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Geotechnical Engineering Report

Clark County Fairgrounds – Lot F
17402 NE Delfel Road
Ridgefield, Washington

Prepared for:
Clark County
Attn: Mr. Darrel Stump, Facilities Manager
816 W 13th Street
Vancouver, Washington 98660

May 18, 2016
Project No. 73189.000

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 General 1
1.2 Purpose and Scope 1
1.2.1 Subsurface Explorations 1
1.2.2 Soils Testing 1
1.2.3 Geotechnical Engineering Analysis 1
1.2.4 Report Preparation 1
1.3 Project Understanding 1
2.0 SITE CONDITIONS 2
2.1 Surface Description 2
2.2 Subsurface Conditions 2
2.2.1 Soil 2
2.2.2 Groundwater 2
3.0 CONCLUSIONS AND RECOMMENDATIONS 2
3.1 Geotechnical Design Considerations 2
3.2 Recommended Pavement Sections 3
3.2.1 Pavement Design 3
3.2.2 Cement Amendment 3
4.0 CONSTRUCTION RECOMMENDATIONS 4
4.1 Site Preparation 4
4.1.1 Proofrolling/Subgrade Verification 4
4.2 Subgrade Protection 4
4.2.1 Wet-Weather/Wet-Soil Conditions 4
4.2.2 Dry Weather Conditions 5
4.3 Excavation 5
4.4 Slopes 5
4.5 Structural Fill 6
4.5.1 On-Site Soil 6
4.5.2 Select Granular Fill 6
4.5.3 Crushed Aggregate Base 6
4.5.4 Utility Trench Backfill 6
5.0 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS 7
6.0 LIMITATIONS 7
7.0 REFERENCES 9

SUPPORTING DATA

Figures

Figure 1 Vicinity Map
Figure 2 Site Plan

Appendix A – Field Explorations

Table A-1 Terminology Used to Describe Soil and Rock
Table A-2 Key to Test Pit and Boring Log Symbols
Figures A1 – A5 Logs for Borings B-1 through B-5

Appendix B – Laboratory Testing

Figure B1 Atterberg Limits Test Results
Figure B2 Moisture-Density Relationship
Figure B3 Dry Density vs. Soaked CBR
Figure B4 Unconfined Compression – 5 percent cement
Figure B5 Unconfined Compression – 7 percent cement

1.0 INTRODUCTION

1.1 General

This report presents the results of the PBS Engineering and Environmental Inc. (PBS) geotechnical engineering services for the proposed Lot F parking lot rehabilitation for the Clark County Fairgrounds in Ridgefield, Washington. The site location is shown on the Vicinity Map, Figure 1. The exploration locations in relation to existing site features are shown on the Site Plan, Figure 2.

1.2 Purpose and Scope

The purpose of PBS' services was to develop geotechnical design and construction recommendations in support of the proposed parking lot rehabilitation. This was accomplished by performing the following scope of services:

1.2.1 Subsurface Explorations

PBS completed five borings within the proposed parking rehabilitation area. The borings were advanced to depths up to 6.5 feet below the existing ground surface (bgs). These explorations were logged and representative soil samples collected by a member of the PBS geotechnical engineering staff.

1.2.2 Soils Testing

Collected soil samples were transported to our laboratory for testing that included natural moisture contents, Atterberg limits, maximum dry density (Proctor), California Bearing Ratio (CBR), and unconfined compression of cement amended samples (refer, Appendix B – Laboratory Testing).

1.2.3 Geotechnical Engineering Analysis

Data collected during the subsurface explorations and laboratory testing were used to develop specific geotechnical design and construction recommendations, including an option for cement amendment of the subgrade.

1.2.4 Report Preparation

This Geotechnical Engineering Report summarizes the results of our explorations, testing, and analyses, including information relating to the following:

- Boring logs and site plan showing approximate boring locations
- Laboratory test results
- Earthwork and grading, cut, and fill recommendations:
  - Structural fill materials and preparation
  - Wet weather considerations
  - Utility trench excavation and backfill requirements
  - Cement amendment recommendations
- Pavement subgrade preparation
- New pavement section recommendations

1.3 Project Understanding

Based on our May 15, 2015, site meeting, PBS' current understanding is that the chip seal surfacing of Lot F was damaged by a semi-truck and trailer. The truck broke through the wearing course and penetrated into the underlying subgrade, creating ruts. The truck was unable to move under its own power and was ultimately towed away.

The purpose of PBS' services was to evaluate the subsurface conditions within the proposed parking lot rehabilitation footprint and provide pavement design alternatives in support of final reconstruction, rehabilitation, and plans and specifications for use by Clark County (County) for bidding the project.

2.0 SITE CONDITIONS

2.1 Surface Description

The Clark County parking Lot F property is located on the northwestern wing of the Clark County Fairgrounds, bounded by NE 10th Street to the south and grass areas to the west, north, and east. The southern portion of the eastern boundary is bordered by an existing asphalt concrete (AC) pavement parking lot (refer, Figure 2). The property slopes gently to the east, with elevations varying from 312 to 317 feet above mean sea level (amsl) (datum: WGS84 EGM96 Geoid). The surface wearing course is relatively thin, approximately ½ inch thick, with localized AC and gravel patches.

2.2 Subsurface Conditions

2.2.1 Soil

Subsurface conditions at the site were explored on March 15, 2016, by advancing five borings designated as B-1 through B-5. Dan Fischer Excavating, Inc., advanced the borings to depths up to 6.5 feet bgs using a Big Beaver drill equipped with a 3-inch-diameter solid stem auger. The explorations were logged and representative samples collected by a member of the PBS geotechnical engineering staff. Boring logs summarizing the subsurface conditions encountered in the explorations are presented in Appendix A.

PBS has summarized the subsurface units as follows:

SURFACE MATERIALS:	An approximately half-inch-thick chip seal over four to five inches of gravel fill was present at the ground surface.
FINE-GRAINED DEPOSITS	Beneath the surface material, borings encountered very soft to hard fat CLAY (CH) to the depths explored. SPT N-values ranged from 2 to 40. Near surface N-values generally ranged from 2 to 5. Moisture contents ranged form 20 to 30 percent.

The soil types are based on visual-manual classifications using ASTM D 2488-09a guidelines. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil layers were noted. The terminology used in the soil classifications and other modifiers are defined and presented on the attached Table A-1 included in Appendix A.

2.2.2 Groundwater

Groundwater was not encountered during our explorations, however, water runoff from the gravel surface was observed and collected to the top of boring B-1 during exploration. Perched groundwater may be encountered during construction and depths will fluctuate due to variations in rainfall, agricultural irrigation, and the season.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Design Considerations

The subsurface conditions underlying the site consist of very soft to hard clay. Based on our observations and analyses, excavation with conventional equipment is feasible over the majority

of the site. The clay is generally very soft to soft at the near surface and easily disturbed, particularly when wet. Due to the potential for disturbance, we recommend planning construction for dry summer conditions.

3.2 Recommended Pavement Sections

3.2.1 Pavement Design

The provided pavement recommendations were developed using the American Association of State Highway and Transportation Officials (AASHTO) design methods and references the associated Washington Department of Transportation (WSDOT) specifications for construction. In general, traffic will consist primarily of passenger cars and small trucks. During fair season and special events this area may be used as a truck turn-around or for staging. Given the potential for large truck traffic, we have based our traffic estimate on a factor of 2 equivalent single axle loads (ESALs) per truck and a total traffic volume over the 20 year design life of approximately 100,000 ESALs (7 trucks per day).

The minimum recommended pavement sections are provided in Table 1.

Table 1: Minimum AC Pavement Sections

Traffic Loading	AC (inches)	Base Course (inches)	Amended Subgrade* (inches)	Subgrade
Drive Lanes and Access Roads	3.0	12	0	Stiff subgrade as verified by PBS personnel
	3.0	6	12	

* Amend subgrade with a minimum of 5 percent cement to a depth of 12 inches. Must pass proofroll

The asphalt cement (AC) binder should be performance graded according to WSDOT SS 9-02.1(4) – Performance Graded Asphalt Binder. The AC should consist of ½-inch hot mix asphalt (HMA). The maximum lift thickness should be 3.0 inches. The AC should conform to WSDOT SS 5-04.3(7)A – Mix Design, WSDOT SS 9-03.8(2) – HMA Test Requirements, and WSDOT SS 9-03.8(6) – HMA Proportions of Materials. The AC should be compacted to 91 percent of maximum theoretical density (Rice value) of the mix, as determined in accordance with the ASTMD 2041, following the guidelines set in WSDOT SS 5-04.3(10) – Compaction.

Heavy construction traffic on new pavements or partial pavement sections (such as base course over the prepared subgrade) will likely exceed the design loads and could potentially damage or shorten the pavement life. Therefore, we recommend construction traffic not be allowed on new pavements, or that the contractor take appropriate precautions to protect the subgrade and pavement during construction.

If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

3.2.2 Cement Amendment

As an alternative to the use of thicker imported granular material for wet-weather subgrade improvement or structural fill, an experienced contractor should be able to amend the on-site soils with portland cement to obtain suitable support properties. If successfully executed, cement amended subgrade can also be utilized as a subbase layer in the pavement section, thereby reducing the overlying aggregate base course thickness in the pavement section.

Successful use of soil amendment depends on the use of correct mixing techniques, soil moisture content, and cement quantities. We recommend a target strength for cement amended soils of 90 psi. The amount of cement used to achieve this target generally varies with moisture content and soil type. Field performance of soils to cement amendment is difficult to predict due to variability in soil response, and we recommend laboratory testing to confirm expectations. However, for preliminary design purposes, 5 percent cement by weight of dry soil can generally be used when the soil moisture content does not exceed approximately 20 to 25 percent. If the soil moisture content is in the range of 25 to 40 percent, 6 to 7 percent cement by weight of dry soil is recommended. We recommend initially assuming a cement ratio of 5 percent. The cement ratio may need to be adjusted based on field observations and performance at the time of amendment. Due to the presence of clay in the near-surface soil, multiple passes may be required with the tiller to adequately mix cement and achieve the required maximum particle size.

Typically, a minimum curing of 3 days is required between treatment and construction traffic access. The amended surface should be protected from abrasion by placing a minimum of 6 inches of crushed rock. As discussed in sections 3.2.1 and 4.2.1, thicker layers of crushed rock may be required for the pavement section or for staging and haul roads.

Portland cement amended soils are hard and have low permeability. Therefore, these soils do not drain well, nor are they suitable for planting. Areas planned for future planting should not be cement amended, if practical. Otherwise, accommodations should be made for drainage and planting.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

Proposed site grading is unknown at this time. However, based on the proposed site plan, mass grading cuts may be on the order of 1 foot and fills of less than about 3 feet. Stripped vegetation and topsoil should be transported off-site for disposal, or with the owner's approval, stockpiled for re-use in landscaped areas.

4.1.1 Proofrolling/Subgrade Verification

Following site preparation and cement amendment, and prior to placing aggregate base, the exposed subgrade should be evaluated by proofrolling. The subgrade should be proofrolled with a fully-loaded dump truck or similar heavy, rubber-tire construction equipment to identify soft, loose, or unsuitable areas. If evaluation of the subgrades occur during wet conditions, or if proofrolling the subgrades will result in disturbance, they should be evaluated using a steel foundation probe. We recommend that PBS be retained to perform the subgrade verifications.

4.2 Subgrade Protection

4.2.1 Wet-Weather/Wet-Soil Conditions

Due to the presence of fine-grained soil (i.e. clay) in the near-surface materials within the construction area, construction equipment may have difficulty operating on the near-surface soils when above the optimum moisture required for compaction. Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed to firm ground and replaced with compacted structural fill.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads may help reduce further damage to the exposed native subgrade. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic (typically 18 to 24 inches). The actual thickness of haul roads and staging areas should be based on the contractor's approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in lifts no greater than eight inches in thickness over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller.

During wet conditions, where imported granular material is placed over soft-soil subgrades, we recommend a geotextile be placed between the subgrade and imported granular material. Depending on site conditions, the geotextile should meet WSDOT SS 9-33.2 – Geosynthetic Properties for soil separation or stabilization. The geotextile should be installed in conformance with WSDOT SS 2-12.3 – Construction Geosynthetic (Construction Requirements) and, as applicable, WSDOT SS 2-12.3(2) – Separation or WSDOT SS 2-12.3(3) – Stabilization.

Site earthwork and subgrade preparation should not be completed during freezing conditions. We recommend the earthwork construction at the site be performed during the dry season.

4.2.2 Dry Weather Conditions

Medium to high plasticity clay subgrade soils remaining beneath pavements should not be allowed to dry significantly. Clay soils should be covered within 4 hours of exposure by 4 inches of crushed rock or plastic sheeting during the dry season. Exposure of these materials should be coordinated with the geotechnical engineer so that the subgrade suitability can be evaluated prior to being covered.

4.3 Excavation

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and State regulations. The contractor is solely responsible for adherence to the OSHA requirements. Trench cuts should stand relatively vertical to a depth of approximately four feet bgs, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used in the clay, provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. The trenches should be flattened if sloughing occurs or seepage is present. If shallow groundwater is observed during construction, use of a trench shield or other approved temporary shoring is recommended for cuts that extend below groundwater seepage, or if vertical walls are desired for cuts deeper than four feet bgs. If dewatering is used, we recommend that the type and design of the dewatering system be the responsibility of the contractor, who is in the best position to choose systems that fit the overall plan of operation. The near-surface soils at the site can be excavated with conventional earthwork equipment, but sloughing and caving may occur.

4.4 Slopes

If the project will include slopes or open excavation, temporary and permanent cut slopes up to 10 feet high may be inclined at 1.5H:1V and 2H:1V, respectively. Access roads and pavements should be located at least five feet from the top of temporary slopes. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face.

4.5 Structural Fill

The extent of site grading is currently unknown; however, we estimate cuts will be limited to less than about 1 foot and fills limited in thickness to less than 3 feet. Structural fill, including base rock, should be placed over subgrades that have been prepared in conformance with the Site Preparation and Wet-Weather/Wet-Soil Conditions sections of this report. Structural fill material should consist of relatively well-graded soil, or an approved rock product that is free of organic material and debris, and contains particles not greater than 4-inches nominal dimension.

If fill and excavated material will be placed on slopes steeper than 5H:1V, these must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately two feet.

4.5.1 On-Site Soil

On-site soils encountered in our explorations may be suitable for placement as structural fill during moderate, dry weather when moisture contents can be maintained by air drying and/or addition of water. The fine-grained fraction of the site soils are moisture sensitive, and during wet weather, may become unworkable because of excess moisture content. In order to reduce moisture content, some aerating and drying of fine-grained soils will likely be required. The material should be placed in lifts with a maximum uncompacted thickness of approximately 8 inches and compacted to at least 92 percent of the maximum dry density, as determined by ASTM D 1557.

It may be feasible to amend site soils with cement for re-use as structural fill if moisture contents cannot be reasonably reduced to near optimum moisture. On-site soils used as structural fill should be amended with 3 to 5 percent cement and compacted in maximum 8 inch-thick lifts. The next lift of fill should be placed and compacted within four hours of treating the underlying layer of fill. Due to the presence of very soft to soft soils at the site, it will likely be necessary to amend the subgrade prior to placing fill.

4.5.2 Select Granular Fill

Selected granular backfill used during periods of wet weather for structural fill construction should meet the specifications provided in WSDOT SS 9-03.14(2) – Select Borrow. The imported granular material should be uniformly moisture conditioned to within about 2 percent of the optimum moisture content and compacted in relatively thin lifts using suitable mechanical compaction equipment. Selected granular backfill should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557.

4.5.3 Crushed Aggregate Base

Crushed aggregate base course below asphalt concrete should be clean, crushed rock or crushed gravel that contains no deleterious materials, has less than 5 percent by weight passing the US Standard No. 200 Sieve, and meets the specifications provided in WSDOT SS 9-03.9(3) – Crushed Surfacing Top Course or Base Course. The crushed aggregate base course should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557.

4.5.4 Utility Trench Backfill

Utility trench backfill placed beneath, adjacent to, and for at least 2 feet above utility lines (i.e., the pipe zone), should consist of well-graded granular material with a maximum particle size of 1-inch and less than 10 percent by weight passing the US Standard No. 200 Sieve,

and should meet the standards prescribed by WSDOT SS 9-03.12(3) – Gravel Backfill for Pipe Zone Bedding. The pipe zone backfill should be compacted to at least 90 percent of the maximum dry density as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department.

Within pavement areas, the remainder of the trench backfill should consist of well-graded granular material with a maximum particle size of 1½-inches, less than 10 percent by weight passing the US Standard No. 200 Sieve, and should meet standards prescribed by WSDOT SS 9-03.19– Bank Run Gravel for Trench Backfill. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department. The upper two feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557.

Outside of structural improvement areas, trench backfill placed above the pipe zone should consist of excavated material free of wood waste, debris, clods, or rocks greater than 6-inches in diameter and meet WSDOT SS 9-03.14 – Borrow and WSDOT SS 9-03.15 – Native Material for Trench Backfill. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department.

5.0 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

PBS should be retained to review the plans and specifications for this project before they are finalized. Such a review allows us to verify that our recommendations and concerns have been adequately addressed in the design.

Satisfactory earthwork performance depends 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. We recommend that PBS be retained to observe general excavation, stripping, fill placement, and pavement subgrades. 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.

In most cases, other services beyond completion of a geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require the performance of additional work that was not anticipated when the geotechnical report was written. PBS offers a range of environmental, geological, geotechnical, and construction services to suit the varying needs of our Clients.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their engineers, for aiding in the design and construction of the proposed parking lot and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without express written consent of the Client and PBS. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review, field explorations, laboratory testing, and engineering analyses. Soil, rock, or groundwater conditions between, or beyond, our explorations may vary from those encountered. If soil, rock, or groundwater conditions are encountered during construction that differ from those described herein, the Client is responsible for ensuring that PBS is notified immediately so that we may reevaluate the recommendations of this report.

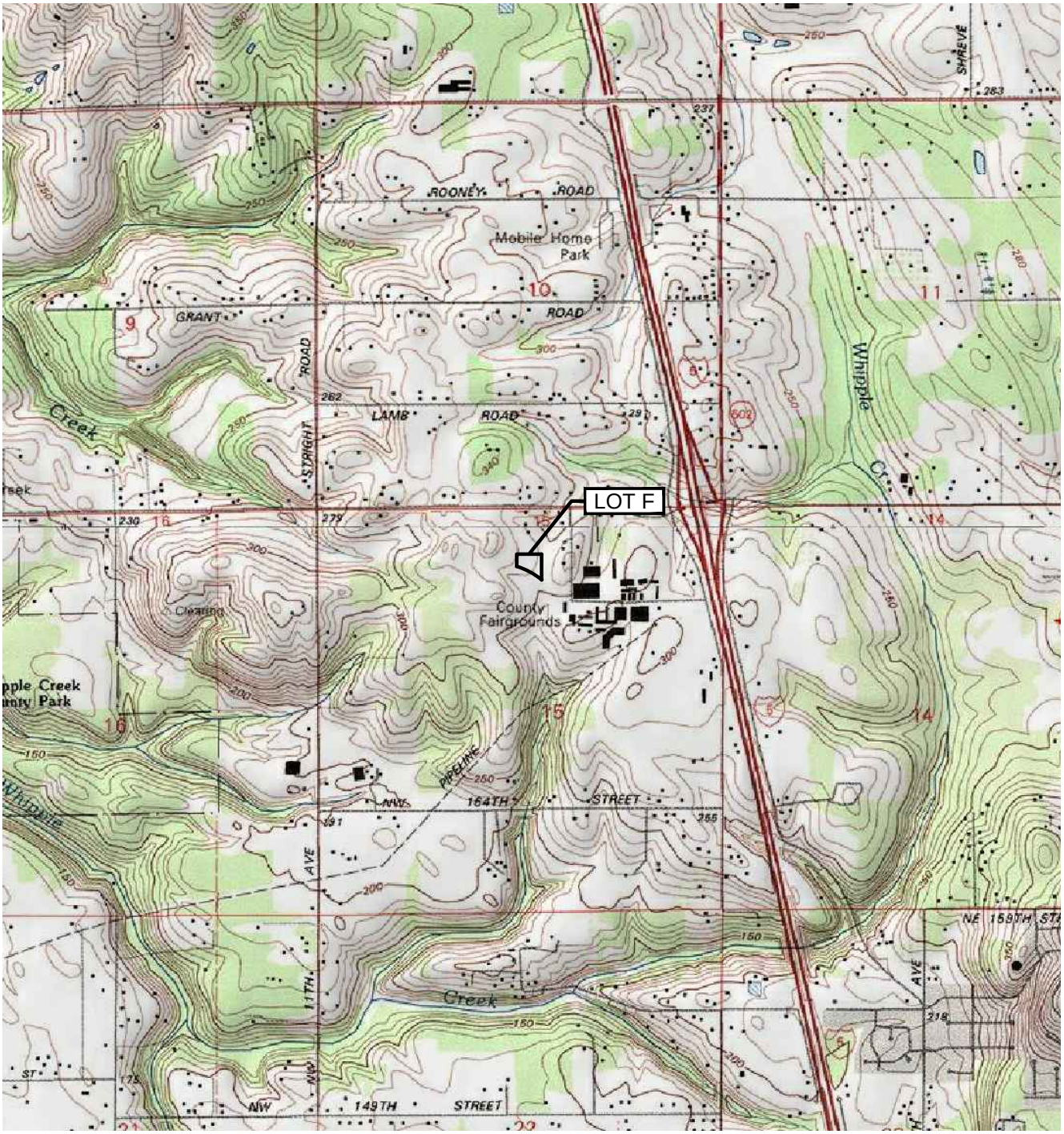
The scope of services for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on and off site), or other factors may change over time and could materially affect our findings. Therefore, this report should not be relied upon after two years from its issue, or in the event that the site conditions change.

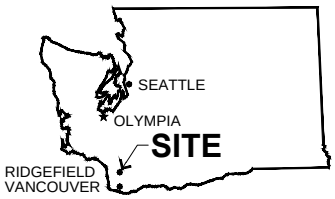
7.0 REFERENCES

WSDOT SS (2016). *Standard Specifications for Road, Bridge, and Municipal Construction, M 41-10*. Olympia, WA. Washington State Department of Transportation.

FIGURES



SOURCE: USGS VANCOUVER, WA OR QUADRANGLE 1990



WASHINGTON

0' 1000' 2000' 4000'

SCALE: 1" = 2,000'

PBS	PROJECT # 73189.000	VICINITY MAP	FIGURE
	DATE MAY 2016	CLARK COUNTY FAIRGROUNDS - LOT F RIDGEFIELD, WASHINGTON	1

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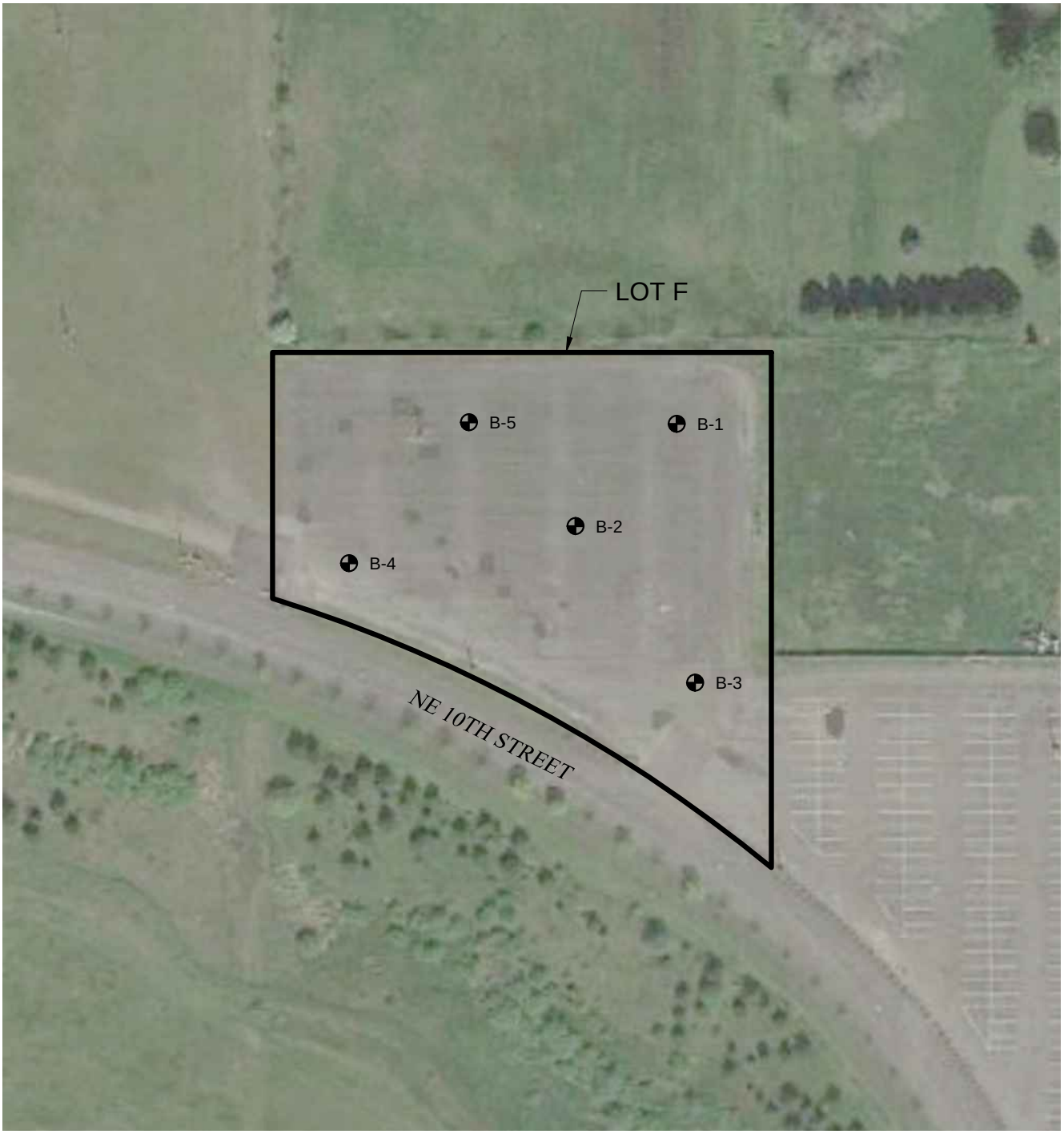

SOURCE: © 2016 GOOGLE EARTH PRO

LEGEND

B-1 BORING NUMBER AND LOCATION

0' 50' 100' 200'

SCALE: 1" = 100'

PBS

PROJECT # 73189.000

DATE MAY 2016

SITE PLAN

CLARK COUNTY FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

FIGURE 2

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APPENDIX A

Field Explorations

APPENDIX A – FIELD EXPLORATIONS

A1.0 GENERAL

PBS explored subsurface conditions at the project site by completing five borings on March 15, 2016. The approximate locations of the explorations, designated B-1 through B-5, are shown on the Site Plan, Figure 2. The procedures and techniques used to advance the borings, collect samples, and other field techniques are described in detail in the following paragraphs. Unless otherwise noted, all soil sampling and classification procedures followed applicable ASTM standards.

A2.0 BORINGS

A2.1 Drilling

The borings were advanced to a depth of about 6.5 feet below ground surface (bgs) with a Big Beaver drill rig provided and operated by Dan J. Fischer Excavating, Inc., of Forest Grove, Oregon. Borings were advanced using solid-stem auger drilling techniques. The borings were observed by a member of the PBS geotechnical engineering staff who maintained a detailed log of the subsurface conditions and materials encountered during the course of the work.

A2.2 Sampling

Disturbed soil samples were taken in the borings at selected depth intervals. The samples were obtained using a standard 2-inch outside diameter (OD), split-spoon sampler following procedures prescribed for the Standard Penetration Test (SPT). Using the SPT, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance, or N-value. The N-value provides a measure of the relative density of granular soils such as sands and gravels, and the consistency of cohesive soils such as clays and plastic silts. The disturbed soil samples were examined by the PBS staff and then sealed in plastic bags for further examination and physical testing in our laboratory.

A2.3 Boring Logs

The logs show the various types of materials that were encountered in the borings and the depths where the materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. The types of samples taken during drilling, along with their sample identification number, are shown to the right of the classification of materials. Standard penetration resistances (N-values) and natural water (moisture) contents are shown further to the right.

A3.0 MATERIAL DESCRIPTION

Initially, soil samples were classified visually in the field. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil samples were noted. Afterward, the samples were reexamined in the PBS laboratory, various standard classification tests were conducted, and the field classifications were modified where necessary. The terminology used in the soil classifications and other modifiers are defined in Appendix A, Table A-1, Terminology Used to Describe Soil.

Soil Descriptions

Soils exist in mixtures with varying proportions of components. The predominant soil, i.e., greater than 50 percent based upon total dry weight, is the primary soil type and is capitalized in our log descriptions, e.g., SAND, GRAVEL, SILT or CLAY. Lesser percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the Visual-Manual Procedure (ASTM D2488-93). "General Accordance" means that certain local and common descriptive practices have been followed. In accordance with ASTM D2488, group symbols (such as GP or CH) are applied on that portion of the soil passing the 3-inch (75mm) sieve based upon visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

Fine - Grained Soils (More than 50% fines passing 0.074 mm, #200 sieve)
The primary soil type, i.e. SILT or CLAY is designated through visual – manual procedures to evaluate soil toughness, dilatency, dry strength, and plasticity. The following describes the terminology used to describe fine - grained soils, and varies from ASTM 2488 terminology in the use of some common terms.

Primary soil NAME, adjective and symbols			Plasticity Description	Plasticity Index (PI)
SILT ML & MH	CLAY CL & CH	ORGANIC SILT & CLAY OL & OH		
SILT		Organic SILT	Non-plastic	0 - 3
SILT		Organic SILT	Low plasticity	4 - 10
Clayey SILT	Silty CLAY	Organic clayey SILT	Medium Plasticity	>10 – 20
Clayey SILT	CLAY	Organic silty CLAY	High Plasticity	>20 – 40
Clayey SILT	CLAY	Organic CLAY	Very Plastic	>40

Modifying terms describing secondary constituents, estimated to 5 percent increments, are applied as follows:

Description	% Composition
Trace sand, trace gravel	5% - 10%
With sand; with gravel	15% - 25%
Sandy, or gravelly	30% - 45%

Borderline Symbols, for example CH/MH, are used where soils are not distinctly in one category or where variable soil units contain more than one soil type. **Dual Symbols,** for example CL-ML, are used where two symbols are required in accordance with ASTM D2488.

Soil Consistency. Consistency terms are applied to fine-grained, plastic soils (i.e., PI $\geq$ 7). Descriptive terms are based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84, as follows.

Consistency Term	SPT N-value	Unconfined Compressive Strength Tons/ft^2	kPa
Very soft	Less than 2	Less than 0.25	Less than 24
Soft	2 – 4	0.25 - 0.5	24 - 48
Medium stiff	5 – 8	0.5 - 1.0	48 – 96
Stiff	9 – 15	1.0 - 2.0	96 – 192
Very stiff	16 – 30	2.0 - 4.0	192 – 383
Hard	Over 30	Over 4.0	Over 383
Very soft	Less than 2	Less than 0.25	Less than 24

Note: For SILT with low to non-plastic behavior, (i.e., PI < 7) a relative density description is applied.

Soil Descriptions

Coarse - Grained Soils (less than 50% fines)
Coarse-grained soil descriptions, i.e., SAND or GRAVEL, are based on that portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488 based upon the degree of grading, or distribution of grain sizes of the soil. For example, well graded sand containing a wide range of grain sizes is designated SW; poorly graded gravel, GP, contains high percentages of only certain grain sizes. Terms applied to grain sizes follow.

Material	Particle Diameter Inches	Particle Diameter Millimeters
Sand (S)	0.003 - 0.19	0.075 - 4.8
Gravel (G)	0.19 - 3.0	4.8 - 75
	Additional Constituents	
Cobble	3.0 - 12	75 - 300
Boulder	12 - 120	300 - 3050
Rock Block	>120	>3050

The primary soil type is capitalized, and the amount of fines in the soil are described as indicated by the following examples. Other soil mixtures will provide similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

5% fines	10% fines (Dual Symbols)	15% to 45% fines
GRAVEL with trace silt: GW or GP	GRAVEL with silt, GW-GM	Silty GRAVEL: GM
SAND with trace clay: SW or SP	SAND with clay, SP-SC	Silty SAND: SM

Additional descriptive terminology applied to coarse-grained soils follow.

Coarse-Grained Soil Containing Secondary Constituents	
Clean	< 5% fines
With sand or with gravel	15% - 25% sand or gravel
Sandy or gravelly	30% - 45% sand or gravel
With cobbles; with boulders	Any amount cobbles or boulders. Additional terms may be used to describe amount including abundant, scattered.

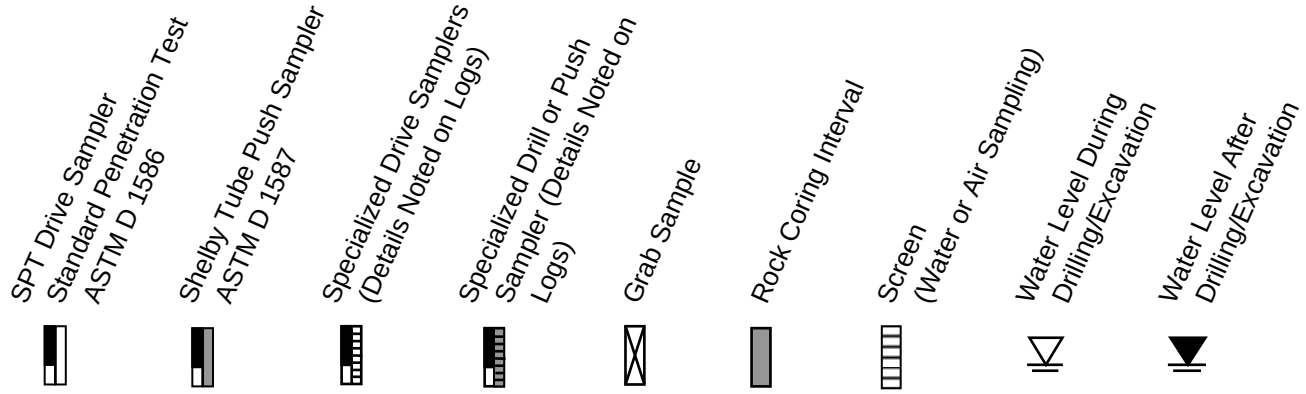
Cobble and boulder deposits may include a description of the matrix soils, as defined above.

Relative Density terms are applied to granular, non-plastic soils based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84.

Relative Density Term	SPT N-value
Very loose	0 - 4
Loose	4 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	> 50

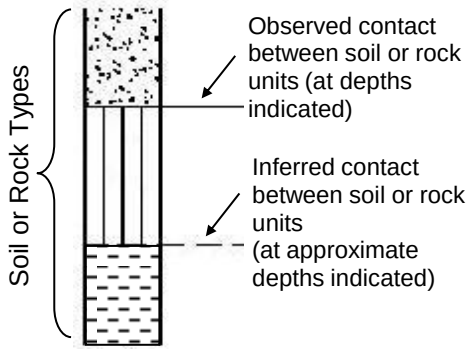
Table A-2
Key To Test Pit and Boring Log Symbols

SAMPLING DESCRIPTIONS[1]

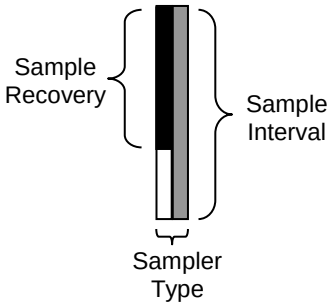


LOG GRAPHICS

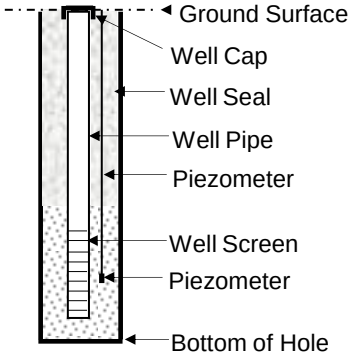
Soil and Rock



Sampling Symbols



Instrumentation Detail



Geotechnical Testing/Acronym Explanations

PP	Pocket Penetrometer	SIEV	Sieve Gradation
SC	Sand Cone	DD	Dry Density
DCP	Dynamic Cone Penetrometer	ATT	Atterberg Limits
SP	Static Penetrometer	CBR	California Bearing Ratio
TOR	Torvane	OC	Organic Content
CON	Consolidation	RES	Resilient Modulus
DS	Direct Shear	VS	Vane Shear
P200	Percent Passing U.S. Standard No. 200 Sieve	HCL	Hydrochloric Acid
UC	Unconfined Compressive Strength	kPa	kiloPascal
PL	Plasticity Limit	GPS	Global Positioning System
PI	Plasticity Index	bgs	Below ground surface
LL	Liquid Limit	MSL	Mean Sea Level
HYD	Hydrometer Gradation		

Environmental Testing/Acronym Explanations

bgs	Below ground surface	ATD	At Time of Drilling
CA	Sample Submitted for Chemical Analysis	NS	No Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
PPM	Parts Per Million	MS	Moderate Sheen
ND	Not Detected	HS	High Sheen

[1]Note: Details of soil and rock classification systems are available on request.

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CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

BORING B-1

PBS PROJECT NUMBER:
73189.000

APPROX. BORING B-1 LOCATION:
45.748752, -122.670861

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE / SAMPLE ID	▲ UNCORRECTED N-VALUE ◇ DYNAMIC CONE PENETROMETER ● MOISTURE CONTENT % RQD% / CORE REC% (0 – 50 – 100)	INSTALLATION AND COMMENTS Surface Conditions: Gravel
0.0		GRAVEL (5 INCHES)					
		Medium stiff brown gray fat CLAY (CH) with rootlets; high plasticity; moist	0.4		S-1	5	Bulk sample taken from 0.5 to 2 feet bgs.
1.0							
2.0		becomes soft			S-2	4	
3.0							
4.0							
5.0		becomes very stiff, brown			S-3	22	
6.0			6.5				
		Boring completed at 6.5 feet bgs; boring backfilled with soil cuttings to existing ground surface. Groundwater not encountered during exploration.					
7.0							
8.0							
9.0							
10.0							

DRILLING METHOD: Big Beaver Auger Drill Rig
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: T. Rikli

BIT DIAMETER: 3 inches
HAMMER EFFICIENCY PERCENT: 60
LOGGING COMPLETED: 3/15/16

FIGURE A1

BORING LOG 73189.000 031616 B1TOB5 TR.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/20/16:RPG

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CLARK CO. FAIRGROUNDS - LOT F
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BORING B-2

PBS PROJECT NUMBER:
73189.000

APPROX. BORING B-2 LOCATION:
45.748516, -122.671144

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	▲ UNCORRECTED N-VALUE ◇ DYNAMIC CONE PENETROMETER ● MOISTURE CONTENT % RQD% CORE REC% 0 50 100	INSTALLATION AND COMMENTS Surface Conditions: Gravel
0.0		GRAVEL (4 INCHES)					
		Medium stiff brown fat CLAY (CH); high plasticity; moist	0.3		S-1	5	Bulk sample taken from 0.5 to 2 feet bgs.
1.0							
2.0		becomes very stiff			S-2	21	
3.0							
4.0							
5.0					S-3	22	
6.0			6.5				
		Boring completed at 6.5 feet bgs; boring backfilled with soil cuttings to existing ground surface. Groundwater not encountered during exploration.					
7.0							
8.0							
9.0							
10.0							

DRILLING METHOD: Big Beaver Auger Drill Rig
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: T. Rikli

BIT DIAMETER: 3 inches
HAMMER EFFICIENCY PERCENT: 60
LOGGING COMPLETED: 3/15/16

FIGURE A2

BORING LOG 73189.000 031616 B1TOB5 TR.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/20/16:RPG

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CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

BORING B-3

PBS PROJECT NUMBER:
73189.000

APPROX. BORING B-3 LOCATION:
45.748219, -122.670860

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE / SAMPLE ID	▲ UNCORRECTED N-VALUE ◆ DYNAMIC CONE PENETROMETER ● MOISTURE CONTENT % RQD% / CORE REC% (0 – 50 – 100)	INSTALLATION AND COMMENTS Surface Conditions: Gravel
0.0		GRAVEL (5 INCHES)					
		Soft brown-gray fat CLAY (CH) with rootlets; high plasticity; moist	0.4		S-1	4	Bulk sample taken from 0.5 to 2 feet bgs.
1.0							
2.0		becomes medium stiff			S-2	7	
3.0							
4.0							
5.0		becomes very stiff, brown			S-3	19	
6.0			6.5				
		Boring completed at 6.5 feet bgs; boring backfilled with soil cuttings to existing ground surface. Groundwater not encountered during exploration.					
7.0							
8.0							
9.0							
10.0							

DRILLING METHOD: Big Beaver Auger Drill Rig
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: T. Rikli

BIT DIAMETER: 3 inches
HAMMER EFFICIENCY PERCENT: 60
LOGGING COMPLETED: 3/15/16

FIGURE A3

BORING LOG 73189.000 031616 B1TOB5 TR.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/20/16:RPG

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CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

BORING B-4

APPROX. BORING B-4 LOCATION:
45.748470, -122.671714

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE / SAMPLE ID	▲ UNCORRECTED N-VALUE ◇ DYNAMIC CONE PENETROMETER ● MOISTURE CONTENT % RQD% / CORE REC% (0 – 50 – 100)	INSTALLATION AND COMMENTS Surface Conditions: Gravel
0.0		GRAVEL (5 INCHES)					
		Very stiff brown fat CLAY (CH); high plasticity; moist	0.4				Bulk sample taken from 0.5 to 2 feet bgs.
1.0					S-1	18	
2.0							
3.0					S-2	19	
4.0							
5.0		becomes hard			S-3	40	
6.0							
		Boring completed at 6.5 feet bgs; boring backfilled with soil cuttings to existing ground surface. Groundwater not encountered during exploration.	6.5				
7.0							
8.0							
9.0							
10.0							

DRILLING METHOD: Big Beaver Auger Drill Rig
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: T. Rikli

BIT DIAMETER: 3 inches
HAMMER EFFICIENCY PERCENT: 60
LOGGING COMPLETED: 3/15/16

FIGURE A4

BORING LOG 73189.000 031616 B1TOB5 TR.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/20/16:RPG

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CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

BORING B-5

APPROX. BORING B-5 LOCATION:
45.748742, -122.671426

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE / SAMPLE ID	▲ UNCORRECTED N-VALUE ◇ DYNAMIC CONE PENETROMETER ● MOISTURE CONTENT % RQD% / CORE REC% (0 – 50 – 100)	INSTALLATION AND COMMENTS Surface Conditions: Gravel
0.0		GRAVEL (5 INCHES)					
		Very soft brown-gray fat CLAY (CH) with rootlets; high plasticity; moist	0.4				Bulk sample taken from 0.5 to 2 feet bgs.
1.0				ATT	S-1	2	LL = 51 PL = 21 PI = 30
2.0		becomes medium stiff					
3.0					S-2	8	
4.0							
5.0		becomes very stiff					
					S-3	23	
6.0			6.5				
		Boring completed at 6.5 feet bgs; boring backfilled with soil cuttings to existing ground surface. Groundwater not encountered during exploration.					
7.0							
8.0							
9.0							
10.0							

DRILLING METHOD: Big Beaver Auger Drill Rig
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: T. Rikli

BIT DIAMETER: 3 inches
HAMMER EFFICIENCY PERCENT: 60
LOGGING COMPLETED: 3/15/16

FIGURE A5

BORING LOG 73189.000 031616 B1TOB5 TR.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/20/16:RPG

APPENDIX B

Laboratory Testing

APPENDIX B – LABORATORY TESTING

B1.0 GENERAL

Samples collected from the field explorations were examined in the PBS laboratory. The physical characteristics of the samples were noted and the field classifications were modified where necessary. The testing procedures are presented in the following paragraphs, and unless noted otherwise, all test procedures were performed in general accordance with applicable ASTM standards. “General accordance” means that certain local and common descriptive practices and methodologies may have been followed.

B2.0 CLASSIFICATION TESTS

B2.1 Visual Classification

The soils were classified in accordance with the Unified Soil Classification System with certain other terminology, such as the relative density or consistency of the soil deposits, in general accordance with engineering practice. In determining the soil type (that is, gravel, sand, silt, or clay) the term that best described the major portion of the sample is used. Modifying terminology to further describe the samples is defined in Terminology Used to Describe Soil in Appendix A.

B2.2 Moisture (Water) Contents

Natural moisture content determinations were made on samples of the fine-grained soils (that is, clay, silts, and silty sands). The natural moisture content is defined as the ratio of the weight of water to dry weight of soil, expressed as a percentage. The results of the moisture content determinations are presented on the test pit and boring logs in Appendix A.

B2.3 Atterberg Limits

Atterberg limits tests were performed on a sample by determining the liquid and plastic limits of the soil. The results of the Atterberg limits testing are presented on the logs in Appendix A and graphically on Figure B1– Atterberg Limits Test Results, in Appendix B.

B3.0 MOISTURE-DENSITY RELATIONSHIP

One laboratory compaction test, modified Proctor (ASTM D 1557), was performed on composite bulk samples to obtain a moisture-density relationship for use in preparing compacted CBR (California Bearing Ratio) specimens. The test results are expressed as a curve of compacted dry density versus molding moisture contents on the attached Figure B2 – Moisture Density Relationship, in Appendix B. The maximum dry density for the composite sample was 115.0 per cubic foot (pcf) with an optimum moisture content of 15.0 percent.

B4.0 CALIFORNIA BEARING RATIO

CBR testing was performed on a composite of bulk samples taken during our explorations. These were completed to determine the relative strength and deformation properties of the subgrade materials for use in pavement design studies. The compacted specimens were prepared by adjusting the moisture content of the soil to 2 to 3 percent wet of optimum moisture, as determined by ASTM D 1557, and compacting the soil into the CBR test molds using 10, 25, and 56 blows per lift. Approximately 100 percent compaction is represented by the energy using 56 blows per lift. The graphical results of CBR testing are presented on the attached Figure B3.

B5.0 UNCONFINED COMPRESSION TESTS

Unconfined compression tests were performed on laboratory prepared soil-cement samples in order to evaluate the compressive strength of composite soil samples amended with various percentages of cement. For each test, a cylindrical test specimen was axially loaded to failure in a test frame at a strain rate of approximately 1 percent per minute. The unconfined compressive strength is the maximum value of load per unit area, or the load per unit area at 20 percent strain, whichever is reached first. The graphical results of the tests are included as Figures B4 and B5.

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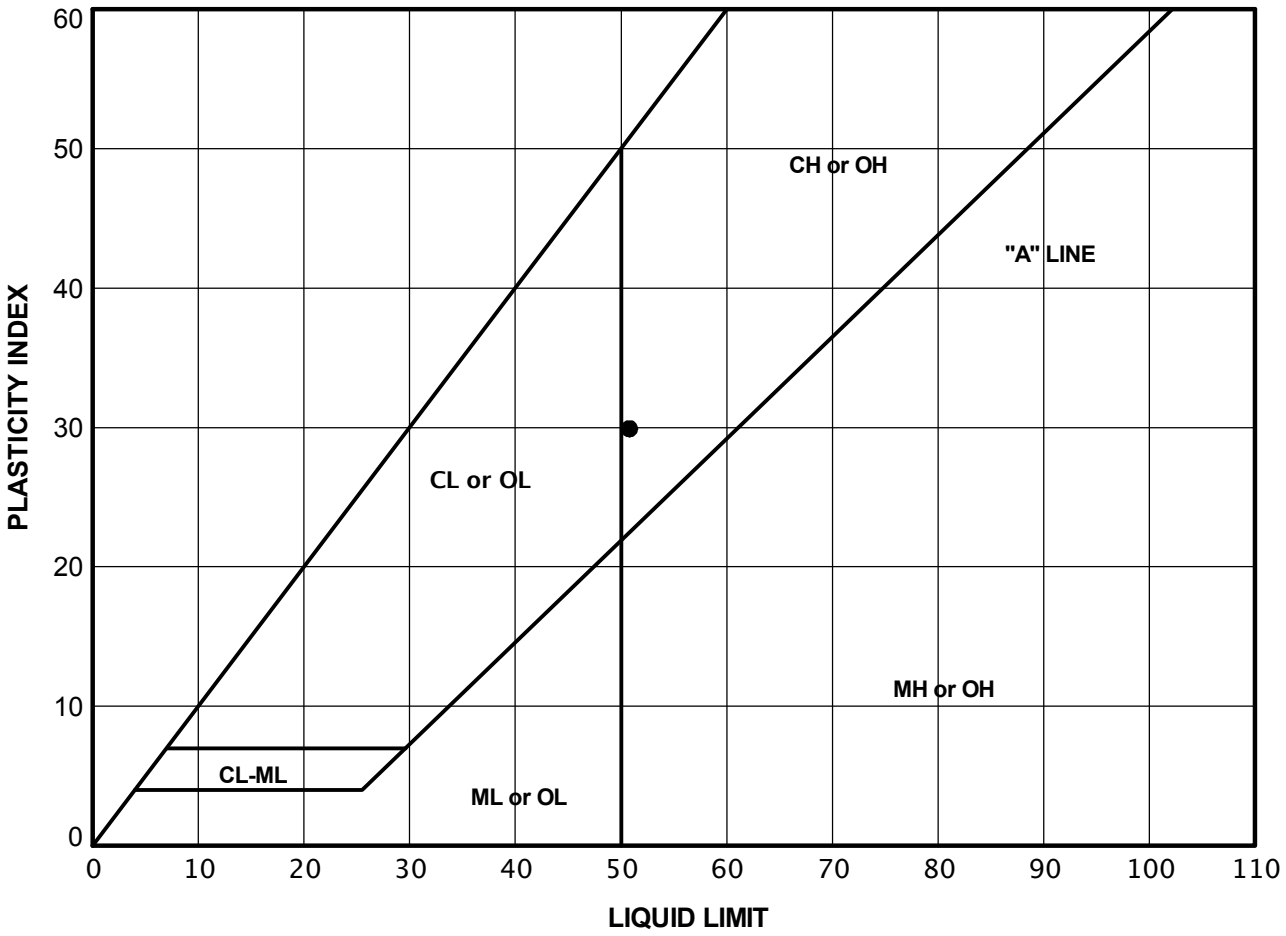
ATTERBERG LIMITS TEST RESULTS

CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

TEST METHOD: ASTM D4318



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	NATURAL MOISTURE CONTENT (PERCENT)	PERCENT PASSING NO. 40 SIEVE (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-5	S-1	1.0	32	NA	51	21	30

FIGURE B1

_ATTERBERG LIMITS 73189.000_031616_B1TOB5_TR.GPJ PBS_DATATMPL_GEO.GDT PRINT DATE: 5/18/16:RW

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MOISTURE- DENSITY RELATIONSHIP

CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

SOURCE OF MATERIAL: COMPOSITE
DESCRIPTION OF MATERIAL: BROWN GRAY CLAY (CH)

TEST METHOD: ASTM D1557 Method A

TEST RESULTS:
Maximum Dry Density 115.0 pcf
Optimum Water Content 15.0 %

NOTES:

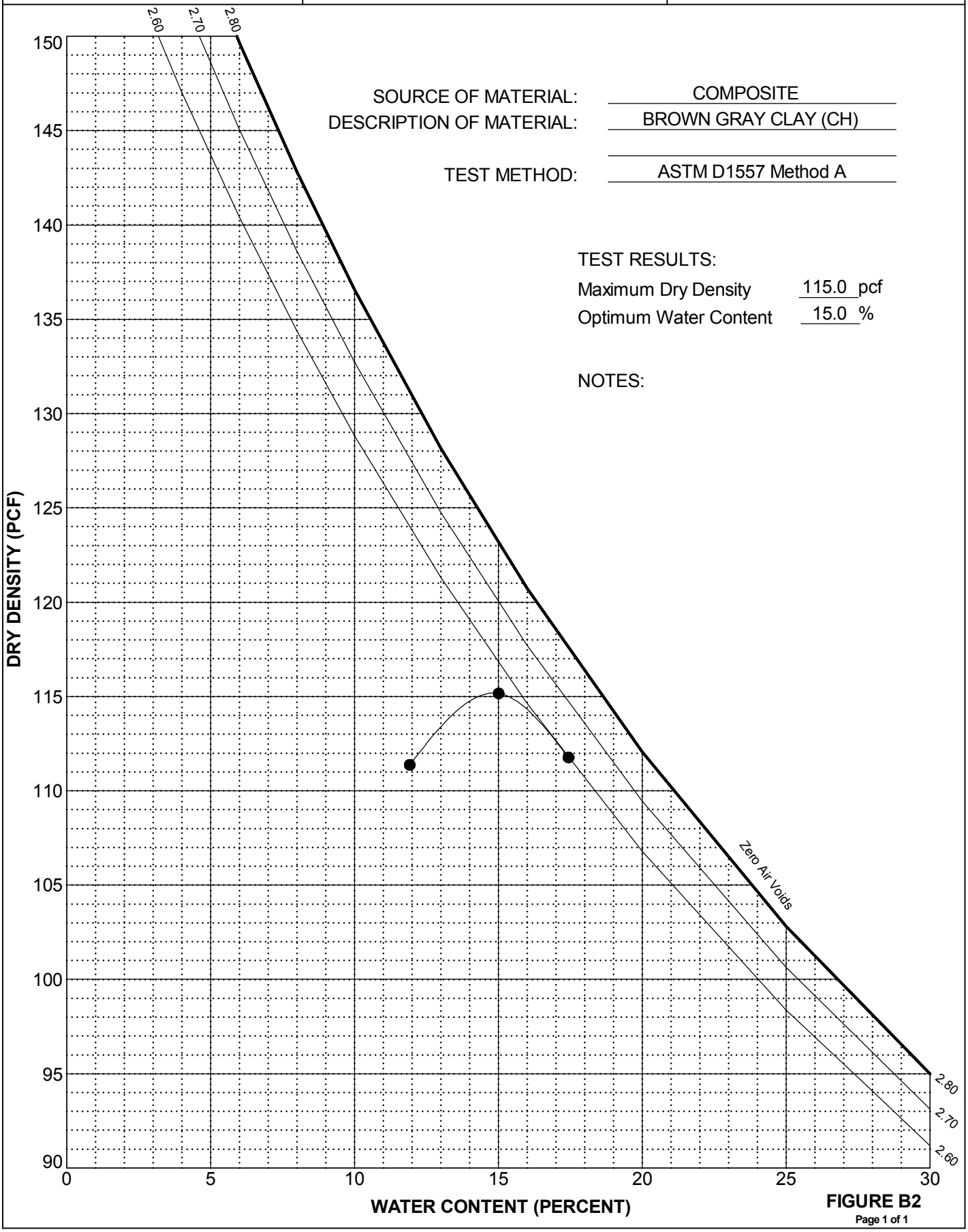

FIGURE B2

__MOISTURE-DENSITY RELATIONSHIP 73189.000_031616_B1TOB5_TR.GPJ PBS_DATATMPL_GEO.GDT PRINT DATE: 5/18/16:RW

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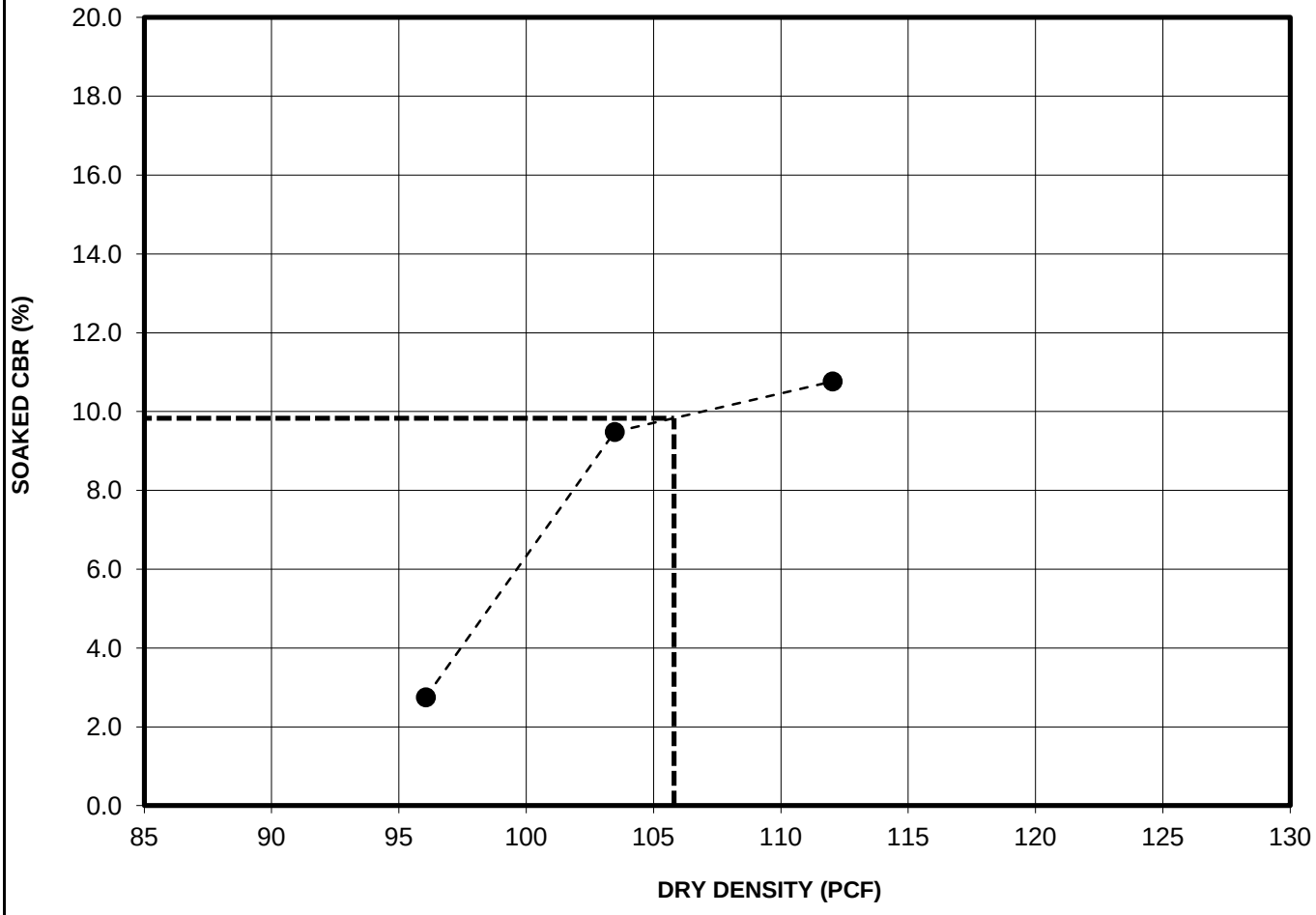
DRY DENSITY vs SOAKED CBR

CLARK CO. FAIRGROUND - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

TEST METHOD: ASTM D-1883



● **(1st)**	10 Blows
● **(2nd)**	25 Blows
● **(3rd)**	56 Blows
- - - - - - - - - - - - - -	CBR at 92% Compaction

EXPLORATION NUMBER	SAMPLE DEPTH (FEET BGS)	OPTIMUM MOISTURE CONTENT (PERCENT)	MAXIMUM DRY DENSITY (PCF)	DESIGN COMPACTION (PERCENT)	DRY DENSITY AT DESIGN COMPACTION (PCF)	CBR VALUE AT DESIGN COMPACTION
COMPOSITE	0.5 - 2.0	15.0	115	92	106	9

CBR_Graph.xlsx

FIGURE B3

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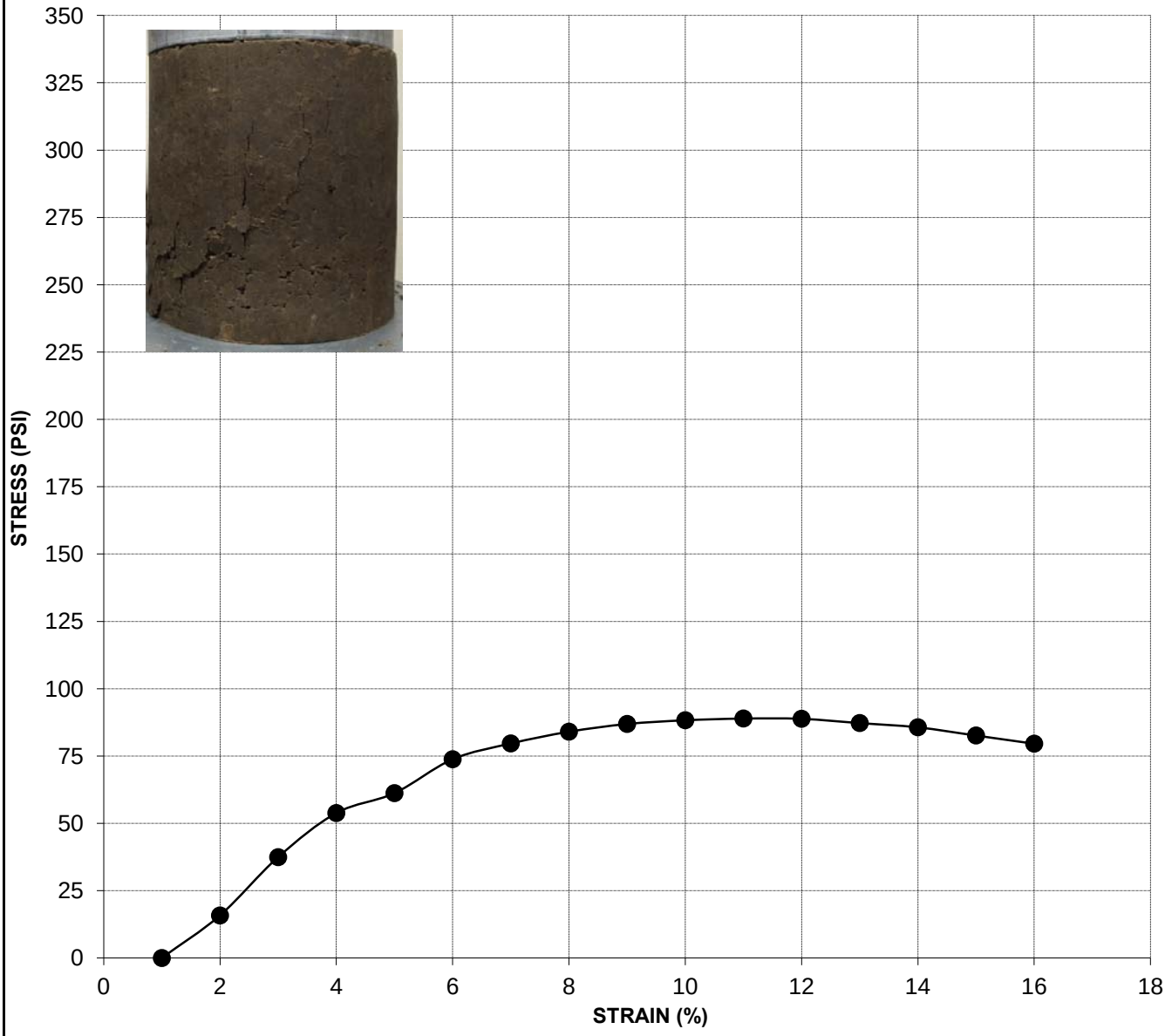
UNCONFINED COMPRESSION

CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

TEST METHOD: ASTM D-1663



CEMENT CONTENT (PERCENT)	AGGREGATE CONTENT (PERCENT)	MOISTURE CONTENT (PERCENT)	WET DENSITY (PCF)	DRY DENSITY (PCF)
5	n/a	21.7	125.6	103.2

UC_Graph.xlsx

FIGURE B4

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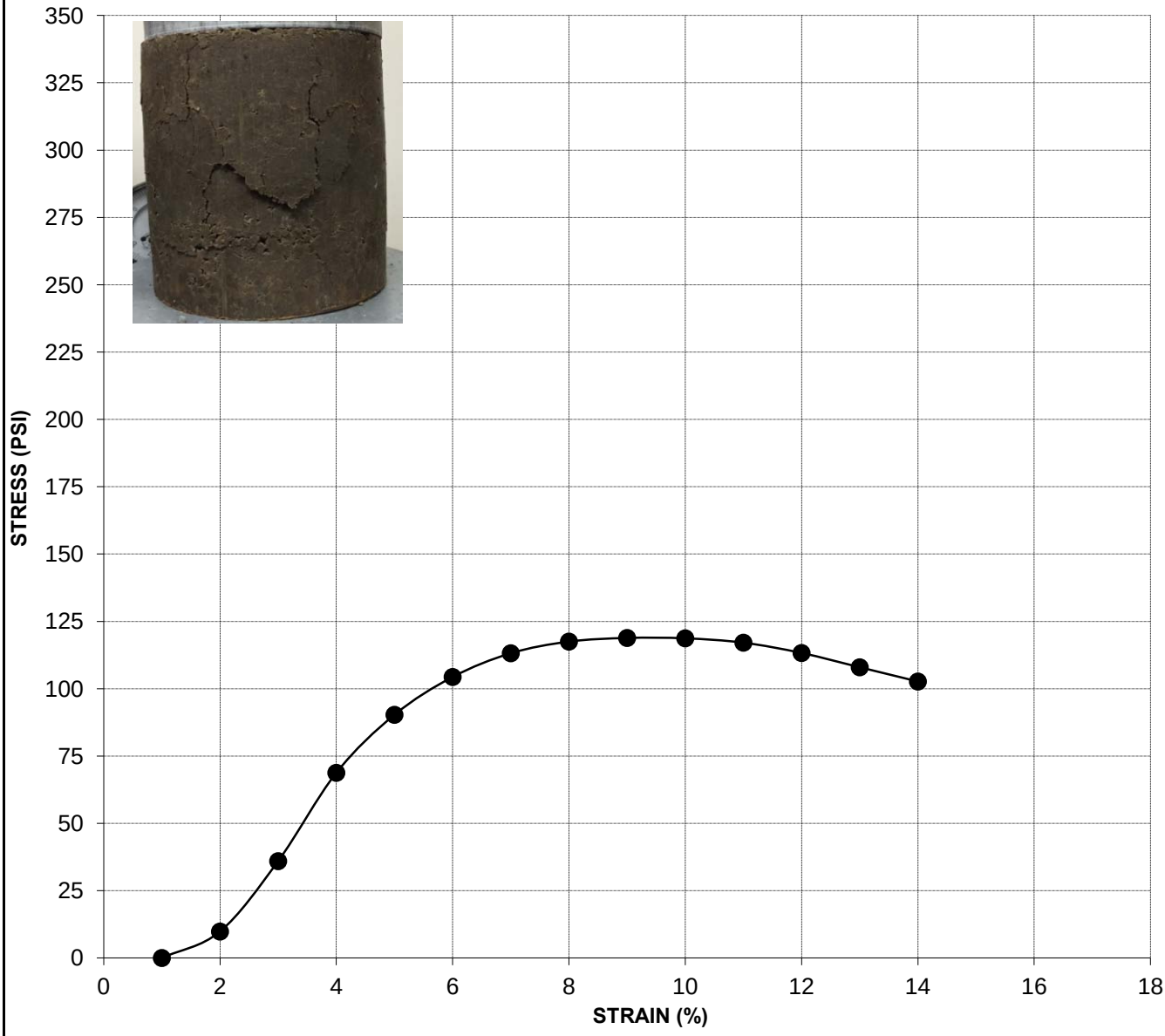
UNCONFINED COMPRESSION

CLARK CO. FAIRGROUNDS - LOT F
RIDGEFIELD, WASHINGTON

PBS PROJECT NUMBER:
73189.000

TEST METHOD: ASTM D-1663



CEMENT CONTENT (PERCENT)	AGGREGATE CONTENT (PERCENT)	MOISTURE CONTENT (PERCENT)	WET DENSITY (PCF)	DRY DENSITY (PCF)
7	n/a	21.6	126.1	103.8

UC_Graph.xlsx

FIGURE B5