (700 -1,500) pounds per lineal foot. Slab-on-grade garage floor loads will most likely range from one hundred to one hundred and fifty pounds per square foot (100-150 psf).

If any of the above information is incorrect or changes, we should be consulted to review the recommendations contained in this report. In any case, it is recommended that Soil and Water Technologies perform a general review of the final design.

SITE CONDITIONS

Surface

The rectangular shaped property is located approximately one-tenth of a mile east of the intersection of NE 3rd Avenue and NE Wedgewood Court in Camas, Washington. The subject property is bordered on the north by forested land, to the east by high-density residential development, to the west by single family residences and on the south by NE 3rd Avenue.

The property slopes gently downwards from the north to the south at an approximately 10H:1V (horizontal: vertical) slope gradient. The maximum total elevation change across the site is approximately forty feet (40'). At the time of our field investigation the southern half of the property was vegetated with brambles and with native shrubs and trees at the northern half of the property. While onsite, we observed one partially demolished residence. It is our understanding that this building will be completely demolished prior to site construction.

Subsurface

On August 3rd, 2018 we observed the exploration of three test pits with an excavator, designated I-1 TP-2, and TP-3. All exploration locations were selected by SWT to determine subsurface conditions in the vicinity of the proposed building lots, pavement areas and stormwater facilities. The approximate locations are shown on the *Site Plan, Figure 2.*

All soil was classified in general accordance with the *Unified Soil Classification System (USCS).* Soil samples obtained from the test pits were returned to our office for additional evaluation and laboratory testing. Descriptions of field and laboratory procedures are included in Appendices A and B, respectively.

The following is a generalized description of the subsurface units encountered.

SURFACE MATERIALS: Surface materials encountered in the explorations consisted of 4 to 6 inches of organic topsoil in all test pit locations.

SILT: Native Silt (ML), was encountered below the surface materials in test pits TP-2 and TP-3, extending to a maximum explored depth of 10 feet below ground surface. In general, the Silt was brown, with medium plasticity and moist. The consistency of the Silt ranged from medium stiff to hard. The moisture content of samples from this unit ranged from 19 to 23 percent.

SILTY GRAVEL: Native silty Gravel (GM), was encountered below the surface materials in test pit I-1 and extended to a maximum depth of 2 feet below ground surface. In general, the silty Gravel was brown and moist. The consistency of the silty Gravel was medium dense and became cleaner with depth.

SANDY GRAVEL: Native sandy Gravel (GP), was encountered below the silty Gravel in test pit I-1 and extended to a maximum explored depth of 12.5 feet below ground surface. In general, the sandy Gravel was grayish brown and moist. The consistency of the sandy Gravel was dense. The moisture content of samples from this unit ranged from 4 to 12 percent. Fines content of samples ranged from 4 to 6 percent.

Please refer to our test pit logs, Plates A2 through A4 for a more detailed description of the conditions encountered at each location explored.

Infiltration Testing

Infiltration testing was performed in the vicinity of the proposed onsite stormwater tract. The approximate location of the infiltration test pit is shown on the *Site Plan, Figure 2.* It is our understanding that the proposed stormwater tract is to provide stormwater treatment and control for all onsite impervious surfaces. Infiltration testing was performed at a depth of five and one-half feet (5.5') below the existing ground surface at I-1, in accordance with the 2016 Clark County Stormwater Management Manual guidelines.

In general, the test consists of driving a six-inch diameter pipe six inches into the exposed ground surface at the bottom of the test pit. The pipe is filled with water and the soil around the bottom of the pipe is saturated for several hours. The pipe is filled again and the amount of time required for the water to fall, per inch, for six inches, is recorded. This step is performed a minimum of three times. The test results are averaged, recorded and the field infiltration rate is calculated in inches per hour. Infiltration testing was performed at the site on August 3rd, 2018.

All soil was classified following the *Unified Soil Classification System* (USCS) and the *AASHTO Soil Classification System (M145).* The following table provides the field infiltration test results and associated laboratory testing:

Location	USCS* Soil Type	AASHTO Soil Type	Depth (ft.)	% Passing #200 sieve	Moisture content	Field-Measured Infiltration Rate
I-1	GP	A-1-a	5.5	4%	7%	4.0 iph

* Unified Soil Classification System / iph - inches per hour

The infiltration rate presented is not a permeability/hydraulic conductivity, but an average field-measured rate and does not include correction factors related to long-term infiltration rates. It is recommended that the designer include correction factors to account for the level of maintenance, type of system, vegetation, siltation, etc. The rate is dependent on the percentage of fines in the soil (i.e., silt and clay), the degree of soil saturation and the relative density of the in-situ soil. Field measured infiltration rates are typically reduced by a minimum factor of 2 to 4 for use in design.

Due to the subsurface conditions encountered, rates of infiltration and our laboratory test results, it is our opinion that the on-site soils in the vicinity of the of I-1 at the lower, southern side of the property are suitable for the infiltration of stormwater.

Groundwater

No groundwater was encountered to the maximum depth of exploration at our test pits. Our review of water well logs from the Washington Department of Ecology database indicates that the static groundwater level in the area is greater than one-hundred feet (100') below the surface.

It is important to note that groundwater conditions are not static; fluctuations may be expected in the level and seepage of flow depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the groundwater level is higher and seepage rate is greater in the wetter winter months (typically October through May). The static groundwater level may approach the ground surface during these months.

General Regional Geology

General information about geologic conditions and soils in the vicinity of the site was obtained by reviewing the Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon (2008).

In the vicinity of the subject property, a low elevation bench slopes upwards and generally northeastward towards the Cascade Mountain Range. The underlying bedrock is poorly exposed Oligocene epoch (34 to 23 mya) basaltic andesite flows emplaced by eruptions from the nearby Elkhorn Mountain during the early formation of the regional segment of the Cascade volcanic arc. The bedrock's appearance is usually limited to steep slopes and cliff faces, landslide scarps, and streambeds and is overlain by Neogene-Quaternary period (23 to 2.5 mya) fine-grained Hillsboro soil series.

The material encountered in our test pits consists predominantly of basaltic andesite overlain by brown Silt, consistent with the fine-grained Hillsboro soil series, and Gravel (at I-1) which we interpret to represent weathered Late Pleistocene coarse-grained sedimentary flood deposits.

Geologic Hazards

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

Slope and Landslide Hazards:

A review of the Clark County Maps Online for the site indicates the slopes at the northernmost side of of the site exceed 15% and are mapped as areas of potential slope instability and subject to review prior to development. Title 40, Section 40.430.C.2 Geologic Hazard Areas, of the Clark County, Washington, Unified Development Code defines potential landslide hazard areas as areas meeting all three of the following characteristics: 1) slopes steeper than 15%; 2) Hillsides intersecting geologic contacts with permeable sediment overlying low permeable sediment or bedrock, and; 3) Any springs or groundwater seepage.

While we did observe slopes greater than 15%, we did not observe the other two necessary characteristics of potential landslide areas. Based upon the results of our site reconnaissance, our experience with localized soils in the area and definitions of a geologic hazard area provided by Clark County Unified Development Code, the subject building area does not meet Clark County's definition of a geologic hazard area. It is our opinion that the proposed development as planned will not create a risk of increased slope instability at the site.

Seismic Hazards:

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

<u>Ground Motion Amplification:</u> Based on a review of Clark County Maps Online, the site is designated as seismic Site Class "B/C". However, based on our field explorations and recommendations below, it is our opinion that a Site Class "D" is appropriate for use at the site. Our seismic design criteria, which are partially based on the site class designation, are included in the Geotechnical Design Recommendations portion of this report.

<u>Liquefaction</u>: Structures are subject to damage from earthquakes due to direct and indirect action. Shaking represents direct action. Indirect action is represented by foundation failures and is typified by liquefaction. Liquefaction occurs when soil loses all shear strength for short periods of time during an earthquake. Ground shaking of sufficient duration then results in the loss of grain-to-grain contact as well as a rapid increase in pore water pressure. This causes the soil to assume the physical properties of a fluid.

To have potential for liquefaction a soil must be loose, cohesion-less (generally sands and silts), below the groundwater table, and must be subjected to sufficient magnitude and duration of ground shaking.

Based on the anticipated groundwater table depth, as well as the relative consistency of the exposed bedrock, we consider the potential for liquefaction within the site boundaries to be very low. Indeed, the site is mapped as having a "Bedrock" to "Very Low" liquefaction susceptibility based on the Liquefaction Susceptibility Layer of Clark County Maps Online.

GEOTECHNICAL DESIGN RECOMMENDATIONS

General

Based on the results of our study, it is our opinion the proposed residential subdivision can be constructed as planned, provided the geotechnical recommendations contained in this report are incorporated into the final design. The following sections present detailed recommendations and parameters pertaining to the geotechnical engineering design for this project.

Foundations

Based on the encountered subsurface soil conditions, preliminary building design criteria, and assuming compliance with the preceding *Site Earthwork and Grading* section, the proposed building foundations may be supported on conventional shallow spread footings bearing on undisturbed medium stiff to hard native Silt.

Individual spread footings or continuous wall footings providing support for the proposed building may be designed for a maximum allowable bearing value of 2,000 pounds per square foot (psf). Footings for one level structures should be at least 12 inches in width. Footings for two level structures should be at least 15 inches in width. Footings for three level structures should be at least 18 inches in width. All footings should extend to a depth of at least 12 inches below the lowest adjacent finished sub grade.

These basic allowable bearing values are for dead plus live loads and may be increased one-third for combined dead, live, wind, and seismic forces. It is estimated that total and differential footing settlements for the relatively light residential buildings will be approximately one and one-half inches, respectively.

Slab on Grade

If concrete floor slabs are desired, then any disturbed soils must be re-compacted prior to pouring concrete. Satisfactory subgrade support for lightly-loaded building floor slabs can be obtained on the undisturbed native soil or on engineered structural fill. A subgrade modulus of 125 pounds per cubic inch (pcf) may be used to design floor slabs.

A minimum 6-inch-thick layer of free draining fill should be placed and compacted over the prepared subgrade to assist as a capillary break and blanket drain.

It is also suggested that nominal reinforcement such as "6X6-10/10" welded wire mesh be employed, near midpoint, in new concrete slabs. In areas where slab moisture is undesirable, a vapor barrier such as a 6-mil plastic membrane should be placed beneath the slab.

Site Drainage

The site should be graded so that surface water is directed off the site. Water should not be allowed to stand in any area where buildings or foundations are to be constructed. Loose surfaces should be sealed at the end of each workday by compacting the surface to reduce the potential of moisture infiltrating into the soils. Final site grades should allow for drainage away from the building foundations.

The ground should be sloped at a gradient of three percent for a distance of at least ten feet away from the buildings. We recommend that a foundation footing drain be installed around the perimeter of the buildings. The drain should consist of a four-inch diameter perforated pipe with holes facing down and installed in an envelope of clean drain rock or pea gravel wrapped with free draining filter fabric. The drain should be a minimum of one-foot-wide and one-foot-deep with sufficient gradient to initiate flow. The drain should be routed to a suitable discharge area and rock spalls placed at the outlet to dissipate flow from the system. Details for the footing drain have been included as *Figure 3, Footing and Drainage Detail.*

Under no circumstances should the roof down spouts be connected to the perimeter building drain. We suggest that clean outs be installed at several accessible locations to allow for the periodic maintenance of the drain system.

Pavement Areas

Asphaltic Cement (AC) and Crushed Rock Base (CRB) materials should conform to WSDOT specifications. All pavement area subgrades should be compacted to at least 95 percent of the ASTM D1557 modified proctor laboratory test standard. We recommend that a minimum of 3 inches of AC underlain by 8 inches of compacted CRB in the vicinity of all paved roadway areas.

Exterior concrete slabs that are subject to vehicle traffic loads should be at least four inches in thickness. It is also suggested that nominal reinforcement such as "6x6-10/10" welded wire mesh be installed, near midpoint, in new exterior concrete slabs and paving. Fiber mesh concrete may be used in lieu of welded wire mesh.

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

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

Seismic Design Criteria:

Supportive foundation soils encountered at the site are classified as a type "D" soil in accordance with "Site Class Definitions (IBC 2006, Section 1613, Table 1613.5.2; page 303). For more detail regarding soil conditions refer to the soil logs in Appendix A of this report.

The seismic design criteria for this project found herein is based on the International Building Code (IBC) 2012/2015 and the USGS website. A summary of IBC seismic design criterion is below.

Table 1. 2012/2015 IBC Seismic Design Parameters

Location (Latitude: 45.588908°, Longitude: -122.380502°)	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.859 g	S_1 = 0.366 g
Site Class	D	
Site Coefficient	F_a = 1.156	F_v = 1.668
Adjusted Spectral Acceleration	S_{MS} = 0.993 g	S_{M1} = 0.611 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.662 g	S_{D1} = 0.407 g

g – acceleration due to gravity

CONSTRUCTION RECOMMENDATIONS

Site Earthwork and Grading

Clearing and Grubbing:

Prior to grading, the project area should be cleared of all rubble, trash, debris, etc. Any buried organic debris, undocumented fill or other unsuitable material encountered during subsequent excavation and grading work should also be removed. Excavations for removal of any existing footings, slabs, walls, utility lines, tanks, and any other subterranean structures should be processed and backfilled in the following manner:

- Clear the excavation bottom and side cuts of all loose and/or disturbed material.
- Once the organic topsoil has been adequately removed, the upper one foot of native soil shall be scarified to twelve (12) inches in depth and dried to within 2 percent of its optimal moisture content and re-compacted. Density testing shall be performed prior to placement of additional fill.
- Prior to placing backfill, the excavation bottom should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to at least 95 percent of the ASTM D-1557 laboratory test standard.
- Backfill should be placed, moisture conditioned (i.e., watered and/or aerated as required and thoroughly mixed to a uniform, near optimum moisture content), and compacted by mechanical means in approximate 6-inch lifts. The degree of compaction obtained should be at least 95 percent of the ASTM D-1557 laboratory test standard, as applicable.

It is also critical that any surficial sub grade materials disturbed during initial demolition and clearing work be removed and/or re-compacted in the course of subsequent site preparation earthwork operations.

If encountered, it is important that all soft, undocumented fill is to be over-excavated and replaced with suitable structural fill. Supporting the proposed buildings on homogeneous material will significantly decrease the potential for differential settlement across the foundation area. In order to create uniform sub grade support conditions, the following earthwork operations are recommended:

- Over-excavate existing soils to a competent native subgrade below the bottom of the proposed foundations. The excavations should extend at least one-half width laterally beyond the foundation footprint, or as constrained by existing structures.
- The fill soils placed shall consist of clean soils with an expansion index (EI) less than twenty (20), and be free of organic material, debris, and rocks greater than three inches in maximum diameter. Based on the field observations and laboratory testing, the existing native soil is suitable for use as structural fill so long as the material does not exceed three (3) inches in diameter and is within two percent (2%) of its optimum moisture content prior to compaction.
- The backfill shall consist of minimum ninety-five percent (95%) compacted fills (Note: ASTM D1557). In addition to the relative compaction requirements, all fills shall be compacted to a firm non-yielding condition.
- Import soils should be sampled, tested, and approved by SWT prior to arrival on site. Imported soils shall consist of clean soils (EI of 20 or less) free from vegetation, debris, or rocks larger than three inches in maximum dimension.

Subgrade Verification and Proof Rolling

After clearing and grading the site, it is possible that some localized areas of soft, wet or unstable sub grade may still exist. Before placement of any base rock, the sub grade should be scarified eight inches in depth and compacted with suitable compaction equipment. Yielding areas that are identified should be excavated to medium dense material and replaced with compacted two inch-minus clean crushed rock. All building and pavement areas should be compacted to a dense non-yielding condition with suitable compaction equipment. This phase of earthwork compaction shall be performed prior to the placement of any structural fill, at the bottom of all foundation excavations and along the roadway sub-grade, before the placement of base rock.

Wet Weather Construction & Moisture Sensitive Soils:

Field observations and laboratory testing indicates that Silt (ML) encountered at the site is a moisture sensitive material. As such, in an exposed condition, moisture sensitive soil can become disturbed during normal construction activity, especially when in a wet or saturated condition. Once disturbed, in a wet condition, these soils will be unsuitable for support of foundations, floor slabs and roadways.

Therefore, where soil is exposed and will support new construction, care must be taken not to disturb their condition. If disturbed soil conditions develop, the affected soil must be removed and replaced with structural fill. The depth of removal will be dependent on the depth of disturbance developed during construction. Covering the excavated area with plastic and refraining from excavation activities during rainfall will minimize the disturbance and decrease the potential degradation of supportive soils.

Utility Support and Backfill

Based on the conditions encountered, the soil to be exposed by utility trenches should provide adequate support for utilities. Utility trench backfill is a concern in reducing the potential for settlement along utility alignments, particularly in pavement areas. It is also important that each section of utility line be adequately supported in the bedding material. The backfill material should be hand tamped to ensure support is provided around the pipe haunches.

Fill should be carefully placed and hand tamped to about twelve inches above the crown of the pipe before any compaction equipment is used. The remainder of the trench back fill should be placed in lifts having a loose thickness of eight inches.

A typical trench backfill section and compaction requirements for load supporting and non-load supporting areas is presented on *Figure 4, Utility Trench Backfill Detail*.

Imported granular material or on-site native soil to be used as backfill should be submitted to our laboratory at least one week prior to construction so that we can provide a laboratory proctor for field density testing. If native soil is planned for use as backfill, additional testing will be required to determine the suitability of the material.

Temporary Excavations

The following information is provided solely as a service to our client. Under no circumstances should this information be interpreted to mean that SWT is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred. In no case should excavation slopes be greater than the limits specified in local, state and federal safety regulations.

Based on the information obtained from our field exploration and laboratory testing, the onsite soils expected to be encountered in excavations will most likely consist of native medium stiff to hard Silt (ML) and sandy Gravel (GP). These soils would be classified as a type "C" soil. Therefore, temporary excavations and cuts greater than four feet in height, should be sloped at an inclination no steeper than 1½ H:1V (horizontal to vertical).

If slopes of this inclination, or flatter, cannot be constructed, or if excavations greater than four feet in depth are required, temporary shoring may be necessary. This shoring would help protect against slope or excavation collapse and would provide protection to workmen in the excavation. If temporary shoring is required, we will be available to provide shoring design criteria, if requested.

LIMITATIONS

Our recommendations and conclusions are based on the site materials observed, selective laboratory testing, engineering analyses and other design information provided to Soil and Water Technologies as well as our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pits. Soil and groundwater conditions between the test pits may vary from those encountered. The nature and extent of variations may not become evident until construction. If variations do appear, Soil and Water Technologies should be requested to reevaluate the recommendations contained in this report and to modify or verify them in writing prior to proceeding with the proposed construction.

ADDITIONAL SERVICES & EARTHWORK MONITORING

Soil and Water Technologies will be available to provide consultation services related to review of the final design to verify that the recommendations within our purview have been properly interpreted and implemented in the approved construction plans and specifications. A representative from our office will be available to attend a pre-construction meeting to discuss and/or clarify all geotechnical issues related to the proposed project.

In addition, it is suggested that our office be retained to provide geotechnical services during construction to observe compliance with the design concepts and project specifications and to allow design changes in the event subsurface conditions differ from those anticipated. Our construction services would include monitoring and documenting the following:

- Verify the removal of organic strippings and other deleterious material.
- Verify over-excavation and replacement of undocumented fills, where encountered.
- Observe the placement and compaction of structural fill at building areas, utility trenches and roadways.
- Perform laboratory tests on structural fill source and roadway base rock materials.
- Perform density tests on structural fill and utility trench backfill.
- Verify the field rate of infiltration.
- Monitor proof rolling of roadway subgrade and base rock.
- Perform density testing on roadway base rock and asphalt pavement.
- Concrete Testing (i.e. Temp., Slump, Air, Compressive Strength), if required.
- Provide certified erosion control design, monitoring and consulting.
- Provide written field reports and electronically submit to all associated parties.

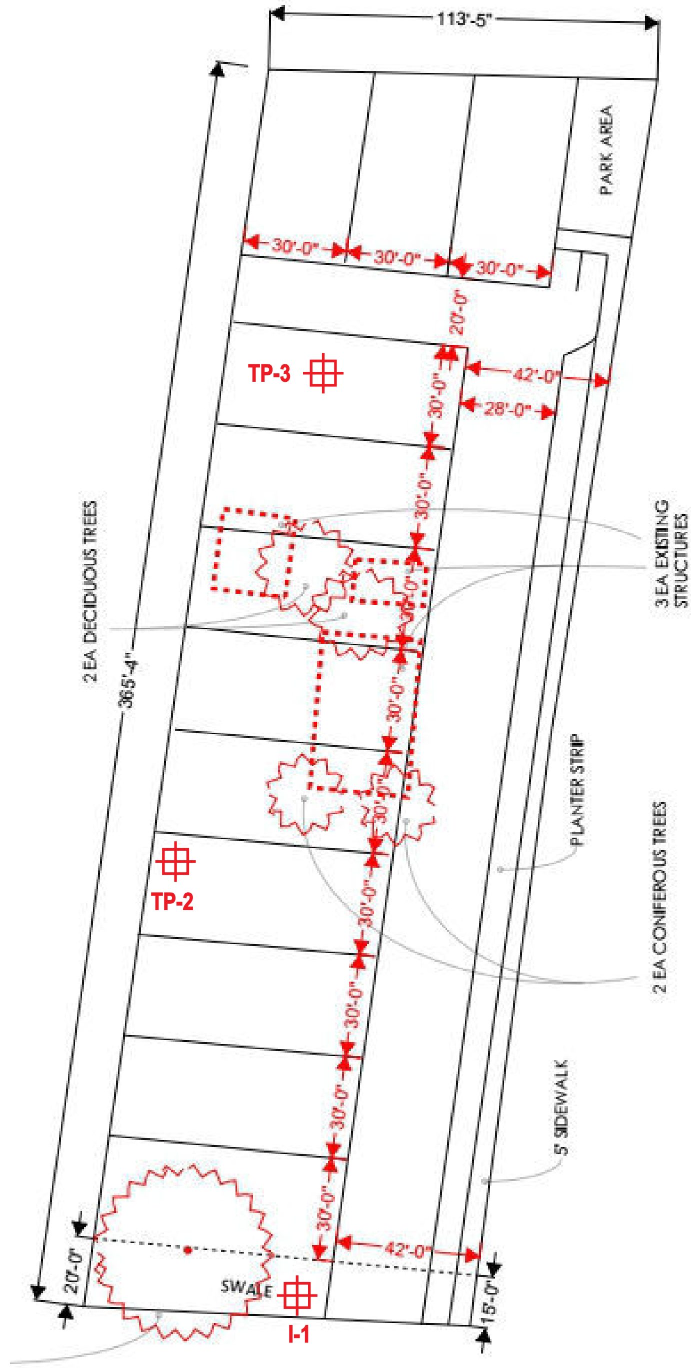
VICINITY MAP

N
Not to Scale

Soil and Water Technologies, Inc PO Box 59 Vancouver, WA 98666 PH: 360 281-5406 www.swt.ski	*CLIENT:* DD&C, LLC	*DRAWN:*	JR
	PROJECT: 2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	*DATE:*	7/30/2018
		FIGURE:	1
		PRO. #:	G0941800

SITE MAP

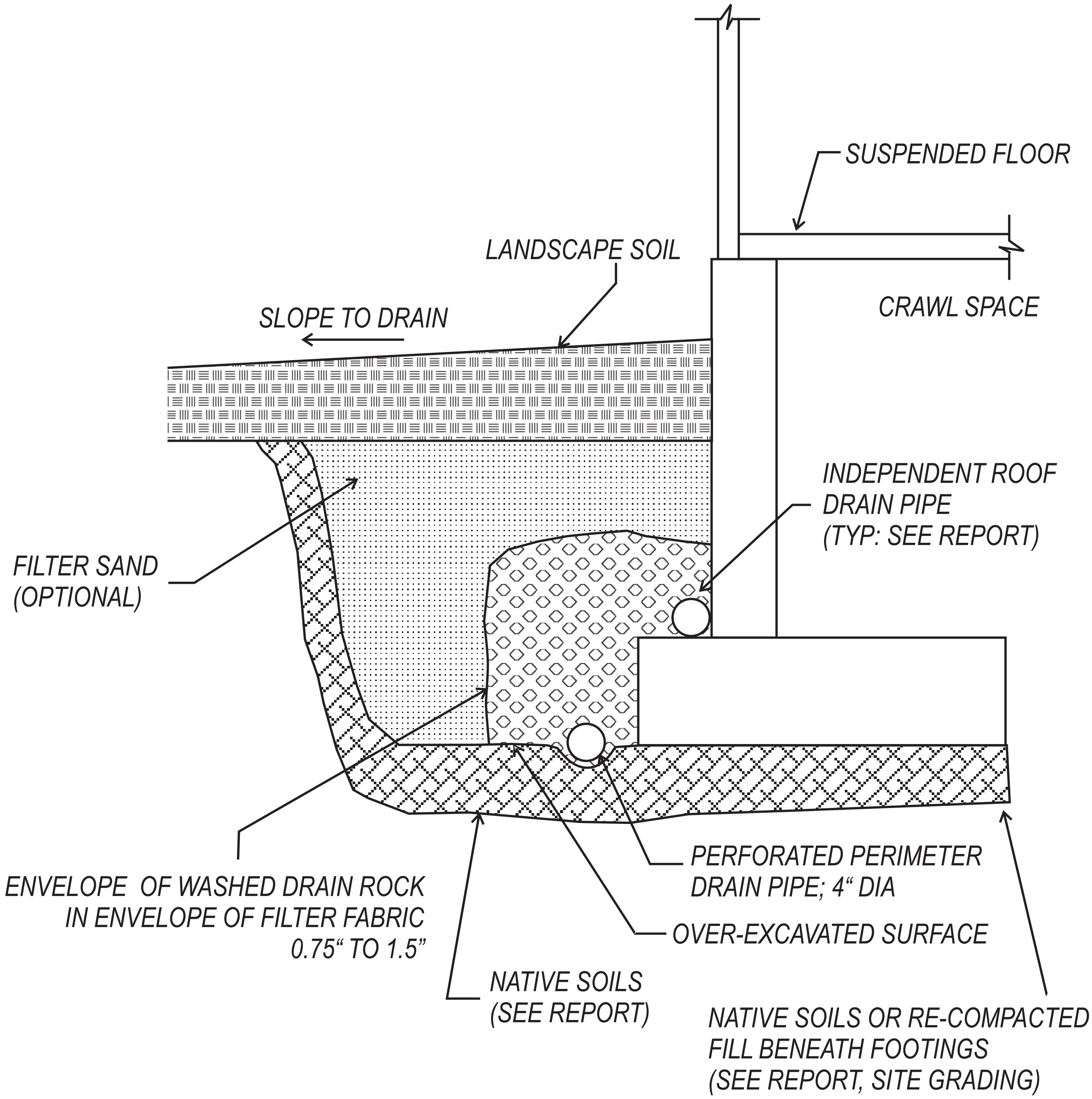
N
Not to Scale



Legend

TP-2 ⌖ Approximate Test Pit Location

Soil and Water Technologies, Inc PO Box 59 Vancouver, WA 98666 PH: 360 281-5406 www.swt.ski	*CLIENT:* DD&C, LLC	*DRAWN:* JR	
	PROJECT: 2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	*DATE:* 7/30/2018	
		FIGURE: 2	
		PRO. #: G0941800	



NOTES:

1. FILTER SAND - FINE AGGREGATE FOR PORTLAND CEMENT; SECTION 9=03.1(2)
2. PERFORATED OR SLOTTED RIGID PVC PIPE WITH A POSITIVE DRAINAGE GRADIENT
3. NATIVE SOIL COMPACTED TO 95% (STANDARD PROCTOR ASTM D698)

FOOTING DRAINAGE DETAIL

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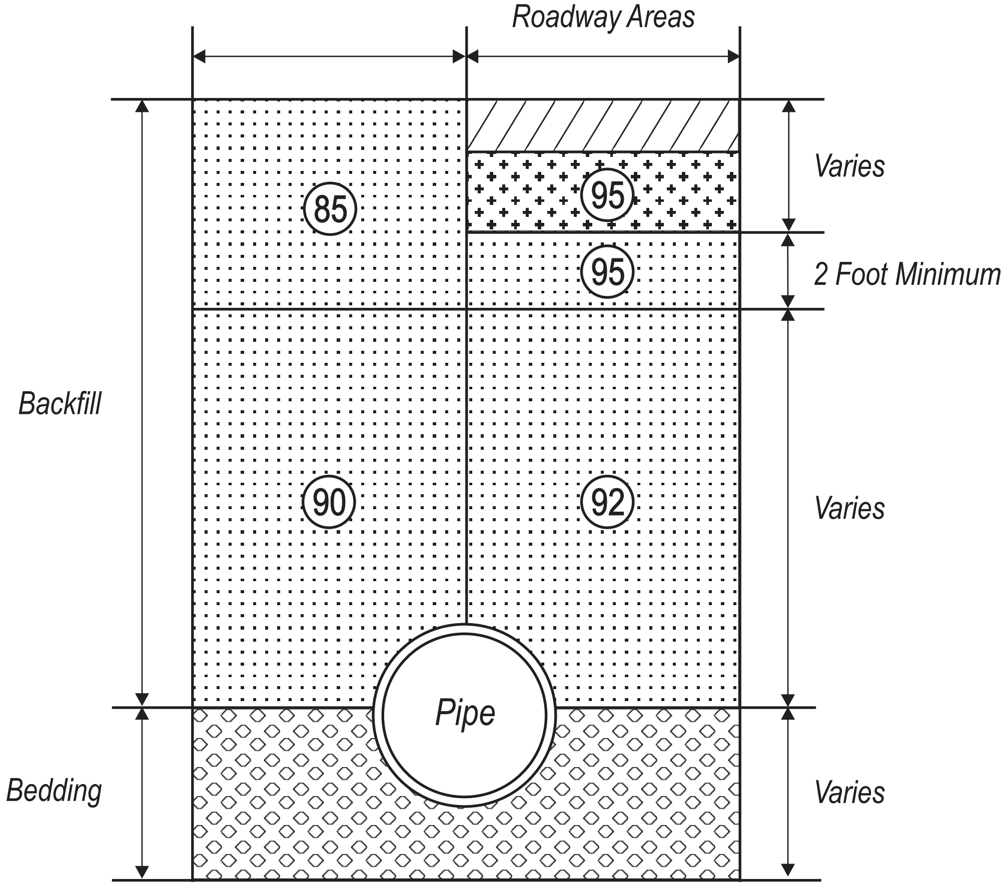
PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	7/30/2018
		FIGURE:	3
		PRO. #:	G0941800



LEGEND

Asphalt or Concrete Pavement

Roadway Base Material or Base Rock

Backfill: Compacted on-site soil or imported select fill material as described in the site preparation of the general Earthwork Section of the attached report text.

(92) Minimum percentage of maximum Laboratory Dry Density as determined by ASTM Test method D1557 (Modified Proctor),unless otherwise specified in the attached report text.

Bedding Material: Material type depends on type of pipe and laying conditions. Bedding should conform to the manufacturer's recommendations for the type of pipe selected.

UTILITY TRENCH BACKFILL DETAIL

Not to Scale

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PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	7/30/2018
		FIGURE:	4
		PRO. #:	G0941800

APPENDIX A

(FIELD EXPLORATION)

FIELD EXPLORATION

Our field exploration was performed on August 3rd, 2018. Subsurface conditions at the site were explored by excavating three test pits to the maximum depth of twelve and one-half feet (12.5') below the existing ground surface. The test pits were excavated by the use of a 135 class track hoe.

The approximate test pit locations were determined by pacing from existing site features. The locations should be considered accurate only to the degree implied by the method used. These approximate locations are shown on the *Site Plan, Figure 2.*

The field exploration was monitored by two Soil and Water Technologies representatives, who classified the soil encountered and maintained a log of each test pit, obtained representative samples, and observed pertinent site features. Representative soil samples were placed in closed containers and returned to the laboratory for further examination and testing.

All samples were visually classified in accordance with the Unified Soil Classification System (USCS), which is presented on *Plate A1*. Logs of the test pits are presented in *Appendix A*. The final logs represent our interpretations of the field logs and the results of the laboratory tests on field samples. The stratification lines on the logs represent the approximate boundaries between soil types. In fact, the transitions may be more gradual.

UNIFIED SOIL CLASSIFICATION SYSTEM LEGEND

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils More Than 50% Material Larger Than No 200 Sieve Size	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No 4 Sieve	Clean Gravels (little or no fines)		GW gw	Well-Graded Gravels, Gravel-Sand Mixtures Little or no Fines
				GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines (appreciable amount of fines)		GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No 4 Sieve	Clean Sand (little or no fines)		SW sw	Well-graded Sands, Gravelly Sands Little or no Fines
				SP sp	Poorly-Graded Sands, Gravelly Sands Little or no Fines
		Sands with Fines (appreciable amount of fines)		SM sm	Silty Sands, Sand-Silt Mixtures
				SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More Than 50% Material Smaller Than No 200 Sieve Size	Silts and Clays	Liquid Limit Less than 50		ML ml	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ slight Plasticity
				CL cl	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
				OL ol	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit Greater than 50		MH mh	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
				CH ch	Inorganic Clays of High Plasticity, Fat Clays
				OH oh	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT pt	Peat, Humus, Swamp Soils with High Organic Contents

Topsoil		Humus and Duff Layer
Fill		Highly Variable Constituents

SAMPLING DESCRIPTIONS

Grab Sample	SPT Drive Sampler (ASTM D1586)	Shelby Tube Push Sampler (ASTM D1587)	Dames and Moore Drive Sampler (ASTM D3550)

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CLIENT:	DD&C, LLC	DRAWN:	JR
PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	7/30/2018
		PLATE:	A1
		PRO. #:	G0941800

LOG OF TEST PIT I-1

ELEVATION: **+/- 43 feet**
EXPLORATORY EQUIPMENT: **135 CLASS TRACK HOE**
DATE: **8/3/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
0–0.5		~ 6" Soft, dark brown, Organic Topsoil, dry				
0.5–2		Medium dense, brown, (Native) **silty Gravel (GM)**, *with sand, moist*				
2–12.5		Dense, brownish gray, **sandy Gravel (GP)**, *with cobbles trace silt moist* - Unfactored field infiltration rate of 4.0" inches per hour @ 5.5 bgs				
3	●			4	6	
5.5	●			7	4	
8	●			12	5	

Bottom of test pit at 12.5 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	8/7/2018
		PLATE:	A2
		PRO. #:	G0941800

LOG OF TEST PIT **TP-2**

ELEVATION: ***+/- 52 feet***
EXPLORATORY EQUIPMENT: ***135 CLASS TRACK HOE***
DATE: ***8/3/2018***

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 4-6" Soft, dark brown, Organic Topsoil, dry				
1		*Med. stiff to hard, brown,* **Silt (ML)** *moist*				
2	●			19	-	5.0 TSF
3						Gray Mottling
4						
5	●			23	-	Atterberg Limits LL - 26 PL - 18 PI - 8
6						
7						
8	●			22	-	
9						
10		(Native)				

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered.

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DRAWN: JR
DATE: 8/20/2018
PLATE: A3
PRO. #: G0941800

LOG OF TEST PIT **TP-3**

ELEVATION: ***+/- 60 feet***
EXPLORATORY EQUIPMENT: ***135 CLASS TRACK HOE***
DATE: ***8/3/2018***

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 4-6" Soft, dark brown, Organic Topsoil, moist				
1–5	● (3)	*Med. stiff to hard, brown,* **Silt (ML)** *moist*		23	-	
6		*Basaltic andesite bedrock (Native)*				*Refusal*

Bottom of test pit at 6.0 feet below existing ground surface.
Refusal due to weathered basaltic andesite bedrock.
No groundwater or groundwater seepage encountered.

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CLIENT:	DD&C, LLC	DRAWN:	JR
PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	8/20/2018
		PLATE:	A4
		PRO. #:	G0941800

APPENDIX B

(LABORATORY TESTING)

LABORATORY TESTING

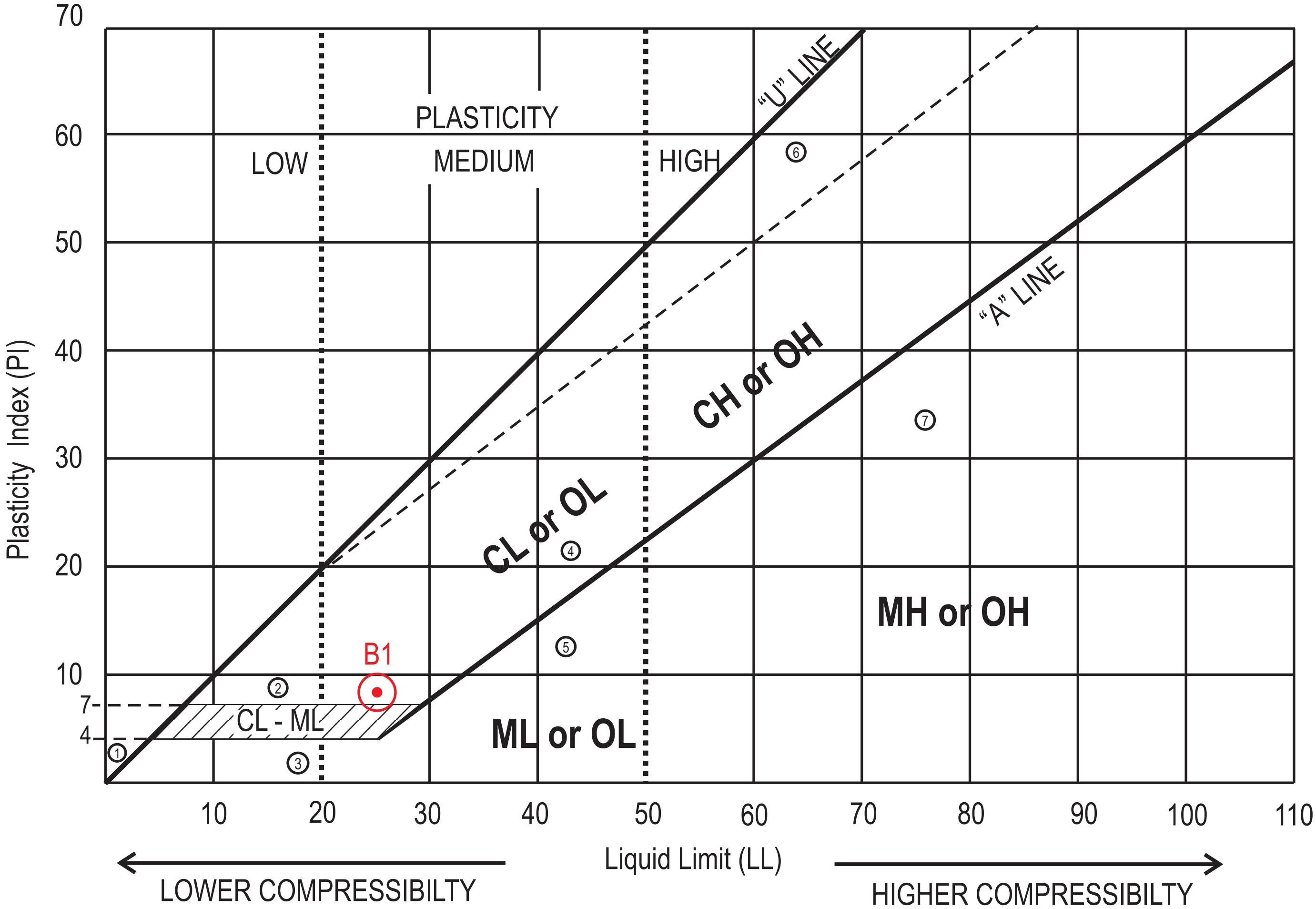
Laboratory tests were conducted on representative soil samples to verify or modify field soil classifications, and to evaluate the general physical properties and engineering characteristics of the soils encountered.

The following provides information about the testing procedures performed on representative soil samples:

- Moisture Content Tests (ASTM-D2216) were performed on representative samples.
- Atterberg Limits Testing (ASTM-D4318) was performed on one representative sample of native Silt to determine the "water-plasticity" ratio of in-situ soil. This test also provides an indication of relative soil strength as well as the potential for soil volume changes with variation in moisture content. Please refer to our Atterberg Limits Charts, Plate B1.
- A Minus 200 Wash (ASTM- C117) was performed on a representative sample collected from the proposed infiltration zone.
- Grain Size Analysis (ASTM-C136) was performed on a representative sample collected from I-1. Please refer to our Grain Size Distribution Chart, G1.

The results of laboratory tests performed on specific samples are provided at the appropriate sample depth on the individual test pit logs. However, it is important to note that some variation of subsurface conditions may exist. Our geotechnical recommendations are based on our interpretation of these test results.

ATTERBERG LIMITS
(ASTM D4318)



Legend

TP-2 @ 5' - **Silt (ML)**
(LL- 26 - PL-18 - PI-8)

1. COHESIONLESS SOILS
2. INORGANIC CLAYS, LOW PLASTICITY
3. INORGANIC SILTS, LOW COMPRESSIBILTY
4. INORGANIS CLAYS, MEDIUM PLASTICITY
5. INORGANIC SILTS AND ORGANIC CLAYS, MEDIUM COMPRESSIBILITY
6. INORGANIC CLAYS, HIGH PLASTISICTY
7. INORGANIC SILTS AND ORGANIC CLAYS, HIGH COMPRESSIBILTY

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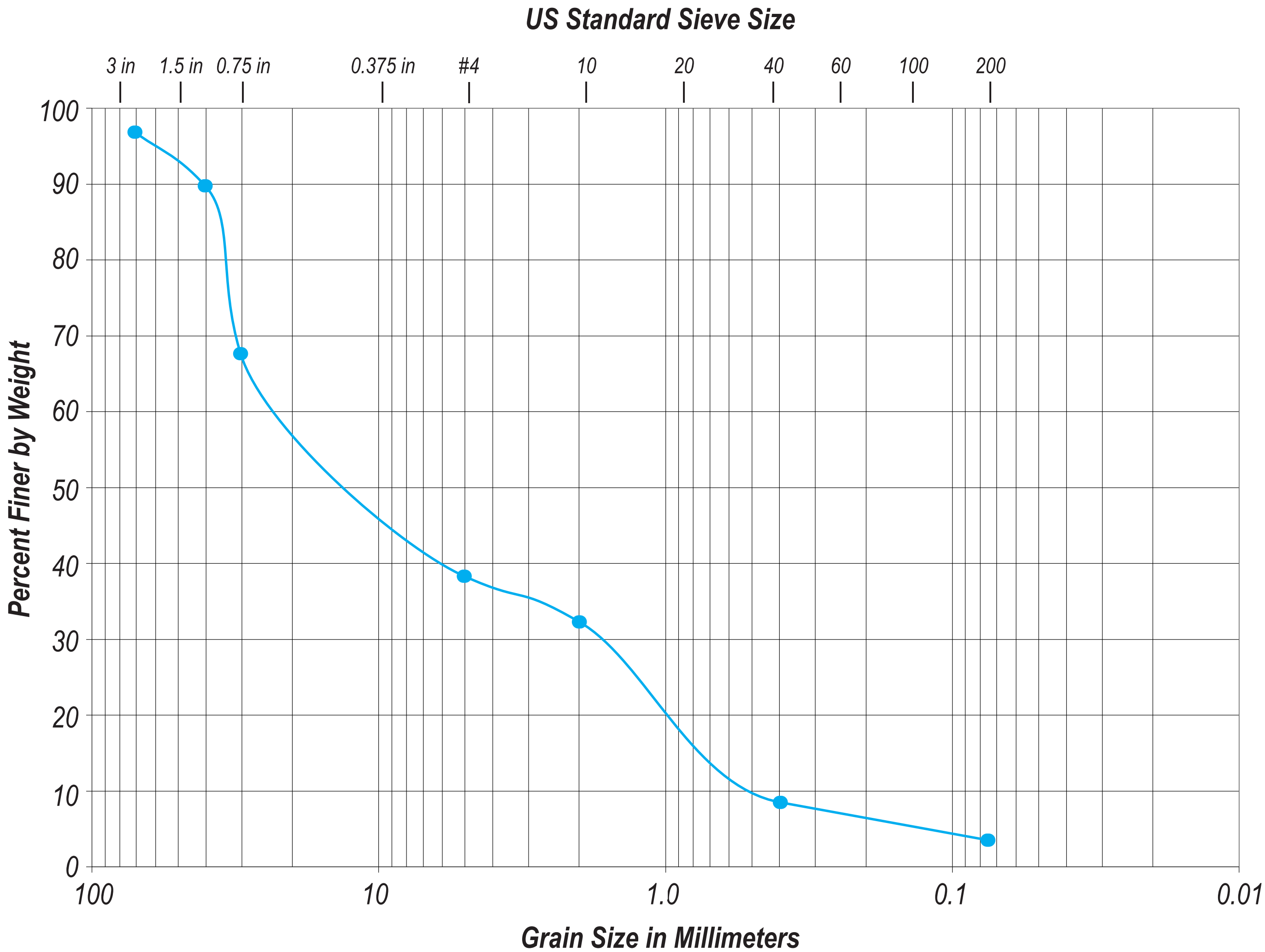
		PRO. #:	G0941800



Gravel		Sand			Silt & Clay
Coarse	Fine	Coarse	Medium	Fine	---

GRAIN SIZE DISTRIBUTION

I-1 at 5.5'
Native poorly-graded sandy Gravel (GP) with cobbles
and 4% passing the #200 Sieve
AASHTO A-1-a

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1 Copy	DD&C, LLC. 418 Date Street Vancouver, WA 98661 Attention: Bryan Desgrosellier