Appendix A
Geotechnical Recommendations Report

DRAFT REPORT

Schaake Property Habitat Improvement Project

Geotechnical Recommendations Report – 30 Percent Design

Prepared for
Bureau of Reclamation

Yakima River Basin Water Enhancement Project

October 19, 2015

CH2M HILL, Inc.
322 East Front Street, Suite 200
Boise, ID 83702
(208) 345-5310
(208) 345-5315

Contents

Section Page

Acronyms and Abbreviations v

1.0 Geotechnical Recommendations Report 1-1
1.1 Introduction 1-1
1.2 Purpose 1-1
1.3 Scope 1-1
1.4 Design Standards 1-1
1.5 Report Organization 1-2
1.6 Limitations 1-3

2.0 Geology and Seismic Setting 2-1
2.1 Regional Geology 2-1
2.2 Local Geology 2-1
2.3 Seismic Setting 2-1

3.0 Subsurface Investigation and Laboratory Testing 3-1
3.1 Previous Investigations 3-1
3.2 Field Investigations 3-1
3.3 Laboratory Testing 3-4

4.0 Summary of Subsurface Conditions 4-1
4.1 General Subsurface Conditions 4-1
4.2 Coarse Alluvium 4-1
4.3 Fine Alluvium 4-2
4.4 Existing Levee Embankment 4-2
4.5 Groundwater 4-2

5.0 Geotechnical Analyses 5-1
5.1 General 5-1
5.2 Cross Section Selection 5-1
5.3 Selection of Engineering Parameters 5-2
5.4 Bearing Capacity 5-4
5.5 Settlement 5-4
5.6 Seepage Analysis 5-4
5.7 Slope Stability 5-6

6.0 Construction Considerations 6-1
6.1 Clearing, Grubbing, Stripping 6-1
6.2 Subgrade Preparation 6-1
6.3 Embankment Fill Material 6-1
6.4 Embankment Construction 6-2
6.5 Crossing Features 6-3
6.6 Construction Monitoring and Testing (CQC, testing, acceptance of materials) 6-3
6.7 Erosion Protection 6-4

7.0 Summary and Conclusions 7-1

8.0 References 8-1

Section Page

Appendixes

A Figures
B Boring and Test Pit Logs and Laboratory Results
C Seismic Velocity Survey Memorandum
D Geotechnical Analyses Summary Plots

Tables

2-1 Summary of USGS National Seismic Hazard Mapping Project Results (USGS, 2008)
3-1 Borehole Summary
3-2 Test Pit Summary
3-3 Laboratory Results Summary
5-1 Levee Cross Section Summary
5-2 Summary of Soil Properties for Slope Stability Analysis
5-3 Summary of Soil Properties for Seepage Analysis
5-4 Slope Stability Factor Results

Figure(s)

2-1 Geologic Map of the Ellensburg Quadrangle
3-1 November 2014 Soil Boring and Test Pit Location Plan
4-1 November 2014 Observed Depth to Groundwater
5-1 Cross Sections for Geotechnical Analysis

Acronyms and Abbreviations

ASTM	American Society of Testing and Materials
BDR	Basis of Design Report
bgs	below ground surface
CH2M	CH2M HILL, Inc.
CL	lean clay
CLSM	controlled low strength material
CY	cubic yards
EM	engineer manual
Ft/s	feet/second
GP	Poorly graded gravel
GRR	Geotechnical Recommendations Report
GW	Well graded gravel
GW-GM	Well graded gravel with silt
MASW	Multichannel Analysis of Surface Waves
MDE	Maximum Design Earthquake
MH	elastic silt
ML	silt
No.	number
NP	Non-Plastic
NV	No Value
OBE	Operating Basis Earthquake
OD	outside diameter
pcf	pounds per cubic foot
PGA	peak ground acceleration
ppm	parts per million
psf	pounds per square foot
Project	Schaake Property Habitat Improvement Project
Reclamation	U.S. Bureau of Reclamation
SM	Silty Sand
SP	Poorly graded sand
SPT	Standard Penetration Test
SW-SM	Well graded sand with silt
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
wopt	Optimum moisture content
γmax	Maximum laboratory dry density

SECTION 1

Geotechnical Recommendations Report

1.1 Introduction

On behalf of the U.S. Bureau of Reclamation (Reclamation), CH2M HILL, Inc. (CH2M), is supporting the design of a levee setback and side channel rejuvenation project known as the Schaake Property Habitat Improvement Project (Project). The Project is located immediately north and east of the Yakima River, south of Interstate 90, and west of Canyon Road in unincorporated Kittitas County near Ellensburg, Washington. A full project background is provided as part of the *Schaake Property Habitat Improvement Project Basis of Design Report – 30 Percent Design* (BDR) (CH2M, 2015).

1.2 Purpose

The purpose of this Geotechnical Recommendations Report (GRR) is to document the geotechnical field investigation program, data reduction, geotechnical analyses, and geotechnical design for the proposed setback levee. Generalized subsurface conditions, results of geotechnical analyses performed, and recommendations for design and construction of the setback levee are presented.

1.3 Scope

Specifically, CH2M was scoped to perform the following tasks related to the geotechnical field investigation, analysis, and design of the proposed setback levee:

Geotechnical Exploration

- Perform exploration program consisting of geophysical survey, drilling, and sampling
- Perform laboratory testing on recovered samples for evaluation of engineering properties and soil characteristics
- Locate, characterize, and Evaluate potential on site borrow sources for use in constructing the setback levee

Geotechnical Evaluation

- Provide engineering interpretations of subsurface conditions
- Select representative and critical setback levee cross sections for evaluation
- Evaluate static bearing capacity and settlement for selected cross sections
- Perform stability analysis for selected cross sections
- Perform seepage analysis to evaluate underseepage, critical gradients, and seepage through selected cross sections
- Develop geotechnical design and construction considerations and recommendations
- Prepare this GRR summarizing field investigation program and design and construction considerations

1.4 Design Standards

Chapter 2, Embankment Design, of the U.S. Bureau of Reclamation Design Standard 13, *Embankment Dams* (Reclamation, 2012) and the Engineer Manual (EM) 1110-2-1913, *Design and Construction of*

Levees (U.S. Army Corps of Engineers [USACE], 2000) were the primary guidance documents used in design of the proposed setback levee. In addition, guidance documents published by both Reclamation and USACE were used in evaluation slope stability, underseepage, and erosion protection for the setback levee. These documents include the following:

- Reclamation Design Standard 13, Embankment Dams
    - Chapter 2, Embankment Design (Reclamation, 2014a)
    - Chapter 4, Static Stability Analysis (Reclamation, 2011)
    - Chapter 7, Riprap Slope Protection (Reclamation, 2014b)
    - Chapter 8, Seepage (Reclamation, 2014c)
- USACE
    - Engineer Manual 1110-2-1601, *Hydraulic Design of Flood Control Channels, Chapter 3, Riprap Protection* (June 30, 1994)
    - Engineer Manual 1110-2-1902, *Slope Stabilit*y (October 31, 2003)
    - Engineer Technical Letter 1110-2-569, Engineering and Design, Design Guidance for Levee Underseepage (May 1, 2005)
    - Engineering Regulation, ER 1110-2-1806, Earthquake Design, and Evaluation for Civil Works Projects (USACE, 1995)

1.5 Report Organization

This GRR is organized into the following sections:

- **Section 1: Introduction.**
- **Section 2: Geology and Seismic Setting** provides a summary of the geologic and seismic conditions at the site based on information provided from published sources.
- **Section 3: Subsurface Investigations and Laboratory Testing** presents the data collected from the field exploration and laboratory testing programs that were performed for the project.
- **Section 4: Summary of Subsurface Conditions** presents the soil conditions present in the project vicinity, based on field observations, laboratory data, and published literature.
- **Section 5: Geotechnical Analyses** provides a discussion the assumptions, interpretations, and calculations completed for the design of the setback levee.
- **Section 6: Construction Considerations** provides a discussion of issues to be addressed as part of the design, including many that will be addressed in the design drawings and/or technical specifications.
- **Section 7: Conclusions and Recommendations** provides a summary of conclusions based on the geotechnical conditions and analyses performed, with recommendations for design and construction of the Project.
- **Section 8: References** contains a bibliography of documents cited in the text.

Supporting information is provided in Appendixes:

- **Appendix A** contains figures referenced in the main text of this report.
- **Appendix B** contains boring and text pit logs and laboratory test results.

- **Appendix C** contains the seismic velocity survey memorandum prepared by Sage Earth Science.
- **Appendix D** contains the results of the seepage and slope stability analyses.

1.6 Limitations

This report has been prepared for the exclusive use of Reclamation and CH2M for specific application to the Schaake Property Habitat Improvement Designs Project. The report has been prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

The design and construction recommendations contained in this report are based on data from a limited number of subsurface explorations performed during the November 2014 field exploration, and associated laboratory testing along with results from a September and October 2010 field exploration and laboratory testing. Exploration data indicate soil conditions and groundwater conditions only at specific locations and times, and only to the depths penetrated. Subsurface conditions and water levels at other locations may differ from conditions occurring at these explored locations. Also, the passage of time may result in a change in conditions at these locations. Some of the geologic information and geotechnical analysis is interpretive and reflects only the opinion of the geologist or engineer with regard to the character and extent of geologic materials.

This report has not been prepared to meet the technical requirements or needs of the contractors. Any such use of this report without guidance from CH2M consists of improper use that could lead to erroneous assumptions and faulty conclusions.

- If any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained within this report should not be considered valid unless the changes are reviewed and the conclusions of the report are modified or verified in writing by CH2M.

SECTION 2

Geology and Seismic Setting

2.1 Regional Geology

The Schaake property is located near Ellensburg, Washington, in the southern part of the Kittitas Valley, near the western edge of the Columbia Plateau. The Kittitas Valley lies in the informally named Yakima Fold Belt subprovince (Myers and Price, 1979), a highly folded and faulted part of the Columbia Plateau. The Yakima Fold Belt was tectonically deformed during mid- to late-Miocene time around the same time most of the Columbia River Basalt Group was erupted. The folding resulted in the formation of structural basins, including Kittitas Valley, bounded by asymmetric anticlinal ridges underlain by volcanic rocks of the Columbia River Basalt Group. The synclinal basins in the Yakima Fold Belt contain thick sedimentary sequences, including the Ellensburg Formation, a Miocene sedimentary formation derived from volcanic rocks on the adjacent ridges (Vaccarro, et al., 2009).

2.2 Local Geology

Figure 2-1, included in Appendix A at the end of this memorandum, shows a portion of the Geologic map of the Ellensburg Quadrangle (Bentley and Campbell, 1983) in the vicinity of the Schaake property. The lower panel within Figure 2-1 shows a southwest-northeast geologic cross section through the map where the Schaake property is along Yakima River just northwest of section.

The Schaake property lies along the Yakima River in the southern part of Kittitas Valley, several miles north of the Manastash Ridge (Figure 2-1). The Manastash Ridge is an anticline underlain by the Grande Ronde basalt (units Tgn2 and Tgr2) and overlying volcanic flows and sedimentary deposits (Bentley and Campbell, 1983; see lower panel of Figure 2-1). In the southern Kittitas Valley, the Vantage member of the Ellensburg Formation (unit Tv) is overlain by younger Yakima River deposits (units Qam, Qt1, and Qt2), sidestream deposits (unit Qas), and windblown (eolian) deposits (unit Qe).

Within the Schaake property itself, only sedimentary deposits are exposed, and these deposits have been mapped as Alluvium, mainstream facies (unit Qam; Bentley and Campbell, 1983; see upper panel in Figure 2-1). This unit includes fluvial deposits of the Yakima River composed of gravel, sand, and silt of mixed lithologies, including clasts derived from the Cascade Range far upstream. Fieldwork in the Schaake property in fall 2010 consisting of hand-dug test pits and geotechnical drilling and backhoe test pit excavation in fall 2014 revealed a consistent two-part stratigraphy for the unit consisting of channel facies (mostly rounded cobble gravel) overlain by 0 to 3 feet of floodplain fines (silt and fine sand) with some zones of clay deposits (CH2M, 2011).

These young river deposits are bounded on the northwest and southeast by two Quaternary terrace units with similar compositions (units Qt1 and Qt2), but that are slightly to moderately weathered and a few feet higher. The City of Ellensburg lies upon one of these terrace units (unit Qt2).

2.3 Seismic Setting

The USGS interactive quaternary faults mapping website was reviewed to confirm the absence of active faults in the project area (USGS, 2015). There do not appear to be any active faults within 20 miles of the site; the nearest active faults are located south of Royal City and south of Yakima, located approximately 43 miles east and 28 miles south of Ellensburg, respectively.

On the basis of our review of geologic maps, the geotechnical drilling program, and results of a geophysical survey we have conducted at the site, with a maximum exploration depth of 30.9 feet below

ground surface (bgs), CH2M recommends using Site Class D (very dense soil and soft rock) for the Schaake property site.

The current seismic mapping for the Site is the 2008 *USGS National Seismic Hazard Mapping Project* (USGS, 2008). Table 2-1 summarizes several values from the USGS national seismic hazard maps. Peak ground accelerations adjusted for site conditions are provided for return periods of 144, 475, 950, and 2475 years. The 144-year return interval peak ground acceleration adjusted for site conditions is consistent with the Operating Basis Earthquake (OBE) event as defined by ER 1110-2-1806 (USACE, 1995). The 950-year return interval is taken as the Maximum Design Earthquake (MDE) for the Project following guidance in ER 1110-2-1806 and Engineering and Construction Bulletin No. 2015-5 (USACE, 2015). The peak ground acceleration adjusted for site conditions is used for evaluating seismic slope stability as discussed in Section 5.

Table 2-1. Summary of USGS National Seismic Hazard Mapping Project Results (USGS, 2008)

Probability of Exceedance	Nominal Return Period	Peak Ground Acceleration at Site Class B/C Interface (firm rock interface) (g)	Site Coefficient F_{PGA} for Site Class D	Peak Ground Acceleration Adjusted for Site Conditions (Site Class D) (g)
50 percent in 100 years	144 years	0.06	1.60	0.10
10 percent in 50 years	475 years	0.10	1.60	0.16
10 percent in 100 years	950 years	0.14	1.52	0.21
2 percent in 50 years	2475 years	0.21	1.37	0.29

Note: These values are for base rock (National Earthquake Hazards Reduction Program [NEHRP] B/C Boundary) conditions.

PGA = peak ground acceleration

SECTION 3

Subsurface Investigation and Laboratory Testing

3.1 Previous Investigations

CH2M conducted a subsurface exploration program at the Schaake property between September 28 and October 1, 2010. The purpose of the subsurface exploration was to obtain preliminary information on the geotechnical subsurface conditions as part of an initial assessment of the existing levees and the alignments of the proposed levees and side channels. The geotechnical exploration consisted of reviewing existing information and collecting shallow hand-excavated samples.

The findings from this memorandum are summarized in the technical memorandum, *Schaake Property Habitat Improvement Designs Task Order 08B510677B – Phase 1 Initial Geotechnical Data Summary (Mod 1, Task B)* prepared by CH2M dated March 24, 2011 (CH2M HILL, 2011). The contents of this technical memorandum were reviewed and utilized during the planning and execution of the fall 2014 subsurface exploration program and used in the evaluations of the proposed setback levee.

CH2M reviewed a Soil and Site Study by Land Profile, Inc. (2004) which characterized previous uses and evaluated the soil chemistry of the site. Although much of the soil environmental quality data was not used in the geotechnical evaluation, information from the Land Profile report related to groundwater was utilized and is summarized in this report.

3.2 Field Investigations

The geotechnical field exploration program consisted of advancing 12 borings, excavating 16 test pits, and performing a geophysical survey at various locations along the setback levee alignment in November 2014. The boreholes, test pits, and geophysical survey were performed to:

- Gather subsurface information along the proposed setback levee alignment,
- Locate and characterize borrow materials for construction, and
- Evaluate the variance of the depth of groundwater across the site.

The exploration locations are shown in Figure 3-1. Boring and test pit logs and laboratory testing results are included in Appendix B.

During the field investigation the alignment for the levee was planned to extend beyond the Schaake property to the southeast. As shown on Figure 3-1 (as Initial Alignment) borings B-13, B-14, and B-15 were drilled along this segment. Subsequent to the field investigation, for reasons described in the BDR, the alignment of the levee was revised (shown in Figure 3-1 as Final Alignment).

3.2.1 Geotechnical Boreholes

CH2M subcontracted Haz-Tech Drilling, Inc., of Meridian, Idaho, to advance 12 boreholes using a truck-mounted BK81 drill rig using hollow stem auger drilling techniques. The rig was equipped with a 140-pound automatic-trip hammer for use in split spoon sampling of soils. The 12 boreholes were designated B-1 through B-15 (note that CH2M planned to collect 10 borings but identified 15 borings for permitting flexibility; borings B-7, B-9, and B-11 were abandoned in favor of excavating test pits at these locations). The boreholes were advanced between November 4 and 6, 2014. A CH2M geotechnical engineer provided continuous observation and logging of the boreholes.

A summary of the boreholes is presented in Table 3-1. The borehole locations are shown in Figure 3-1.

Table 3-1. Borehole Summary
Schaake Property Habitat Improvement Project

Borehole Number[a]	Northing[a] (feet)	Easting[b] (feet)	Ground Surface Elevation[a] (feet)	Completion Depth (feet below ground surface [bgs])
B-1-14	600646.2	1625304.8	4927.1	21.0
B-2-14	599914.7	1625846.9	4911.2	20.6
B-3-14	599562.1	1626132.5	4901.6	11.5
B-4-14	599180.3	1626351.0	4893.9	15.8
B-5-14	598967.6	1626826.0	4900.4	20.2
B-6-14	598801.1	1627311.2	4893.2	20.0
B-8-14	598288.6	1627945.1	4880.3	21.0
B-10-14	597417.3	1628469.6	4874.5	21.5
B-12-14	596228.5	1629046.7	4857.9	21.5
B-13-14	595267.9	1629087.3	4852.0	20.5
B-14-14	594483.5	1629769.3	4845.8	21.5
B-15-14	593693.4	1630769.6	4827.6	30.9

[a] CH2M abandoned planned borings B-7, B-9, and B-11 in favor of excavating test pits at these locations

[b] The locations of the soil boreholes were determined using a hand-held global positioning system device. The Northing and Easting values shown are accurate to within approximately 10 feet. Coordinates are based on Washington State Plane Coordinate System, Washington South Zone, North American Datum of 1983 (NAD83), U.S. Survey Feet. Reported elevations are referenced to North American Vertical Datum of 1988 (NAVD88) and were extracted from the Existing Conditions digital terrain model (see CH2M, 2015 for survey sources) for the mapped coordinate.

Soil samples were collected from the boreholes using a 2-inch outside diameter (OD), split-spoon sampler in accordance with standard procedures outlined in American Society of Testing and Materials (ASTM) International Method D1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*.

Soil samples from the soil boreholes were examined and visually classified in accordance with ASTM D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, which uses the Unified Soil Classification System guidelines. Sampling intervals and field classifications of soil samples are recorded on the borehole logs presented in Appendix B.

Selected soil samples from the boreholes were tested in a laboratory to confirm field soil classifications, to measure soil properties, and to provide quantitative data for use in engineering analyses.

3.2.2 Test Pit Excavations

CH2M utilized a Caterpillar track-hoe excavator, owned and operated by Reclamation, to excavate geotechnical test pits. Sixteen test pits were excavated as part of the geotechnical field exploration program between November 4 and 5, 2014. The test pits were excavated to depths ranging from 3.5 to 8.5 feet. A CH2M geotechnical engineer provided continuous observation and logging of the test pits and collected samples for laboratory testing. The test pits were generally excavated until the side walls of the pits collapsed and made further digging impractical; usually this was due to encountering shallow groundwater which limited the depth of excavation.

Soil samples from the test pits were examined and classified in general accordance with ASTM D2488. The sampling intervals and the field classifications of the soil samples are recorded on the test pit logs included in Appendix B.

A summary of the test pits is presented in Table 3-2. The test pit locations are shown in Figure 3-1.

Table 3-2. Test Pit Summary
Schaake Property Habitat Improvement Project

Test Pit Number	Northing[a] (feet)	Easting[a] (feet)	Ground Surface Elevation[a] (feet)	Completion Depth (feet below ground surface [bgs])
TP-1-14	598015.3	1627704.3	4884.5	7.5
TP-2-14	598654.2	1626537.4	4899.8	8.0
TP-3-14	599264.8	1626100.4	4904.7	5.0
TP-4-14	600523.8	1625127.1	4921.2	6.0
TP-5-14	595923.4	1627972.2	4858.8	4.8
TP-6-14	596454.5	1628395.4	4868.0	8.5
TP-7-14	597451.3	1628452.2	4873.4	4.5
TP-8-14	596941.3	1628807.8	4869.1	5.5
TP-9-14	596253.7	1628716.9	4862.0	4.5
TP-10-14	596509.9	1628699.2	4863.8	6.5
TP-11-14	596797.9	1628263.7	4872.0	4.5
TP-12-14	596753.4	1627987.5	4872.1	4.5
TP-13-14	597095.2	1627530.9	4883.0	3.5
TP-14-14	597757.8	1628102.2	4877.4	5.0
TP-15-14	598659.4	1627717.6	4886.6	5.5
TP-16-14	596290.1	1628152.9	4864.4	4.3

[a] The locations of the test pits were determined using a hand-held global positioning system device. The Northing and Easting values shown are accurate to within approximately 10 feet. Coordinates are based on Washington State Plane Coordinate System, Washington South Zone, North American Datum of 1983 (NAD83), U.S. Survey Feet. Reported elevations are referenced to North American Vertical Datum of 1988 (NAVD88) and were extracted from the Existing Conditions digital terrain model (see CH2M, 2015 for survey sources) for the mapped coordinate.

3.2.3 Geophysical Survey

Sage Earth Science, a subcontractor to CH2M, performed a shear wave velocity and compression wave (p-wave) refraction survey along portions the setback levee alignment specified by CH2M.

The geophysical survey was completed using the Multichannel Analysis of Surface Waves (MASW) method. MASW uses the dispersive characteristics of surface waves to determine the variation of shear wave velocity with depth. Data are acquired by analyzing seismic surface waves generated by an impulsive source and received by a linear array of geophones. A dispersion curve is calculated from the data that shows the phase velocity of the surface waves as a function of frequency or wavelength. A shear wave velocity profile, or 1D sounding of velocity as a function of depth, is then modeled from the dispersion curve. The resulting shear wave soundings at multiple locations along a survey line are combined and contoured to generate a 2D cross section of shear wave velocity.

Given a physical setting of increasing density with depth, and by measuring the travel time of a p-wave between known points, the seismic refraction method can be used to determine the depth to a refracting horizon(s), the seismic velocity of the refracting horizon(s), as well as thickness and velocities of the overlying materials.

Approximately 2,250 feet of shear wave MASW profile and p-wave refraction profile were acquired. Sage Earth Science used a 24-channel engineering seismograph and 16 pound sledge hammer or 8-gauge blank shotgun shell in a shallow hole to perform the acoustic travel time measurements. The survey was designed for a maximum depth of investigation of 100 feet, depending on the subsurface conditions.

The seismic velocity survey memorandum prepared by Sage Earth Science is included in Appendix C. The memorandum includes a figure showing the location and orientation of the surveys as well as profiles of the seismic shear wave velocity and p-wave velocity.

3.3 Laboratory Testing

CH2M subcontracted GeoTek, Inc. of Meridian, Idaho, to perform laboratory testing on selected soil samples collected during the field investigation. All testing was directed by a CH2M geotechnical engineer. The test methods employed are listed below.

- ASTM D422, Standard Test Method for Particle-Size Analysis of Soils
- ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

A summary of the laboratory test results is presented in Table 3-3 and included in Appendix B.

Table 3-3. Laboratory Results Summary
Schaake Property Habitat Improvement Project

Borehole/Test Pit No.	Sample No.	Sample Depth (feet)	USCS Classification	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Fines Content (%)	Other Tests
B-1-14	SS-1	2.5	GW	6.0	-	-	3	% Gravel = 64 % Sand = 33
B-2-14	SS-2	5	GW	7.9	-	-	2	% Gravel = 65 % Sand = 33
B-5-14 a	SS-5	20	SW-SM	11.0	NV	NP	8	% Gravel = 40 % Sand = 52 Resistivity = 11,500 Ohm-cm pH = 6.8 Chloride = 34 ppm Sulfate = 160 ppm
B-8-14	SS-3	10	SP	-	-	-	2	% Gravel = 48 % Sand = 50
B-12-14	SS-1	2.5	GP	5.5	-	-	4	% Gravel = 50 % Sand = 46
B-13-14	SS-1	2.5	SM	34.2	-	-	23	% Gravel = 0 % Sand = 77
B-13-14	SS-2	5	SM	45.7	-	-	27	% Gravel = 0 % Sand = 73
B-13-14	SS-4	15	GW	5.5	NV	NP	1	% Gravel = 74 % Sand = 25
B-13-14	SS-5	20	SW-SM	12.7	NV	NP	9	% Gravel = 32 % Sand = 59
B-14-14	SS-1	2.5	ML	-	-	-	60	% Gravel = 0 % Sand = 40
B-14-14	SS-2	5	SM	27.7	-	-	20	% Gravel = 0 % Sand = 80
B-15-14	SS-7	30	GW-GM	10.9	-	-	12	% Gravel = 55 % Sand = 33

Table 3-3. Laboratory Results Summary
Schaake Property Habitat Improvement Project

Borehole/Test Pit No.	Sample No.	Sample Depth (feet)	USCS Classification	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Fines Content (%)	Other Tests
TP-1-14	B-2	3.5	CL	32.3	36	16	89	% Gravel = 0 % Sand = 11
TP-2-14	BKT-1	2	GW	-	-	-	2	% Gravel = 79 % Sand = 19 γmax = 129.5 pcf wopt = 4.5%
TP-4-14	BKT-1	1.5	GW-GM	15.0	-	-	9	% Gravel = 56 % Sand = 35
TP-6-14	BKT-1	1.5	MH	32.6	52	19	94	% Gravel = 0 % Sand = 6 γmax = 93.0 pcf wopt = 21.5%
TP-7-14	B-1	0.6	ML	19.4	-	-	95	% Gravel = 0 % Sand = 5
TP-8-14	BKT-1	1.5	SP	16.5	-	-	2	% Gravel = 7 % Sand = 91
TP-8-14	B-2	2.5	GW	-	-	-	1	% Gravel = 67 % Sand = 32
TP-9-14	B-1	0.75	ML	20.4	-	-	57	% Gravel = 27 % Sand = 16
TP-9-14	BKT-2	1.5	ML	36.4	45	9	93	% Gravel = 0 % Sand = 7 γmax = 92.0 pcf wopt = 22.5%
TP-10-14	B-1	2	CL	36.0	41	15	80	% Gravel = 0 % Sand = 20
TP-12-14	B-1	2	ML	36.5	35	10	84	% Gravel = 0 % Sand = 16
TP-13-14	B-1	2	SM	6.8	NV	NP	41	% Gravel = 2 % Sand = 57

Table 3-3. Laboratory Results Summary
Schaake Property Habitat Improvement Project

Borehole/Test Pit No.	Sample No.	Sample Depth (feet)	USCS Classification	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Fines Content (%)	Other Tests
TP-14-14	BKT-1	0.5	GP	-	-	-	-	γmax = 132.0 pcf wopt = 5.0%
TP-14-14	B-2	1.5	ML	25.2	-	-	94	% Gravel = 0 % Sand = 6
TP-14-14	B-3	3.5	CL	32.6	42	18	89	% Gravel = 0 % Sand = 11
TP-15-14	B-1	1	ML	-	-	-	63	% Gravel = 0 % Sand = 37
TP-15-14	B-2	3	ML	21.4	NV	NP	26	% Gravel = 19 % Sand = 55

[a] Resistivity, pH, Chlorides, and Sulfates for corrosion testing performed on composite sample of SS-1, 2, and 3 from B-4 and B-5.

Notes:

B-1-14 = borehole 1, advanced in 2014
TP-1-14 = test pit 1, excavated in 2014
CL = lean clay
GP = Poorly graded gravel
GW = Well graded gravel
GW-GM = Well graded gravel with silt
MH = elastic silt
ML = silt
No. = number
NP = Non-Plastic
NV = No Value
pcf = pounds per cubic foot
ppm = parts per million
SP = Poorly graded sand
SM = Silty Sand
SW-SM = Well graded sand with silt
USCS = Unified Soil Classification System
w_{opt} = Optimum moisture content
γ_{max} = Maximum laboratory dry density

SECTION 4

Summary of Subsurface Conditions

4.1 General Subsurface Conditions

The general subsurface conditions at the Schaake project site consist of coarse- and fine-grained alluvium, overlain by fine-grained sediments, agricultural soil, or old stockyard waste (manure-rich soils). Much of the shallow subsurface profile has been disturbed over time as the previous use of this site was as a cattle feedlot with meat processing and wastewater handling facilities (Land Profile, 2004).

Following the removal of facilities, the surficial soils have been disked and furrowed to support growing native grasses for site restoration and erosion protection. The proposed setback levee alignment follows terrain that had the following previous uses: sprayfields, cattle feedlot, settling ponds, and wastewater lagoon (Land Profile, 2004).

Photograph 1. Aerial Photograph of Schaake Property (1984), courtesy of Reclamation

4.2 Coarse Alluvium

The coarse alluvium consists of poorly graded gravel with cobbles and some small boulders, with some finer-grained sandy lenses interbedded in the gravel layers. Coarse alluvium was observed to be well-rounded, with sizes typically ranging from 6-inch to 12-inch cobbles to fine (3/4-inch) gravel-sized

particles. The percentages of gravel and sand within the coarse alluvium deposits varied across the Schaake property but the fines content in these layers was generally low (less than 20 percent).

The density of the deposit was noted to increase with depth. Above 10 feet bgs, SPT N-values indicate the material is loose to medium dense. Below 10 feet bgs, SPT N-values recorded in the coarse alluvium indicated a relative density of medium dense to very dense, however it is noted that higher blowcounts at depth may be due to the presence of gravels and cobbles and are not truly indicative of the material's relative density.

4.3 Fine Alluvium

Fine-grained alluvium consists of backwater and flood deposits including clays, silts, and sands. Some detritus and topsoil (silts and clays) are also present in sheltered areas near the river based on observations at the surface. The fine alluvium was not encountered with much consistency in the boreholes. Primarily silty soils encountered near the surface were generally loose in relative density and a thin layer of very soft clay was noted in borehole B-12-14 at 5 feet bgs.

4.4 Existing Levee Embankment

The existing levee embankment was investigated during CH2M's 2010 field exploration. Levee fill material was sampled on the landward side of the existing levees at 16 locations; this material is generally expected to be less coarse than the material on the riverside of the levee. The sampled material typically consisted of alluvial gravel and sand with varying gradation (CH2M estimated 5 to 30 percent fines; 5 to 35 percent sand; 20 to 40 percent gravel, and 5 to 10 percent cobbles by volume). The natural moisture content of samples collected from the existing levees ranged from 4 to 19 percent. Some pockets of predominantly clay and silt were also observed within the gravelly stratum.

4.5 Groundwater

Groundwater was observed in each of the boreholes and test pits at the time of the 2014 field investigation with depths ranging from 2.8 to 8.0 feet bgs; primarily the depth to groundwater was between 3 to 5 feet bgs. Figure 4-1 shows the depth to groundwater encountered in each of the boreholes and test pits.

Groundwater depths are anticipated to fluctuate at the site based on time of year and location (specifically proximate to the Yakima River). Because of the predominantly coarse-grained alluvium present at locations near the river and in old and active existing side channels, groundwater near the river is anticipated to be well-connected to the Yakima River level. At locations more distant from the river, where finer-grained soils dominate the shallow subsurface, groundwater levels are anticipated to be influenced by local irrigation input and precipitation. Seasonal fluctuations include higher Yakima River flows and rain or snowmelt in the spring and higher irrigation input during the summer. Annual precipitation at the site is relatively low (9 to 10 inches annually), so natural precipitation is expected to have less influence on groundwater than river flows and irrigation. Localized areas of perched groundwater are also anticipated based on the presence of fine-grained sediments and ponded water observed within the side channel areas.

Additional information from the sites explored during the 2004 investigation (Land Profile, 2004) indicate the water table was observed at depths ranging from 18 to 60 inches below ground surface, depending on specific location. Based on water level measurements from monitoring wells on the property, the inferred direction of groundwater flow fluctuates from south to east with a gradient ranging from 0.003 to 0.010 foot/foot (Land Profile, 2004).

For the purpose of design, the groundwater level is assumed to be at a depth of 3 feet bgs along the alignment where the setback levee will be constructed.

SECTION 5

Geotechnical Analyses

5.1 General

CH2M completed geotechnical analyses as part of the design of the proposed setback levee. The suite of analyses consisted of steady-state seepage and slope stability for six cross sections along the levee alignment. The analyses were conducted using a 100-year Flood event. The BDR (CH2M, 2015) provides discussion around the criteria used to set the levee alignment and vertical profile.

The following text summarizes the estimated soil strength parameters, analysis and design methodology and corresponding Factor of Safety results for the setback levee.

5.2 Cross Section Selection

CH2M selected six cross sections, A through F, at STA 110+00, 119+50, 129+00, 139+00, 156+00, and 166+00, respectively, for evaluation along the setback levee alignment. These sections were selected to capture the variance of embankment height and subsurface conditions along the alignment. Each section shows the existing ground surface, proposed final grade and 100-year flood water elevation. Figure 5-1 identifies the locations of the sections analyzed.

The structural height of the setback levee ranges from approximately 8 feet (Section B) to 2.1 feet (Section C), and the 100-year flood water elevation ranges from to approximately 1502.9 feet (Section A) to 1484.5 feet (Section F). The proposed approximate levee heights and 100-year flood water elevations for the cross sections evaluated are shown in Table 5-1. Note that both the levee crest elevation and 100-year water surface elevation are expected to vary as the design progresses; expected changes are likely to have negligible effect on geotechnical recommendations, but will be updated as part of the final GRR.

Table 5-1. Levee Cross Section Summary
Schaake Property Habitat Improvement Project

Levee Cross Section	Station	Approximate Height of Levee (feet)	Levee Crest Elevation (feet)	100-year Flood Water Elevation (feet)
A	110+00	6.0	1503.4	1502.9
B	119+50	8.0	1499.0	1496.9
C	129+00	2.1	1493.6	1492.7
D	139+00	4.2	1491.6	1490.6
E	156+00	2.6	1487.2	1486.2
F	166+00	2.5	1483.4	1484.5

Note: Section F is through the Low Crest section of the levee and is intended to overtop during the 100-year Flood

The setback levee will have a nominal 12-foot-wide crest. The riverside and landside slopes will be 3H:1V (horizontal to vertical). Critical sections of the riverside face of the levee will be armored with riprap where hydraulic modelling has indicated that water velocities along the levee during flooding will exceed 4.0 feet per second (fps). In these areas riprap will be placed over riprap bedding. In areas with water velocities less than 4.0 fps, the embankment fill on the interior of the levee will consist of a well graded silty, sandy gravel with sufficient coarse material to protect the levee from significant erosion.

The landside face will be vegetated with native grass species to manage erosion. Six inches of crushed gravel surfacing material will be placed on the crest to support vehicular traffic; this surfacing material is not accounted for in the geotechnical analyses but will be placed on top of the sections analyzed.

To alleviate flooding effects on the Yakima River's right bank, hydraulic modeling results have shown that a beneficial component of the setback levee would be a low crest section that would allow overtopping during the design flood. This would allow the landside property, owned by the City of Ellensburg and utilized by Twin City Foods as spray fields for process effluent, to flood, which is similar to the current conditions. The low crest levee will extend from STA 162+22 to STA 166+85 and it will also have a 12-foot-wide crest. The riverside slope will be 3H:1V but the landslide slope will be 5H:1V to provide additional stability during an overtopping flow scenario. The entire section will be covered with an articulated concrete block product overlying a nonwoven geotextile; this will protect the levee during overtopping while also allowing vehicle traffic to cross the low levee area.

5.3 Selection of Engineering Parameters

The following subsections provide descriptions of each stratum and define the geotechnical engineering design parameters used in the geotechnical analyses.

5.3.1 Embankment Fill Material

To the extent possible, the proposed setback levee will be construction using material obtained from two primary on-site sources: 1) native soils obtained from designated borrow areas, and 2) reuse of the existing setback levee soils that are planned for demolition.

The material from onsite borrow sources will be variable and consist of some areas of silt and clay and other areas of sandy gravel with various amounts of silt, silty sand, and silt with sand. CH2M recommends selective borrowing for construction of the setback levee to avoid any material lenses that may consist of clean (low fines) sands or gravels. The identified on-site borrow area is anticipated to have some predominantly fine-grained alluvial deposits (silts and clays) that are recommended for mixing with coarse-grained alluvial soils to achieve a well-graded blend. Ultimately, embankment fill material used to construct the levee will be required to contain a minimum of 20 percent fines, but it is expected that the fines content will vary between 25 percent and 50 percent fines.

Generally speaking, the existing levee material should be suitable for constructing new levees on the project. Approximately 75 percent of the existing levee material is planned for re-use in the proposed setback levee. If areas of organic material, refuse, garbage, or scrap are encountered, they should be excluded. Also, if zones consisting primarily of cobbles and boulders are observed, this material should be mixed uniformly with the rest of the excavated material or excluded from fill material. As indicated by the gradation results, the existing levee material typically contains less than 20 percent fines. Natural moisture content of the levee material was found to be near or below the optimum moisture content determined in the moisture-density tests. Therefore, addition of fine-grained soils and minimal wetting of the material may be required to achieve the specified gradation and compaction, if the material is reused.

Drained strength parameters for embankment fill material have been selected based on engineering judgment from previous similar projects. The hydraulic conductivity of the levee was selected from recommended typical values for various soil types (Reclamation, 2014c). The undrained strength parameters are based on correlations with index properties (Kulhawy and Mayne, 1990), typical values of similar materials, and engineering judgment.

5.3.2 Foundation Material

At the levee cross sections analyzed, the native foundation material consists primarily of cohesionless soils, with the exception of cross section E, where the upper 3 feet of native material is primarily fine-

grained. The strength parameters for the different native materials used in the analysis are based on correlations to index properties determined from laboratory testing (Kulhawy and Mayne, 1990), and engineering judgment from previous experience of similar soils. The hydraulic conductivity for the different native material was estimated by using an empirical soil gradation relationship (Carrier III, 2003).

5.3.3 Engineering Properties for Slope Stability

Engineering parameters selected for setback levee embankment material and various foundation materials encountered beneath representative and critical cross sections selected for slope stability analysis are presented in Table 5-2 for both drained and undrained conditions.

Table 5-2. Summary of Soil Properties for Slope Stability Analysis
Schaake Property Habitat Improvement Project

Layer Description	Cross Section	Moist Unit Weight, γ_m (pcf)	Drained Strength		Undrained Strength	
			ϕ (deg)	c (psf)	ϕ (deg)	c (psf)
Setback Levee Embankment Fill: Silt, Silty Gravel with Sand (SM/ML/GM)	All Sections	120	35	0	20	50
Native Foundation Material. Well graded Gravel (GW) with 30 percent sand.	A, F	125	35	0	35	0
Native Foundation Material. Poorly graded Sand (SP) with Gravel. Near even mixture of fine gravel and coarse sand.	B	110	25	0	25	0
Native Foundation Material. Silty sand (SM)	C	125	35	0	20	25
Native Foundation Material. Well graded Gravel (GW) with Sand. Near even mixture of fine gravel and coarse sand.	D, E	125	35	0	35	0
Native Foundation Material. Elastic silt (MH) with trace sand.	E	105	25	0	25	50

Note: Drained and undrained values used for rapid drawdown stability analysis using the Duncan, Wright, Wong 3 Stage Method (1990).

5.3.4 Engineering Parameters for Seepage Analysis

The hydraulic conductivity (k_h) of native soils is often greater than the vertical conductivity (k_v) because of the presence of horizontal, or near horizontal lenses of lower permeability soils. The low permeability lenses act to reduce the overall vertical conductivity of the soil mass. Because of this, K_v values for native soils have generally been assumed to be 2 to 10 times lower than k_h values (k_v/k_h ratios of 0.5 to 0.1).

Test and performance data from Reclamation embankments indicate that typical compacted embankment fills will have k_h/k_V ratios ranging from 2 to 10, with the higher values relating to higher water contents during placement (Reclamation, 2014c). A k_h/k_V ratio of 10 (k_v/k_h ratio of 0.1) was used for the embankment fill.

Engineering parameters selected for setback levee embankment material and various foundation materials encountered beneath representative and critical cross sections selected for seepage analysis are presented in Table 5-3.

Table 5-3. Summary of Soil Properties for Seepage Analysis
Schaake Property Habitat Improvement Project

Layer Description	Cross Section	Ratio of Vertical to Horizontal Hydraulic Conductivity (k_v/k_h)	Horizontal Hydraulic Conductivity, k_h (feet/second [ft/s])	Vertical Hydraulic Conductivity, k_v (ft/s)
Setback Levee Embankment Fill: Silt, Silty Gravel with Sand (SM/ML/GM)	All Sections	0.1	3.17×10^{-5}	3.17×10^{-6}
Native Foundation Material. Well graded Gravel (GW) with 30 percent sand.	A, F	0.5	4.92×10^{-3}	2.5×10^{-4}
Native Foundation Material. Silty sand (SM)	C	0.1	1.93×10^{-6}	1.93×10^{-7}
Native Foundation Material. Well graded Gravel (GW) with Sand. Near even mixture of fine gravel and coarse sand.	D, E	0.5	3.69×10^{-3}	1.80×10^{-3}
Native Foundation Material. Elastic silt (MH) with trace sand.	E	0.1	2.75×10^{-6}	2.75×10^{-7}

Note: Seepage analyses were not conducted at Cross Section B.

5.4 Bearing Capacity

Based on the review of the subsurface data from field and laboratory, it is anticipated that the setback levee will be founded on primarily granular materials with an allowable bearing pressure in excess of 4,000 pounds per square foot (psf). The maximum height section of the levee after construction is estimated to exert 1,100 psf or less, and the corresponding factor of safety is 3.6. This is greater than the minimum factor of safety requirement and the bearing capacity during construction and long-term stability is achieved. In certain segments the foundation materials will consist of fine alluvium (silt, clay). The allowable bearing pressure for this material is anticipated to be on the order of 2,000 psf. The setback levee height is generally lower in the areas where fine alluvium was encountered but conservatively assuming the maximum levee section height is applied at these locations, the corresponding factor of safety for bearing capacity is 1.8.

5.5 Settlement

The majority of the subsurface soils beneath the levee alignment are coarse grained. Therefore, settlement of the levee foundation soils is expected to occur primarily during construction activities. Additionally, due to the relatively small applied loads from the levee being applied to the subsurface soils, long-term settlement is expected to be less than 1 inch.

5.6 Seepage Analysis

CH2M performed a steady-state seepage evaluation using a two-dimensional finite element method included in the SLIDE slope stability software program (Rocscience, 2015) to estimate the phreatic surface for steady-state seepage in the levee. The evaluation was performed for a scenario in which a total head equivalent to the 100-year flood event was applied to the riverside of the levee. The Schaake setback levee will function as an emergency flood protection barrier for the properties located to the east of this portion of the Yakima River. It is anticipated that the levee will not have a sustained pool of water to hold back, with the exception of large flood events; therefore, the steady-state analysis at the

100-year flood elevation is considered to present a conservative scenario for seepage analysis and levee design.

Within the SLIDE program, cross section geometry, subsurface data, hydraulic conductivities for each strata (Table 5-2), and model boundary conditions were used to develop a phreatic surface for steady-state conditions. The phreatic surface established from the seepage analysis was used in the slope stability analysis. The geometry of the model, the finite element mesh with boundary conditions, and the seepage results for cross sections A and C through F are included in Appendix D.

Seepage analyses were performed to evaluate two seepage mechanisms: seepage through the setback levee embankment (through seepage) and seepage through the foundation soil beneath the setback levee (underseepage). Both mechanisms, if not properly controlled, can result in damage or failure of the levee embankment.

Damage or failure of a levee embankment can result if seepage through the foundation soil (underseepage) results in uplift pressures at the downstream toe that are sufficient to cause flotation and removal of soil particles, which can lead to backward erosion and piping. Experience has shown that levee failures resulting from foundation erosion for embankments constructed on high-plasticity soil, as will be case for small sections of the setback levee, are rare, and that underseepage associated with these types of foundations are almost always associated with internal erosion failures that occur from cracks in the soils rather than intergranular seepage forces (McCook, 2011).

The analysis results show that the phreatic surface stays within the levee slope and exits on the downstream toe of the levee for each cross section. Additionally the results show that the maximum total hydraulic gradient for all the cross sections evaluated is equal to approximately 0.60 (Cross section A). For cohesionless soils, this exit gradient can be compared to the critical gradient, which is a function of particle density. For lightweight, nonorganic soils, the critical exit gradients is approximately 0.5. In most cohesive soils (plastic clays), with the exception of dispersive soils, inter-particle attractions create bonds between particles that make it less likely for these soils to lose strength due to seepage or for individual particles to be easily moved. Laboratory tests have shown that while sands can typically move or become quick under an upward gradient of around 1.0, clay particles may not move until threshold gradients reach values in the tens or even hundreds (Reclamation, 2014b).

Results of the analyses indicate that seepage will not result in erosion or backward piping that could lead to damage or failure of the setback levee. Based on the conservatism of the analysis discussed above and the conservatism in our selection of hydraulic conductivity parameters for the levee and native material, we recommend that additional seepage control measures (such as cutoff trench or toe drain) are not included in the levee at this stage of the design. If seepage issues, such as the formation of sand boils, are observed along the landside toe of the levee during and subsequent to high flood levels, some maintenance may be required. This effort may include installation of localized toe drains consisting of granular fill to prevent erosion, or construction of a seepage berm to reduce critical gradients and seepage volume.

Much of the natural low permeability surficial soils have been stripped in areas where the setback levee alignment crosses land that has been disturbed and regraded as part of its historical use. Removal of this low permeability soil will allow floodwater easier access to the foundation soils under the setback levee, which are typically very pervious. There has been no attempt to cutoff seepage flows under the levee since the area on the protected side of the levee has historically been subjected to flooding and will continue to be under risk of inundation during period of flooding along Wilson Creek. Since seepage cutoff is not part of this project, it should be expected that seepage below the setback levee will occur during Yakima River flood events. The magnitude of this seepage could result in ponding of water and ‘nuisance’ level flooding on the protected side of the levee. No attempt has been made to quantify the magnitude of underseepage because of the variability of the horizontal and vertical hydraulic conductivity of the foundation materials.

5.7 Slope Stability

Slope stability analyses were performed for the following loading conditions:

- Steady state seepage
- Seismic – (pseudostatic loading)
- End of construction
- Rapid drawdown – for the 100-year flood event elevation at each cross section (Table 3-3)

The slope stability analyses were performed for the six cross sections selected for seepage analysis, as discussed previously. Stability analyses were performed using SLIDE (Rocscience, 2015). Within the SLIDE program, the Modified Bishop's and Spencer's Method were used with the appropriate strengths listed in Table 5-1.

5.7.1 Steady-State Seepage Stability

Stability analysis for the steady-state seepage condition was performed assuming the water surface on the riverside of the setback levee is at the 100-year flood elevation and the phreatic surface continued through the levee as determined from seepage analyses.

5.7.2 Seismic Stability

As discussed previously, CH2M recommends a peak ground acceleration (PGA) of 0.21g for the MDE. To evaluate stability during an earthquake event, a pseudostatic seismic coefficient was used for seismic loading. The pseudostatic coefficient recommended for analysis is 0.10g which is equivalent to 1/2*PGA.

5.7.3 End of Construction Stability

Excess pore pressures may develop as fill material is placed to construct the levee. In fine-grained, high plasticity materials the pore pressures will take a relatively long time to dissipate and the positive pore pressures will lead to a reduction in effective strength. In these types of materials it is appropriate to evaluate the end-of-construction stability using undrained shear strength parameters.

Strength parameters used in the end of construction analyses for embankment fill were the same as those used for the steady-state seepage condition as described above.

In material having significant coarse-grained material (sand and gravel) the rate of pore pressure dissipation will be relatively rapid. Based on the anticipated rapid rate of pore pressure dissipation anticipated for the silty sand and gravel materials that will be used for levee construction and the relatively flat (3H:1V) levee slopes, the end-of-construction condition is not anticipated to be a critical loading condition for slope stability with the exception of Cross Section E which is founded on fine-grained elastic material.

5.7.4 Rapid Drawdown Stability

The most severe loading for rapid-drawdown would occur following a large flood event where the water surface elevation along the setback levee has remained high for a period of time and then begins to recede; however, the process of flood waters receding is expected to take a number of days. The duration of the drawdown would allow dissipation of some of the excess pore pressures from within the embankment fill and would tend to minimize the potential for slope failure resulting from this loading condition; however, for completeness, a rapid drawdown stability analysis has been completed assuming that the riverside water prior to the rapid drawdown event is at the 100-year flood elevation. The analyses were completed assuming that the water surface drops to an elevation equal to the ground surface in the vicinity of the setback levee.

Permeable soil materials such as sand, gravel, and riprap are assumed to drain at a sufficient rate so that excess pore pressures are fully dissipated during the drawdown period. For low-permeability soil materials such as the foundation elastic silt and clay, it is assumed that excess pore pressures will not dissipate. The assumption that pore pressures do not have sufficient time to dissipate was also made for the embankment material.

Rapid-drawdown stability analyses were performed with the SLIDE computer program (Rocscience, 2014) using the three-stage undrained strength method proposed by Duncan et al. (1990). The three-stage analysis method can be summarized as follows.

The first stage involves the stability analysis of the embankment before drawdown, when the water level is high and the pore water pressures in the materials are at a steady-state condition. The first-stage analysis is used to determine the principal stress ratios and shear stresses that are acting on the failure surface of each slice along the critical slip surface to be used to determine the appropriate undrained shear strength in the second stage of the analysis for materials that do not drain freely.

The second-stage computations are performed to calculate stability immediately after drawdown, assuming that all low-permeability materials are undrained. The low- permeability materials are assigned undrained shear strength values. Effective stress shear strength parameters are used for materials that drain freely, and appropriate pore water pressures are prescribed. The pore water pressures for free-draining materials are those after drawdown has occurred and steady-state seepage has been reestablished. If a portion of the slope remains submerged after drawdown, the external water pressures acting on the submerged part of the slope are calculated and applied as external loads to the surface of the slope.

In the third stage, the drained shear strength is compared with the value of undrained shear strength for each slice where it was used in the second-stage computations. If the drained shear strength is greater than the undrained shear strength for all slices where the undrained shear strength was used previously, then no further computations are required. In that case, the factor of safety after rapid drawdown is equal to the factor of safety calculated for the second stage. If, for any slice, the drained shear strength is less than the undrained shear strength used for the second-stage computations, a third-stage computation is performed. For those slices where the drained shear strength is less than the undrained shear strength, the effective stress drained shear strength parameters, c’ and ϕ‘, are assigned to those slices for the third-stage computations. Pore water pressures are assigned based on the reestablished steady-state seepage conditions. For those slices where the undrained shear strength is less than the estimated drained shear strength, the same undrained shear strengths used for the second-stage computations are used for the third stage.

To use the staged rapid-drawdown method in SLIDE, the following must be specified:

- Mohr-Coulomb soil strength models
- Effective c’ and ϕ‘ parameters
- Total c and ϕ parameters for nonfreely drained material
- Piezometric line pore water pressure conditions
- Positions of the piezometric lines before rapid drawdown
- Positions of the piezometric lines after rapid drawdown

The phreatic surface for the initial condition where the riverside water is at the 100-year flood elevation was determined using the SLIDE computer program for steady-state seepage through the setback levee. The post-drawdown water surface is equal to the riverside ground surface.

5.7.5 Stability Analysis Results

Resulting factors of safety were rounded to the nearest one-tenth for reporting purposes. The minimum factors of safety used for the stability analyses were those provided in USACE's *Engineering Manual (EM) 1110-2-1913: Design and Construction of Levees* (USACE, 2000) and are as follows:

- Long-term steady state 1.4;
- end-of-construction 1.3; and
- Rapid drawdown 1.2.

A minimum factor of safety for the pseudostatic (seismic) condition is not given in EM 110-2-1913 (USACE, 2000). ER 1110-2-1806 identifies a MDE event as the maximum level of ground motion for which a structure is designed or evaluated. The performance level associated with the MDE is that the project performs without loss of life or catastrophic failure, such as uncontrolled release of a reservoir, although severe damage or economic loss may be tolerated (USACE, 1995). For this project, the minimum allowable factor of safety for this loading condition was selected as 1.1, which is more stringent than the guidance provided in ER 1110-2-1806. By maintaining a factor of safety of at least 1.1 for this loading condition, it is expected that minimal deformation to the levee would occur as a result of the MDE event.

For reference, a summary of the factor of safeties for each loading and boundary condition analyzed are provided in Table 5-4.

Table 5-4. Slope Stability Factor Results

Schaake Property Habitat Improvement Project

Section	Scenario	Factor of Safety	Section	Scenario	Factor of Safety
A	Long-term Landside	1.48	D	Long-term Landside	1.92
A	End of Construction (EOC)-Landside	2.14	D	EOC-Landside	2.16
A	EOC-Riverside	2.39	D	EOC- Riverside	2.19
A	Pseudostatic-Landside	1.59	D	Pseudostatic-Landside	1.73
A	Pseudostatic-Riverside	1.76	D	Pseudostatic-Riverside	1.75
A	Rapid Drawdown (DD)-Riverside	1.45	D	Rapid DD-Poolside	1.69
B	Long-term- Riverside	1.99	E	Long-term Landside	1.28
B	EOC-Landside	1.62	E	EOC-Landside	2.82
B	EOC- Riverside	1.41	E	EOC- Riverside	2.90
			E	Pseudostatic-Landside	1.43
B	Pseudostatic-Landside	1.55	E	Pseudostatic-Riverside	1.45
B	Pseudostatic-Riverside	1.47	E	Rapid DD- Riverside	1.23
C	Long-term Landside	2.12	F	Long-term Landside	1.95
C	EOC-Landside	2.94	F	EOC-Landside	2.74
C	EOC- Riverside	3.07	F	EOC- Riverside	2.77
C	Pseudostatic-Landside	2.13	F	Pseudostatic-Landside	2.00
C	Pseudostatic-Riverside	2.20	F	Pseudostatic-Riverside	2.02
C	Rapid DD- Riverside	2.45	F	Rapid DD- Riverside	2.21

The results of the stability analyses for two critical sections (cross section A and E) are included in Appendix D. Note that the analyses conservatively neglected the presence of riprap and other surficial erosion protection in the cross sections.

SECTION 6

Construction Considerations

6.1 Clearing, Grubbing, Stripping

Currently the site is covered with vegetation that predominantly consists of grass. Removal of vegetation along the setback levee and extending to 2 feet outside of the setback levee will be required. Once vegetation is removed grubbing will be required to remove significant roots. Stripping will also be required to remove topsoil and organic materials from the ground surface before preparation of the subgrade and placement of fill material. Based on observations made during the geotechnical exploration program, the upper 8 to 12 inches of soil at the site contains a high percentage of organic material. It is recommended that a minimum of 12 inches of topsoil be removed beneath the setback levee.

During clearing, woody material suitable for use as habitat cover will be set aside and re-used in the rejuvenated side channels. Otherwise, vegetation removed as part of clearing should be removed from the site. Topsoil should be stockpiled for reuse as topsoil material as required over the landward slope of the setback levee or at other locations as indicated on the construction drawings. Strippings should not be used as fill material for construction of the setback levee.

6.2 Subgrade Preparation

After clearing, grubbing, and stripping is performed and the subgrade is exposed, it should be visually examined by a CH2M geotechnical engineer to identify areas of debris, soft elastic silt or clay, or other unsuitable material. Zones of unacceptable material within the setback levee foundation should be removed to a depth of at least 2 feet and replaced with compacted embankment fill. Areas of the subgrade that pump or appear wet and soft should be scarified, dried, and recompacted or may be removed and replaced with compacted embankment fill material at the direction of the engineer.

Prior to placing the embankment material the excavated surface shall be disked, moisture controlled, and compacted with a minimum of three passes of a vibratory drum roller.

6.3 Embankment Fill Material

Approximately 40,000 cubic yards (CY) of embankment fill will be required to construct the setback levee. Fill material for construction of the setback levee will be generated from onsite borrow sources which will require blending of soils to achieve the required gradation as identified below. Additionally, material from the existing levees which are planned for demolition may be reused for embankment fill material.

Embankment fill material should have the characteristics of semipervious material as defined in Chapter 10, Embankment Construction, of Reclamation Design Standard 13, *Embankment Dams* (Reclamation, 1994). Semipervious materials include silty sands or gravels (SM or GM). Silts, silty sands, and silty gravels are sometimes used in the impervious zones and perform adequately for flood protection levees. Increasing the fines content of a soil increases its imperviousness. According to Reclamation Design Standard 13, materials can be considered impervious if they have at least 25 percent passing the standard No. 200 sieve (in some cases, 10 to 15 percent passing is the minimum considered necessary for adequate impervious fill).

Recommended requirements for the embankment fill material for the setback levee include the following:

- Minimum fines content (soil particles passing the No. 200 sieve) = 20 percent
- Maximum particle size = 3 inches
- Maximum percent particles greater than No. 4 sieve = 45 percent

If necessary, imported material meeting the characteristics described above may be used for embankment fill. For estimating purposes, it is recommended that 3,000 CY of import material is included for a cost basis to account for a material contingency.

6.3.1 Borrow Material Considerations

Test Pits TP-11 through TP-13 were excavated in the vicinity of the proposed borrow area. The location of this area was selected based on the presence of fine alluvium in the vicinity, however it is noted that there is high potential for variability in the gradation of soil in the borrow area due to previous site disturbance (site uses) and the depositional nature of the alluvial soils. Additional exploration involving test pits or test trenches performed within the proposed borrow site and in a few additional select locations at the site would allow for better characterization of the type and extent of the materials present in the borrow area, and potentially the identification of additional borrow areas. The additional select sites would be determined based on a review of existing data and historic photographs and activities to attempt to identify areas where native soil with relativity high fines content may still exist. The data obtained from these explorations would help in determining the volume of acceptable borrow soil present and the extent to which on-site materials may need to be mixed in order to meet embankment fill specifications. The data would also be used by potential bidders in developing their work plans and bids.

As discussed previously, mixing of borrow materials is anticipated to be necessary to achieve the required gradation for embankment fill material. Based on available information, it is expected that select excavation of materials will be required prior to transporting material from the borrow location to the setback levee alignment. In some instances coarser materials will need to be spread out in horizontal lifts and material consisting primarily of silt or clay added and spread out. One method of mixing would involve agricultural disking of the soils as they are placed in lifts to mix coarse and fine alluvial materials to achieve the required blend prior to compaction.

The presence of groundwater should also be considered in developing the borrow source. For the purpose of planning, it should be anticipated that the depth to groundwater in the borrow area will be approximately three feet. Excavation of material below the groundwater could result in segregation of soil (loss of fines) or moisture contents of the borrowed material being too high for use as embankment fill without moisture conditioning to dry the soil. Localized dewatering could be implemented to reduce the potential for segregation and need for moisture condition the borrow soil prior to compaction in the setback levee.

6.3.2 Zoned Embankment

As an alternative to reduce or potentially eliminate the need for mixing borrow source material, a zoned embankment may be utilized. A zoned embankment would consist of a core of fine alluvium material (silt and silty sand) with the slope on either side of the core consisting of sand and gravel (coarse alluvium). This concept may reduce the demand to mix borrow materials at the site and still provide a relatively impervious embankment for seepage control purposes. This concept will be further considered during subsequent design phases.

6.4 Embankment Construction

Because of the potential for high groundwater at the site, it is recommended that construction of the setback levee occur during the dryer months or the year.

Embankment fill material should be placed in horizontal loose lifts not exceeding 8 inches and compacted to no less than 95 percent of the maximum dry density as determined by ASTM D698 (standard Proctor compaction). Embankment fill material should be moisture conditioned so that it has a moisture content within approximately 1 percent below and 2.5 percent above the optimum moisture content. The moisture content of selected embankment fill material should be tested at onsite borrow location before the material is placed in the fill position. If the test results show that the material has moisture content outside of specified limits, moisture conditioning will be required. Moisture conditioning shall be completed at the onsite borrow location prior to placement in the embankment. Sufficient in-place density tests should be completed to confirm that adequate compaction is being achieved at the proper moisture content. If testing of material that has already been placed and compacted shows low densities or moisture content outside of specified ranges, the material should be rejected and removed.

It is expected that moisture conditioning will be performed using traditional techniques. Excessively high moisture content should be reduced by spreading and disking the material. Low moisture should be corrected by spreading the material in thin layers, adding water by sprinkling, and disking until the water is distributed uniformly throughout the material.

6.5 Crossing Features

Setback levee penetrations will occur at Wetland E (STA 118+70) and Tjossem Ditch (STA 160+25). Each crossing will consist of a 24-inch high density polyethylene (HDPE) pipe to facilitate surficial drainage water and irrigation water, respectively. The Wetland E crossing will have a tide gate on the riverside of the levee to prevent floodwater from crossing through to the landside. The Tjossem Ditch crossing will incorporate a reinforced concrete outlet structure with a manually operated headgate on the riverside of the levee to control irrigation flow through Tjossem Ditch.

The trench for the crossing pipes should be constructed by placing compacted embankment fill to a minimum of 2 feet above the design top of pipe elevation and then trenching through the constructed embankment to place the pipe. A trench cutoff should be constructed every 10 linear feet along the pipe to prevent seepage paths from forming along the pipe conduit. The trench, and trench cutoffs, should be backfilled with controlled low strength material (CLSM) in the pipe backfill zone. Compacted embankment material should then be placed over the pipe zone following set-up of the CLSM.

6.6 Construction Monitoring and Testing (CQC, testing, acceptance of materials)

Laboratory testing should be performed on representative samples of embankment fill from each approved source of embankment fill during the period when material is being obtained from the source. Sources are anticipated to consist of onsite borrow material, existing levee material, and import). The laboratory tests should include grain size and plasticity. The following laboratory tests should be conducted to verify that the embankment fill material imported to the site meets the requirements of acceptable fill material:

1. Grain size: Minimum of one test per each 1,500 cubic yards of embankment fill material
2. Plasticity (Atterberg Limits): Minimum of one test per each 2,000 cubic yards of embankment fill material

Sufficient in-place density tests should be completed to confirm that adequate compaction is being achieved at the proper moisture content. This testing should be completed in accordance with requirements of ASTM D6938 or D1556. If testing of material that has already been placed and compacted shows low densities or moisture content outside of specified ranges, the material should be

rejected and removed. One in-place density test should be completed for each 2,000 square feet of embankment fill placed. In-place density testing should be at various elevations so that some testing is completed in each horizontal lift required to construct the levee.

A full-time construction manager is recommended to oversee construction of the setback levee and verify that the site is constructed in accordance with the requirements of design drawings and technical specifications. In addition, CH2M's geotechnical engineer should provide observation of the prepared subgrade and complete periodic observation of the construction. The geotechnical engineer should verify that foundation conditions along the setback levee are similar to the conditions evaluated in this report. If conditions are different that those depicted in this report, additional geotechnical analyses may be required and changes in the design may be necessary.

6.7 Erosion Protection

Both sides of the setback levee should be protected against expected erosive forces. Protection on the riverside of the setback levee may vary dependent on hydraulic modeling results. Where higher velocities are expected, rock riprap should be placed and designed using USACE's *EM 1110-2-1601: Hydraulic Design of Flood Control Channels* (USACE, 1994). At the overflow control structure, articulating concrete blocks should be used where use of riprap would otherwise result in a porous levee. Where lower velocities are expected on the riverside of the levee, cobbles should be mixed into to the topsoil and the resultant soil vegetated in accordance with *Engineering Technical Letter 1110-2-583: Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures (USACE, 2014)* and the USACE Seattle District's variance to ETL 1110-2-583 (USACE, 1995).

SECTION 7

Summary and Conclusions

The concept for developing the Schaake Property Habitat Improvement is to construct a setback levee with a minimum 12-foot-wide crest built with 3H:1V landside and riverside slopes. Fill material for the embankment will be primarily generated from an onsite borrow source where some blending of borrowed soil will be required to achieve the specified gradation. Material generated from the demolition of existing levees onsite as well as excavation of the side channels and alcoves may also be used for embankment material provided it meets the specified gradation and moisture content limits. Although not anticipated, embankment fill material may also be imported from offsite.

Seepage analyses were performed to evaluate the phreatic water surfaces that would develop in the setback levee under extreme conditions. The analysis indicate that critical gradients that could lead to piping of soil particles within and under the setback levee will not occur. However, because the foundation soils below much of the levee are very pervious and much of the natural low permeability surficial soils have been stripped away as part of the sites historical use, underseepage beneath the setback levee should be expected during significant Yakima River flooding. The magnitude of this seepage could result in ponding of water and 'nuisance' level flooding on the protected side of the levee and some maintenance of the levee may be required.

Slope stability evaluations indicate that the proposed levee geometry, including the 3H:1V levee embankment slopes, provide adequate slope stability for the loading cases and conditions evaluated. The critical load cases were the end-of-construction and rapid drawdown cases.

Assessment of the potential need to blend onsite soil to produce a material meeting the requirements for the embankment fill will be an important consideration for bidders in developing their cost proposals. Additional investigations of the proposed borrow source, and perhaps one or two additional select areas should be considered to provide additional information that would allow for better defining the limits of borrow source areas, volumes and variability of material present, and depth to groundwater.

SECTION 8

References

Bentley, R.D. and N.P. Campbell. 1983. Geologic map of the Ellensburg quadrangle, Washington. State of Washington, Department of Natural Resources, Division of Geology and Natural Resources, Geologic Map GM-28.

Carrier III, D.W. 2003. "Goodbye, Hazen: Hello, Kozeny-Carman." *Journal of Geotechnical and Geoenvironmental Engineering.*

CH2M HILL. 2011. *Schaake Property Habitat Improvement Designs Task Order 08B510677B – Phase 1 Initial Geotechnical Data Summary.*

CH2M HILL. 2015. *Schaake Property Habitat Improvement Project Basis of Design Report – 30 Percent Design (BDR).*

Duncan, J.M., Wright, S.G., and K. A. Wong. 1990. "Slope Stability During Rapid Drawdown," *Proceedings of H. Bolten Seed Memorial Symposium,* Vol. 2.

Kulhawy, F. and P. Mayne. 1990. *Manual on Estimating Soil Properties for Foundation Design.* Electric Power Research Institute.

Land Profile Inc. 2004. *Soil and Site Study for Bureau of Reclamation, Former Schaake Property, 1180 Umptanum Road, Ellensburg, WA.*

McCook, D.K. 2011. *A Discussion of Uplift and Exit Gradient Terminology and Factors of Safety.* Association of State Dame safety Officials Annual Conference Proceedings. Lexington, KY.

Myers, C.W. and S.M. Price, eds. 1979. *Geologic studies of the Columbia Plateau—A Status Report: RHO-BWI-ST-4, Rockwell Hanford Operations.*

Rocscience, Inc. (2015). Slide version 6.036, Slope Stability Analysis Computer Program. Build date: July 13, 2015.

U.S. Army Corps of Engineers (USACE). 1994. Engineer Manual EM 1110-2-1601*, Hydraulic Design of Flood Control Channels*.

U.S. Army Corps of Engineers (USACE). 1995. Engineering Regulation, ER 1110-2-1806, Earthquake Design, and Evaluation for Civil Works Projects.

U.S. Army Corps of Engineers (USACE). 2000. Engineer Manual (EM) 1110-2-1913, *Design and Construction of Levees*.

U.S. Army Corps of Engineers (USACE). 2003. Engineer Manual (EM) 1110-2-1902, *Slop Stability.*

U.S. Army Corps of Engineers (USACE). 2005. Engineer Technical Letter 1110-2-569, Engineering and Design, Design Guidance for Levee Underseepage. May.

U.S. Army Corps of Engineers (USACE). 2014. Engineer Technical Letter 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures April.

U.S. Army Corps of Engineers (USACE). 2015. Engineering Regulation, ER 1110-2-1806 and Engineering and Construction Bulletin No. 2015-5.

U.S. Bureau of Reclamation (Reclamation). 2011. *Design Standards No. 13, Embankment Dams*, Chapter 4: Static Stability Analysis.

U.S. Bureau of Reclamation (Reclamation). 2014a. *Design Standards No. 13, Embankment Dams,* Chapter 2: Embankment Design.

U.S. Bureau of Reclamation (Reclamation). 2014b. *Design Standards No. 13, Embankment Dams,* Chapter 7: Riprap Slope Protection.

U.S. Bureau of Reclamation (Reclamation). 2014c. *Design Standards No. 13, Embankment Dams,* Chapter 8: Seepage.

U.S. Geologic Survey (USGS). 2008. *USGS National Seismic Hazard Mapping Project*.

U.S. Geologic Survey (USGS). 2015. *Quaternary Faults (Age)* map. http://earthquake.usgs.gov/hazards/qfaults/map/. Accessed October 12, 2015.

Vaccarro, J.J., M.A. Jones, D.M. Ely, M.E. Keys, T.D. Olsen, W.B. Welch, and S.E. Cox. 2009. "Hydrogeologic framework of the Yakima River Basin aquifer system, Washington." *U.S. Geological Survey Scientific Investigations Report 2009-5152*.

Appendix A
Figures

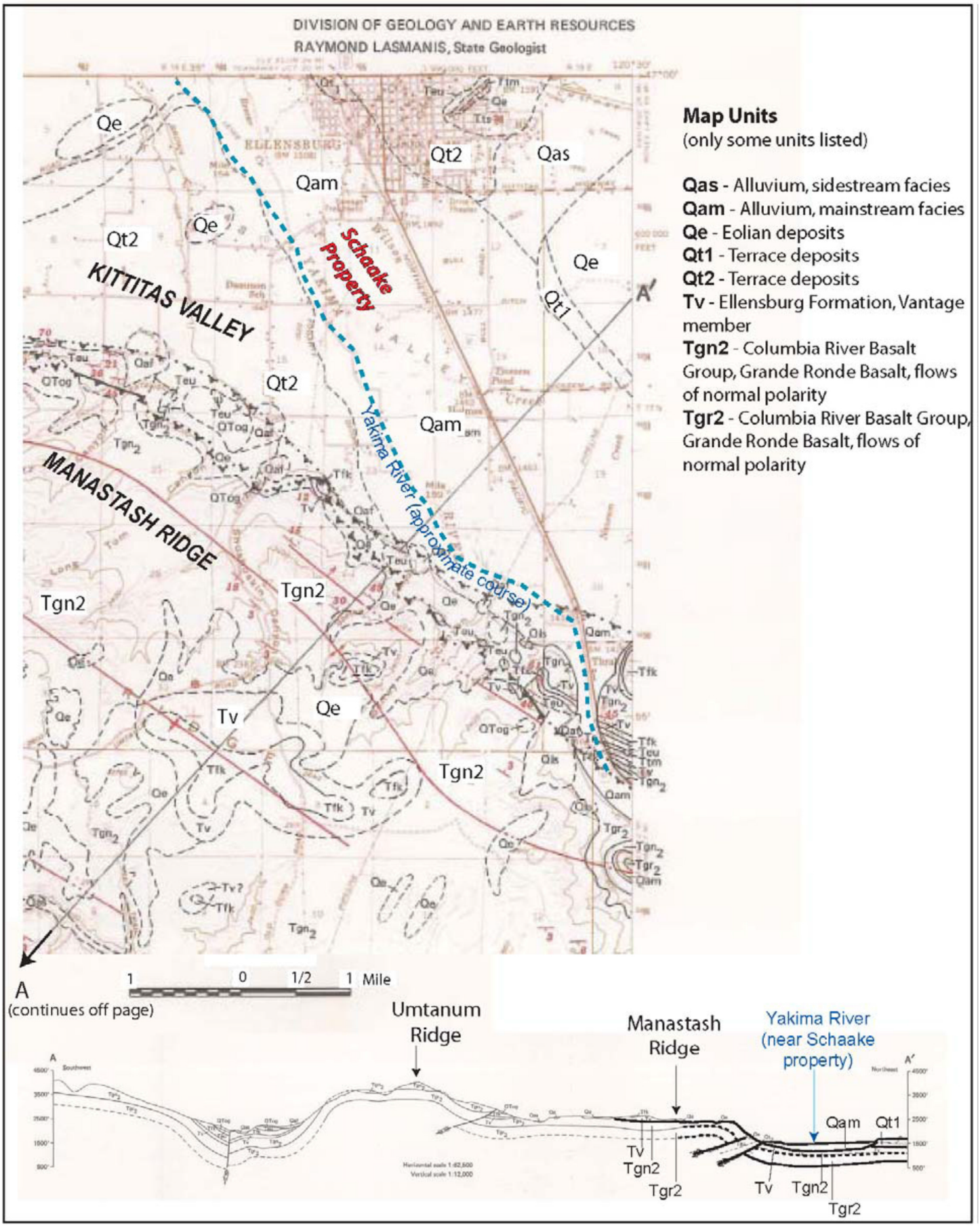
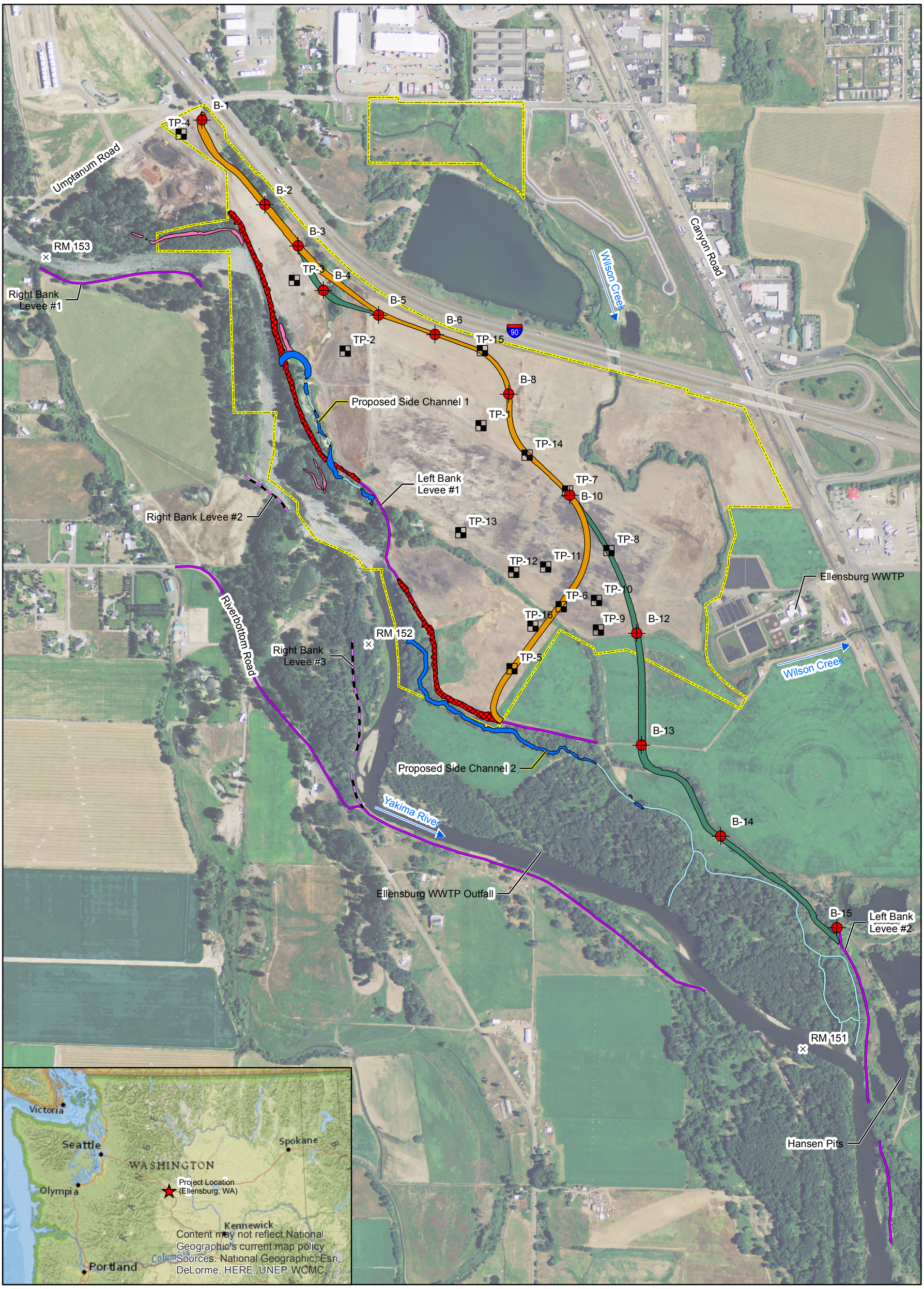


Figure 2-1. Geologic Map of the Ellensburg Quadrangle

Schaake Property Habitat Improvements Project - Geotechnical Summary Memorandum



LEGEND

Background Elements

- × Yakima River Mile (RM)
- Abandoned Levee
- Active Levee
- Schaake Property Boundary

Fall 2014 Geotechnical Investigation

- Test Pit
- Soil Boring

Proposed Project Elements

- Alcove Excavation
- Levee Removal
- Setback Levee, Initial Alignment
- Setback Levee, Final Alignment
- Side Channel Excavation
- Reinvigorated Side Channel

NOTES:
1. Ownership boundaries are approximate.
2. Soil Boring Numbers B-7, B-9, and B-11 intentionally omitted.

N

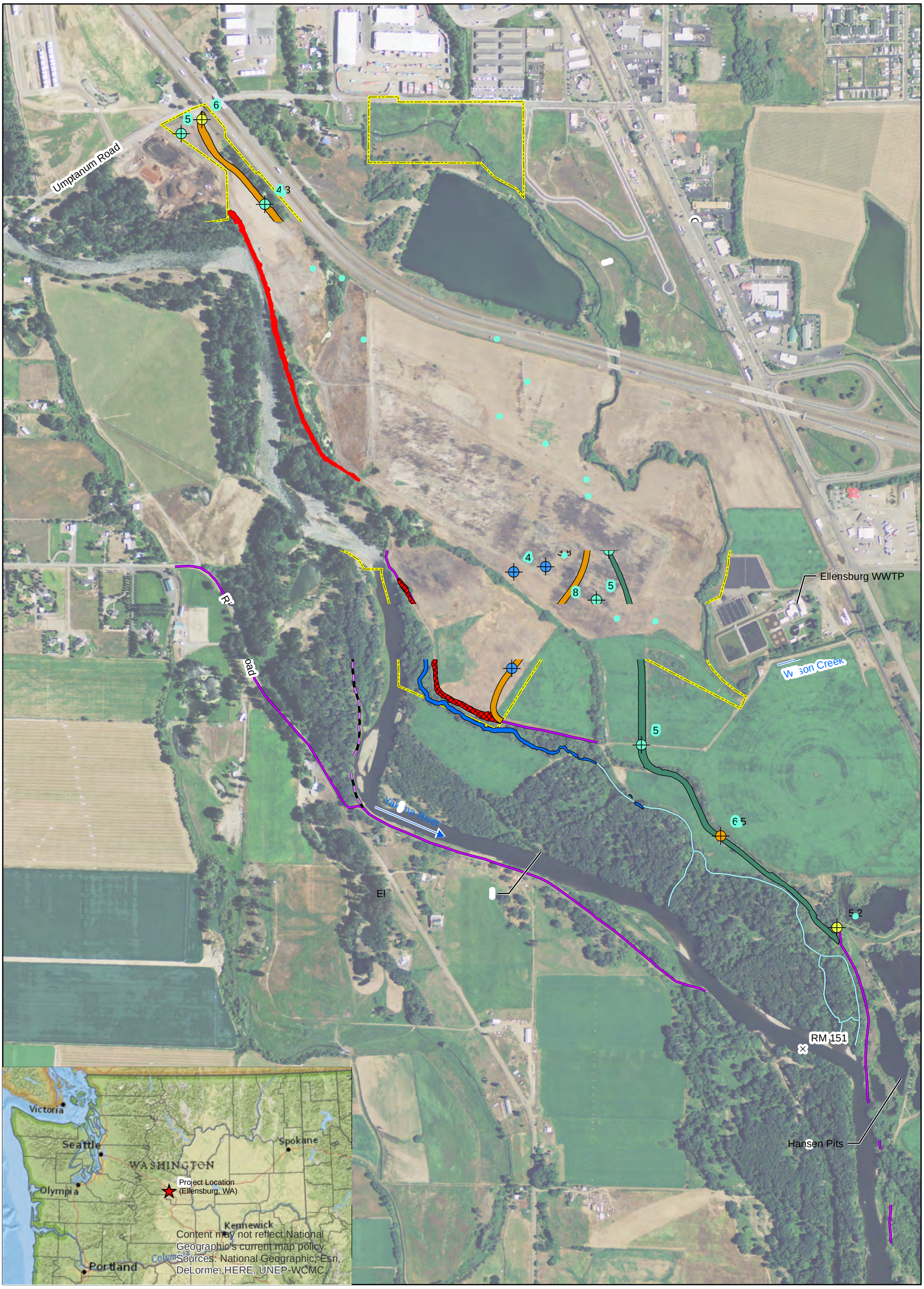
0 250 500 1,000 1,500 2,000 Feet

Sources: Aerial Imagery (ESRI ArcGIS Online); Property Lines (Reclamation, 2010); Existing Levees (Reclamation, 2009); Project Elements (CH2M HILL and Reclamation 2014); Soil Boring and Test Pit Locations (CH2M HILL, 2014)

Figure 3-1. **November 2014 Soil Boring and Test Pit Location Plan**
Yakima River Floodplain Reconnection Project
DRAFT November 11, 2014

CH2MHILL

Z:\BUREAUOFRECLAMATION\457818SCHAAKEPHASE2\GIS\MAPFILES\FIELDWORK\SCHAAKE_GEOTECHWORK_20150901.MXD 9/1/2015



LEGEND

Background Elements

- × Yakima River Mile (RM)
- Abandoned Levee
- Active Levee
- Schaake Property Boundary

Proposed Project Elements

- Alcove Excavation
- Levee Removal
- Setback Levee, Initial Alignment
- Setback Levee, Final Alignment
- Side Channel Excavation
- Reinvigorated Side Channel

Observed Groundwater Depth (ft)

- 7 to 8
- 6 to 7
- 5 to 6
- 4 to 5
- 3 to 4
- Less than 3

N

0 250 500 1,000 1,500 2,000 Feet

Sources: Aerial Imagery (ESRI ArcGIS Online); Schaake Property Boundary (Reclamation, 2010); Existing Levees (Reclamation, 2009); Project Elements (CH2M HILL and Reclamation 2014); Observed Depth to Groundwater (CH2M HILL, 2014)

NOTES:
1. Schaake property boundary is approximate.
2. Depth to groundwater based on field observations conducted November 4 to 6, 2014. Observed depth to groundwater in text next to observation location. Units are feet.
3. See Figure 2 for identification of groundwater observation locations as test pits or soil borings.

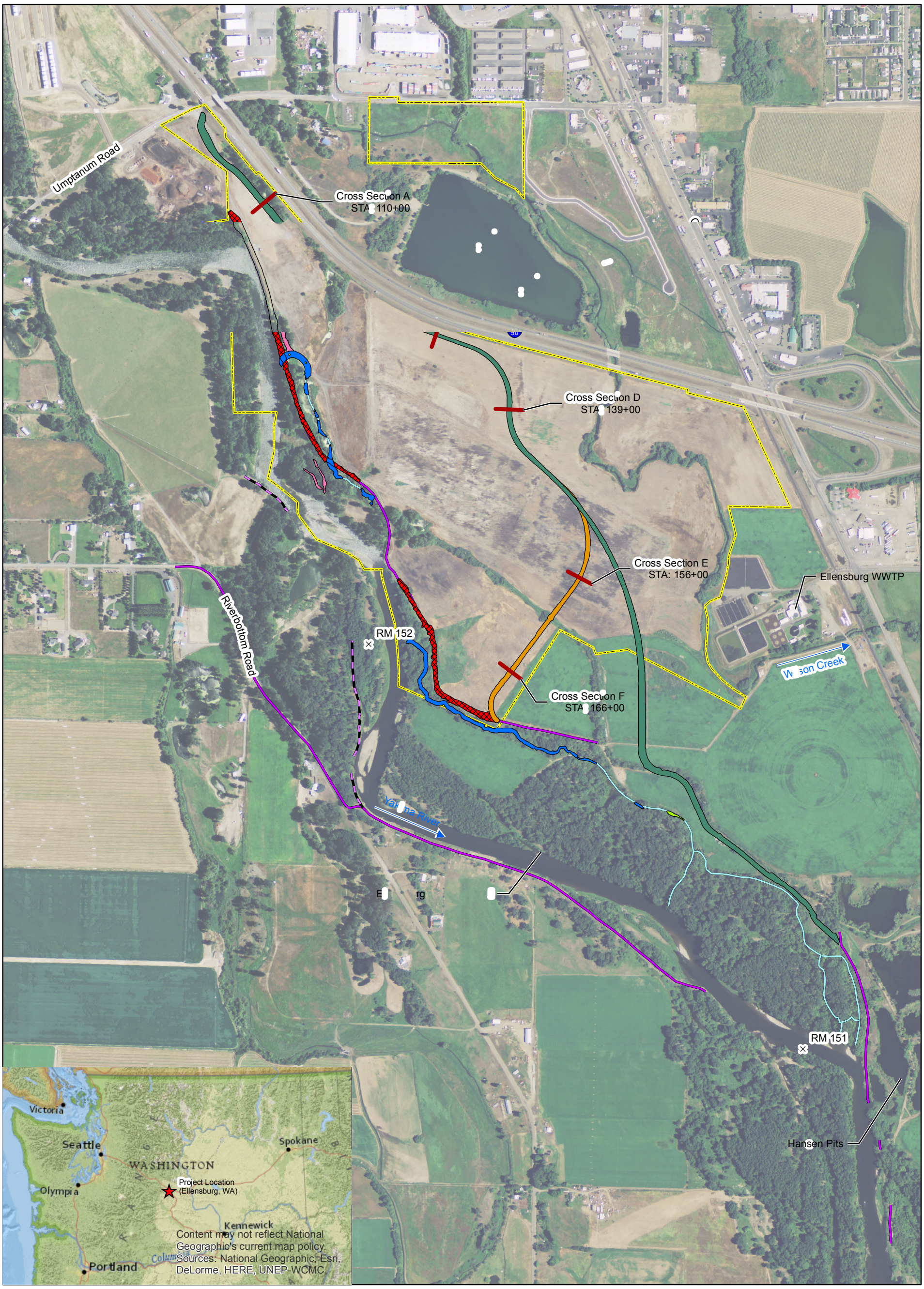
Figure 4-1. **November 2014 Observed Depth to Groundwater**

Geotechnical Evaluation TM

Schaake Property Habitat Improvement Project

DRAFT September 30, 2015

ch2m



LEGEND

Background Elements

- Yakima River Mile (RM)
- Schaake_Geotech_XSections
- Abandoned Levee
- Active Levee
- Schaake Property Boundary

Proposed Project Elements

- Alcove Excavation
- Constructed Riffle
- Levee Removal
- Setback Levee, Initial Alignment
- Setback Levee, Final Alignment
- Side Channel Excavation
- Reinvigorated Side Channel

N

0 255 510 1,020 1,530 2,040 Feet

Sources: Aerial Imagery (ESRI ArcGIS Online); Schaake Property Boundary (Reclamation, 2010); Existing Levees (Reclamation, 2009); Project Elements (CH2M HILL and Reclamation 2014); Observed Depth to Groundwater (CH2M HILL, 2014)

NOTES:
1. Schaake property boundary is approximate.
2. Stationing refers to horizontal alignment along Setback Levee

Figure 5-1. **Cross Sections for Geotechnical Analysis**

Geotechnical Evaluation TM

Schaake Property Habitat Improvement Project

DRAFT September 30, 2015

ch2m

Appendix B
Boring and Test Pit Logs and Laboratory Results

PROJECT NUMBER:	BORING NUMBER:	
457818	B-1-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (600646.2 N, 1625304.8 E)
ELEVATION : 4927.1 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 6.0 ft bgs
START : 11/6/14 11:25
END : 11/6/14 12:35
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4927.1							
	2.5						
	4.0	0.6	SS-1	12-15-15 (30)	**WELL GRADED GRAVEL WITH SAND (GW)** orange brown to black, moist, medium dense		Moisture = 6% Gravel = 64% Sand = 33% Fines = 3%
5	5.0						
4922.1	6.5	0.5	SS-2	13-9-7 (16)	**WELL GRADED GRAVEL WITH SAND (GW)** orange brown to black, moist, medium dense		Groundwater at 6.0' bgs
10	10.0						
4917.1	11.5	1.0	SS-3	21-42-18 (60)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, very dense, medium to coarse sand, fractured gravels		Soil contact at 10.0' bgs
15	15.0						
4912.1	16.5	0.7	SS-4	4-16-14 (30)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, medium to coarse sand, fractured gravels		
20	20.0						
4907.1	21.5	0.5	SS-5	50/4 (50/4")	**CLAYEY SAND WITH GRAVEL (SC)** orange-brown, wet, very dense, similar to above but greater fines content Bottom of Boring at 21.0 ft bgs on 11/6/14 12:35		21.0' - Augers grading on cobbles Drilled at 21.0' for 20 minutes with no advance Terminated boring in dense cobbles
25 4902.1							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-2-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (599914.7 N, 1625846.9 E)
ELEVATION : 4911.2 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 4.3 ft bgs
START : 11/4/14 03:00
END : 11/5/16 08:30
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4911.2							
	2.5						Contact gravels at 2.0' bgs
	4.0	1.0	SS-1	7-17-14 (31)	**POORLY GRADED SAND WITH GRAVEL (SP)** brown to white, slightly moist, dense, fractured gravels ~40%, coarse to medium sand		
▼ 5	5.0						Groundwater at 4.3' bgs
4906.2	6.5	1.0	SS-2	37-20-22 (42)	**POORLY GRADED SAND WITH GRAVEL (SP)** brown to white, wet, dense, fractured gravels ~40%, coarse to medium sand		Moisture = 7.9% Gravel = 65% Sand = 33% Fines = 2%
10	10.0						
4901.2	11.5	0.7	SS-3	11-14-9 (23)	**POORLY GRADED SAND WITH GRAVEL (SP)** brown to white, wet, medium dense, fractured gravels ~40%, coarse to medium sand		Large gravel in shoe
15	15.0						
4896.2	16.5	1.4	SS-4	20-22-33 (55)	**CLAYEY GRAVEL WITH SAND (SC)** red brown to gray, moist to wet, very dense, some iron oxide staining, almost 50/50 split of coarse sand/gravel		Hole heaving at 15.0' bgs Can not drop sampler into place Stopped for day at 4:00 p.m.
20	20.0						
4891.2	21.5	0.5	SS-5	32-50/1 (50/1")	**CLAYEY GRAVEL WITH SAND (SC)** 5" heave in top of sample, red brown to gray, moist to wet, very dense, some iron oxide staining, almost 50/50 split of coarse sand/gravel Bottom of Boring at 20.6 ft bgs on 11/5/16 08:30		11/5/14 - Resume at 7:45 a.m. Re-drill hole, water to supress heave
25 4886.2							
30							

PROJECT NUMBER:	BORING NUMBER:
457818	B-3-14 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (599562.1 N, 1626132.5 E)
ELEVATION : 4901.6 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 3.0 ft bgs
START : 11/6/14 10:20
END : 11/6/14 10:45
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4901.6							
	2.5						
▼	4.0	0.6	SS-1	11-21-26 (47)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium to coarse sand, 30-40% gravel		SS-1, large gravel in shoe Groundwater at 3.0' bgs
5 4896.6	5.0						
	6.5	0.9	SS-2	11-22-22 (44)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium to coarse sand, 30-40% gravel		SS-2, large gravel in shoe
10 4891.6	10.0						
	11.5	0.8	SS-3	11-22-24 (46)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium to coarse sand, 30-40% gravel		
					Bottom of Boring at 11.5 ft bgs on 11/6/14 10:45		
15 4886.6							
20 4881.6							
25 4876.6							
30							

PROJECT NUMBER:	BORING NUMBER:
457818	B-4-14 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (599180.3 N, 1626351.0 E)
ELEVATION : 4893.9 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 2.8 ft bgs
START : 11/6/14 09:15
END : 11/6/14 09:55
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4893.9							
	2.5						
▼	4.0	0.8	SS-1	10-13-16 (29)	**POORLY GRADED SAND WITH GRAVEL (SP)** black to brown, wet, medium dense, mostly fine gravel and 30-40% coarse sand		Groundwater at 2.8' bgs SS-1, SS-2, SS-3 Resistivity = 11,500 ohm-cm pH = 6.8 (note: combined with B-5-14: SS-1, SS-2, SS-3)
5	5.0						
4888.9	6.5	0.9	SS-2	7-10-13 (23)	**POORLY GRADED SAND WITH GRAVEL (SP)** black to brown, wet, medium dense, almost 50/50 mix of sand/gravel		
10	10.0						
4883.9	11.5	0.8	SS-3	9-17-22 (39)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense		
15	15.0						
4878.9	16.5	0.7	SS-4	17-50/3 (50/3")	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, very dense Bottom of Boring at 15.8 ft bgs on 11/6/14 09:55		SS-4, large gravel in shoe
20 4873.9							
25 4868.9							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-5-14	SHEET 1 OF 1

SOIL BORING LOG -

PROJECT : Schaake
LOCATION : (598967.6 N, 1626826.0 E)
ELEVATION : 4900.4 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 5.0 ft bgs
START : 11/6/14 07:50
END : 11/6/14 08:50
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4900.4							
	2.5						
	4.0	0.6	SS-1	7-8-7 (15)	**POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC)** brown, moist, medium dense		
▼	5.0						
4895.4	6.5	0.7	SS-2	4-13-21 (34)	**CLAYEY SAND WITH GRAVEL (SC)** red brown, wet, dense		Groundwater at 5.0' bgs SS-1, SS-2, SS-3 Resisity = 11,500 ohm-cm pH = 6.8 (note: combined with B-4-14: SS-1, SS-2, SS-3)
10	10.0						
4890.4	11.5	0.7	SS-3	6-11-20 (31)	**POORLY GRADED SAND WITH GRAVEL (SP)** black to orange, wet, dense, medium to coarse sand and 1/4" to 3/4" gravel		
15	15.0						
4885.4	16.5	0.5	SS-4	5-14-41 (55)	**POORLY GRADED SAND WITH GRAVEL (SP)** black to orange, wet, very dense, medium to coarse sand and 1/4" to 3/4" gravel		
20	20.0						
4880.4	21.5	0.4	SS-5	50/3 (50/3")	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)** Bottom of Boring at 20.2 ft bgs on 11/6/14 08:50		Moisture = 11% LL = No Value PI = Non-plastic Gravel = 40% Sand = 52% Fine = 8%
25 4875.4							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-6-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (598801.1 N, 1627311.2 E)
ELEVATION : 4893.2 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 3.0 ft bgs
START : 11/5/14 13:45
END : 11/5/14 15:00
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4893.2	2.5						
▼	4.0	0.4	SS-1	5-9-11 (20)	**SILTY SAND (SM)** gray, soft with wood debris		Groundwater at 3.0' bgs
					POORLY GRADED WITH SAND (SP) black to gray, wet, 1/4" rounded gravels		
5	5.0				**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium to coarse sand, 1/2" fractured gravel, 1/4" rounded gravel		
4888.2	6.5	0.7	SS-2	8-16-20 (36)			
10	10.0						
4883.2	11.5	1.2	SS-3	21-30-30 (60)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, very dense, medium to coarse sand, 1/2" fractured gravel, 1/4" rounded gravel		
15	15.0						
4878.2	16.5	1.2	SS-4	17-33-43 (76)	**CLAYEY SAND WITH GRAVEL (SC)** red brown, wet, very dense, similar sand/gravel as above but with 20% tan clay fines		
20	20.0						
4873.2					Bottom of Boring at 20.0 ft bgs on 11/5/14 15:00		No sample at 20.0' bgs Pilot bit broke off at bottom of auger stem
25 4868.2							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-8-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (598288.6 N, 1627945.1 E)
ELEVATION : 4880.3 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 2.9 ft bgs
START : 11/5/14 12:15
END : 11/5/14 13:05
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4880.3							
	2.5						
▼	4.0	0.8	SS-1	11-14-18 (32)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium sand, ~40% gravels		Groundwater at 2.9' bgs
5	5.0						
4875.3	6.5	0.9	SS-2	21-26-26 (52)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, very dense, medium sand, ~40% gravels		SS-2, large gravel in shoe
10	10.0						
4870.3	11.5	0.5	SS-3	5-9-11 (20)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, medium sand, ~40% gravels		Driller notes hole is taking water at 10.0' bgs, SS-10 has low recovery Gravel = 48% Sand = 50% Fine = 2%
15	15.0						
4865.3	16.5	0.9	SS-4	14-50/5.5 (50/5.5")	**POORLY GRADED SAND WITH GRAVEL (SP)** brown to black, wet, dense, medium sand, ~40% gravels		
20	20.0						
4860.3	21.5	0.5	SS-5	31-50/5.5 (50/5.5")	**CLAYEY SAND WITH GRAVEL (SC)** red-brown, wet, very dense Bottom of Boring at 21.0 ft bgs on 11/5/14 13:05		
25 4855.3							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-10-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (597417.3 N, 1628469.6 E)
ELEVATION : 4874.5 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 3.8 ft bgs
START : 11/5/14 10:50
END : 11/5/14 11:40
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4874.5							Auger chatter from gavel 0.0-2.5' bgs
	2.5						
	4.0	0.0	SS-1	4-4-6 (10)	**NO RECOVERY** gravel in shoe		Groundwater at 3.8' bgs
5	5.0						
4869.5	6.5	0.7	SS-2	8-13-11 (24)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, medium graded sand with 30-40% fractured 1/2" gravel and rounded 1/4" gravel		
10	10.0						
4864.5	11.5	0.2	SS-3	10-12-22 (34)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, medium graded sand with 30-40% fractured 1/2" gravel and rounded 1/4" gravel		SS-3 low recovery due to no catcher in SPT, no sample At 10.0' bgs, driller notes he was pumping water in hole at maximum rate and hole was taking all the water, may be zone of looser, more fluid, deposit due to low recovery and hole taking on water
15	15.0						
4859.5	16.5	1.0	SS-4	16-27-18 (45)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, medium graded sand with 30-40% fractured 1/2" gravel and rounded 1/4" gravel		
20	20.0						
4854.5	21.5	0.7	SS-5	9-23-25 (48)	**POORLY GRADED GRAVEL WITH SAND (GP)** black, wet, dense, 1/2-1/4" rounded gravels, sand matrix Bottom of Boring at 21.5 ft bgs on 11/5/14 11:40		
25 4849.5							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-12-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (596228.5 N, 1629046.7 E)
ELEVATION : 4857.9 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 4.7 ft bgs
START : 11/5/14 09:10
END : 11/5/14 10:20
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4857.9							
	2.5						
	4.0	0.4	SS-1	10-6-3 (9)	**POORLY GRADED GRAVEL WITH SAND (GP)** brown, dry, some wood debris		Moisture = 5.5% Gravel = 50% Sand = 46% Fines = 4% Driller notes soft from 3.0-5.5'
5	5.0						Groundwater at 4.7' bgs
4852.9	6.5	1.0	SS-2	0-3-16 (19)	**LEAN CLAY (CL)** gray-brown, moist, very soft, some woody debris **POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, woody debris in clay		WOH for first 6" SS-2, retained clay only in sample bag
10	10.0						
4847.9	11.5	1.0	SS-3	10-15-21 (36)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, woody debris in clay		grinding through cobbles a 11.0' bgs
15	15.0						
4842.9	16.5	0.6	SS-4	12-36-35 (71)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, dense, woody debris in clay		
20	20.0						
4837.9	21.5	0.9	SS-5	27-32-29 (61)	**CLAYEY GRAVEL WITH SAND (GC)** brown, wet, very dense		
					Bottom of Boring at 21.5 ft bgs on 11/5/14 10:20		
25 4832.9							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-13-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (595267.9 N, 1629087.3 E)
ELEVATION : 4852.0 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 5.0 ft bgs
START : 11/4/14 08:25
END : 11/4/14 09:35
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4852.0							Grass spray-field surface Cuttings are Sandy Silty Clay
	2.5						
	4.0	1.1	SS-1	1-1-1 (2)	**CLAYEY SAND (SC)** gray-brown, moist, very loose, fine sand, sample transitions to gray poorly graded sand		Moisture = 34.2% Gravel = 1% Sand = 77% Fines = 22%
▼	5.0						
4847.0	6.5	0.5	SS-2	WOH (WOH")	**SILTY CLAYEY SAND (SC-SM)** gray, wet, very loose, fine sand, ~30% fines		Groundwater at 5.0' bgs Moisture = 45.7% Gravel = 0% Sand = 73% Fines = 27% contact gravels at 7.0' bgs
	7.0						
10	10.0						
4842.0	11.5	0.8	SS-3	10-15-16 (31)	**POORLY GRADED GRAVEL WITH SAND (GP)** gray to black, wet, dense, 1/2" gravels (60%), coarse to medium sand (30%) and, some fines		At 10.0' bgs, 4.0' of heaving sands in auger stem. Break for water at 8:45. Resume at 9:10. SS-3, gravel in shoe suspect N-value
15	15.0						
4837.0	16.5	0.7	SS-4	5-11-16 (27)	**POORLY GRADED GRAVEL WITH SAND (GP)** gray to black, wet, dense, 1/2" gravels (60%), coarse to medium sand (30%) and, some fines		SS-4, gravel in shoe Moisture = 5.5% LL = No Value PI = Non-plastic Gravel = 74% Sand = 25% Fines = 1%
20	20.0						
4832.0	21.5	0.7	SS-5	50/5 (50/5")	**SILTY SAND WITH GRAVEL (SM)** red-brown, wet, medium to coarse sandy silty with ~40% 1/2" to 1/4" gravels Bottom of Boring at 20.5 ft bgs on 11/4/14 09:35		SS-5, gravel in shoe Moisture = 12.7% LL = No Value PI = Non-plastic Gravel = 32% Sand = 59% Fines = 9%
25 4827.0							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-14-14	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (594483.5 N, 1629769.3 E)
ELEVATION : 4845.8 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 6.5 ft bgs
START : 11/4/14 10:10
END : 11/4/14 10:50
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4845.8							
	2.5						
	4.0	0.6	SS-1	2-2-2 (4)	**SANDY SILT (ML)** brown, moist, loose, fine sand		Gravel = 0% Sand = 39% Fines = 61%
5	5.0						
4840.8 ▼	6.5	0.9	SS-2	1-1-6 (7)	**SILTY SAND (SM)** brown, moist, loose, some iron oxide staining		Moisture = 27.7% Gravel = 0% Sand = 80% Fines = 20% Groundwater and gravel contact at 6.5' bgs
10	10.0						
4835.8	11.5	0.8	SS-3	8-9-10 (19)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium dense, ~50/50 mix of medium to coarse sand and 1/4" subrounded gravels, trace fines		SS-3, gravel stuck in shoe Auger chattering in gravel
15	15.0						
4830.8	16.5	1.1	SS-4	6-23-27 (50)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, very dense, ~50/50 mix of medium to coarse sand and 1/4" subrounded gravels, trace fines		SS-4, gravel in shoe
20	20.0						
4825.8	21.5	1.1	SS-5	27-41-50/5.5 (91/11.5")	**CLAYEY SAND WITH GRAVEL (SC)** dark gray to red brown, moist, very dense, traces of oxidation and calcification, fines have some plasticity		
					Bottom of Boring at 21.5 ft bgs on 11/4/14 10:50		
25 4820.8							
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-15-14	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (593693.4 N, 1630769.6 E)
ELEVATION : 4827.6 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 5.2 ft bgs
START : 11/4/14 11:30
END : 11/4/14 14:00
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4827.6							
	2.5						
	4.0	0.9	SS-1	18-24-20 (44)	**POORLY GRADED SAND WITH GRAVEL (SP)** orange brown, dry, dense, ~40% fractured gravels, some fines		SS-1, gravel in shoe
5	5.0						
4822.6	6.5	1.0	SS-2	21-24-27 (51)	**POORLY GRADED SAND WITH GRAVEL (SP)** orange brown, moist, dense, densed fractured gravels in sample, some fines		Groundwater at 5.2' bgs
10	10.0						
4817.6	11.5	0.9	SS-3	8-19-21 (40)	**POORLY GRADED GRAVEL WITH SAND (GP)** gray to black, wet, ~40% coarse to medium sand, fractured gravels		
15	15.0						
4812.6	16.5	1.3	SS-4	12-32-36 (68)	**POORLY GRADED GRAVEL WITH SAND (GP)** gray to black, wet, ~40% coarse to medium sand, fractured gravels		Gravel in shoe of all samples
20	20.0						
4807.6	21.5	0.5	SS-5	12-22-33 (55)	**POORLY GRADED SAND WITH GRAVEL (SP)** black, wet, medium sand, ~40% fractured gravels, gravel stuck in shoe of sampler		Auger is whining and chattering, slow advance, 3" diameter flat, rounded cobbles returned in auger cuttings Very slow advance from 20.0-25.0' bgs
25	25.0						
4802.6	26.5	0.7	SS-6	50/60 (50/60")	**POORLY GRADED GRAVEL WITH SAND AND CLAY (GP)** orange brown, very moist		12:40 p.m., mix drilling mud Very slow advance from 25.0-30.0' bgs
30							

PROJECT NUMBER:	BORING NUMBER:	
457818	B-15-14	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Schaake
LOCATION : (593693.4 N, 1630769.6 E)
ELEVATION : 4827.6 ft
DRILLING CONTRACTOR : Haz Tech
DRILLING EQUIPMENT AND METHOD : Hollow Stem Auger BK81
WATER LEVELS : 5.2 ft bgs
START : 11/4/14 11:30
END : 11/4/14 14:00
LOGGER : J. Barker

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
4797.6	30.0 31.5	0.7	SS-7	32-50/5 (50/5")	**POORLY GRADED GRAVEL WITH SAND AND CLAY (GP)** orange brown, very moist Bottom of Boring at 30.9 ft bgs on 11/4/14 14:00		Moisture = 10.9% Gravel = 55% Sand = 35% Fines = 12% Driller notes constant gravel, cobbles boulders
35 4792.6							
40 4787.6							
45 4782.6							
50 4777.6							
55 4772.6							
60							

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-1 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (598015.3 N, 1627704.3 E)
ELEVATION: 4884.5 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT Track Hoe
DATE EXCAVATED: 11/4/2014 2:00:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 7.4 ft bgs
APPROX. DIMENSIONS: Length: 18' Width: 50' Maximum Depth: 7.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**POORLY GRADED GRAVEL WITH SILT AND SAND (GP)** 0.0-0.5'- ~30% silt with fine plant roots		
			POORLY GRADED GRAVEL WITH SAND (GP) 0.5-3.3'- light gray slightly moist, dense, rounded to subrounded gravel		
	1.5	B-1			
	2.0				
			SILTY CLAY (CL-ML) 3.3-6.75'- blue gray, moist, firm, medium plasticity		3.33' bgs - Transition to Silty Clay, easily indented with thumb Moisture = 32.3% LL = 36 PI = 16 Gravel = 0% Sand = 11% Fines = 89%
	3.5	B-2			
	4.0				
5					
					Groundwater begins to seep into pit at 6.16' bgs Relatively slow seepage into pit estimate at 3 gallons per minute
			POORLY GRADED GRAVEL WITH SAND (GP) 6.75-7.5'- brown, wet, dense		Gravels at 6.67' bgs
	7.5		Bottom of Test Pit at 7.5 ft bgs on 11/4/14 14:26		Minor caving in upper 2.5' bgs and below 6.67' bgs
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-2 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (598654.2 N, 1626537.4 E)
ELEVATION: 4899.8 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT Track Hoe
DATE EXCAVATED: 11/4/2014 1:28:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 6.3 ft bgs
APPROX. DIMENSIONS: Length: 20' Width: 6' Maximum Depth: 8' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL/POORLY GRADED GRAVEL WITH SAND AND SILT** 0.0-0.5'- manure rich		
			POORLY GRADED GRAVEL WITH SAND (GP) 0.5-8.0'- dense, subrounded to rounded, hard, mostly well graded gravel, ~50%, 10% cobbles to 9", 30% sand and 5-10% fines, dense, color transitions to brown with red at 3.0' bgs		Surface with sparse vegetation, appears reworked, approximately 35% sand
	2.0	BCKT-1			Two buckets collected at 2.0' bgs Gravel = 79% Sand = 19% Fines = 2%
	2.5				Max dry density = 129.5 pcf Optimal Moisture = 4.5%
5					
					Groundwater at 6.33' bgs Minor caving of test pit walls
	8.0		Bottom of Test Pit at 8.0 ft bgs on 11/4/14 13:36		Backfill test pit Water infiltration into test pit was rapid
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-3 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (599264.8 N, 1626100.4 E)
ELEVATION: 4904.7 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: John Deere 10-C Rubber Tre Backhoe
DATE EXCAVATED: 11/4/2014 9:00:00 AM
LOGGER: T. Cotten -
WATER LEVELS: 4.2 ft bgs
APPROX. DIMENSIONS: Length: 12' Width: 4.5' Maximum Depth: 5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL** 0.0-0.33'		
			WELL GRADED GRAVEL WITH SAND (GW) 0.33-2.0'- gray brown, moist, dense, estimate 50% gravel, 35% sand, 5% silts, 10% cobbles		4-inches topsoil with trace roots Cobbles to 11 length and 4 width oblong
	2.0	B-1	**POORLY GRADED GRAVE WITH SAND (GP)** 2.0-5.0'- red brown, moist, hard, ~50% fine to coarse, subrounded to rounded gravel, 10% hard cobbles to 9" maximum dimensions, 35% well graded sand and <5% fines		Groundwater seepage at 48, minor caving of test pit walls
	2.5				Groundwater seepage is from river Side water seeping in is clean
5	5.0		Bottom of Test Pit at 5.0 ft bgs on 11/4/14 09:15		Groundwater stabilizes at 50 depth Minor caving, especially along river side of TP. Maximum particle size typically 9.0' length by 5" x 4" Gray brown to 20" depth, red brown below, no rubble observed
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-4 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (600523.8 N, 1625127.1 E)
ELEVATION: 4921.2 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/5/2014 2:40:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 5.0 ft bgs
APPROX. DIMENSIONS: Length: 15' Width: 6' Maximum Depth: 6' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**SILTY SAND WITH GRAVEL (SM)** 0.0-3.0'- light brown to brown, moist, ~45% sand, 30% silt, 35% gravel, some fine plant roots, some manure mixed in especially in upper 8"		Ground has recently been disked
	1.5	BCKT-1			Moisture = 15% Gravel = 56% Sand = 35% Fine = 9%
	2.5				Transitions to 6 layers of silt to clay with <10% sand
			SILT TO CLAY (ML-CL) 3.0-3.5'- brown to gray, moist, firm, ~10% sand		
			POORLY GRADED GRAVEL WITH SAND (GP) 3.5-6.0'- brown to red, moist to wet, dense, ~50% gravel becoming ~60% with depth, <5% fines occasional cobbles		
5					Groundwater begins to infiltrate into test pit At 5.0' bgs, infiltration rates is moderate at about 10 gallons/minutes
	6.0		Bottom of Test Pit at 6.0 ft bgs on 11/5/2014		Moderate caving of test pit wells below 5.0' bgs Maximum particle size at bottom of testpit = 12" x 7" x 6"
10					

PROJECT NUMBER: 457818	TEST PIT NUMBER: TP-5 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (595923.4 N, 1627972.2 E)
ELEVATION: 4858.8 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT
DATE EXCAVATED: 11/5/2014 1:40:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 4.0 ft bgs
APPROX. DIMENSIONS: Length: Width: Maximum Depth: 4.8' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**SANDY SILT (ML)** 0.0-0.67'- dark brown, moist, loose		
			POORLY GRADED GRAVEL (GP) 0.67-1.5'- dry		
	1.5	B-1	**POORLY GRADED SAND WITH GRAVEL (SP)** 1.5-3.0'- red, brown, moist and becoming wet with depth, dense		
	2.5				
			POORLY GRADED GRAVEL (GP) 3.0-4.75'- red, brown, wet, dense		
			- occasional cobbles below 4.0' bgs		Percent gravel increases with depth Size of rock increases with depth Maximum particles size to 7" at bottom of testpit
5	4.8		Bottom of Test Pit at 4.8 ft bgs on 11/5/2014		Groundwater stabilizes at 48 depth Significant caving of testpit walls below 3.0' bgs
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-6 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596454.5 N, 1628395.4 E)
ELEVATION: 4868.0 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT
DATE EXCAVATED:
LOGGER: T. Cotten -
WATER LEVELS: ---
APPROX. DIMENSIONS: Length: Width: Maximum Depth: 8.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**SILT (MH)** 0.0-2.8'- brown, moist, firm, medium plasticity		Begin excavation at 3:50 p.m. Maximum particle size 10" occasional cobbles
	1.5	BCKT-1			Moisture = 32.6% LL = 52 PI = 19 Gravel = 0% Sand = 6% Fines = 94% Max dry density = 93 pcf Optimal moisture = 21.5%
	2.0		**POORLY GRADED GRAVEL WITH SAND (GP)** 2.8-8.5'- brown, moist, dense, rounded to subrounded, hard, fine to coarse gravel ~50%, 10% cobbles, 35% sand and 5% fines		Change to gravel at 2.8' bgs Color change to slightly to red-orange at 3.5' bgs Red orange at 4.0' bgs
5					
	8.5		Bottom of Test Pit at 8.5 ft bgs on		Groundwater infiltration at ~8.0' bgs 3 gallons/min Side wall remain moistly vertical Very minor caving
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-7 SHEET 1 OF 1

TEST PIT LOG

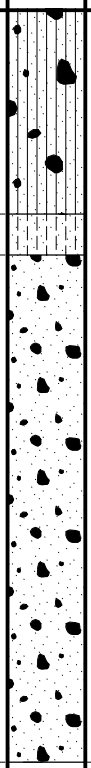
PROJECT: Schaake
LOCATION: (597451.3 N, 1628452.2 E)
ELEVATION: 4873.4 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/4/2014 2:40:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 3.5 ft bgs
APPROX. DIMENSIONS: Length: 16' Width: 5' Maximum Depth: 4.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL: POORLY GRADED SAND WITH SILT AND GRAVEL (SP)** 0.0-0.6'- brown, moist		More roots in topsoil layer - mostly fine Soil to ~26" appears to be disturbed Metal pipe - 2 OD at 18" bgs
	0.6	B-1	**SILT (ML) TO POORLY GRADED GRAVEL (GP)** 0.6-1.0'- dry to slightly moist, hard, many fine plant roots		Moisture = 19.4% Gravel = 0% Sand = 5% Fines = 95%
	1.0		**POORLY GRADED GRAVEL WITH SAND (GP)** 1.0-4.5'- gray-brown, moist, dense, rounded to subrounded, hard, fine to coarse gravels, mostly below, 4" maximum dimension, occasional cobbles to 9", maximum dimension, ~30% sand, <5% fines		Ground water at 3.5' bgs
	4.5		Bottom of Test Pit at 4.5 ft bgs on 11/4/2014		Caving of side walls below 2.5' bgs Groundwater stabilized at 3.5' bgs
5					
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-8 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596941.3 N, 1628807.8 E)
ELEVATION: 4869.1 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/4/2014 3:20:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 5.0 ft bgs
APPROX. DIMENSIONS: Length: 16' Width: 5' Maximum Depth: 5.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**POORLY GRADED SAND WITH SILT AND GRAVEL (SP)** 0.0-1.5'- manure rich soil, many fine plant roots, some Organic Silt (OM)		
	1.5	BCKT-1	**POORLY GRADED SAND WITH SILT (SP-SM)** 1.5-1.8'- gray, moist, dense, fine-grained sand with ~15% fines		SP - Layer - 5"-6" thick
	1.8		**POORLY GRADED GRAVEL WITH SAND (GP)** 1.8-5.5'- brown, moist, dense, fine-grained sand with ~15% fines		Bucket 1 Moisture = 16.5% Gravel = 7% Sand = 91% Fines = 2% Bucket 2 Gravel = 67% Sand = 32% Fines = 1% Gravel primarily 2" and finer, some up to 4"
	2.5	B-2			
	3.0				
5					Groundwater at 5.0' bgs
	5.5		Bottom of Test Pit at 5.5 ft bgs on 11/4/2014		
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-9 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596253.7 N, 1628716.9 E)
ELEVATION: 4862.0 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320
DATE EXCAVATED: 11/5/2014 8:05:00 AM
LOGGER: T. Cotten -
WATER LEVELS: 4.3 ft bgs
APPROX. DIMENSIONS: Length: 16' Width: 5' Maximum Depth: 4.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL/SANDY SILTY WITH GRAVEL TO SILTY GRAVEL OR SILTY SAND** 0.0-0.5'- dark brown, moist, many fine flower roots		Tall grass and weeds surface
	0.8	B-1	**SANDY SILT WITH GRAVEL (ML)** 0.5-1.5'- tan, brown, moist, loose, approximately 30% rounded to subrounded gravel, 30% silt, 40% sand		Moisture = 20.4% Gravel = 27% Sand = 16% Fines = 57% 1.25' transitions to gray clay
	1.0				
	1.5	BCKT-2	**SILT (ML)** 1.5-4.0'- gray with brown streams, moist, firm, medium plastic		Moisture = 36.4% LL = 45 PI = 9 Gravel = 0% Sand = 7% Fines = 93% Max dry density = 92 pcf Optimum moisture = 25%
	2.0				
			POORLY GRADED GRAVEL WITH SAND (GP) 4.0-4.5'- brown-red, moist, dense, ~50% to 60% gravel, occasional rounded cobbles, 20-30% sand, trace fines		Transition to gravels at 4.0' bgs
	4.5		Bottom of Test Pit at 4.5 ft bgs on 11/5/2014		Minor caving below 4.0' bgs ~3 of groundwater seeps Slowly into testpit over ~10 minute period
5					
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-10 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596509.9 N, 1628699.2 E)
ELEVATION: 4863.8 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320
DATE EXCAVATED: 11/5/2014 3:00:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 5.0 ft bgs
APPROX. DIMENSIONS: Length: 17' Width: 5' Maximum Depth: 6.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL** 0.0-0.67'- dark brown, moist		
			SILTY SAND (SM) TO SANDY SILT WITH GRAVEL (ML) 0.67-1.75'- tan, moist, loose		
			SANDY FAT CLAY (CL) 1.75-6.0'- gray, firm, moist, medium plasticity		
	2.0	B-1			Moisture = 36% LL = 41 PI = 19 Gravel = 0% Sand = 20% Fines = 80%
	2.5				
5					
			POORLY GRADED GRAVEL WITH SAND (GP) 6.0-6.5'- brown to red, wet, dense		Minor Caving below 6.0' bgs
	6.5		Bottom of Test Pit at 6.5 ft bgs on 11/5/2014		
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-11 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596797.9 N, 1628263.7 E)
ELEVATION: 4872.0 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320
DATE EXCAVATED: 11/5/2014 9:20:00 AM
LOGGER: T. Cotten -
WATER LEVELS: 3.8 ft bgs
APPROX. DIMENSIONS: Length: 15' Width: 5.5' Maximum Depth: 4.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL** 0.0-0.5'		
			POORLY GRADED GRAVEL WITH SAND (GP) 0.5-3.75'- light brown, slightly moist to moist, dense, fine to coarse, hard, rounded to subrounded, gravel ~50-60%, occasional cobbles to 9" maximum dimension		
	3.8	B-1	**POORLY GRADED SAND (SP)** 3.75-4.5'- red-brown, wet, loose, mostly medium to fine-grained sand, ~ 5% gravel, 5-10% silt		Transition to Sand (SP) layer at 3.5' bgs Appears sand layer could be susceptible to ligue faction Groundwater seepage into pit to ~3.83' bgs, caving of test pit walls in SP material
	4.3				
	4.5		Bottom of Test Pit at 4.5 ft bgs on 11/5/2014		
5					
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-12 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596753.4 N, 1627987.5 E)
ELEVATION: 4872.1 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320
DATE EXCAVATED: 11/5/2014 9:30:00 AM
LOGGER: T. Cotten -
WATER LEVELS: 4.0 ft bgs
APPROX. DIMENSIONS: Length: 17' Width: 6' Maximum Depth: 4.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL** 0.0-0.7'		
			SILT WITH SAND (ML) 0.7-3.5'- brown, moist, firm, ~20-0% fine sand, low to medium plasticity		
	2.0	B-1			Moisture = 36.5% LL = 35 PI = 10 Gravel = 0% Sand = 16% Fines = 84%
	3.0				
			CLAYEY GRAVEL (GC) 3.5-4.25'- gray and brown, wet, dense		Mottled at 3.8' bgs
			POORLY GRADED GRAVEL WITH SAND (GP) 4.25-4.5'- gray, wet, dense		
	4.5		Bottom of Test Pit at 4.5 ft bgs on 11/5/2014		
5					Groundwater seeps into testpit to 4.0' depth, caving of test pit walls to below ~3.8' bgs
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-13 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (597095.2 N, 1627530.9 E)
ELEVATION: 4883.0 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT:
DATE EXCAVATED: 11/5/2014 10:15:00 AM
LOGGER: T. Cotten -
WATER LEVELS: ---
APPROX. DIMENSIONS: Length: 15' Width: 5' Maximum Depth: 3.5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL** 0.0-1.0'- previously disturbed		
			POORLY GRADED GRAVEL WITH SILT AND SAND (GP) 1.0-2.0'- tan, slightly moist, firm, ~30% silt, 30% sand, 40% gravel, some wood and plastic		1.0' topsoil with many fine plant roots and some debris
	2.0	B-1	**SANDY SILT (GP)** 2.0-3.0'- tan with brown slightly moist, dense, ~15%, very fine sand		Debris down to ~2.0' depth
	2.5		**POORLY GRADED GRAVEL WITH SAND (GP)** 3.0-3.5'- brown, moist, very dense		Soil is friable Moisture = 6.8% LL = No Value PI = Non-plastic Gravel = 2% Sand = 57% Fines = 41% Transition to GP at 3.0' bgs
	3.5		Bottom of Test Pit at 3.5 ft bgs on 11/5/2014		
5					
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-14 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (597757.8 N, 1628102.2 E)
ELEVATION: 4877.4 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/5/2014
LOGGER: T. Cotten -
WATER LEVELS: 4.5 ft bgs
APPROX. DIMENSIONS: Length: 18' Width: 6' Maximum Depth: 5' -

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (ft)	SAMPLE #TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	COMMENT: DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**SAND WITH SILT AND GRAVEL (SP)** 0.0-0.5'- brown, firm, moist, many fine plant roots		
	0.5	BCKT-1	**POORLY GRADED GRAVEL WITH SAND (GP)** 0.5-1.5'- brown, moist, dense, ~10% silt, 40-50% sand, 40-50% gravel, rounded to subrounded, hard		Bucket 1: Max Dry Density = 132 pcf Optimal Moisture = 5% Max Particle to ~ 5"
	1.5	B-2	**SILT (ML)** 1.5-3.5'- tan with rust colored mottling, moist, firm, contains fine plant roots		B-2: Moisture = 25.2% Gravel = 0% Sand = 6% Fines = 94%
	2.0				
	3.5	B-3	**CLAY (CL-CH)** 3.5-4.5'- gray, moist, soft to firm, mottled with iron staining, medium to high plasticity, sometimes zones of sandy clay		B-3: Moisture = 32.6% LL = 42 PI = 18 Gravel = 0% Sand = 11% Fines = 89% GW seepage at ~4.5 bgs
	4.0		**POORLY GRADED GRAVEL WITH SAND (GP)** 4.5-5.0'- ~50-60% rounded to subrounded gravel, ~30-40% sand, occasional cobbles, 40% fines		
5	5.0		Bottom of Test Pit at 5.0 ft bgs on 11/5/2014		Groundwater seeps into testpit at ~5-10 gallons per minute Minor caving of test pit walls below 4.5' bgs
10					

PROJECT NUMBER:	TEST PIT NUMBER:
457818	TP-15 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (598659.4 N, 1627717.6 E)
ELEVATION: 4886.6 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/5/2014 1:00:00 PM
LOGGER: T. Cotten -
WATER LEVELS: 3.8 ft bgs
APPROX. DIMENSIONS: Length: Width: Maximum Depth: 5.5 -

SAMPLE		SOIL DESCRIPTION		COMMENT
DEPTH BELOW SURFACE (FT)	INTERVAL (ft)	#TYPE	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
	0.0		**TOPSOIL/SANDY SILT WITH GRAVEL (ML)** 0.0-0.75'- brown, moist, many fine plant roots		
	1.0	B-1	**SILT WITH POCKETS OF POORLY GRADED GRAVEL WITH SAND (ML)** 0.75-2.0'- brown to gray, moist, silt, moves up to ~70% of layer, and is low to medium plastic		Appears to be fill or previously disturbed soil to 2.0' bgs Bag sample is of silt (ML) material B-1: Gravel = 0% Sand = 37% Fines = 63%
	2.0		**SILT (ML)** 2.0-3.0'- similar to above, low to medium plasticity		
	3.0	B-2	**SANDY CLAY TO CLAY SAND (CL-SC)** 3.0-3.8'- gray with red mottling, moist to wet, soft to firm, trace gravel		B-2: Moisture = 21.4% LL = No Value PI = Non-plastic Gravel = 19% Sand = 55% Fines = 26% Transition to GP at ~3.8' bgs Groundwater stabilizes at ~3.8' bgs
	3.5				
	4.0	B-3	**POORLY GRADED SAND WITH GRAVEL (SP)** 3.8-5.5'- brown, wet, firm, <5% fines, ~50-60% mostly coarse sand, gravel to 3" maximum dimension		
	4.5				
5					
	5.5		Bottom of Test Pit at 5.5 ft bgs on 11/5/2014		Groundwater infiltrates rapidly into testpit below 3.8' bgs Sidewalls cave below ~3.8' bgs
10					

PROJECT NUMBER: 457818	TEST PIT NUMBER: TP-16 SHEET 1 OF 1

TEST PIT LOG

PROJECT: Schaake
LOCATION: (596290.1 N, 1628152.9 E)
ELEVATION: 4864.4 ft
CONTRACTOR: USBR
EXCAVATION EQUIPMENT: CAT 320 D
DATE EXCAVATED: 11/5/2014 2:02:00 PM
LOGGER: T. Cotten
WATER LEVELS: ---
APPROX. DIMENSIONS: Length: 15' Width: 5' Maximum Depth: 4.25'

SAMPLE			SOIL DESCRIPTION		COMMENT
DEPTH BELOW SURFACE (FT)	INTERVAL (ft)	#TYPE	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE GRADATIONAL CONTACTS, TEST, INSTRUMENTATION
			TOPSOIL TO SILT WITH SAND AND GRAVEL (ML) 0.0-0.75'- light brown to brown, moist		
			SILT WITH GRAVEL AND SAND (SP) 0.75-2.5'- ~50% silt, 30% sand and 20% gravel		
			POORLY GRADED SAND WITH GRAVEL (SP) 2.5-3.25'- brown turning to gray, moist, dense		
			POORLY GRADED GRAVEL WITH SAND (GP) 3.25-4.25'- gray, moist, dense, coarse sand ~40-50% fine to coarse gravel, rounded to subrounded		
			Bottom of Test Pit at 4.3 ft bgs on 11/5/2014		Minor sidewall caving below 2.5' bgs No groundwater observed
5					
10					

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

Schaake - (1500-ID1)

MOISTURE CONTENT AND ATTERBERG LIMITS

Moisture contents were performed on representative samples in general accordance with ASTM D 2216. Atterberg limits were performed on representative samples in general accordance with ASTM D 4318. Test results are presented in the following plates.

Location of Material	Moisture Content (%)	Liquid Limit	Plasticity Index
B-1-14 @ 2.5', SS-1	6.0	---	---
B-2-14 @ 5', SS-2	7.9	---	---
B-5-14 @ 20', SS-5	11.0	NV	Non-Plastic
B-12-14 @ 2.5', SS-1	5.5	---	---
B-13-14 @ 2.5', SS-1	34.2	---	---
B-13-14 @ 5', SS-2	45.7	---	---
B-13-14 @ 15', SS-4	5.5	NV	Non-Plastic
B-13-14 @ 20', SS-5	12.7	NV	Non-Plastic
B-14-14 @ 5', SS-2	27.7	---	---
B-15-14 @ 30', SS-7	10.9	---	---
TP-1-14 @ 3.5', B-2	32.3	36	16
TP-4-14 @ 1.5', BKT-1	15.0	---	---
TP-6-14 @ 1.5', BKT-1	32.6	52	19
TP-7-14 @ 0.6', B-1	19.4	---	---
TP-8-14 @ 1.5', BKT-1	16.5	---	---
TP-9-14 @ 0.75', B-1	20.4	---	---
TP-9-14 @ 1.5', BKT-2	36.4	45	9
TP-10-14 @ 2.0', B-1	36.0	41	15
TP-12-14 @ 2', B-1	36.5	35	10
TP-13-14 @ 2', B-1	6.8	NV	Non-Plastic
TP-14-14 @ 1.5', B-2	25.2	---	---
TP-14-14 @ 3.5', B-3	32.6	42	18
TP-15-14 @ 3', B-2	21.4	NV	Non-Plastic

American Geotechnics
5260 Chinden Blvd.
Boise, Idaho 83714
Phone:(208) 658-8700
Fax: (208) 658-8703

Report to: GeoTek Inc.
Report Date: 12/12/14
Project No.: 00783.205
Project: Shaake

Material Information

Date Sampled: December 2014
Sampled By: GeoTek Inc.
Date Received: 12/8/14
Date Tested: 12/12/2014

Test Results

Soil Resistivity and pH for Corrosion Testing

AASHTO T-288, T-289

Lab Number	Sample ID	Minimum Resistivity Ohm-cm	pH	@ Temp, F°
14-0693	B-4,5; SS-1,2,3 Composite	11,500	6.8	69.1

Note: Due to limited material testing performed on minus #4 material.

Reviewed By: _____

Analytical Laboratories, Inc.

1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 12/29/2014 3:44:49 PM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1450749

Attn: DAVID WAITE
GEOTEK, INC
320 E CORPORATE DR STE 300
MERIDIAN, ID 83642

Collected By: J BARKER
Submitted By: D WAITE

Source of Sample:
SCHAAKE B-4/B-5 SOIL

Time of Collection:
Date of Collection: 11/14/2014
Date Received: 12/23/2014
Report Date: 12/29/2014

PWS#:

Field Temp: Temp Rcvd in Lab:

PWS Name:

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Soil Chloride, Cl		34	mg/kg	10	EPA 300.0	12/28/2014	NC
Soil Sulfate, SO4		160	mg/kg	10	EPA 300.0	12/28/2014	NC

12·31·14

Thank you for choosing Analytical Laboratories for your testing needs.

If you have any questions about this report, or any future analytical needs, please contact your client manager:

James Hibbs

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2754
Sample ID: B-1-14 SS-1
Source: 2.5'
Specifications: No Specs
USCS Soil Classification: GW, Well-graded Gravel with Sand

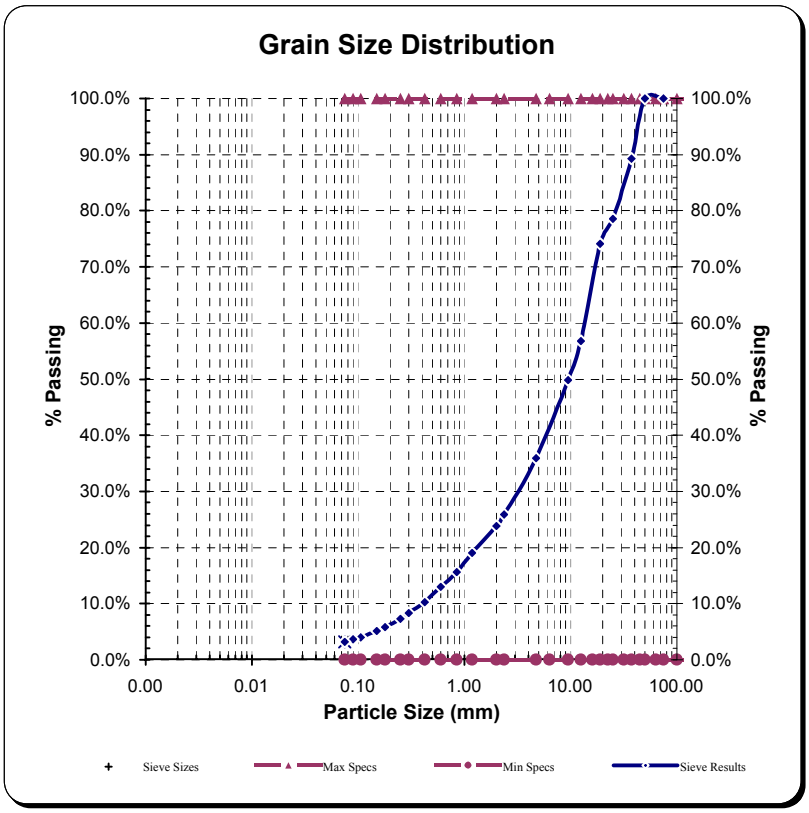
$D_{(10)}$= 0.408 mm
$D_{(30)}$= 3.334 mm
$D_{(60)}$= 13.708 mm
Liquid Limit= n/a

% Gravel = 64.0%
% Sand = 32.7%
% Silt & Clay = 3.2%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.99
Coeff. of Uniformity, C_U = 33.56
Fineness Modulus= 5.79
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50		89.3%	100.0%	0.0%
1.00"	25.00	78.5%	78.5%	100.0%	0.0%
3/4"	19.00	74.1%	74.1%	100.0%	0.0%
1/2"	12.50	56.8%	56.8%	100.0%	0.0%
3/8"	9.50	49.9%	49.9%	100.0%	0.0%
#4	4.75	36.0%	36.0%	100.0%	0.0%
#8	2.360	25.9%	25.9%	100.0%	0.0%
#10	2.000		23.8%	100.0%	0.0%
#16	1.180	19.0%	19.0%	100.0%	0.0%
#20	0.850		15.6%	100.0%	0.0%
#30	0.600	13.0%	13.0%	100.0%	0.0%
#40	0.425		10.3%	100.0%	0.0%
#50	0.300	8.3%	8.3%	100.0%	0.0%
#60	0.250		7.3%	100.0%	0.0%
#80	0.180		5.8%	100.0%	0.0%
#100	0.150	5.2%	5.2%	100.0%	0.0%
#140	0.106		4.0%	100.0%	0.0%
#170	0.090		3.6%	100.0%	0.0%
#200	0.075	3.2%	3.2%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2755
Sample ID: B-2-14 SS-2
Source: 5.0'
Specifications: No Specs
USCS Soil Classification: GW, Well-graded Gravel with Sand

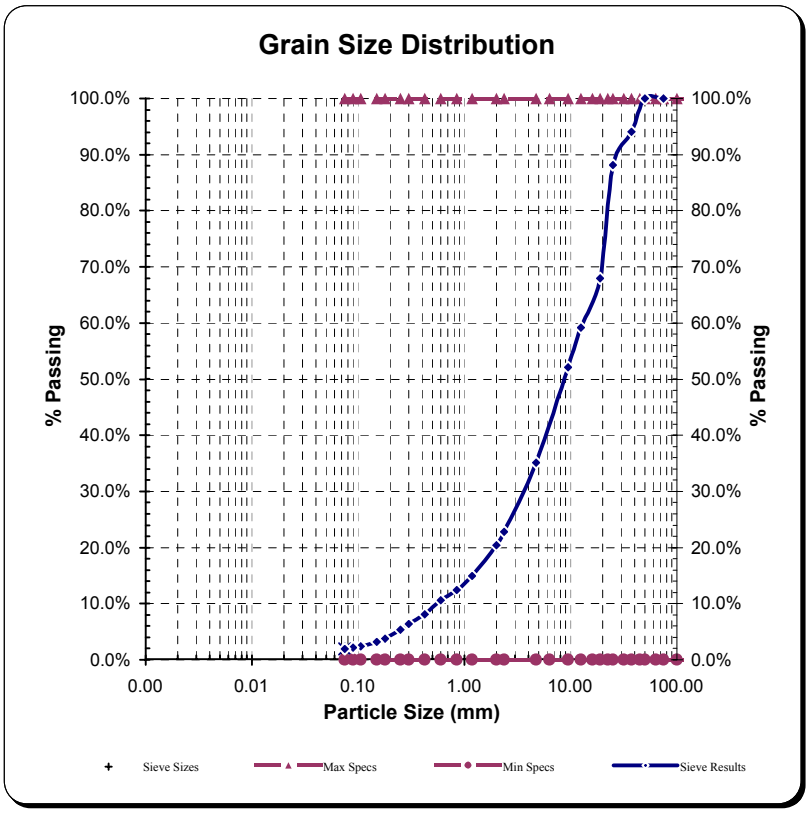
$D_{(10)}$= 0.560 mm
$D_{(30)}$= 3.747 mm
$D_{(60)}$= 13.079 mm
Liquid Limit= n/a

% Gravel = 64.8%
% Sand = 33.3%
% Silt & Clay = 1.9%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.92
Coeff. of Uniformity, C_U = 23.37
Fineness Modulus= 5.93
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50		94.1%	100.0%	0.0%
1.00"	25.00	88.1%	88.1%	100.0%	0.0%
3/4"	19.00	68.0%	68.0%	100.0%	0.0%
1/2"	12.50	59.2%	59.2%	100.0%	0.0%
3/8"	9.50	52.1%	52.1%	100.0%	0.0%
#4	4.75	35.2%	35.2%	100.0%	0.0%
#8	2.360	22.8%	22.8%	100.0%	0.0%
#10	2.000		20.4%	100.0%	0.0%
#16	1.180	14.9%	14.9%	100.0%	0.0%
#20	0.850		12.4%	100.0%	0.0%
#30	0.600	10.6%	10.6%	100.0%	0.0%
#40	0.425		8.1%	100.0%	0.0%
#50	0.300	6.4%	6.4%	100.0%	0.0%
#60	0.250		5.3%	100.0%	0.0%
#80	0.180		3.8%	100.0%	0.0%
#100	0.150	3.2%	3.2%	100.0%	0.0%
#140	0.106		2.4%	100.0%	0.0%
#170	0.090		2.1%	100.0%	0.0%
#200	0.075	1.9%	1.9%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2757
Sample ID: B-5-14 SS-5
Source: 20.0'
Specifications: No Specs
USCS Soil Classification: SW-SM, Well-graded Sand with Silt and Gravel

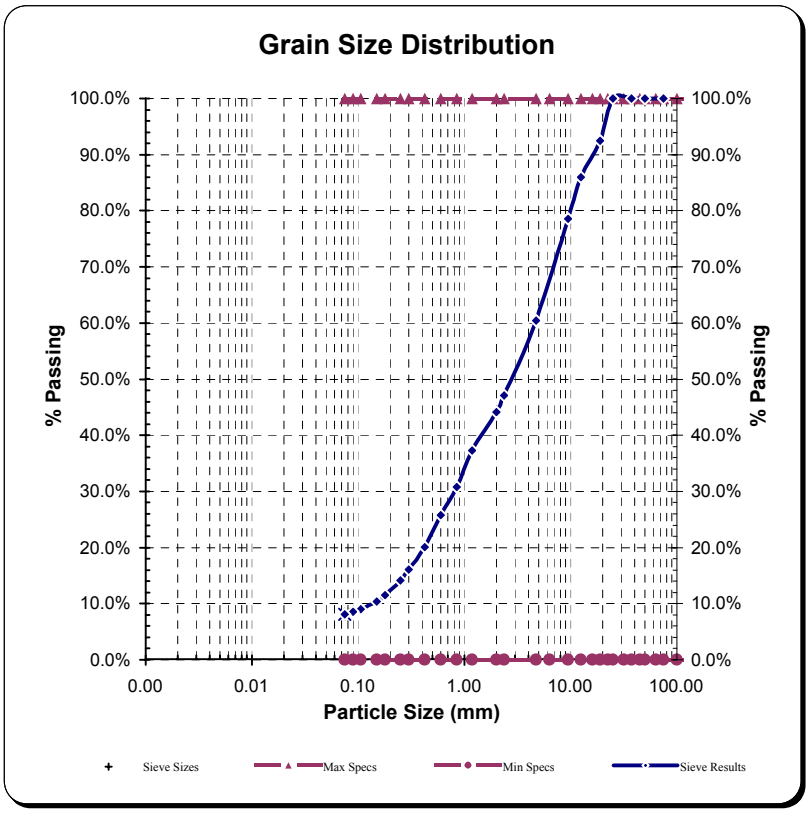
$D_{(10)}$= 0.137 mm
$D_{(30)}$= 0.812 mm
$D_{(60)}$= 4.678 mm
Liquid Limit= 0.0%

% Gravel = 39.6%
% Sand = 52.3%
% Silt & Clay = 8.1%
Plastic Limit= 0.0%

Coeff. of Curvature, C_C = 1.03
Coeff. of Uniformity, C_U = 34.10
Fineness Modulus= 4.32
Plasticity Index= 0.0%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00	100.0%	100.0%	100.0%	0.0%
3/4"	19.00	92.4%	92.4%	100.0%	0.0%
1/2"	12.50	86.0%	86.0%	100.0%	0.0%
3/8"	9.50	78.5%	78.5%	100.0%	0.0%
#4	4.75	60.4%	60.4%	100.0%	0.0%
#8	2.360	47.1%	47.1%	100.0%	0.0%
#10	2.000		44.1%	100.0%	0.0%
#16	1.180	37.3%	37.3%	100.0%	0.0%
#20	0.850		30.8%	100.0%	0.0%
#30	0.600	25.8%	25.8%	100.0%	0.0%
#40	0.425		20.1%	100.0%	0.0%
#50	0.300	16.0%	16.0%	100.0%	0.0%
#60	0.250		14.2%	100.0%	0.0%
#80	0.180		11.5%	100.0%	0.0%
#100	0.150	10.4%	10.4%	100.0%	0.0%
#140	0.106		9.0%	100.0%	0.0%
#170	0.090		8.5%	100.0%	0.0%
#200	0.075	8.1%	8.1%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2758
Sample ID: B-8-14 SS-3
Source: 10.0'
Specifications: No Specs
USCS Soil Classification: SP, Poorly graded Sand with Gravel

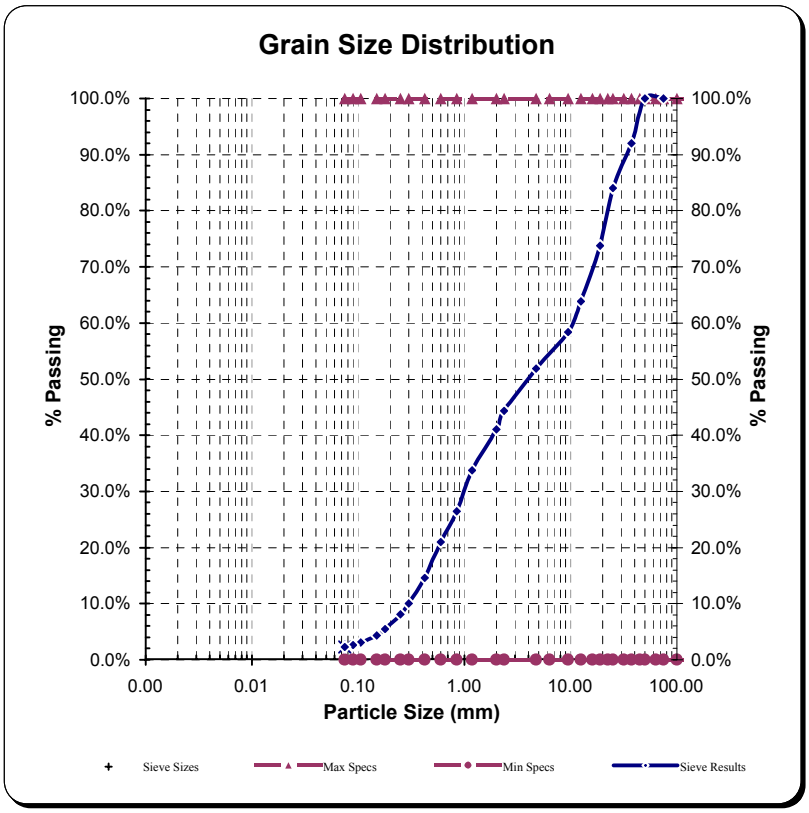
$D_{(10)}$= 0.299 mm
$D_{(30)}$= 1.012 mm
$D_{(60)}$= 10.373 mm
Liquid Limit= n/a

% Gravel = 48.1%
% Sand = 49.6%
% Silt & Clay = 2.3%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 0.33
Coeff. of Uniformity, C_U = 34.72
Fineness Modulus= 5.11
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50		92.0%	100.0%	0.0%
1.00"	25.00	84.1%	84.1%	100.0%	0.0%
3/4"	19.00	73.8%	73.8%	100.0%	0.0%
1/2"	12.50	63.8%	63.8%	100.0%	0.0%
3/8"	9.50	58.4%	58.4%	100.0%	0.0%
#4	4.75	51.9%	51.9%	100.0%	0.0%
#8	2.360	44.3%	44.3%	100.0%	0.0%
#10	2.000		41.1%	100.0%	0.0%
#16	1.180	33.7%	33.7%	100.0%	0.0%
#20	0.850		26.4%	100.0%	0.0%
#30	0.600	20.9%	20.9%	100.0%	0.0%
#40	0.425		14.6%	100.0%	0.0%
#50	0.300	10.0%	10.0%	100.0%	0.0%
#60	0.250		8.1%	100.0%	0.0%
#80	0.180		5.4%	100.0%	0.0%
#100	0.150	4.3%	4.3%	100.0%	0.0%
#140	0.106		3.1%	100.0%	0.0%
#170	0.090		2.7%	100.0%	0.0%
#200	0.075	2.3%	2.3%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2760
Sample ID: B-12-14 SS-1
Source: 2.5'
Specifications: No Specs
USCS Soil Classification: GP, Poorly graded Gravel with Sand

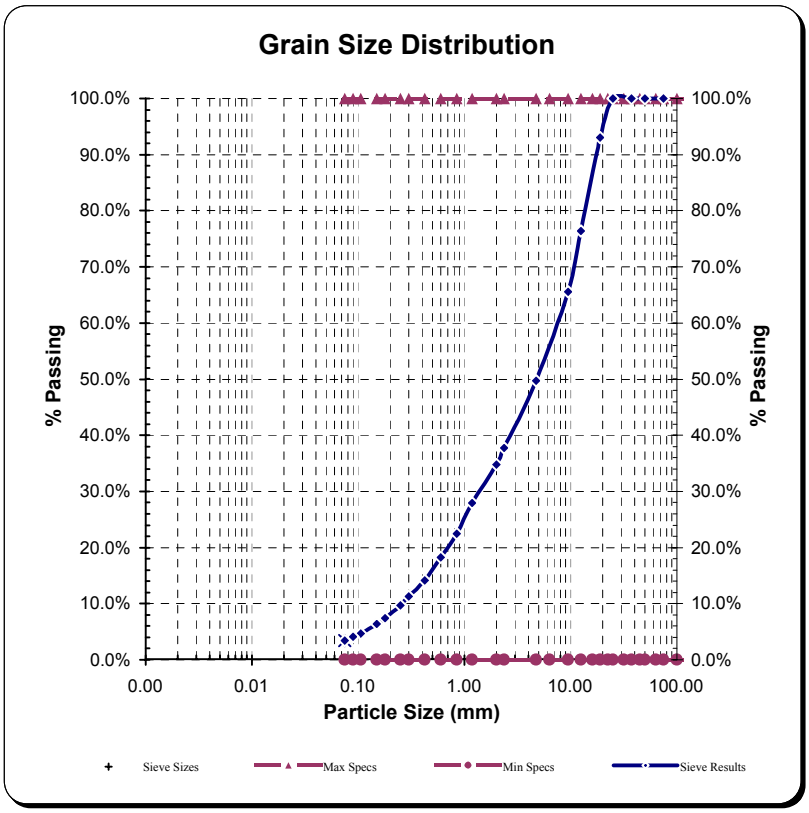
$D_{(10)}$= 0.261 mm
$D_{(30)}$= 1.428 mm
$D_{(60)}$= 7.837 mm
Liquid Limit= n/a

% Gravel = 50.3%
% Sand = 46.2%
% Silt & Clay = 3.5%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.00
Coeff. of Uniformity, C_U = 29.99
Fineness Modulus= 4.90
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00	100.0%	100.0%	100.0%	0.0%
3/4"	19.00	93.0%	93.0%	100.0%	0.0%
1/2"	12.50	76.4%	76.4%	100.0%	0.0%
3/8"	9.50	65.6%	65.6%	100.0%	0.0%
#4	4.75	49.7%	49.7%	100.0%	0.0%
#8	2.360	37.8%	37.8%	100.0%	0.0%
#10	2.000		34.8%	100.0%	0.0%
#16	1.180	27.9%	27.9%	100.0%	0.0%
#20	0.850		22.4%	100.0%	0.0%
#30	0.600	18.3%	18.3%	100.0%	0.0%
#40	0.425		14.2%	100.0%	0.0%
#50	0.300	11.2%	11.2%	100.0%	0.0%
#60	0.250		9.6%	100.0%	0.0%
#80	0.180		7.4%	100.0%	0.0%
#100	0.150	6.4%	6.4%	100.0%	0.0%
#140	0.106		4.7%	100.0%	0.0%
#170	0.090		4.0%	100.0%	0.0%
#200	0.075	3.5%	3.5%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2761
Sample ID: B-13-14 SS-1
Source: 2.5'
Specifications: No Specs

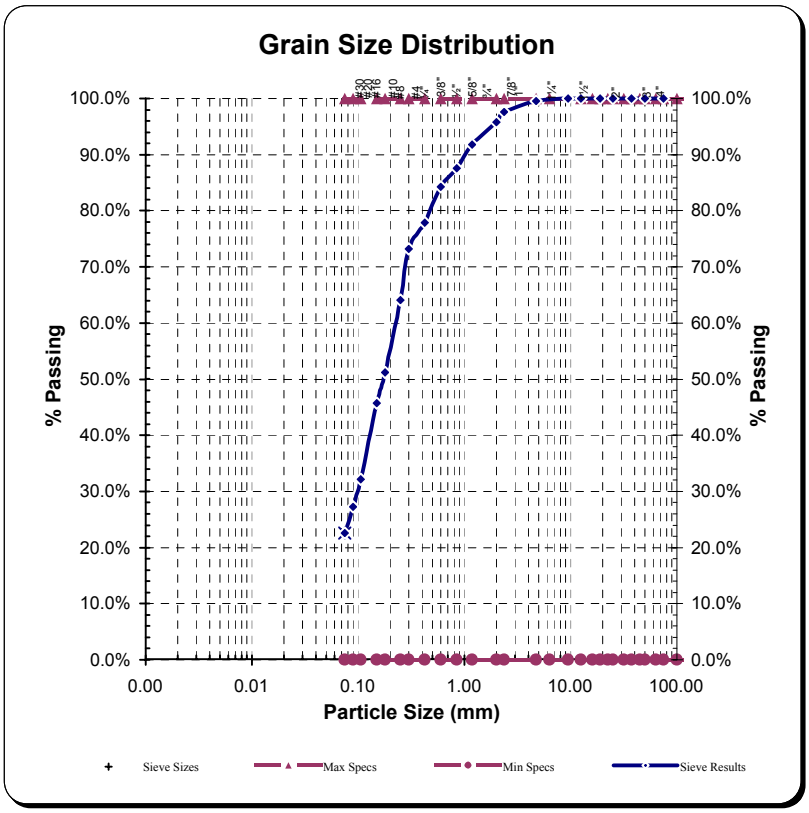
$D_{(10)}$= 0.033 mm
$D_{(30)}$= 0.099 mm
$D_{(60)}$= 0.228 mm
Liquid Limit= n/a

% Gravel = 0.5%
% Sand = 76.9%
% Silt & Clay = 22.6%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.30
Coeff. of Uniformity, C_U = 6.87
Fineness Modulus= 1.08
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	99.5%	99.5%	100.0%	0.0%
#8	2.360	97.6%	97.6%	100.0%	0.0%
#10	2.000		95.8%	100.0%	0.0%
#16	1.180	91.8%	91.8%	100.0%	0.0%
#20	0.850		87.5%	100.0%	0.0%
#30	0.600	84.3%	84.3%	100.0%	0.0%
#40	0.425		77.8%	100.0%	0.0%
#50	0.300	73.2%	73.2%	100.0%	0.0%
#60	0.250		64.1%	100.0%	0.0%
#80	0.180		51.2%	100.0%	0.0%
#100	0.150	45.7%	45.7%	100.0%	0.0%
#140	0.106		32.2%	100.0%	0.0%
#170	0.090		27.2%	100.0%	0.0%
#200	0.075	22.6%	22.6%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2762
Sample ID: B-13-14 SS-2
Source: 5.0'
Specifications: No Specs

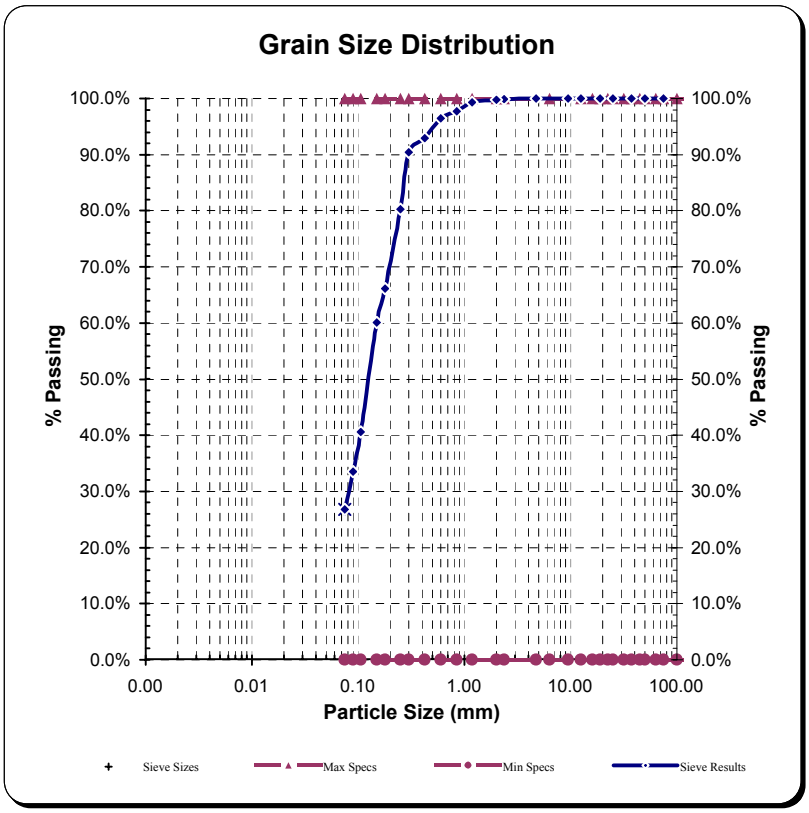
$D_{(10)}$= 0.028 mm
$D_{(30)}$= 0.082 mm
$D_{(60)}$= 0.150 mm
Liquid Limit= n/a

% Gravel = 0.0%
% Sand = 73.2%
% Silt & Clay = 26.8%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.61
Coeff. of Uniformity, C_U = 5.36
Fineness Modulus= 0.54
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	99.9%	99.9%	100.0%	0.0%
#10	2.000		99.7%	100.0%	0.0%
#16	1.180	99.3%	99.3%	100.0%	0.0%
#20	0.850		97.7%	100.0%	0.0%
#30	0.600	96.5%	96.5%	100.0%	0.0%
#40	0.425		92.9%	100.0%	0.0%
#50	0.300	90.4%	90.4%	100.0%	0.0%
#60	0.250		80.3%	100.0%	0.0%
#80	0.180		66.1%	100.0%	0.0%
#100	0.150	60.1%	60.1%	100.0%	0.0%
#140	0.106		40.6%	100.0%	0.0%
#170	0.090		33.5%	100.0%	0.0%
#200	0.075	26.8%	26.8%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2756
Sample ID: B-13-14 SS-4
Source: 15.0'
Specifications: No Specs
USCS Soil Classification: GW, Well-graded Gravel with Sand

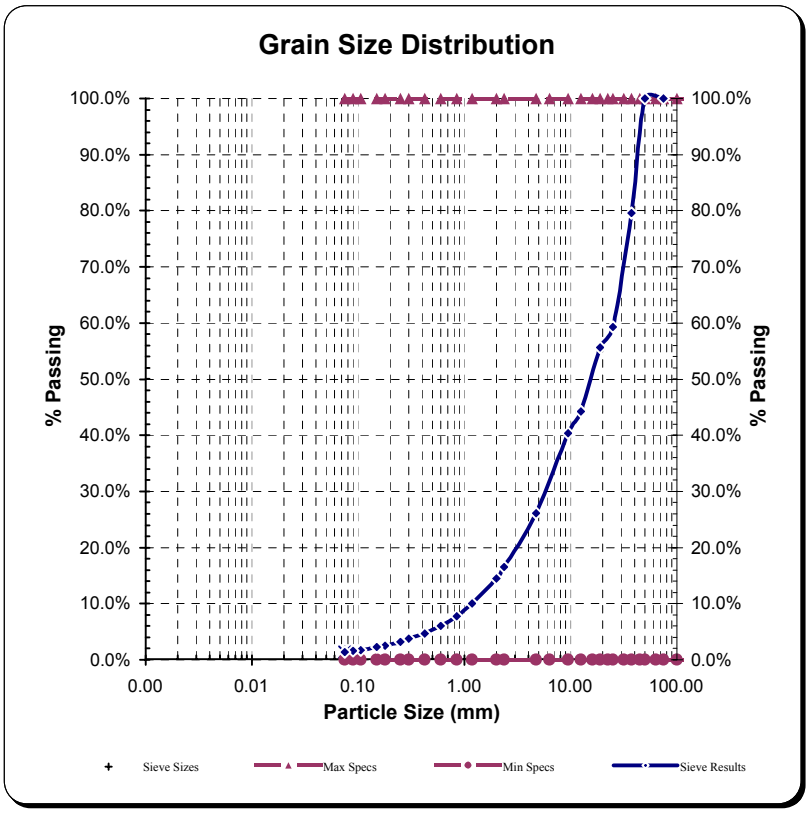
$D_{(10)}$= 1.180 mm
$D_{(30)}$= 6.031 mm
$D_{(60)}$= 25.445 mm
Liquid Limit= 0.0%

% Gravel = 73.8%
% Sand = 24.7%
% Silt & Clay = 1.4%
Plastic Limit= 0.0%

Coeff. of Curvature, C_C = 1.21
Coeff. of Uniformity, C_U = 21.57
Fineness Modulus= 6.60
Plasticity Index= 0.0%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50		79.6%	100.0%	0.0%
1.00"	25.00	59.3%	59.3%	100.0%	0.0%
3/4"	19.00	55.6%	55.6%	100.0%	0.0%
1/2"	12.50	44.2%	44.2%	100.0%	0.0%
3/8"	9.50	40.4%	40.4%	100.0%	0.0%
#4	4.75	26.2%	26.2%	100.0%	0.0%
#8	2.360	16.5%	16.5%	100.0%	0.0%
#10	2.000		14.5%	100.0%	0.0%
#16	1.180	10.0%	10.0%	100.0%	0.0%
#20	0.850		7.7%	100.0%	0.0%
#30	0.600	6.0%	6.0%	100.0%	0.0%
#40	0.425		4.7%	100.0%	0.0%
#50	0.300	3.8%	3.8%	100.0%	0.0%
#60	0.250		3.2%	100.0%	0.0%
#80	0.180		2.5%	100.0%	0.0%
#100	0.150	2.2%	2.2%	100.0%	0.0%
#140	0.106		1.8%	100.0%	0.0%
#170	0.090		1.6%	100.0%	0.0%
#200	0.075	1.4%	1.4%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2763
Sample ID: B-13-14 SS-5
Source: 20.0'
Specifications: No Specs

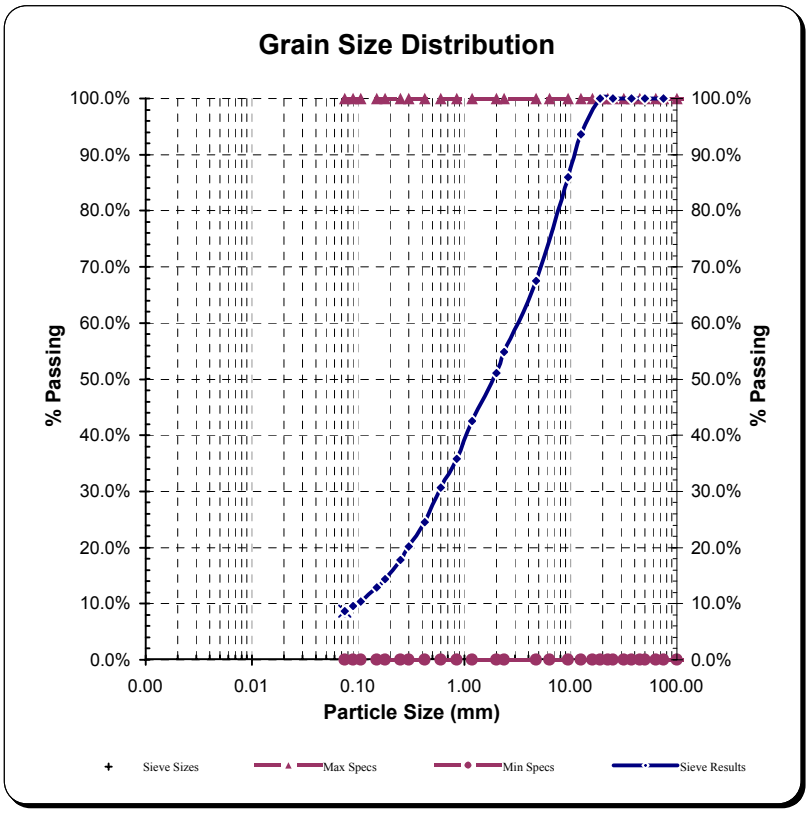
$D_{(10)}$= 0.098 mm
$D_{(30)}$= 0.580 mm
$D_{(60)}$= 3.329 mm
Liquid Limit= n/a

% Gravel = 32.5%
% Sand = 58.9%
% Silt & Clay = 8.7%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.03
Coeff. of Uniformity, C_U = 33.85
Fineness Modulus= 3.85
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00	100.0%	100.0%	100.0%	0.0%
1/2"	12.50	93.6%	93.6%	100.0%	0.0%
3/8"	9.50	85.9%	85.9%	100.0%	0.0%
#4	4.75	67.5%	67.5%	100.0%	0.0%
#8	2.360	54.9%	54.9%	100.0%	0.0%
#10	2.000		51.1%	100.0%	0.0%
#16	1.180	42.5%	42.5%	100.0%	0.0%
#20	0.850		35.8%	100.0%	0.0%
#30	0.600	30.7%	30.7%	100.0%	0.0%
#40	0.425		24.5%	100.0%	0.0%
#50	0.300	20.2%	20.2%	100.0%	0.0%
#60	0.250		17.7%	100.0%	0.0%
#80	0.180		14.4%	100.0%	0.0%
#100	0.150	12.9%	12.9%	100.0%	0.0%
#140	0.106		10.4%	100.0%	0.0%
#170	0.090		9.5%	100.0%	0.0%
#200	0.075	8.7%	8.7%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2764
Sample ID: B-14-14 SS-1
Source: 2.5'
Specifications: No Specs

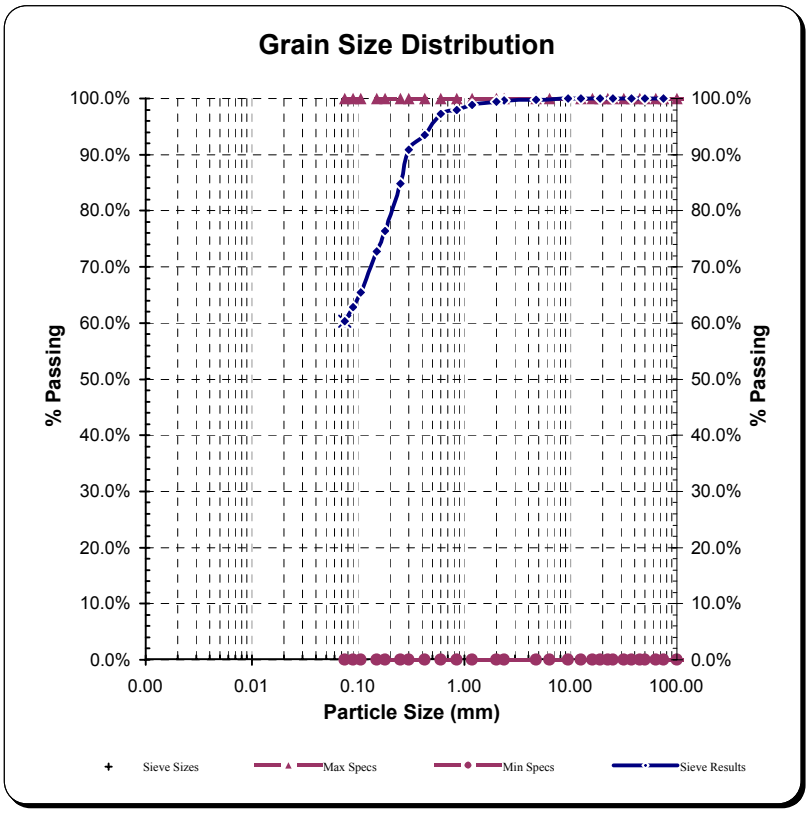
$D_{(10)}$= 0.012 mm
$D_{(30)}$= 0.037 mm
$D_{(60)}$= 0.075 mm
Liquid Limit= n/a

% Gravel = 0.3%
% Sand = 39.4%
% Silt & Clay = 60.3%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.41
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	99.7%	99.7%	100.0%	0.0%
#8	2.360	99.6%	99.6%	100.0%	0.0%
#10	2.000		99.4%	100.0%	0.0%
#16	1.180	98.9%	98.9%	100.0%	0.0%
#20	0.850		97.9%	100.0%	0.0%
#30	0.600	97.2%	97.2%	100.0%	0.0%
#40	0.425		93.5%	100.0%	0.0%
#50	0.300	90.9%	90.9%	100.0%	0.0%
#60	0.250		84.9%	100.0%	0.0%
#80	0.180		76.4%	100.0%	0.0%
#100	0.150	72.8%	72.8%	100.0%	0.0%
#140	0.106		65.4%	100.0%	0.0%
#170	0.090		62.8%	100.0%	0.0%
#200	0.075	60.3%	60.3%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2765
Sample ID: B-14-14 SS-2
Source: 5.0'
Specifications: No Specs

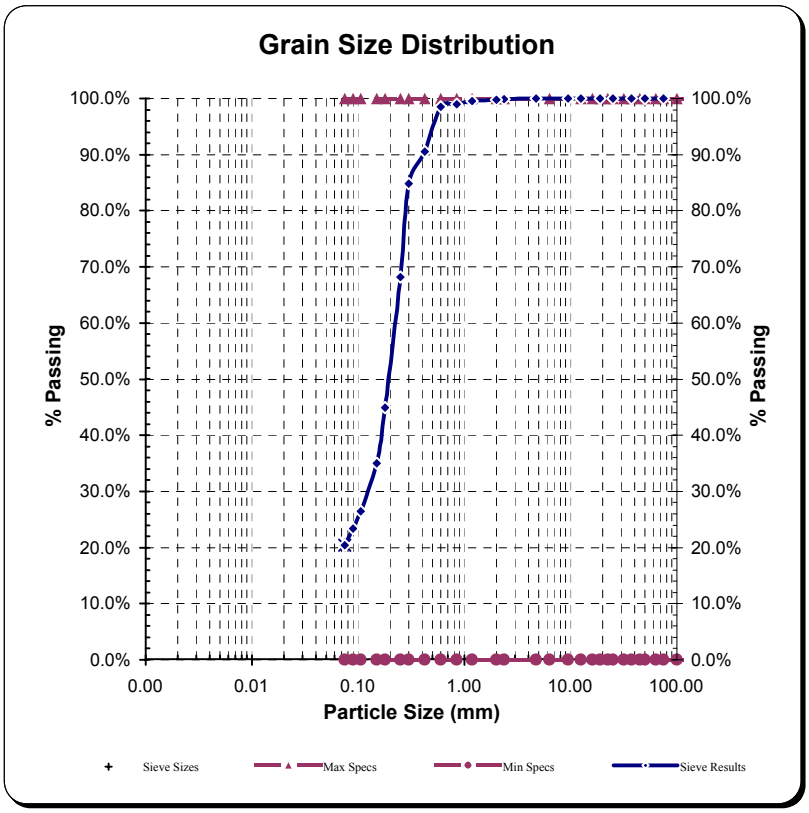
$D_{(10)}$= 0.037 mm
$D_{(30)}$= 0.124 mm
$D_{(60)}$= 0.225 mm
Liquid Limit= n/a

% Gravel = 0.0%
% Sand = 79.6%
% Silt & Clay = 20.4%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.87
Coeff. of Uniformity, C_U = 6.14
Fineness Modulus= 0.82
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	99.9%	99.9%	100.0%	0.0%
#10	2.000		99.8%	100.0%	0.0%
#16	1.180	99.6%	99.6%	100.0%	0.0%
#20	0.850		99.0%	100.0%	0.0%
#30	0.600	98.5%	98.5%	100.0%	0.0%
#40	0.425		90.5%	100.0%	0.0%
#50	0.300	84.8%	84.8%	100.0%	0.0%
#60	0.250		68.2%	100.0%	0.0%
#80	0.180		45.0%	100.0%	0.0%
#100	0.150	35.0%	35.0%	100.0%	0.0%
#140	0.106		26.5%	100.0%	0.0%
#170	0.090		23.4%	100.0%	0.0%
#200	0.075	20.4%	20.4%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2783
Sample ID: B-15-14 SS-7
Source: 30.0'
Specifications: No Specs

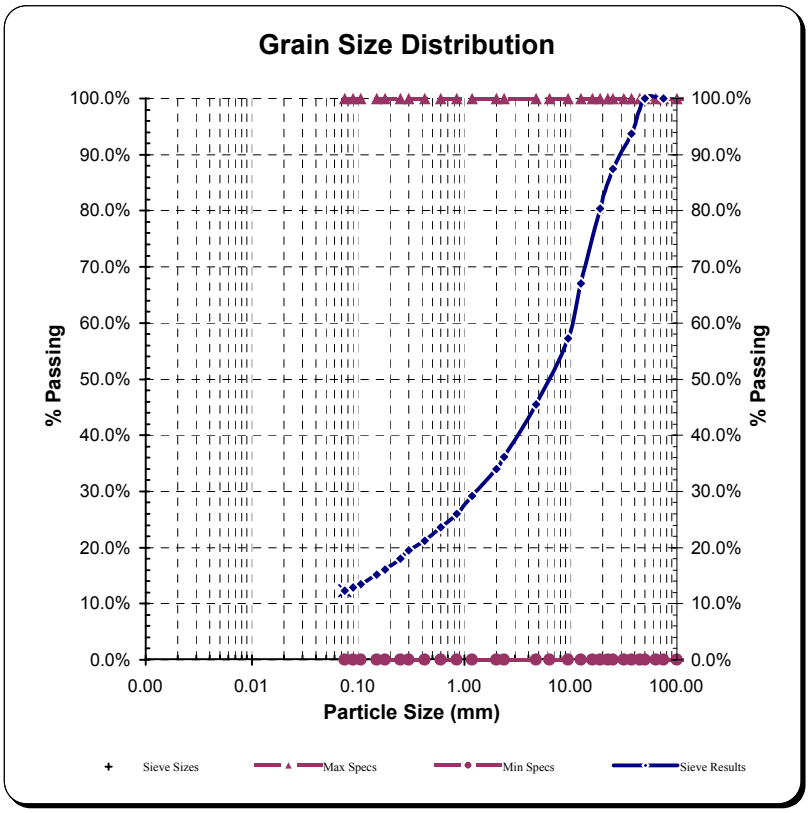
$D_{(10)}$= 0.061 mm
$D_{(30)}$= 1.322 mm
$D_{(60)}$= 10.355 mm
Liquid Limit= n/a

% Gravel = 54.6%
% Sand = 33.2%
% Silt & Clay = 12.3%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 2.76
Coeff. of Uniformity, C_U = 169.35
Fineness Modulus= 5.00
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50		93.7%	100.0%	0.0%
1.00"	25.00	87.4%	87.4%	100.0%	0.0%
3/4"	19.00	80.4%	80.4%	100.0%	0.0%
1/2"	12.50	67.0%	67.0%	100.0%	0.0%
3/8"	9.50	57.2%	57.2%	100.0%	0.0%
#4	4.75	45.4%	45.4%	100.0%	0.0%
#8	2.360	36.1%	36.1%	100.0%	0.0%
#10	2.000		34.0%	100.0%	0.0%
#16	1.180	29.2%	29.2%	100.0%	0.0%
#20	0.850		26.0%	100.0%	0.0%
#30	0.600	23.6%	23.6%	100.0%	0.0%
#40	0.425		21.2%	100.0%	0.0%
#50	0.300	19.5%	19.5%	100.0%	0.0%
#60	0.250		18.0%	100.0%	0.0%
#80	0.180		16.0%	100.0%	0.0%
#100	0.150	15.2%	15.2%	100.0%	0.0%
#140	0.106		13.5%	100.0%	0.0%
#170	0.090		12.9%	100.0%	0.0%
#200	0.075	12.3%	12.3%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

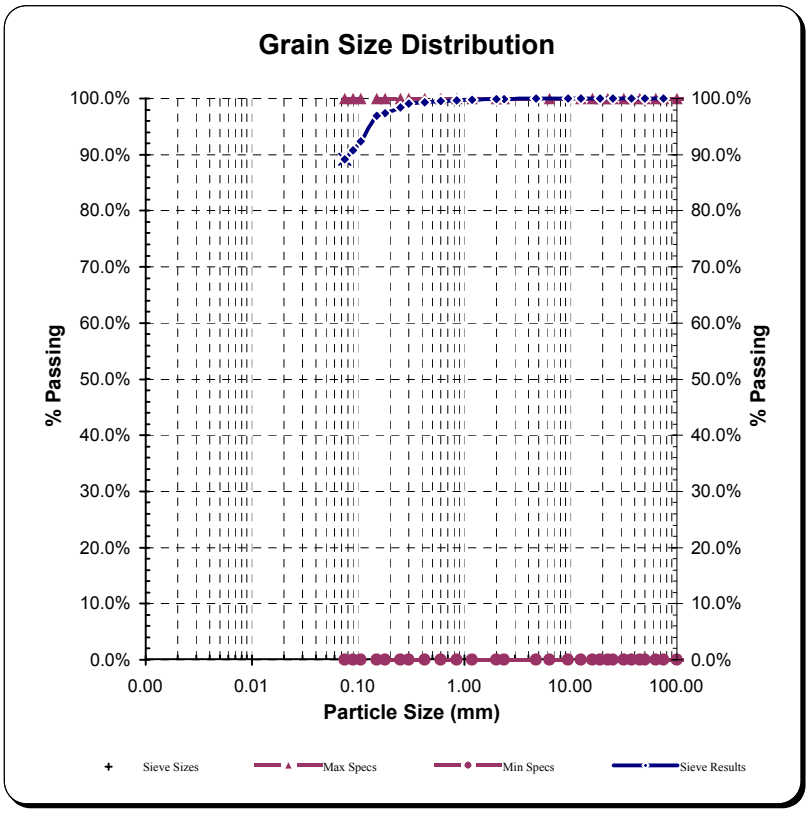
ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2766
Sample ID: TP-1-14 B-2
Source: 3.5'
Specifications: No Specs
USCS Soil Classification: CL, Lean Clay

$D_{(10)}$= 0.008 mm	% Gravel = 0.0%	Coeff. of Curvature, C_C = 1.50
$D_{(30)}$= 0.025 mm	% Sand = 10.8%	Coeff. of Uniformity, C_U = 6.00
$D_{(60)}$= 0.050 mm	% Silt & Clay = 89.2%	Fineness Modulus= 0.05
Liquid Limit= 35.8%	Plastic Limit= 20.2%	Plasticity Index= 15.6%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	99.9%	99.9%	100.0%	0.0%
#10	2.000		99.9%	100.0%	0.0%
#16	1.180	99.8%	99.8%	100.0%	0.0%
#20	0.850		99.7%	100.0%	0.0%
#30	0.600	99.6%	99.6%	100.0%	0.0%
#40	0.425		99.3%	100.0%	0.0%
#50	0.300	99.1%	99.1%	100.0%	0.0%
#60	0.250		98.4%	100.0%	0.0%
#80	0.180		97.3%	100.0%	0.0%
#100	0.150	96.9%	96.9%	100.0%	0.0%
#140	0.106		92.4%	100.0%	0.0%
#170	0.090		90.8%	100.0%	0.0%
#200	0.075	89.2%	89.2%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2767
Sample ID: TP-2 Bucket 1
Source: 2.0'
Specifications: No Specs
USCS Soil Classification: GW, Well-graded Gravel with Sand

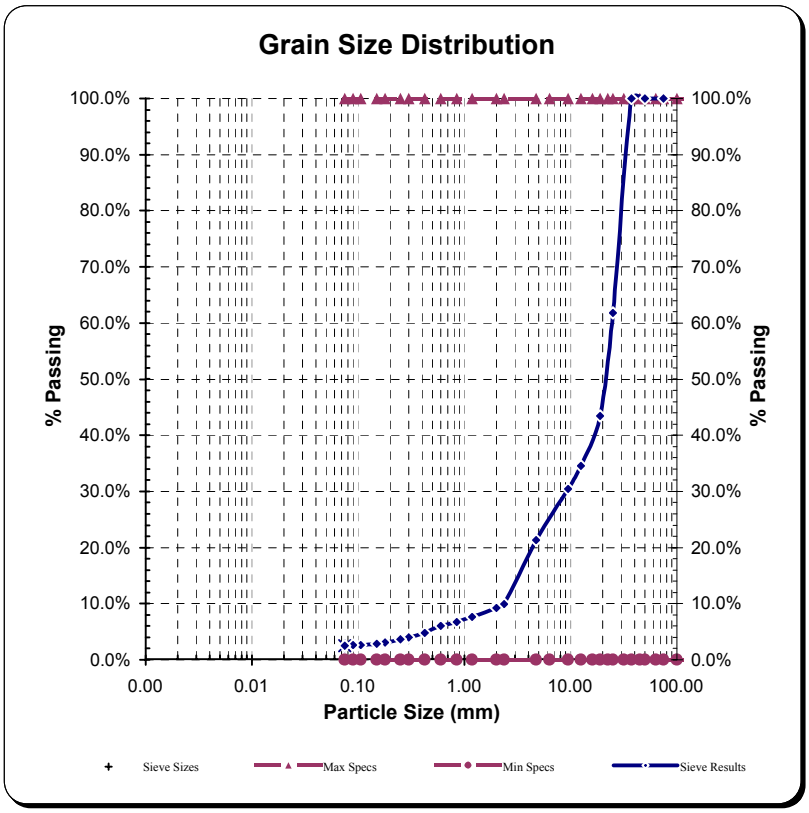
$D_{(10)}$= 2.376 mm
$D_{(30)}$= 9.252 mm
$D_{(60)}$= 24.413 mm
Liquid Limit= 0.0%

% Gravel = 78.7%
% Sand = 18.8%
% Silt & Clay = 2.5%
Plastic Limit= 0.0%

Coeff. of Curvature, C_C = 1.48
Coeff. of Uniformity, C_U = 10.28
Fineness Modulus= 6.74
Plasticity Index= 0.0%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50	100.0%	100.0%	100.0%	0.0%
1.00"	25.00		61.8%	100.0%	0.0%
3/4"	19.00	43.5%	43.5%	100.0%	0.0%
1/2"	12.50		34.6%	100.0%	0.0%
3/8"	9.50	30.5%	30.5%	100.0%	0.0%
#4	4.75	21.3%	21.3%	100.0%	0.0%
#8	2.360	9.9%	9.9%	100.0%	0.0%
#10	2.000		9.2%	100.0%	0.0%
#16	1.180	7.6%	7.6%	100.0%	0.0%
#20	0.850		6.7%	100.0%	0.0%
#30	0.600	6.0%	6.0%	100.0%	0.0%
#40	0.425		4.8%	100.0%	0.0%
#50	0.300	4.0%	4.0%	100.0%	0.0%
#60	0.250		3.6%	100.0%	0.0%
#80	0.180		3.1%	100.0%	0.0%
#100	0.150	2.9%	2.9%	100.0%	0.0%
#140	0.106		2.7%	100.0%	0.0%
#170	0.090		2.6%	100.0%	0.0%
#200	0.075	2.5%	2.5%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

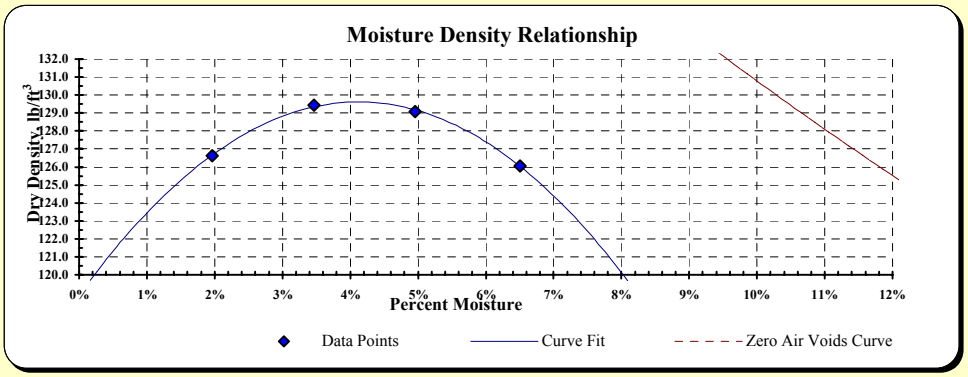
Proctor Report

Project Name: Schaake Habitat Improveme **Sample ID:** TP-2 Bucket 1
Date Received: 11/17/2014 **Source:** 2.0'
Sample #: 2767

Moist:		Manual:			
Dry:	X	Mechanical:	X	Method:	C
AASHTO T 99:		AASHTO T 180:			
ASTM D 698:	X	ASTM D 1557:			

Assumed Sp. Gr.	Point Number	Percent Moisture	Dry Density lb/ft³
2.65	1	2.0%	126.6
	2	3.5%	129.4
	3	5.0%	129.1
	4	6.5%	126.1
	5		

Maximum Dry Density 129.5 lb/ft³
Optimum % Moisture 4.5 %



ASTM D-4718, Correction for Oversize Particles **% Retained 3/4"** 56.5%

% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture	% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture
5%	130.9	2,097	4.3%	20%	135.4	2,169	3.7%
10%	132.4	2,121	4.1%	25%	136.9	2,194	3.5%
15%	133.9	2,144	3.9%	30%	138.5	2,219	3.3%

Copyright Spears Engineering & Technical Services PS, 1996-2003

Sieve Size US	Sieve Size mm		Specifications Max	Specifications Min
6.00"	150.0		100.0 %	0.0 %
4.00"	100.0		100.0 %	0.0 %
3.00"	75.0		100.0 %	0.0 %
2.50"	63.0		100.0 %	0.0 %
2.00"	50.0		100.0 %	0.0 %
1.75"	45.0		100.0 %	0.0 %
1.50"	37.5	100.0 %	100.0 %	0.0 %
1.25"	31.5		100.0 %	0.0 %
1.00"	25.0		100.0 %	0.0 %
7/8"	22.4		100.0 %	0.0 %
3/4"	19.0	43.5 %	100.0 %	0.0 %
5/8"	16.0		100.0 %	0.0 %
1/2"	12.5		100.0 %	0.0 %
3/8"	9.5	30.5 %	100.0 %	0.0 %
1/4"	6.3		100.0 %	0.0 %
#4	4.750	21.3 %	100.0 %	0.0 %
#8	2.360	9.9 %	100.0 %	0.0 %
#10	2.000		100.0 %	0.0 %
#16	1.180	7.6 %	100.0 %	0.0 %
#20	0.850		100.0 %	0.0 %
#30	0.600	6.0 %	100.0 %	0.0 %
#40	0.425		100.0 %	0.0 %
#50	0.300	4.0 %	100.0 %	0.0 %
#60	0.250		100.0 %	0.0 %
#80	0.180		100.0 %	0.0 %
#100	0.150	2.9 %	100.0 %	0.0 %
#140	0.106		100.0 %	0.0 %
#170	0.090		100.0 %	0.0 %
#200	0.075	2.5 %	100.0 %	0.0 %

Specs: **Meets Specs? Yes**
No Specs

% Gravel:	78.7%	$D_{(10)}$:	2.376
% Sand:	18.8%	$D_{(30)}$:	9.252
% Silt&Clay:	2.5%	$D_{(60)}$:	24.413
C_C:	1.48	LL:	0.0%
C_U:	10.28	PL:	0.0%
FM:	6.74	PI:	0.0%

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2768
Sample ID: TP-4-14 BKT 1
Source: 1.5'
Specifications: No Specs

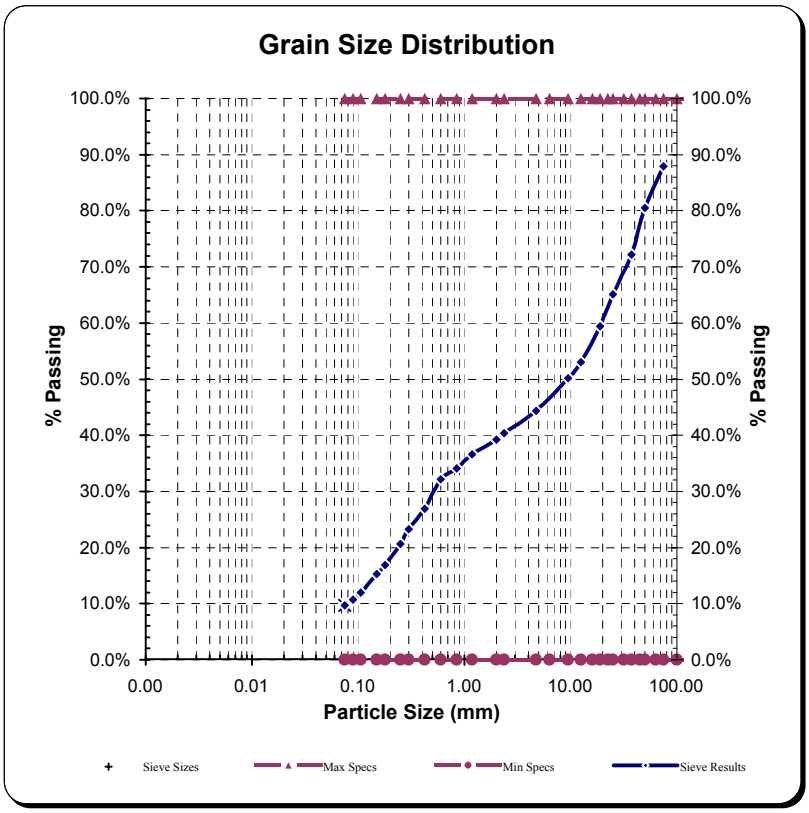
$D_{(10)}$= 0.080 mm
$D_{(30)}$= 0.528 mm
$D_{(60)}$= 19.620 mm
Liquid Limit= 35.8%

% Gravel = 55.7%
% Sand = 34.7%
% Silt & Clay = 9.6%
Plastic Limit= 20.2%

Coeff. of Curvature, C_C = 0.18
Coeff. of Uniformity, C_U = 246.25
Fineness Modulus= 5.39
Plasticity Index= 15.6%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00	87.9%	87.9%	100.0%	0.0%
2.00"	50.00	80.5%	80.5%	100.0%	0.0%
1.50"	37.50	72.1%	72.1%	100.0%	0.0%
1.00"	25.00	65.1%	65.1%	100.0%	0.0%
3/4"	19.00	59.4%	59.4%	100.0%	0.0%
1/2"	12.50	53.0%	53.0%	100.0%	0.0%
3/8"	9.50	50.1%	50.1%	100.0%	0.0%
#4	4.75	44.3%	44.3%	100.0%	0.0%
#8	2.360	40.3%	40.3%	100.0%	0.0%
#10	2.000		39.2%	100.0%	0.0%
#16	1.180	36.6%	36.6%	100.0%	0.0%
#20	0.850		34.0%	100.0%	0.0%
#30	0.600	32.1%	32.1%	100.0%	0.0%
#40	0.425		27.0%	100.0%	0.0%
#50	0.300	23.3%	23.3%	100.0%	0.0%
#60	0.250		20.6%	100.0%	0.0%
#80	0.180		16.9%	100.0%	0.0%
#100	0.150	15.3%	15.3%	100.0%	0.0%
#140	0.106		12.0%	100.0%	0.0%
#170	0.090		10.8%	100.0%	0.0%
#200	0.075	9.6%	9.6%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2769
Sample ID: TP-6 Bucket 1
Source: 1.5'
Specifications: No Specs
USCS Soil Classification: MH, Elastic Silt

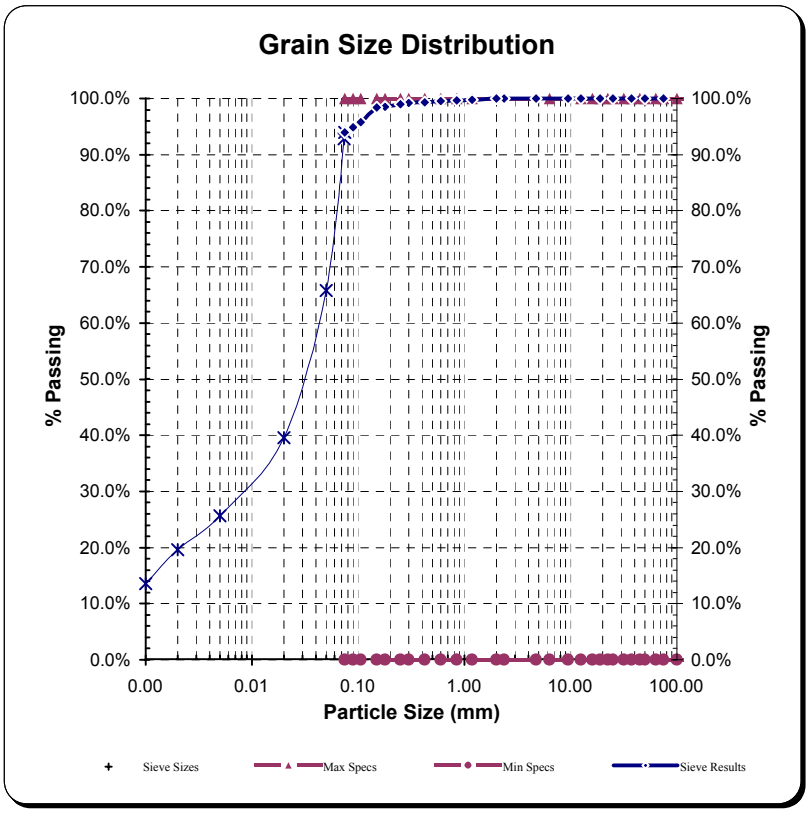
$D_{(10)}$= 0.008 mm
$D_{(30)}$= 0.024 mm
$D_{(60)}$= 0.048 mm
Liquid Limit= 51.5%

% Gravel = 0.0%
% Sand = 6.0%
% Silt & Clay = 94.0%
Plastic Limit= 32.8%

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.03
Plasticity Index= 18.7%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50	100.0%	100.0%	100.0%	0.0%
1.00"	25.00	100.0%	100.0%	100.0%	0.0%
3/4"	19.00	100.0%	100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	100.0%	100.0%	100.0%	0.0%
#10	2.000	100.0%	100.0%	100.0%	0.0%
#16	1.180	99.8%	99.8%	100.0%	0.0%
#20	0.850		99.7%	100.0%	0.0%
#30	0.600	99.6%	99.6%	100.0%	0.0%
#40	0.425		99.4%	100.0%	0.0%
#50	0.300	99.2%	99.2%	100.0%	0.0%
#60	0.250		98.9%	100.0%	0.0%
#80	0.180		98.6%	100.0%	0.0%
#100	0.150	98.4%	98.4%	100.0%	0.0%
#140	0.106		95.8%	100.0%	0.0%
#170	0.090		94.9%	100.0%	0.0%
#200	0.075	94.0%	94.0%	100.0%	0.0%
Silts	0.074	92.9%	92.9%	100.0%	0.0%
	0.050	65.8%	65.8%	100.0%	0.0%
	0.020	39.5%	39.5%	100.0%	0.0%
Clays	0.005	25.7%	25.7%	100.0%	0.0%
	0.002	19.6%	19.6%	100.0%	0.0%
Colloids	0.001	13.6%	13.6%	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

Proctor Report

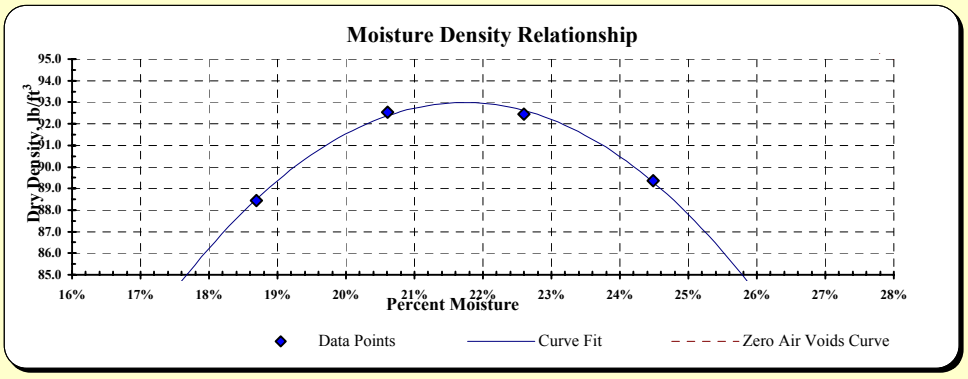
Project Name: Schaake Habitat Improveme **Sample ID:** TP-6 Bucket 1
Date Received: 11/17/2014 **Source:** 1.5'
Sample #: 2769

Moist:	X	Manual:			
Dry:		Mechanical:	X	Method:	A
AASHTO T 99:		AASHTO T 180:			
ASTM D 698:	X	ASTM D 1557:			

Assumed Sp. Gr.	Point Number	Percent Moisture	Dry Density lb/ft³
2.65	1	18.7%	88.4
	2	20.6%	92.5
	3	22.6%	92.4
	4	24.5%	89.4
	5		

Maximum Dry Density 93.0 lb/ft³

Optimum % Moisture 21.5 %



ASTM D-4718, Correction for Oversize Particles **% Retained 3/4"** 0.0%

% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture	% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture
5%	95.1	1,523	20.5%	20%	101.9	1,633	17.3%
10%	97.3	1,558	19.4%	25%	104.4	1,673	16.3%
15%	99.5	1,595	18.4%	30%	107.1	1,715	15.2%

Copyright Spears Engineering & Technical Services PS, 1996-2003

Sieve Size US	mm		Specifications Max	Min
6.00"	150.0	100.0 %	100.0 %	0.0 %
4.00"	100.0		100.0 %	0.0 %
3.00"	75.0		100.0 %	0.0 %
2.50"	63.0		100.0 %	0.0 %
2.00"	50.0		100.0 %	0.0 %
1.75"	45.0		100.0 %	0.0 %
1.50"	37.5	100.0 %	100.0 %	0.0 %
1.25"	31.5		100.0 %	0.0 %
1.00"	25.0	100.0 %	100.0 %	0.0 %
7/8"	22.4		100.0 %	0.0 %
3/4"	19.0	100.0 %	100.0 %	0.0 %
5/8"	16.0		100.0 %	0.0 %
1/2"	12.5		100.0 %	0.0 %
3/8"	9.5	100.0 %	100.0 %	0.0 %
1/4"	6.3		100.0 %	0.0 %
#4	4.750	100.0 %	100.0 %	0.0 %
#8	2.360	100.0 %	100.0 %	0.0 %
#10	2.000	100.0 %	100.0 %	0.0 %
#16	1.180	99.8 %	100.0 %	0.0 %
#20	0.850		100.0 %	0.0 %
#30	0.600	99.6 %	100.0 %	0.0 %
#40	0.425		100.0 %	0.0 %
#50	0.300	99.2 %	100.0 %	0.0 %
#60	0.250		100.0 %	0.0 %
#80	0.180		100.0 %	0.0 %
#100	0.150	98.4 %	100.0 %	0.0 %
#140	0.106		100.0 %	0.0 %
#170	0.090		100.0 %	0.0 %
#200	0.075	94.0 %	100.0 %	0.0 %

Specs: **Meets Specs? Yes**
No Specs

% Gravel:	0.0%	$D_{(10)}$:	0.008
% Sand:	6.0%	$D_{(30)}$:	0.024
% Silt&Clay:	94.0%	$D_{(60)}$:	0.048
C_C:	1.50	LL:	51.5%
C_U:	6.00	PL:	32.8%
FM:	0.03	PI:	18.7%

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2770
Sample ID: TP-7-14 B-1
Source: 0.6'
Specifications: No Specs

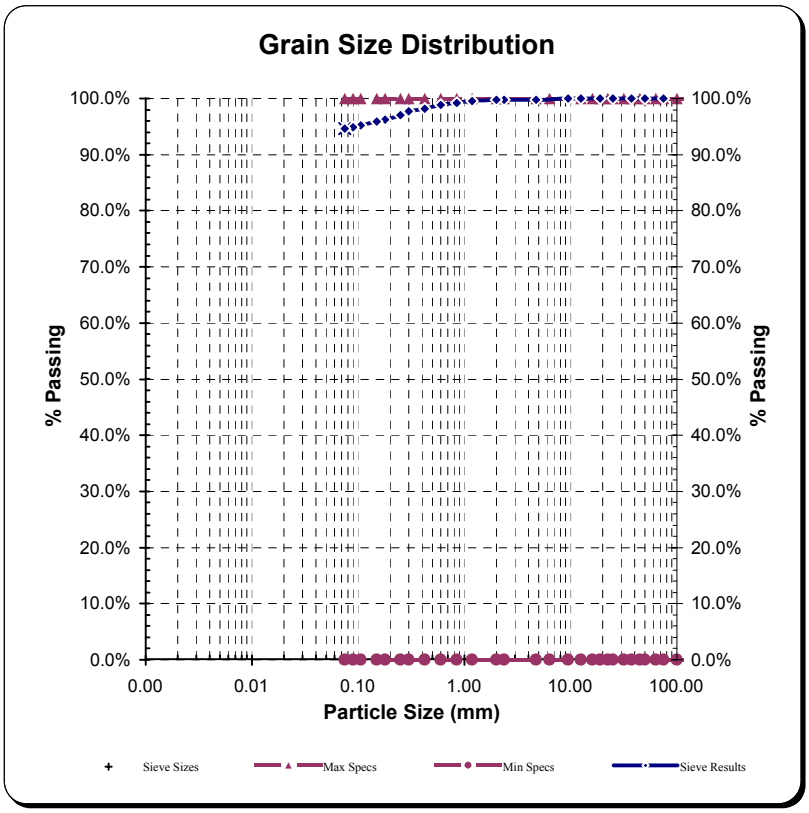
$D_{(10)}$= 0.008 mm
$D_{(30)}$= 0.024 mm
$D_{(60)}$= 0.048 mm
Liquid Limit= n/a

% Gravel = 0.2%
% Sand = 5.2%
% Silt & Clay = 94.6%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.08
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	99.8%	99.8%	100.0%	0.0%
#8	2.360	99.8%	99.8%	100.0%	0.0%
#10	2.000		99.7%	100.0%	0.0%
#16	1.180	99.6%	99.6%	100.0%	0.0%
#20	0.850		99.2%	100.0%	0.0%
#30	0.600	98.9%	98.9%	100.0%	0.0%
#40	0.425		98.2%	100.0%	0.0%
#50	0.300	97.7%	97.7%	100.0%	0.0%
#60	0.250		97.1%	100.0%	0.0%
#80	0.180		96.3%	100.0%	0.0%
#100	0.150	95.9%	95.9%	100.0%	0.0%
#140	0.106		95.2%	100.0%	0.0%
#170	0.090		94.9%	100.0%	0.0%
#200	0.075	94.6%	94.6%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2771
Sample ID: TP-8-14 BKT 1
Source: 1.5'
Specifications: No Specs
USCS Soil Classification: SP, Poorly graded Sand

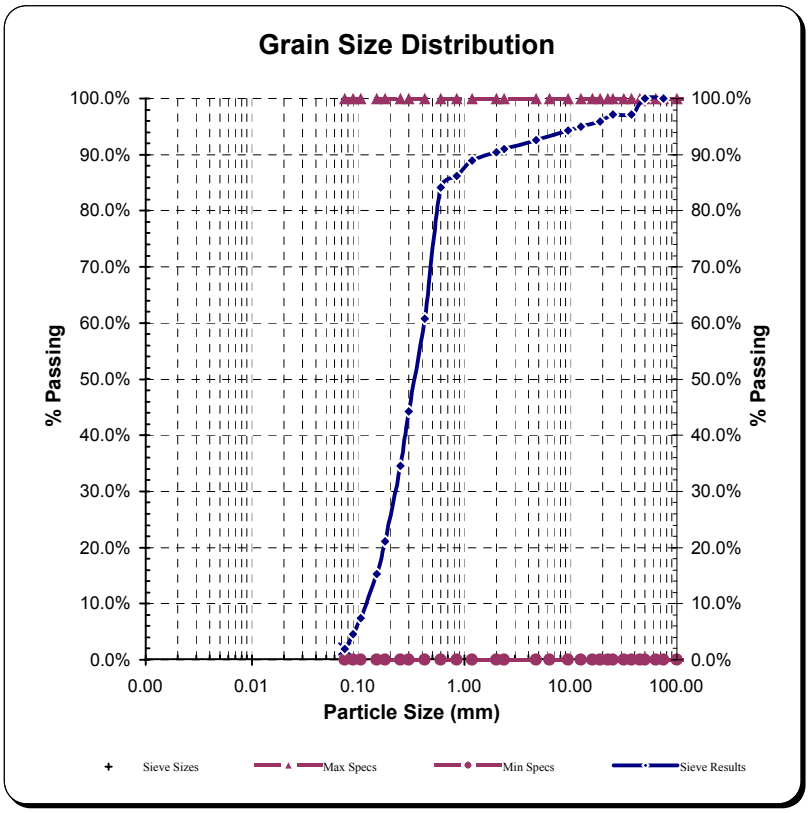
$D_{(10)}$= 0.121 mm
$D_{(30)}$= 0.226 mm
$D_{(60)}$= 0.419 mm
Liquid Limit= n/a

% Gravel = 7.4%
% Sand = 90.7%
% Silt & Clay = 1.9%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.02
Coeff. of Uniformity, C_U = 3.47
Fineness Modulus= 1.97
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00	100.0%	100.0%	100.0%	0.0%
1.50"	37.50	97.1%	97.1%	100.0%	0.0%
1.00"	25.00	97.1%	97.1%	100.0%	0.0%
3/4"	19.00	95.9%	95.9%	100.0%	0.0%
1/2"	12.50	95.0%	95.0%	100.0%	0.0%
3/8"	9.50	94.3%	94.3%	100.0%	0.0%
#4	4.75	92.6%	92.6%	100.0%	0.0%
#8	2.360	91.0%	91.0%	100.0%	0.0%
#10	2.000		90.4%	100.0%	0.0%
#16	1.180	88.9%	88.9%	100.0%	0.0%
#20	0.850		86.2%	100.0%	0.0%
#30	0.600	84.1%	84.1%	100.0%	0.0%
#40	0.425		60.8%	100.0%	0.0%
#50	0.300	44.2%	44.2%	100.0%	0.0%
#60	0.250		34.5%	100.0%	0.0%
#80	0.180		21.0%	100.0%	0.0%
#100	0.150	15.3%	15.3%	100.0%	0.0%
#140	0.106		7.4%	100.0%	0.0%
#170	0.090		4.6%	100.0%	0.0%
#200	0.075	1.9%	1.9%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2772
Sample ID: TP-8-14 B-2
Source: 2.5'
Specifications: No Specs
USCS Soil Classification: GW, Well-graded Gravel with Sand

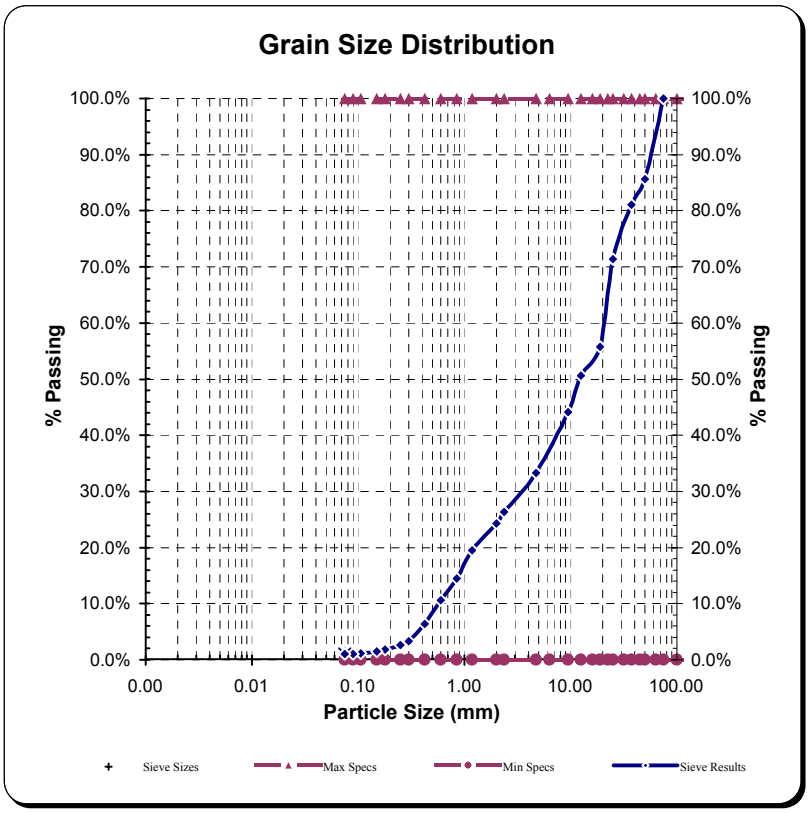
$D_{(10)}$= 0.574 mm
$D_{(30)}$= 3.607 mm
$D_{(60)}$= 20.635 mm
Liquid Limit= n/a

% Gravel = 66.7%
% Sand = 32.3%
% Silt & Clay = 1.0%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.10
Coeff. of Uniformity, C_U = 35.95
Fineness Modulus= 6.25
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00	100.0%	100.0%	100.0%	0.0%
2.00"	50.00	85.7%	85.7%	100.0%	0.0%
1.50"	37.50	81.0%	81.0%	100.0%	0.0%
1.00"	25.00	71.4%	71.4%	100.0%	0.0%
3/4"	19.00	55.7%	55.7%	100.0%	0.0%
1/2"	12.50	50.7%	50.7%	100.0%	0.0%
3/8"	9.50	44.1%	44.1%	100.0%	0.0%
#4	4.75	33.3%	33.3%	100.0%	0.0%
#8	2.360	26.4%	26.4%	100.0%	0.0%
#10	2.000		24.3%	100.0%	0.0%
#16	1.180	19.6%	19.6%	100.0%	0.0%
#20	0.850		14.5%	100.0%	0.0%
#30	0.600	10.6%	10.6%	100.0%	0.0%
#40	0.425		6.3%	100.0%	0.0%
#50	0.300	3.3%	3.3%	100.0%	0.0%
#60	0.250		2.7%	100.0%	0.0%
#80	0.180		1.8%	100.0%	0.0%
#100	0.150	1.5%	1.5%	100.0%	0.0%
#140	0.106		1.2%	100.0%	0.0%
#170	0.090		1.1%	100.0%	0.0%
#200	0.075	1.0%	1.0%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2773
Sample ID: TP-9-14 B-1
Source: 0.75'
Specifications: No Specs

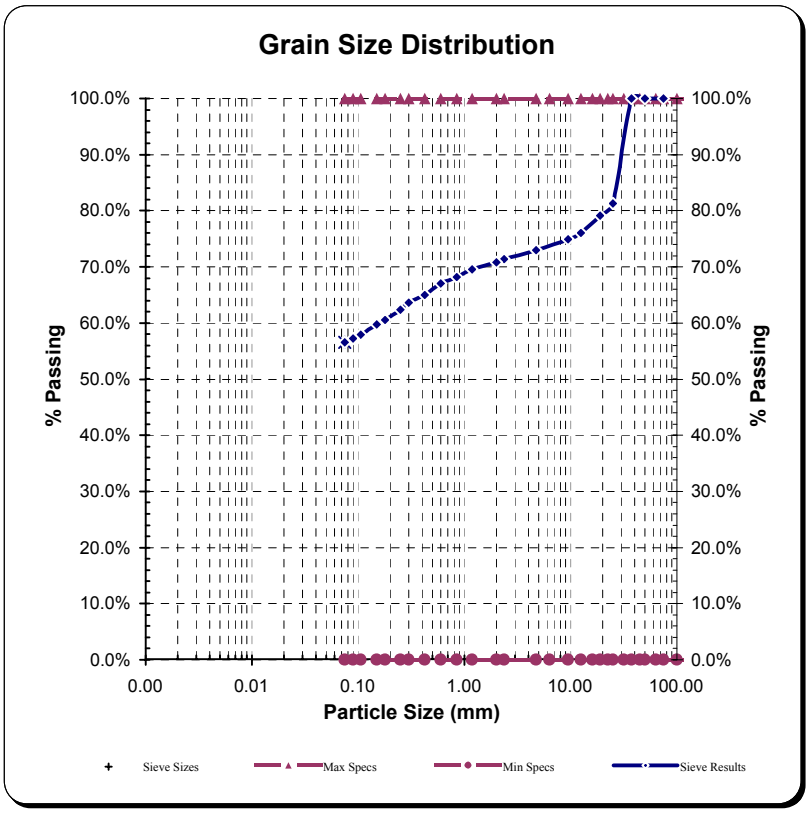
$D_{(10)}$= 0.013 mm
$D_{(30)}$= 0.040 mm
$D_{(60)}$= 0.158 mm
Liquid Limit= n/a

% Gravel = 27.0%
% Sand = 16.4%
% Silt & Clay = 56.6%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 0.76
Coeff. of Uniformity, C_U = 11.92
Fineness Modulus= 2.42
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50	100.0%	100.0%	100.0%	0.0%
1.00"	25.00	81.3%	81.3%	100.0%	0.0%
3/4"	19.00	79.1%	79.1%	100.0%	0.0%
1/2"	12.50	76.1%	76.1%	100.0%	0.0%
3/8"	9.50	74.9%	74.9%	100.0%	0.0%
#4	4.75	73.0%	73.0%	100.0%	0.0%
#8	2.360	71.4%	71.4%	100.0%	0.0%
#10	2.000		70.8%	100.0%	0.0%
#16	1.180	69.6%	69.6%	100.0%	0.0%
#20	0.850		68.1%	100.0%	0.0%
#30	0.600	67.0%	67.0%	100.0%	0.0%
#40	0.425		65.0%	100.0%	0.0%
#50	0.300	63.6%	63.6%	100.0%	0.0%
#60	0.250		62.3%	100.0%	0.0%
#80	0.180		60.6%	100.0%	0.0%
#100	0.150	59.8%	59.8%	100.0%	0.0%
#140	0.106		57.9%	100.0%	0.0%
#170	0.090		57.2%	100.0%	0.0%
#200	0.075	56.6%	56.6%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2774
Sample ID: TP-9 Bucket 2
Source: 1.5'
Specifications: No Specs
USCS Soil Classification: ML, Silt

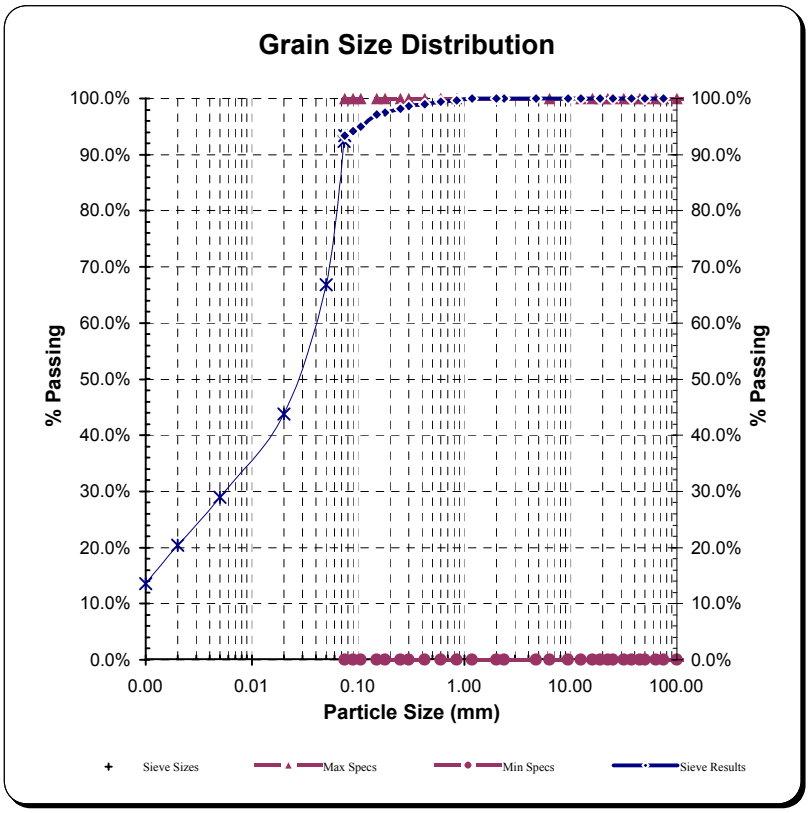
$D_{(10)}$= 0.008 mm
$D_{(30)}$= 0.024 mm
$D_{(60)}$= 0.048 mm
Liquid Limit= 45.2%

% Gravel = 0.0%
% Sand = 6.6%
% Silt & Clay = 93.4%
Plastic Limit= 36.7%

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.05
Plasticity Index= 8.5%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	100.0%	100.0%	100.0%	0.0%
#10	2.000	100.0%	100.0%	100.0%	0.0%
#16	1.180	100.0%	100.0%	100.0%	0.0%
#20	0.850		99.7%	100.0%	0.0%
#30	0.600	99.4%	99.4%	100.0%	0.0%
#40	0.425		98.9%	100.0%	0.0%
#50	0.300	98.6%	98.6%	100.0%	0.0%
#60	0.250		98.1%	100.0%	0.0%
#80	0.180		97.5%	100.0%	0.0%
#100	0.150	97.2%	97.2%	100.0%	0.0%
#140	0.106		95.0%	100.0%	0.0%
#170	0.090		94.2%	100.0%	0.0%
#200	0.075	93.4%	93.4%	100.0%	0.0%
Silts	0.074	92.3%	92.3%	100.0%	0.0%
	0.050	66.8%	66.8%	100.0%	0.0%
	0.020	43.7%	43.7%	100.0%	0.0%
Clays	0.005	29.0%	29.0%	100.0%	0.0%
	0.002	20.4%	20.4%	100.0%	0.0%
Colloids	0.001	13.6%	13.6%	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

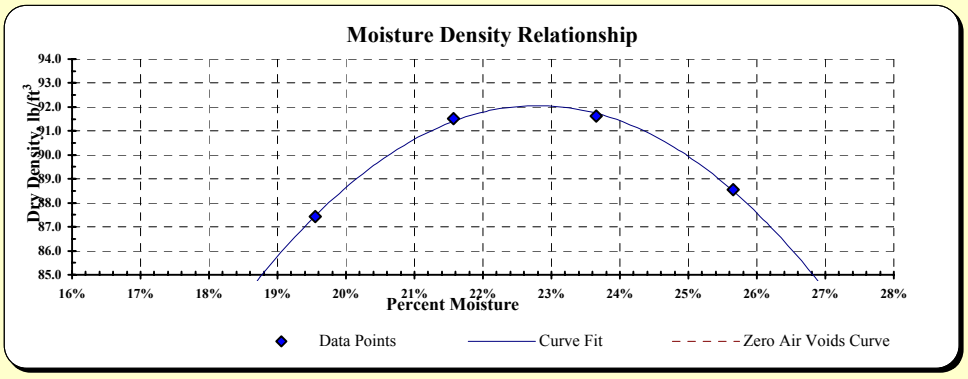
Proctor Report

Project Name: Schaake Habitat Improveme **Sample ID:** TP-9 Bucket 2
Date Received: 11/17/2014 **Source:** 1.5'
Sample #: 2774

Moist:	X	Manual:			
Dry:		Mechanical:	X	Method:	A
AASHTO T 99:		AASHTO T 180:			
ASTM D 698:	X	ASTM D 1557:			

Assumed Sp. Gr.	Point Number	Percent Moisture	Dry Density lb/ft³
2.65	1	19.6%	87.4
	2	21.6%	91.5
	3	23.7%	91.6
	4	25.7%	88.5
	5		

Maximum Dry Density: 92.0 lb/ft³
Optimum % Moisture: 22.5 %



ASTM D-4718, Correction for Oversize Particles — **% Retained 3/4"**

% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture	% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture
5%	94.1	1,507	21.4%	20%	101.0	1,617	18.1%
10%	96.3	1,542	20.3%	25%	103.5	1,658	17.0%
15%	98.6	1,579	19.2%	30%	106.1	1,700	15.9%

Copyright Spears Engineering & Technical Services PS, 1996-2003

Sieve Size US	Sieve Size mm		Specifications Max	Specifications Min
6.00"	150.0		100.0 %	0.0 %
4.00"	100.0		100.0 %	0.0 %
3.00"	75.0		100.0 %	0.0 %
2.50"	63.0		100.0 %	0.0 %
2.00"	50.0		100.0 %	0.0 %
1.75"	45.0		100.0 %	0.0 %
1.50"	37.5		100.0 %	0.0 %
1.25"	31.5		100.0 %	0.0 %
1.00"	25.0		100.0 %	0.0 %
7/8"	22.4		100.0 %	0.0 %
3/4"	19.0		100.0 %	0.0 %
5/8"	16.0		100.0 %	0.0 %
1/2"	12.5		100.0 %	0.0 %
3/8"	9.5		100.0 %	0.0 %
1/4"	6.3		100.0 %	0.0 %
#4	4.750	100.0 %	100.0 %	0.0 %
#8	2.360	100.0 %	100.0 %	0.0 %
#10	2.000	100.0 %	100.0 %	0.0 %
#16	1.180	100.0 %	100.0 %	0.0 %
#20	0.850		100.0 %	0.0 %
#30	0.600	99.4 %	100.0 %	0.0 %
#40	0.425		100.0 %	0.0 %
#50	0.300	98.6 %	100.0 %	0.0 %
#60	0.250		100.0 %	0.0 %
#80	0.180		100.0 %	0.0 %
#100	0.150	97.2 %	100.0 %	0.0 %
#140	0.106		100.0 %	0.0 %
#170	0.090		100.0 %	0.0 %
#200	0.075	93.4 %	100.0 %	0.0 %

Specs: **Meets Specs? Yes**
No Specs

% Gravel:	0.0%	$D_{(10)}$:	0.008
% Sand:	6.6%	$D_{(30)}$:	0.024
% Silt&Clay:	93.4%	$D_{(60)}$:	0.048
C_C:	1.50	LL:	45.2%
C_U:	6.00	PL:	36.7%
FM:	0.05	PI:	8.5%

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2775
Sample ID: TP-10-14 B-1
Source: 2.0'
Specifications: No Specs
USCS Soil Classification: CL, Lean Clay with Sand

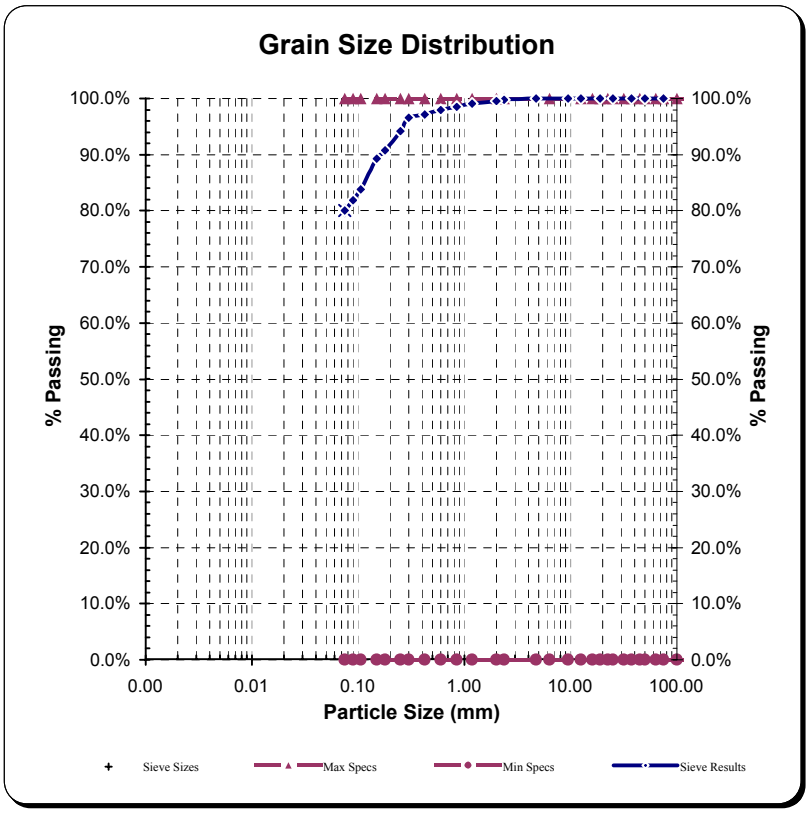
$D_{(10)}$= 0.009 mm
$D_{(30)}$= 0.028 mm
$D_{(60)}$= 0.056 mm
Liquid Limit= 41.0%

% Gravel = 0.0%
% Sand = 20.0%
% Silt & Clay = 80.0%
Plastic Limit= 25.7%

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.17
Plasticity Index= 15.4%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	99.8%	99.8%	100.0%	0.0%
#10	2.000		99.6%	100.0%	0.0%
#16	1.180	99.1%	99.1%	100.0%	0.0%
#20	0.850		98.5%	100.0%	0.0%
#30	0.600	98.0%	98.0%	100.0%	0.0%
#40	0.425		97.2%	100.0%	0.0%
#50	0.300	96.6%	96.6%	100.0%	0.0%
#60	0.250		94.2%	100.0%	0.0%
#80	0.180		90.7%	100.0%	0.0%
#100	0.150	89.3%	89.3%	100.0%	0.0%
#140	0.106		83.8%	100.0%	0.0%
#170	0.090		81.9%	100.0%	0.0%
#200	0.075	80.0%	80.0%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

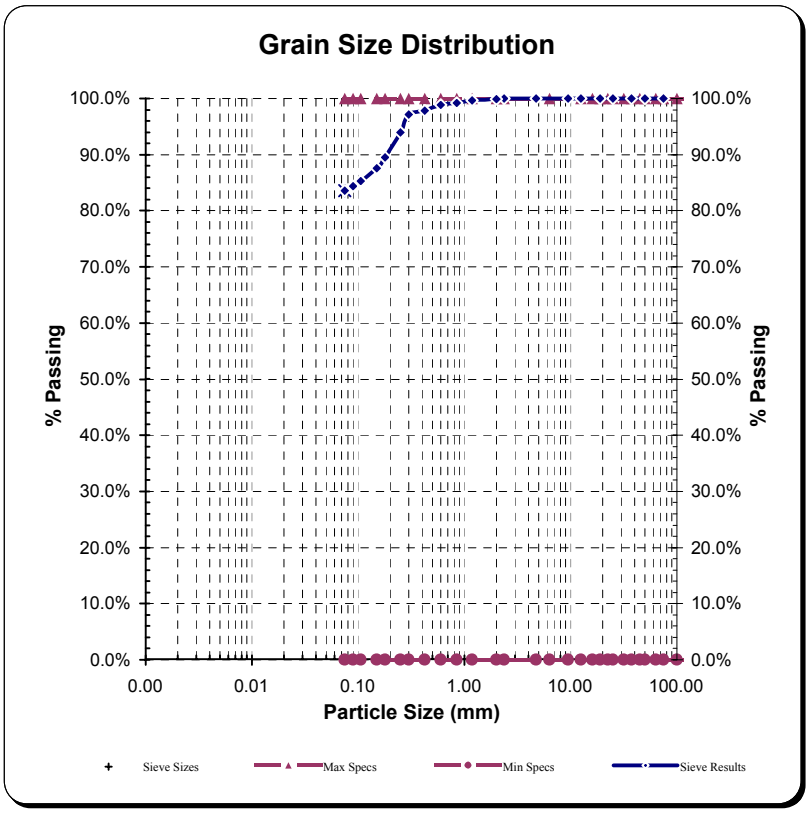
ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2776
Sample ID: TP-12-14 B-1
Source: 2.0'
Specifications: No Specs
USCS Soil Classification: ML, Silt with Sand

$D_{(10)}$= 0.009 mm	% Gravel = 0.0%	Coeff. of Curvature, C_C = 1.50
$D_{(30)}$= 0.027 mm	% Sand = 16.4%	Coeff. of Uniformity, C_U = 6.00
$D_{(60)}$= 0.054 mm	% Silt & Clay = 83.6%	Fineness Modulus= 0.17
Liquid Limit= 34.5%	Plastic Limit= 24.2%	Plasticity Index= 10.3%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50		100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	100.0%	100.0%	100.0%	0.0%
#10	2.000		99.9%	100.0%	0.0%
#16	1.180	99.7%	99.7%	100.0%	0.0%
#20	0.850		99.2%	100.0%	0.0%
#30	0.600	98.8%	98.8%	100.0%	0.0%
#40	0.425		97.8%	100.0%	0.0%
#50	0.300	97.1%	97.1%	100.0%	0.0%
#60	0.250		94.0%	100.0%	0.0%
#80	0.180		89.5%	100.0%	0.0%
#100	0.150	87.6%	87.6%	100.0%	0.0%
#140	0.106		85.3%	100.0%	0.0%
#170	0.090		84.4%	100.0%	0.0%
#200	0.075	83.6%	83.6%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2777
Sample ID: TP-13-14 B-1
Source: 2.0'
Specifications: No Specs
USCS Soil Classification: SM, Silty Sand

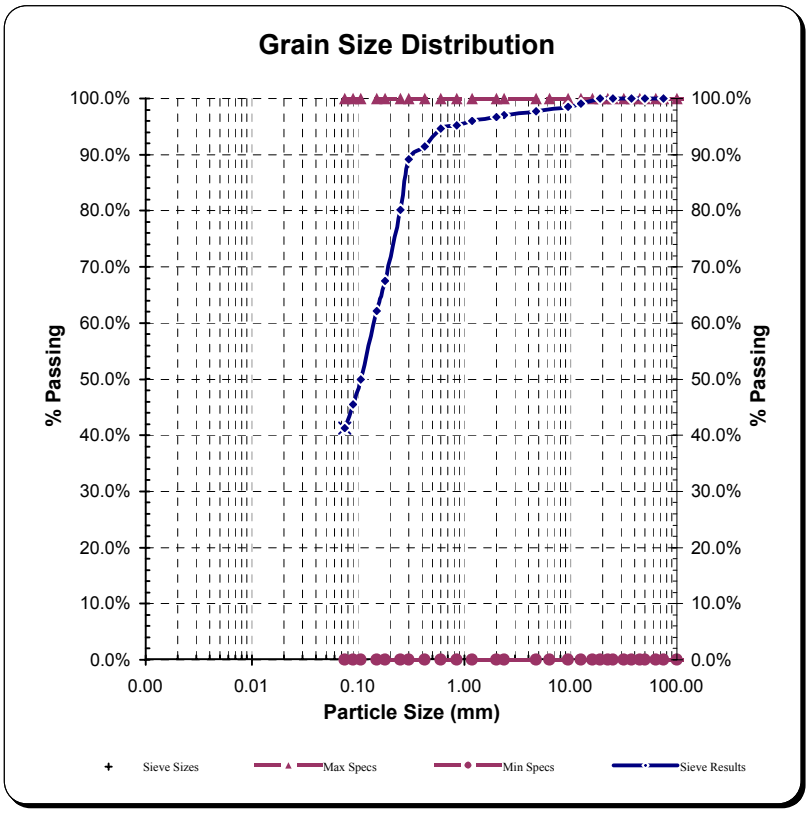
$D_{(10)}$= 0.018 mm
$D_{(30)}$= 0.055 mm
$D_{(60)}$= 0.142 mm
Liquid Limit= n/a

% Gravel = 2.3%
% Sand = 56.4%
% Silt & Clay = 41.3%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.15
Coeff. of Uniformity, C_U = 7.83
Fineness Modulus= 0.65
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00	100.0%	100.0%	100.0%	0.0%
1/2"	12.50	99.1%	99.1%	100.0%	0.0%
3/8"	9.50	98.5%	98.5%	100.0%	0.0%
#4	4.75	97.7%	97.7%	100.0%	0.0%
#8	2.360	97.0%	97.0%	100.0%	0.0%
#10	2.000		96.7%	100.0%	0.0%
#16	1.180	96.0%	96.0%	100.0%	0.0%
#20	0.850		95.2%	100.0%	0.0%
#30	0.600	94.6%	94.6%	100.0%	0.0%
#40	0.425		91.4%	100.0%	0.0%
#50	0.300	89.1%	89.1%	100.0%	0.0%
#60	0.250		80.1%	100.0%	0.0%
#80	0.180		67.5%	100.0%	0.0%
#100	0.150	62.1%	62.1%	100.0%	0.0%
#140	0.106		49.9%	100.0%	0.0%
#170	0.090		45.4%	100.0%	0.0%
#200	0.075	41.3%	41.3%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

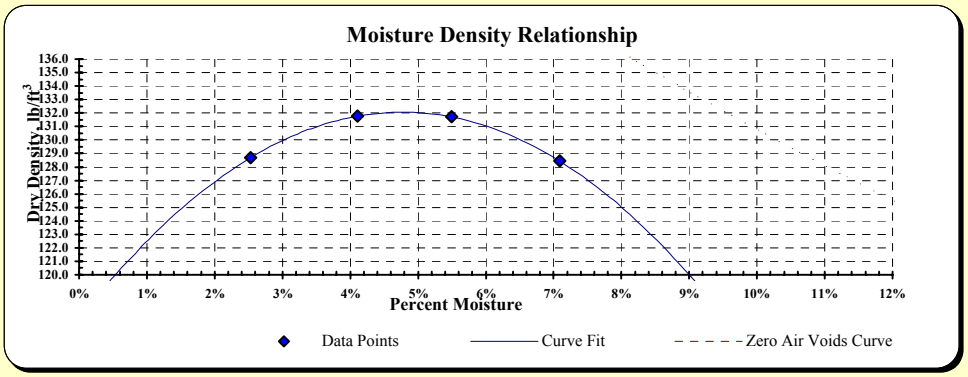
Proctor Report

Project Name: Schaake Habitat Improveme **Sample ID:** TP-14-14 Bucket 1
Date Received: 11/17/2014 **Source:** 0.5'
Sample #: 2778

Moist:		Manual:			
Dry:	X	Mechanical:	X	Method:	C
AASHTO T 99:		AASHTO T 180:			
ASTM D 698:	X	ASTM D 1557:			

Assumed Sp. Gr.	Point Number	Percent Moisture	Dry Density lb/ft³
2.65	1	2.5%	128.7
	2	4.1%	131.8
	3	5.5%	131.7
	4	7.1%	128.4
	5		

Maximum Dry Density 132.0 lb/ft³
Optimum % Moisture 5.0 %



ASTM D-4718, Correction for Oversize Particles **% Retained 3/4"** 26.0%

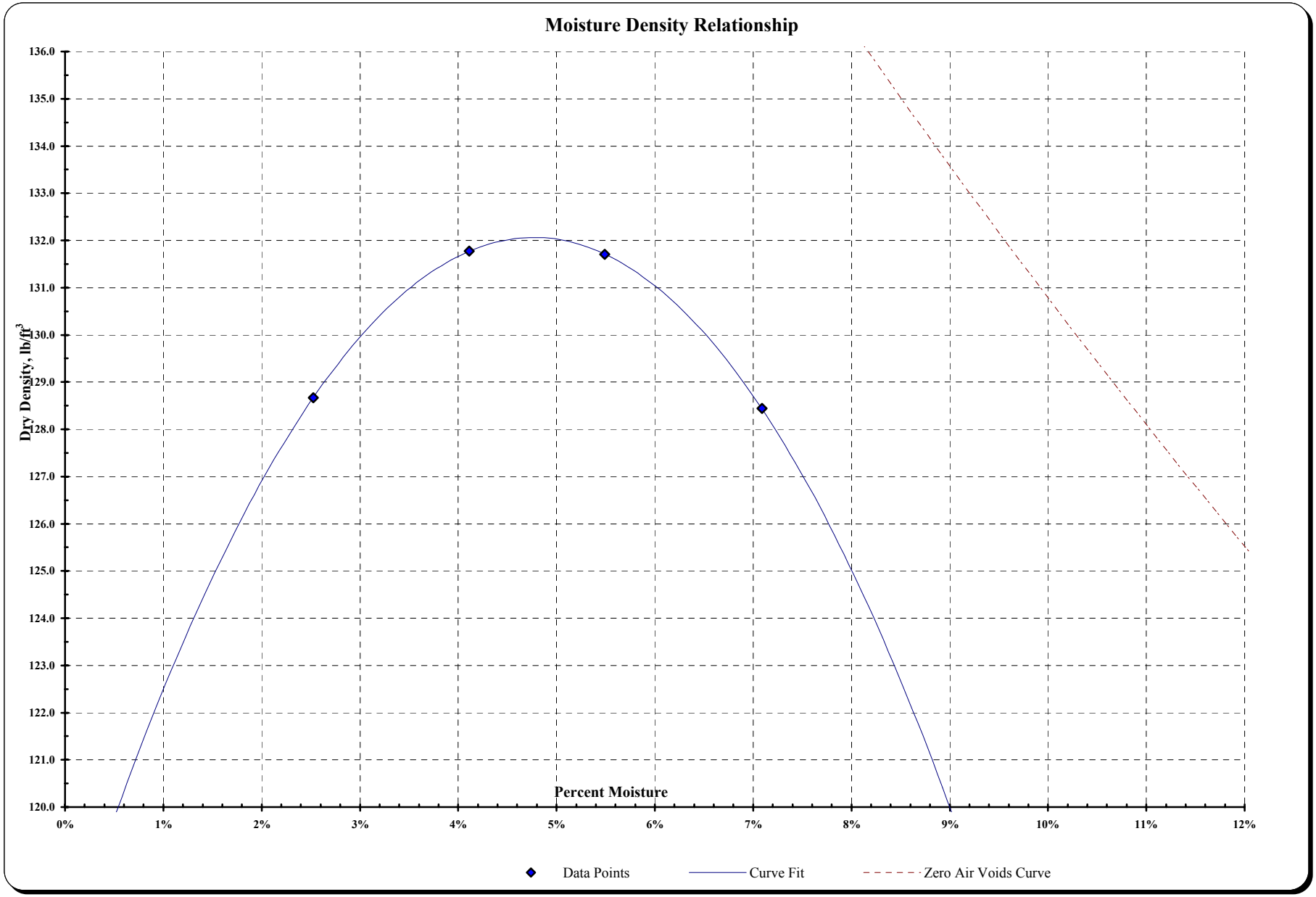
% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture	% Retained 3/4" Sieve	Corrected Density lb/ft³	Corrected Density kg/m³	Optimum Moisture
5%	133.3	2,136	4.8%	20%	137.6	2,204	4.1%
10%	134.7	2,158	4.6%	25%	139.0	2,227	3.9%
15%	136.1	2,181	4.3%	30%	140.5	2,251	3.7%

Copyright Spears Engineering & Technical Services PS, 1996-2003

Sieve Size US	mm	0%	Specifications Max	Min
6.00"	150.0	100.0 %	100.0 %	0.0 %
4.00"	100.0		100.0 %	0.0 %
3.00"	75.0	100.0 %	100.0 %	0.0 %
2.50"	63.0	100.0 %	100.0 %	0.0 %
2.00"	50.0	98.9 %	100.0 %	0.0 %
1.75"	45.0		100.0 %	0.0 %
1.50"	37.5	93.5 %	100.0 %	0.0 %
1.25"	31.5		100.0 %	0.0 %
1.00"	25.0	84.3 %	100.0 %	0.0 %
7/8"	22.4		100.0 %	0.0 %
3/4"	19.0	74.0 %	100.0 %	0.0 %
5/8"	16.0		100.0 %	0.0 %
1/2"	12.5	61.3 %	100.0 %	0.0 %
3/8"	9.5	49.8 %	100.0 %	0.0 %
1/4"	6.3		100.0 %	0.0 %
#4	4.750	42.1 %	100.0 %	0.0 %
#8	2.360	38.7 %	100.0 %	0.0 %
#10	2.000		100.0 %	0.0 %
#16	1.180	30.8 %	100.0 %	0.0 %
#20	0.850		100.0 %	0.0 %
#30	0.600	22.3 %	100.0 %	0.0 %
#40	0.425		100.0 %	0.0 %
#50	0.300	13.6 %	100.0 %	0.0 %
#60	0.250		100.0 %	0.0 %
#80	0.180		100.0 %	0.0 %
#100	0.150	9.2 %	100.0 %	0.0 %
#140	0.106		100.0 %	0.0 %
#170	0.090		100.0 %	0.0 %
#200	0.075	6.0 %	100.0 %	0.0 %

Specs: **Meets Specs? Yes**
No Specs

% Gravel:	57.9%	$D_{(10)}$:	0.178
% Sand:	36.1%	$D_{(30)}$:	1.128
% Silt&Clay:	6.0%	$D_{(60)}$:	12.160
C_C:	0.59	LL:	0.0%
C_U:	68.44	PL:	0.0%
FM:	5.26	PI:	0.0%


Moisture Density Relationship
Dry Density, lb/ft3
136.0
135.0
134.0
133.0
132.0
131.0
130.0
129.0
128.0
127.0
126.0
125.0
124.0
123.0
122.0
121.0
120.0
Percent Moisture
0%
1%
2%
3%
4%
5%
6%
7%
8%
9%
10%
11%
12%
Data Points
Curve Fit
Zero Air Voids Curve

GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2779
Sample ID: TP-14-14 B-2
Source: 1.5'
Specifications: No Specs

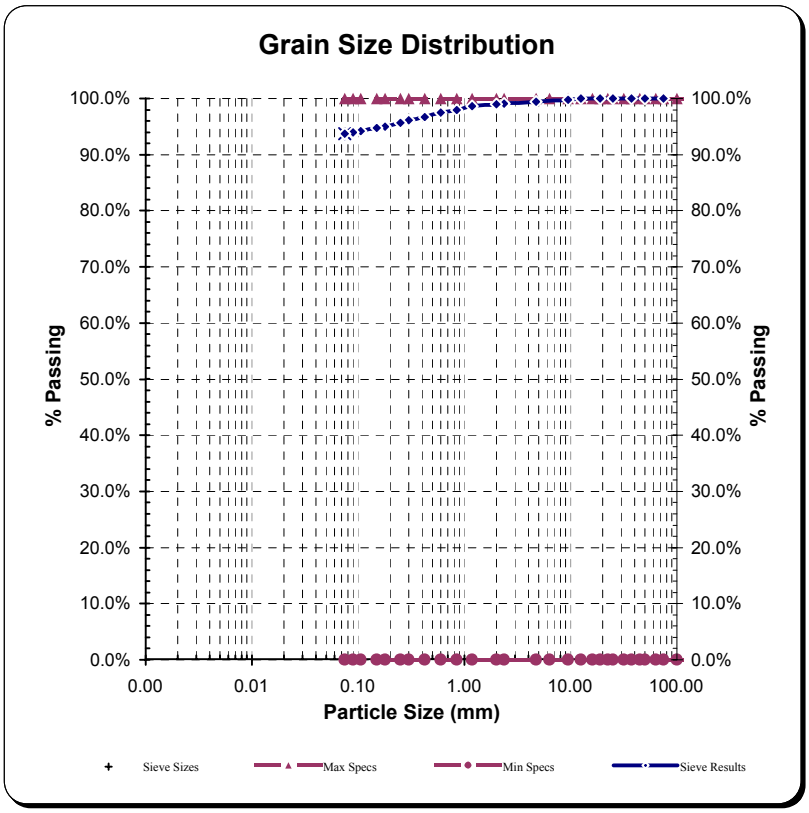
$D_{(10)}$= 0.008 mm
$D_{(30)}$= 0.024 mm
$D_{(60)}$= 0.048 mm
Liquid Limit= n/a

% Gravel = 0.5%
% Sand = 5.7%
% Silt & Clay = 93.8%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.15
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50	100.0%	100.0%	100.0%	0.0%
3/8"	9.50	99.8%	99.8%	100.0%	0.0%
#4	4.75	99.5%	99.5%	100.0%	0.0%
#8	2.360	99.1%	99.1%	100.0%	0.0%
#10	2.000		99.0%	100.0%	0.0%
#16	1.180	98.7%	98.7%	100.0%	0.0%
#20	0.850		98.0%	100.0%	0.0%
#30	0.600	97.5%	97.5%	100.0%	0.0%
#40	0.425		96.7%	100.0%	0.0%
#50	0.300	96.1%	96.1%	100.0%	0.0%
#60	0.250		95.7%	100.0%	0.0%
#80	0.180		95.0%	100.0%	0.0%
#100	0.150	94.7%	94.7%	100.0%	0.0%
#140	0.106		94.2%	100.0%	0.0%
#170	0.090		94.0%	100.0%	0.0%
#200	0.075	93.8%	93.8%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

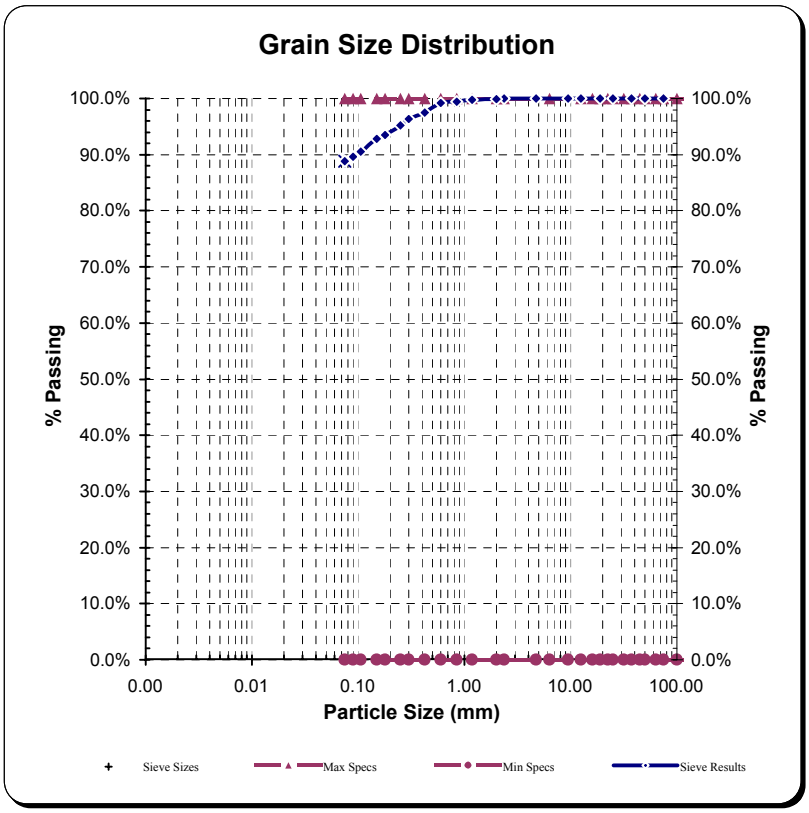
ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2780
Sample ID: TP-14-14 B-3
Source: 3.5'
Specifications: No Specs
USCS Soil Classification: CL, Lean Clay

$D_{(10)}$= 0.008 mm	% Gravel = 0.0%	Coeff. of Curvature, C_C = 1.50
$D_{(30)}$= 0.025 mm	% Sand = 11.1%	Coeff. of Uniformity, C_U = 6.00
$D_{(60)}$= 0.051 mm	% Silt & Clay = 88.9%	Fineness Modulus= 0.12
Liquid Limit= 41.8%	Plastic Limit= 24.1%	Plasticity Index= 17.7%

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50	100.0%	100.0%	100.0%	0.0%
1.00"	25.00	100.0%	100.0%	100.0%	0.0%
3/4"	19.00	100.0%	100.0%	100.0%	0.0%
1/2"	12.50	100.0%	100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	100.0%	100.0%	100.0%	0.0%
#8	2.360	100.0%	100.0%	100.0%	0.0%
#10	2.000		99.9%	100.0%	0.0%
#16	1.180	99.8%	99.8%	100.0%	0.0%
#20	0.850		99.4%	100.0%	0.0%
#30	0.600	99.2%	99.2%	100.0%	0.0%
#40	0.425		97.5%	100.0%	0.0%
#50	0.300	96.3%	96.3%	100.0%	0.0%
#60	0.250		95.2%	100.0%	0.0%
#80	0.180		93.5%	100.0%	0.0%
#100	0.150	92.8%	92.8%	100.0%	0.0%
#140	0.106		90.5%	100.0%	0.0%
#170	0.090		89.7%	100.0%	0.0%
#200	0.075	88.9%	88.9%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2781
Sample ID: TP-15-14 B-1
Source: 1.0'
Specifications: No Specs

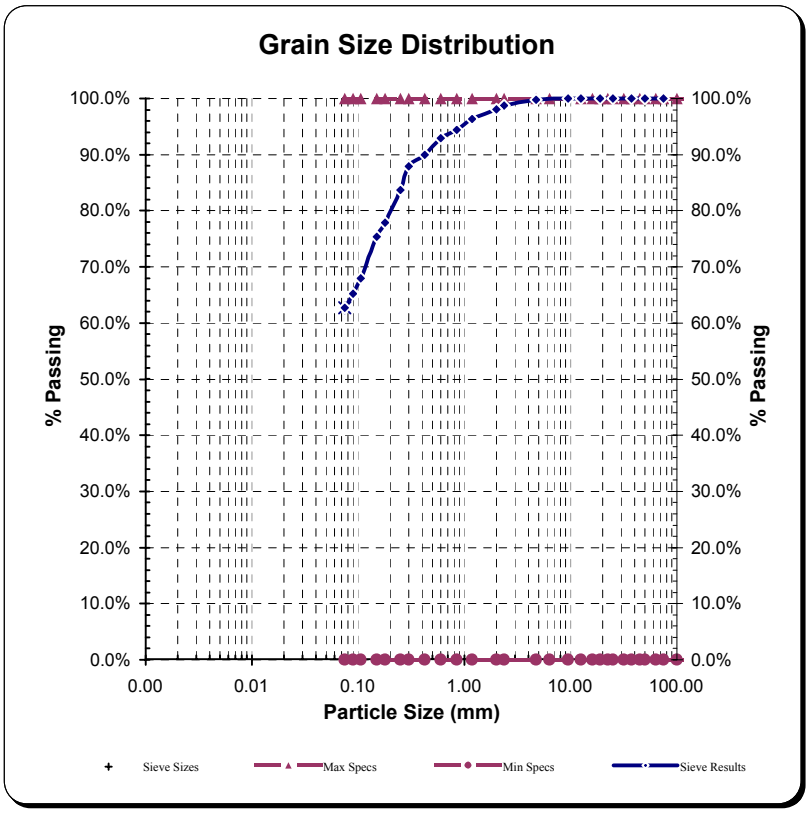
$D_{(10)}$= 0.012 mm
$D_{(30)}$= 0.036 mm
$D_{(60)}$= 0.072 mm
Liquid Limit= n/a

% Gravel = 0.2%
% Sand = 37.1%
% Silt & Clay = 62.7%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.50
Coeff. of Uniformity, C_U = 6.00
Fineness Modulus= 0.49
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50		100.0%	100.0%	0.0%
1.00"	25.00		100.0%	100.0%	0.0%
3/4"	19.00		100.0%	100.0%	0.0%
1/2"	12.50		100.0%	100.0%	0.0%
3/8"	9.50	100.0%	100.0%	100.0%	0.0%
#4	4.75	99.8%	99.8%	100.0%	0.0%
#8	2.360	98.7%	98.7%	100.0%	0.0%
#10	2.000		98.0%	100.0%	0.0%
#16	1.180	96.4%	96.4%	100.0%	0.0%
#20	0.850		94.4%	100.0%	0.0%
#30	0.600	92.9%	92.9%	100.0%	0.0%
#40	0.425		90.0%	100.0%	0.0%
#50	0.300	87.9%	87.9%	100.0%	0.0%
#60	0.250		83.7%	100.0%	0.0%
#80	0.180		77.9%	100.0%	0.0%
#100	0.150	75.4%	75.4%	100.0%	0.0%
#140	0.106		67.9%	100.0%	0.0%
#170	0.090		65.2%	100.0%	0.0%
#200	0.075	62.7%	62.7%	100.0%	0.0%
Silts	0.074	#N/A	#N/A	100.0%	0.0%
	0.050	#N/A	#N/A	100.0%	0.0%
	0.020	#N/A	#N/A	100.0%	0.0%
Clays	0.005	#N/A	#N/A	100.0%	0.0%
	0.002	#N/A	#N/A	100.0%	0.0%
Colloids	0.001	#N/A	#N/A	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



GeoTek, Inc.
320 East Corporate Drive Suite 300 Meridian, ID 83642-3511
(208) 888-7010 Office (208) 888-7924 Fax www.geotekusa.com

ASTM D-422: Particle-Size Analysis of Soils

Project Name: Schaake Habitat Improvement
Date Received: 11/17/2014
Sample #: 2782
Sample ID: TP-15-14 B-2
Source: 3.0'
Specifications: No Specs
USCS Soil Classification: SM, Silty Sand with Gravel

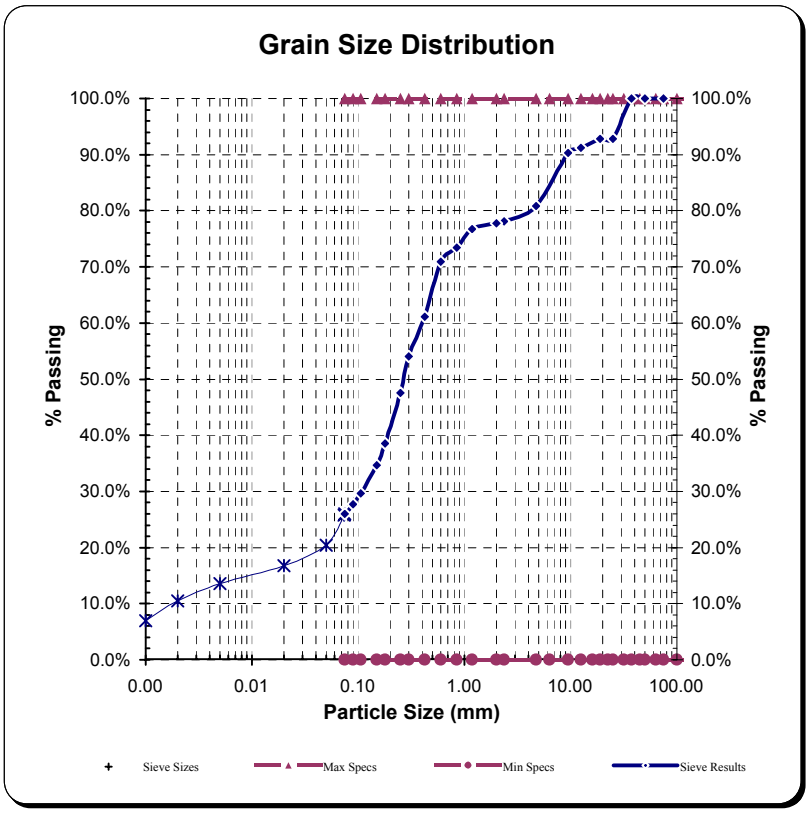
$D_{(10)}$= 0.029 mm
$D_{(30)}$= 0.109 mm
$D_{(60)}$= 0.406 mm
Liquid Limit= n/a

% Gravel = 19.1%
% Sand = 54.8%
% Silt & Clay = 26.0%
Plastic Limit= n/a

Coeff. of Curvature, C_C = 1.02
Coeff. of Uniformity, C_U = 14.10
Fineness Modulus= 2.21
Plasticity Index= n/a

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
3.00"	75.00		100.0%	100.0%	0.0%
2.00"	50.00		100.0%	100.0%	0.0%
1.50"	37.50	100.0%	100.0%	100.0%	0.0%
1.00"	25.00	92.8%	92.8%	100.0%	0.0%
3/4"	19.00	92.8%	92.8%	100.0%	0.0%
1/2"	12.50	91.2%	91.2%	100.0%	0.0%
3/8"	9.50	90.4%	90.4%	100.0%	0.0%
#4	4.75	80.9%	80.9%	100.0%	0.0%
#8	2.360		78.1%	100.0%	0.0%
#10	2.000		77.7%	100.0%	0.0%
#16	1.180	76.8%	76.8%	100.0%	0.0%
#20	0.850		73.5%	100.0%	0.0%
#30	0.600	70.9%	70.9%	100.0%	0.0%
#40	0.425		61.1%	100.0%	0.0%
#50	0.300	54.0%	54.0%	100.0%	0.0%
#60	0.250		47.6%	100.0%	0.0%
#80	0.180		38.5%	100.0%	0.0%
#100	0.150	34.7%	34.7%	100.0%	0.0%
#140	0.106		29.6%	100.0%	0.0%
#170	0.090		27.8%	100.0%	0.0%
#200	0.075	26.0%	26.0%	100.0%	0.0%
Silts	0.074	25.8%	25.8%	100.0%	0.0%
	0.050	20.4%	20.4%	100.0%	0.0%
	0.020	16.7%	16.7%	100.0%	0.0%
Clays	0.005	13.6%	13.6%	100.0%	0.0%
	0.002	10.5%	10.5%	100.0%	0.0%
Colloids	0.001	6.9%	6.9%	100.0%	0.0%

Copyright Spears Engineering & Technical Services PS, 1996-2003



Appendix C
Seismic Velocity Survey Memorandum

November 16, 2014

RE: SEISMIC VELOCITY SURVEY USBR - SCHAAKE HABITAT IMPROVEMENT PROJECT PHASE 2

Shear Wave Velocity Survey

Multichannel Analysis of Surface Waves (MASW) uses the dispersive characteristics of surface waves to determine the variation of shear wave velocity with depth. Data are acquired by analyzing seismic surface waves generated by an impulsive source and received by a linear array of geophones. A dispersion curve is calculated from the data that shows the phase velocity of the surface waves as a function of frequency or wavelength. A shear wave velocity profile, or 1-D sounding of velocity as a function of depth, is then modeled from the dispersion curve. The resulting shear wave soundings at multiple locations along a survey line are combined and contoured to generate a 2-D cross-section of shear wave velocity.

Approximately 2,250 feet of shear wave MASW profile were acquired. Sage Earth Science used a 24-channel engineering seismograph and 16 pound sledge hammer or 8-guage blank in a shallow hole to perform the acoustic travel time measurements. The survey was designed for a maximum depth of investigation of 100 feet depending on the subsurface conditions. Profiles of the seismic shear wave velocity were prepared.

Figure 1 Weight drop source.

P-wave refraction survey

Given a physical setting of increasing density with depth, and by measuring the travel time of a compression wave (*p-wave*) between known points, the seismic refraction method can be used to determine the depth to a refracting horizon(s), the seismic velocity of the refracting horizon(s), as well as thickness and velocities of the overlying materials. Approximately 2,250 feet of p-wave refraction profile were acquired. Data were acquired in accordance with ASTM standard, **ASTM D 5777-00** *Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation*

Sage Earth Science used a 24-channel engineering seismograph and 16 pound sledge hammer or 8-guage blank in a shallow hole to perform the acoustic travel time measurements. The survey was designed for a maximum depth of investigation of 100 feet depending on the subsurface conditions. Profiles of the seismic compression wave velocity were prepared.

In each case, a single seismic field record is used for the shear wave and compression wave refraction data reduction using the following recording parameters.

2184 Channing Way, Suite 110, Idaho Falls, ID 83404
telephone: (208)522-5049, Fax: (208)528-6200, email: sageearthscience@yahoo.com
http://www.sageearthscience.com

Table 1 Seismic Survey recording parameters

recording instrument	Bison 9024 s/n 6-93913
geophone	Mark products – 4.5 hz. vertical
Geophone/station spacing	16.4 feet (5 meters)
number of channels	24
sample rate	0.5 millisecond
number of samples	4,000
record length	2.0 seconds
low pass filter	120 Hz.
low cut filter	4 Hz.
seismic source	16 pound sledge hammer or 8 gauge blank
source locations	Channels 1,10,15,20, and 24
MASW shear wave velocities	Multichannel Analysis of Surface Wave (MASW) SurfSeis™ Geometrics
P-wave refraction	Tomographic travel time inversion. PlotRefra™ Geometrics

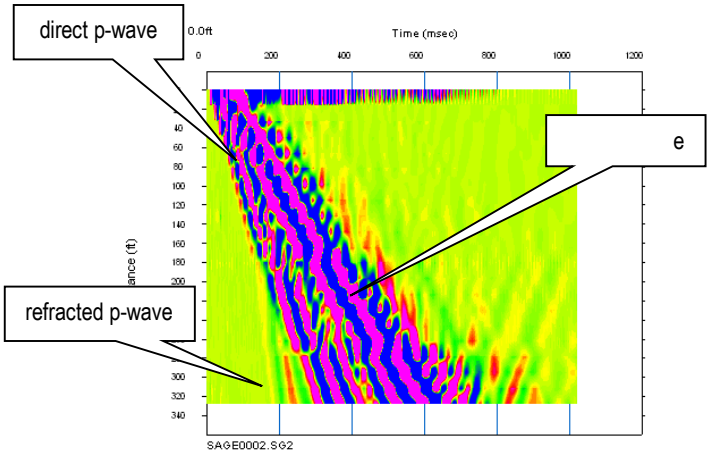


Figure 2. Typical field record

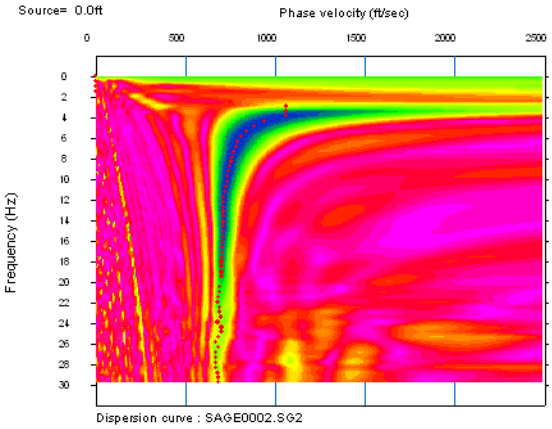


Figure #3. Phase vs. velocity plot

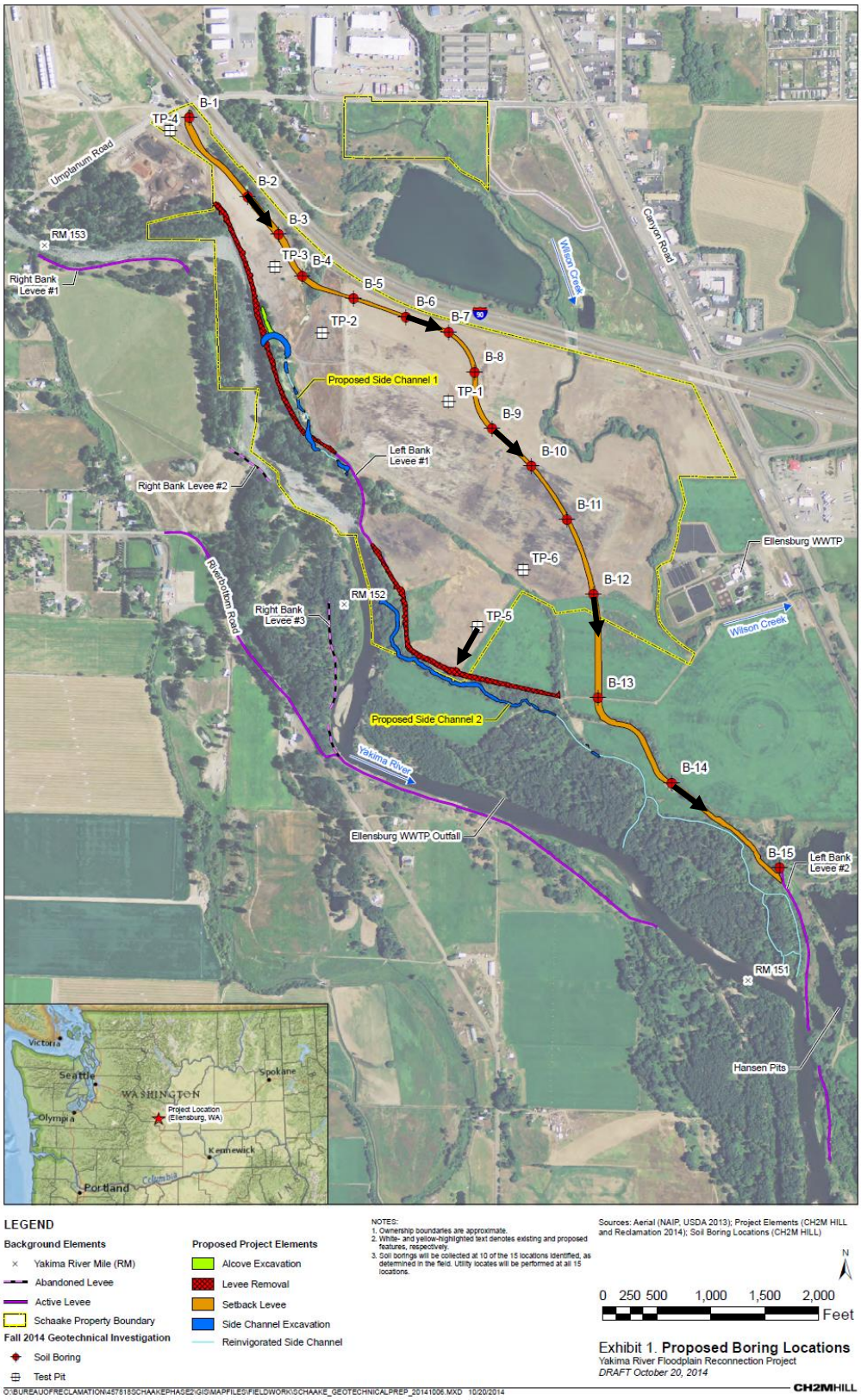


Figure 4. Profile location/orientation map *(locations and scales approximate)*

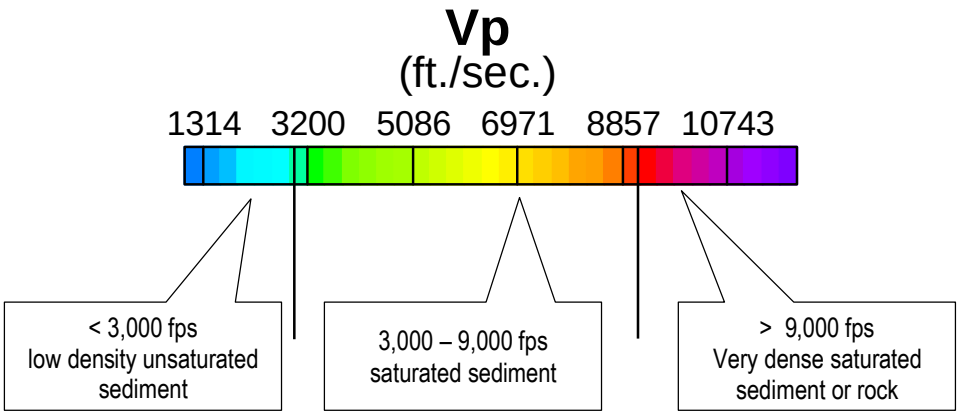
Discussion

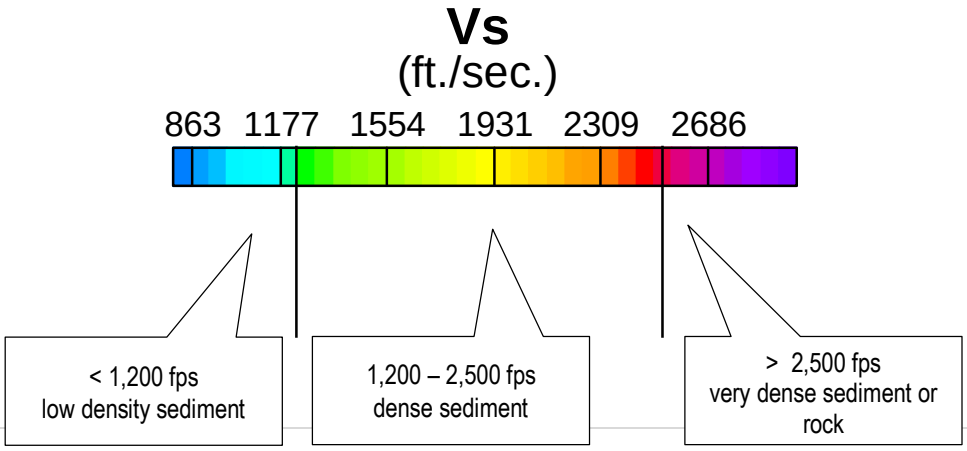
The following figures show the compression and shear wave velocity at the profile locations shown in figure 4.

The compression wave refraction velocities mapped across the site are characterized by three zones. At the surface is a low velocity zone (<3,000 fps). This material is likely unsaturated sediments. Beneath the surface zone is the water table or saturated sediments (3,000-9,000 fps). The underlying refractor exhibits a velocity greater than 9,000 fps indicating a very dense saturated sediment or rock.

The shear wave velocity values found across the site are generally high. The velocity of the very near surface materials range from 600 to 1,200 feet per second and is not preset at some locations. Beneath the surface is a moderate to high velocity zone, 1,200-2,500 fps, indicative of a stiff sediment or soft rock. The deep zone exhibits a velocity greater than 2,500 fps suggesting extremely stiff sediment or rock.

The following figures show range of compression and shear wave velocities as encountered at the project site. Descriptions are based on general descriptions. Because typical ranges for a given material can be broad an often overlap significantly with other materials, it is important to correlate measured velocities with material description based on boreholes and test pits.





Distances are measured in feet. Depth are reported as depth below grade in feet. Velocities are reported as feet per second. Distances are profile distance measured from field control points / boring locations in the direction as indicated in figure 4.

Quoting from the ASTM standard, **ASTM D 5777-00** *Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation*

> *The seismic refraction method provides the velocity of compressional P-waves in subsurface materials. Although the P-wave velocity can be a good indicator of the type of soil or rock, it is not a unique indicator. Table 2 shows that each type of sediment or rock has a wide range of seismic velocities, and many of these ranges significantly overlap. While the seismic refraction technique measures the seismic velocity of seismic waves in earth materials, it is the interpreter who based on knowledge of the local conditions or other data, or both, must interpret the seismic refraction data and arrive at a geologically reasonable solution*

Table 2

Material	***wave velocity Vp feet/second***
Weathered surface material	*800-2,000*
Gravel or dry sand	*1,500-3,000*
Sand (saturated)	*4,000-6,000*
Clay (saturated)	*3,000-9,000*
Sandstone	*6,000-13,000*
Shale	*9,000-14,000*
Chalk	*6,000-13,000*
Limestone	*7,000-20,000*
Granite	*15,000-19,000*
Metamorphic rock	*10,000-23,000*

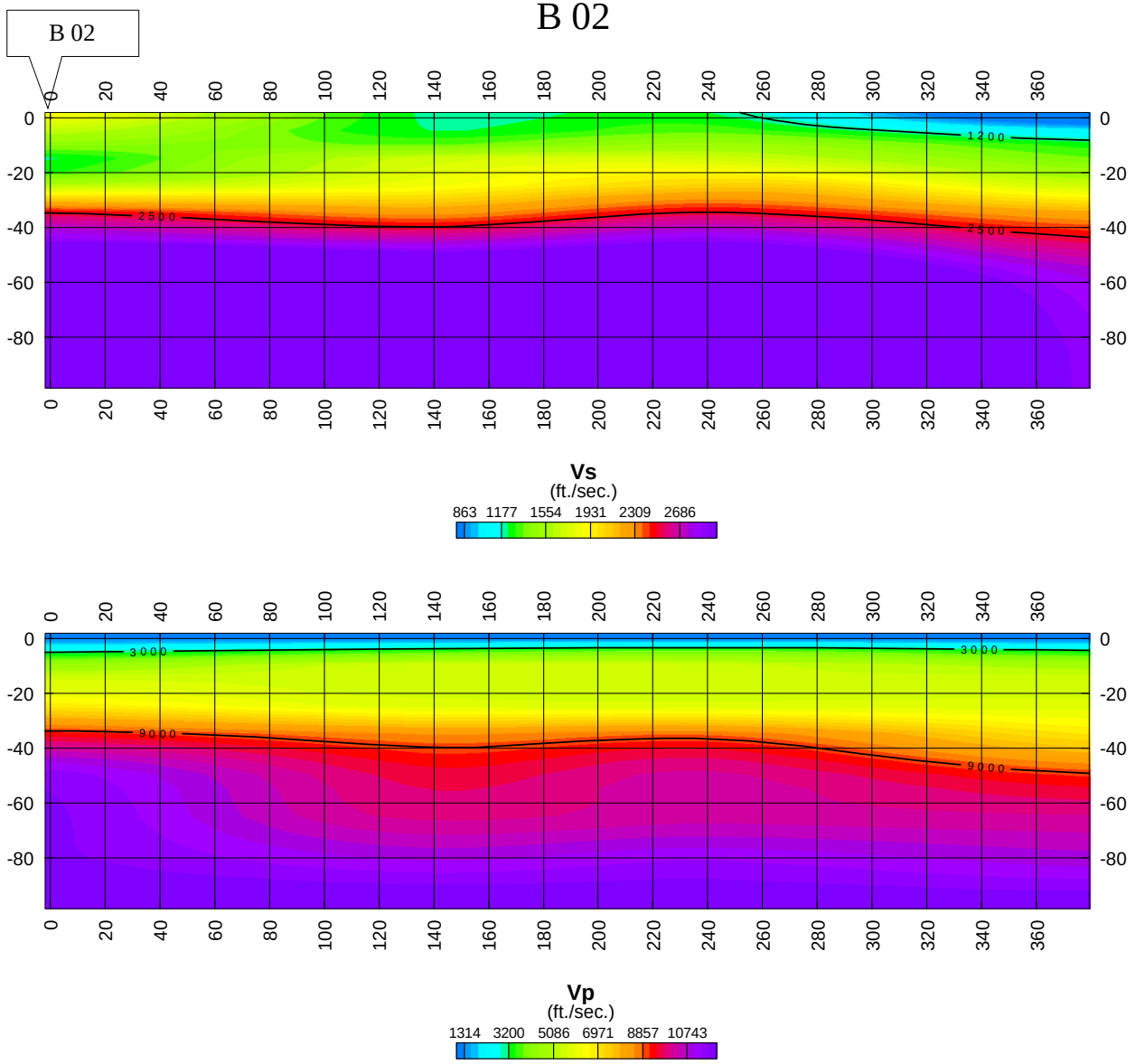
5.2.2. According to Mooney (8), P-wave velocities are generally greater for:

1. Denser rocks than lighter rocks
2. Older rocks than younger rocks
3. Igneous rocks than sedimentary rocks
4. Solid rocks than rocks with crack and fractures
5. Unweathered rocks than weathered rocks
6. Consolidated sediments than unconsolidated sediments
7. Water saturated rocks/sediments than unsaturated rocks/sediments
8. Wet soils than dry soils

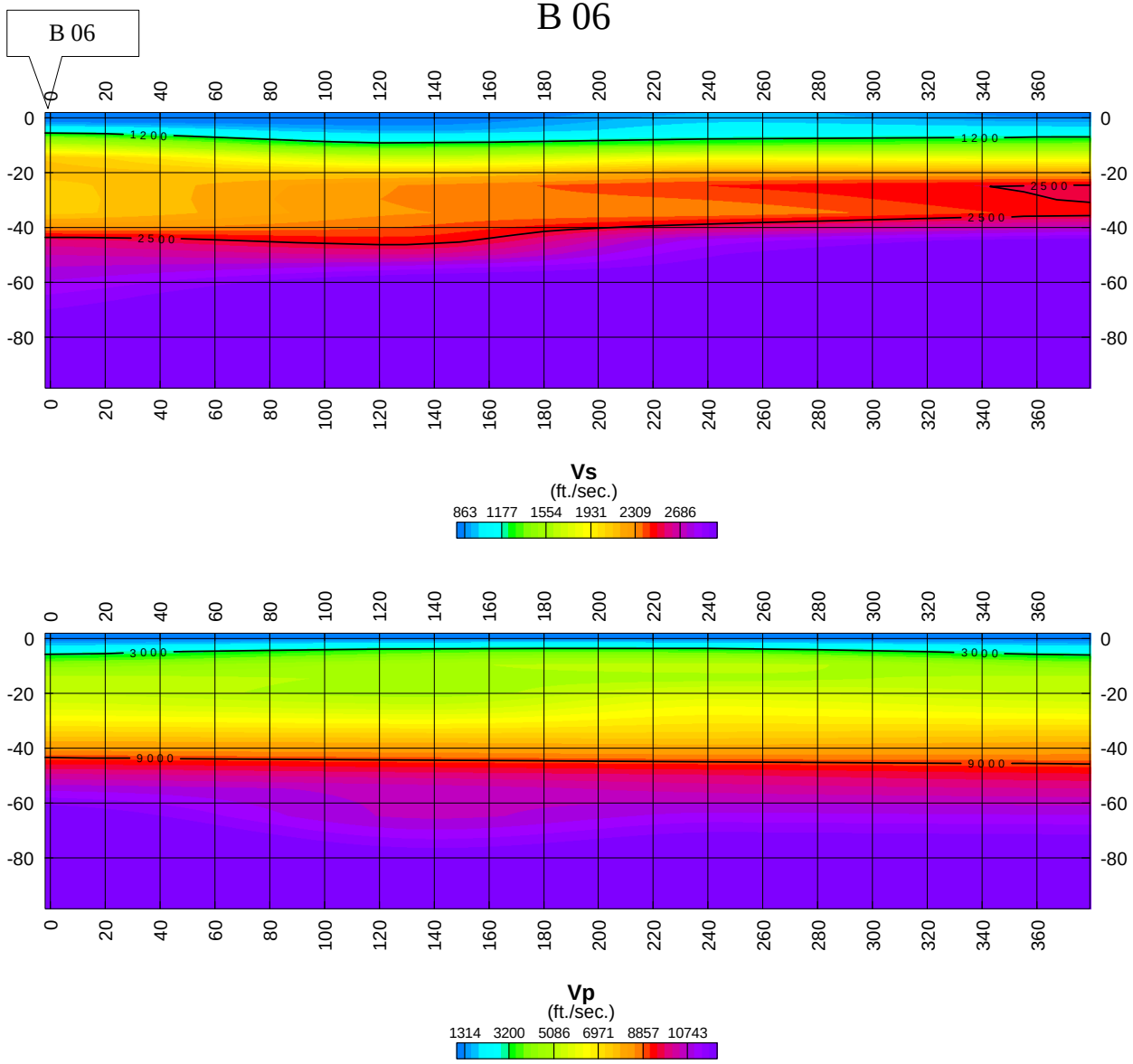
Shear waves typically propagate about 60 percent of the p-wave velocity. Quoting from the National Earthquake Hazards Reduction Program (NEHRP), geologic materials are classified as follows. Significantly, the shear wave velocity is largely unaffected by the degree of water saturation.

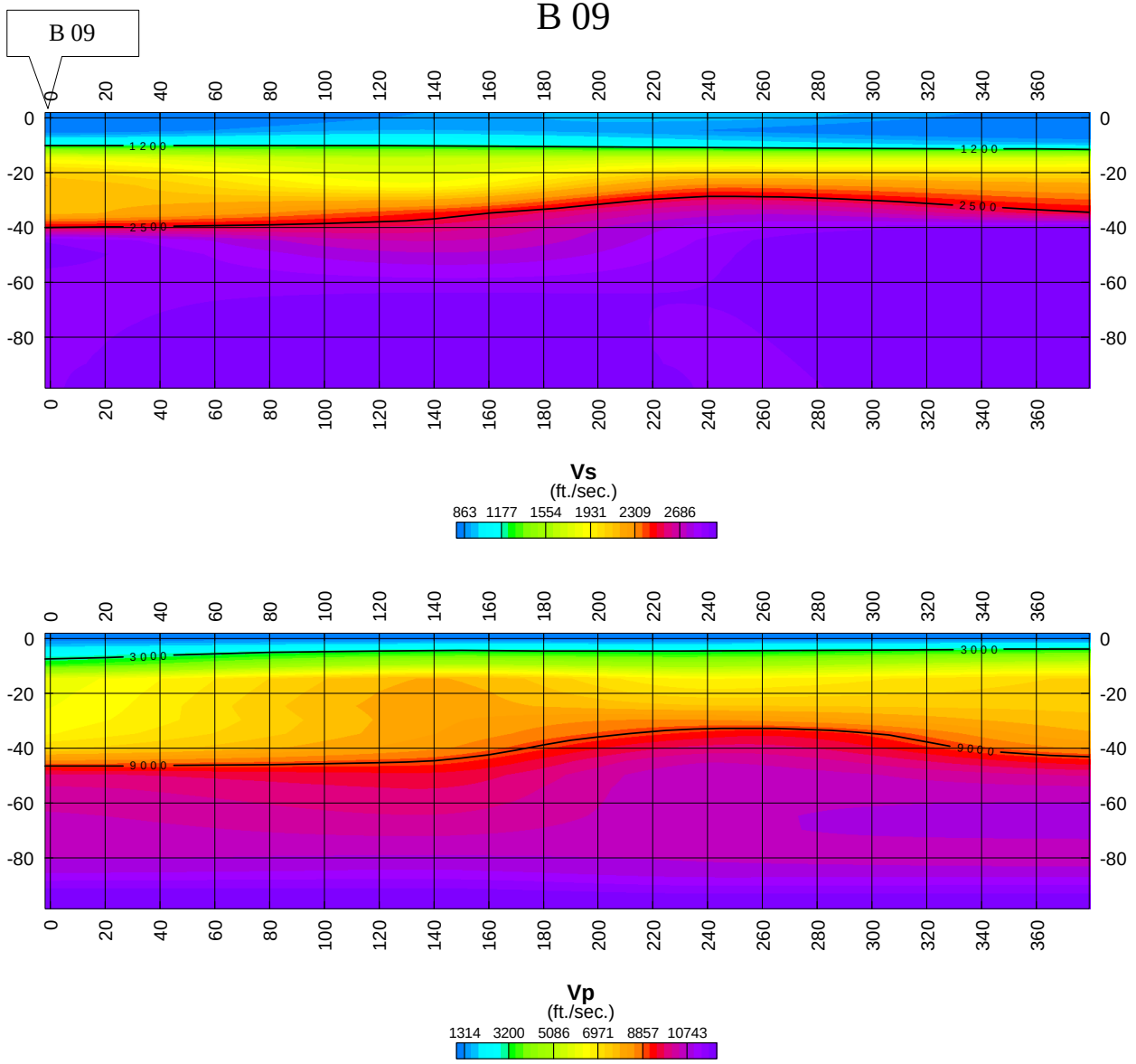
Table 3. Site categories in NEHRP Provisions (Martin, 1994)

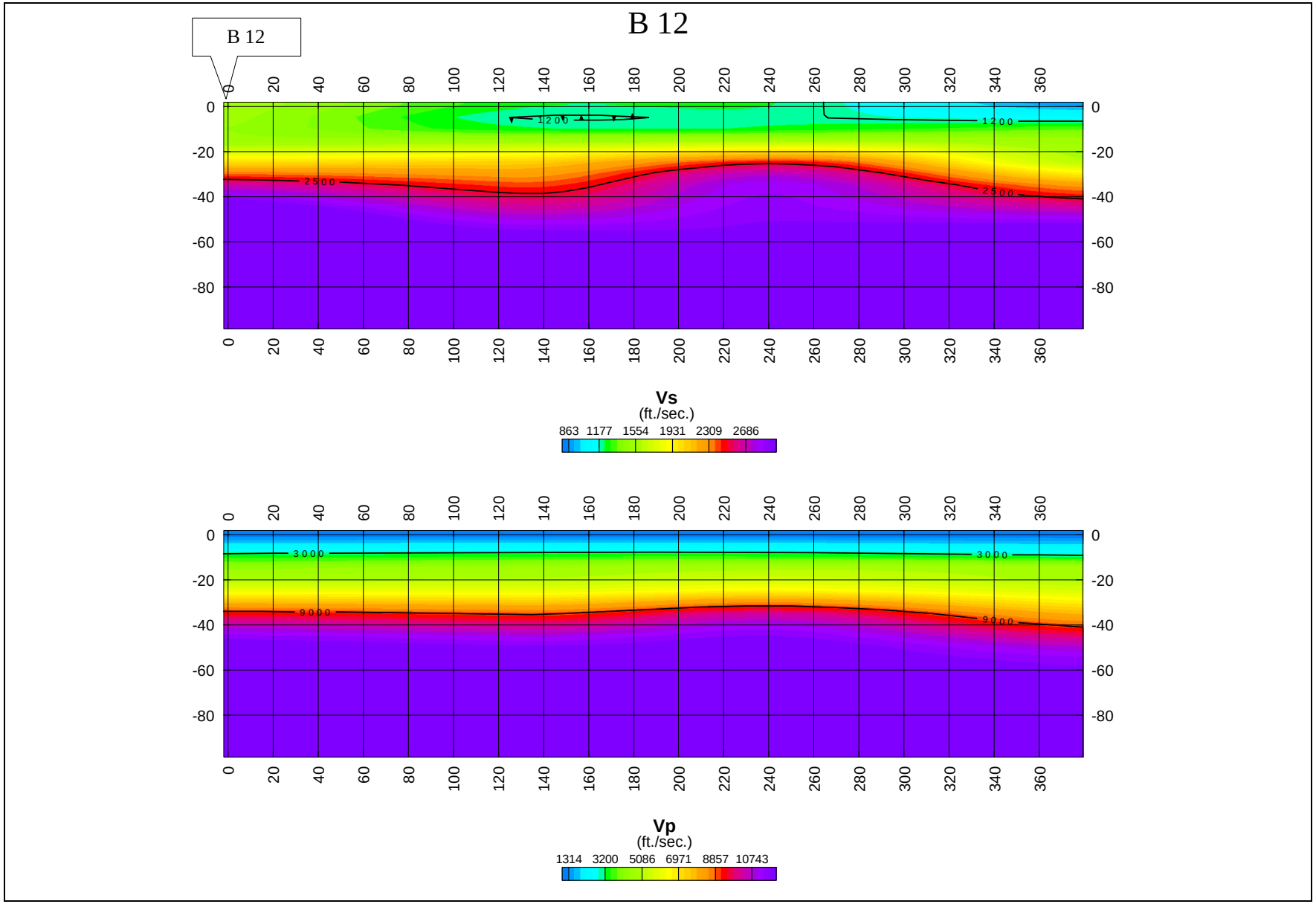
Material	***wave velocity Vs feet/second***
Hard rock	*>5,000*
Firm to hard rock	*2,500 – 5,000*
Dense soil, soft rock	*1,200 - 2,500*
Stiff soil	*600 - 1,200*
Soft clays	*< 600*

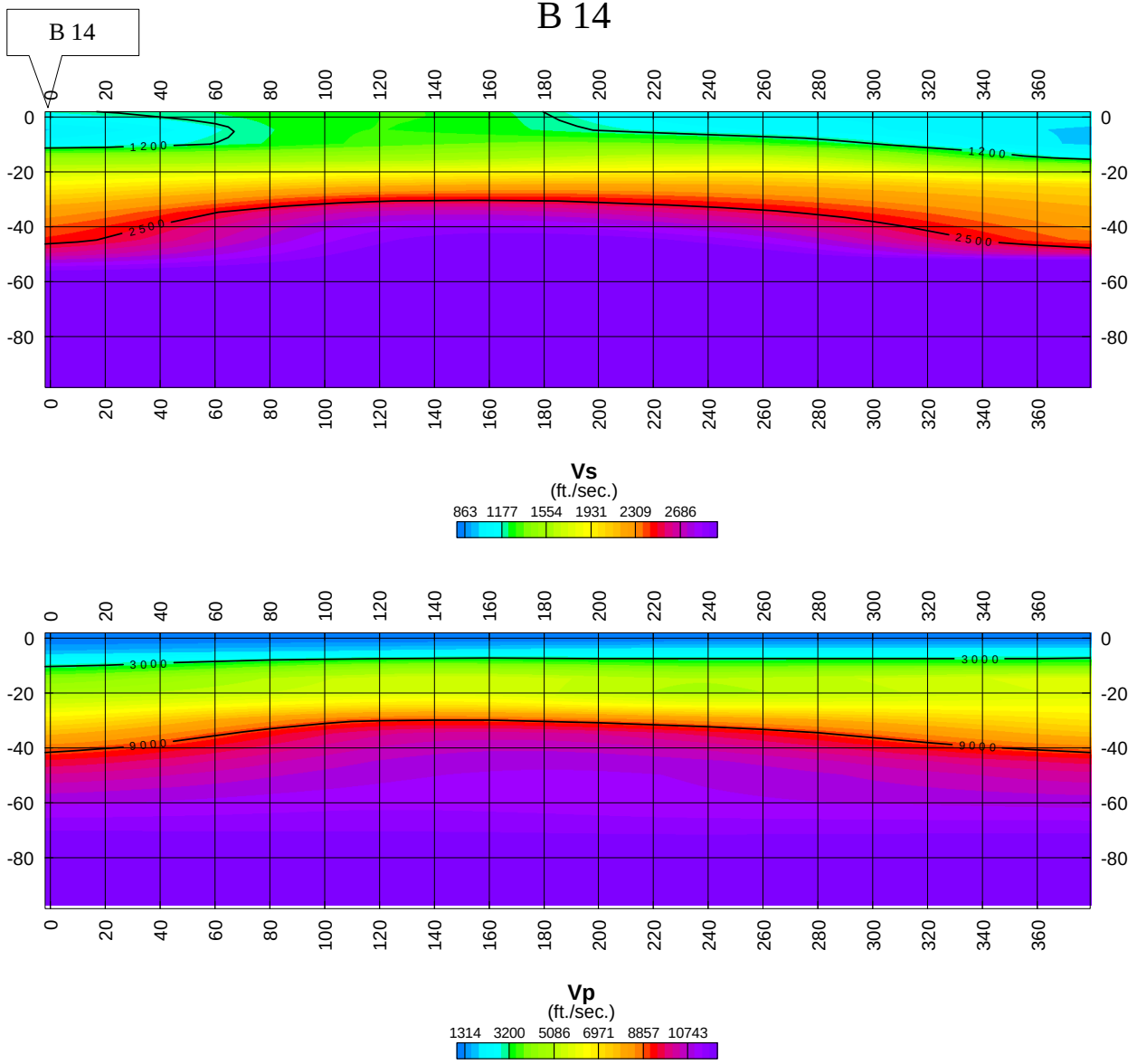

B 02
B 02
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743

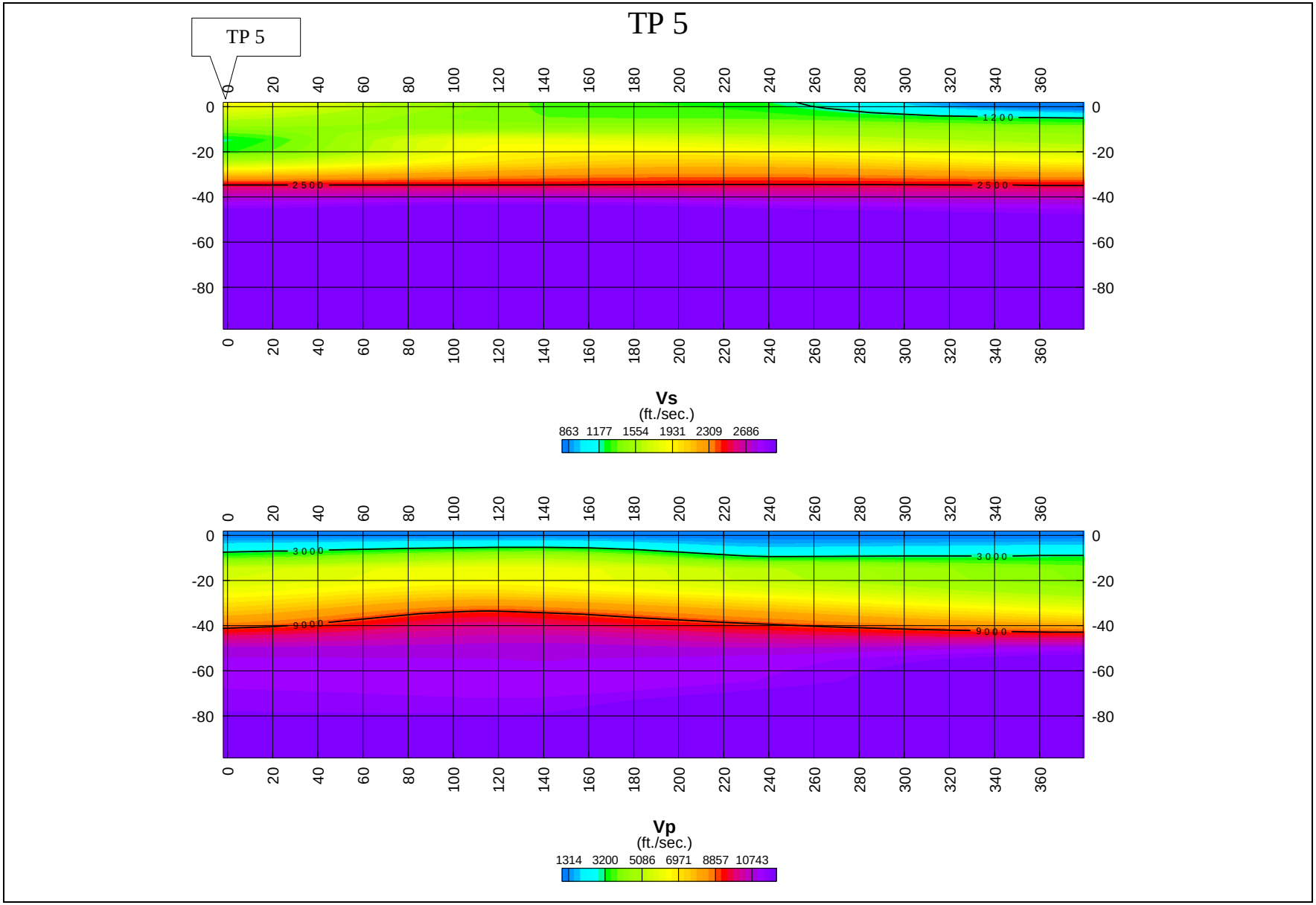
B 06


B 06
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743

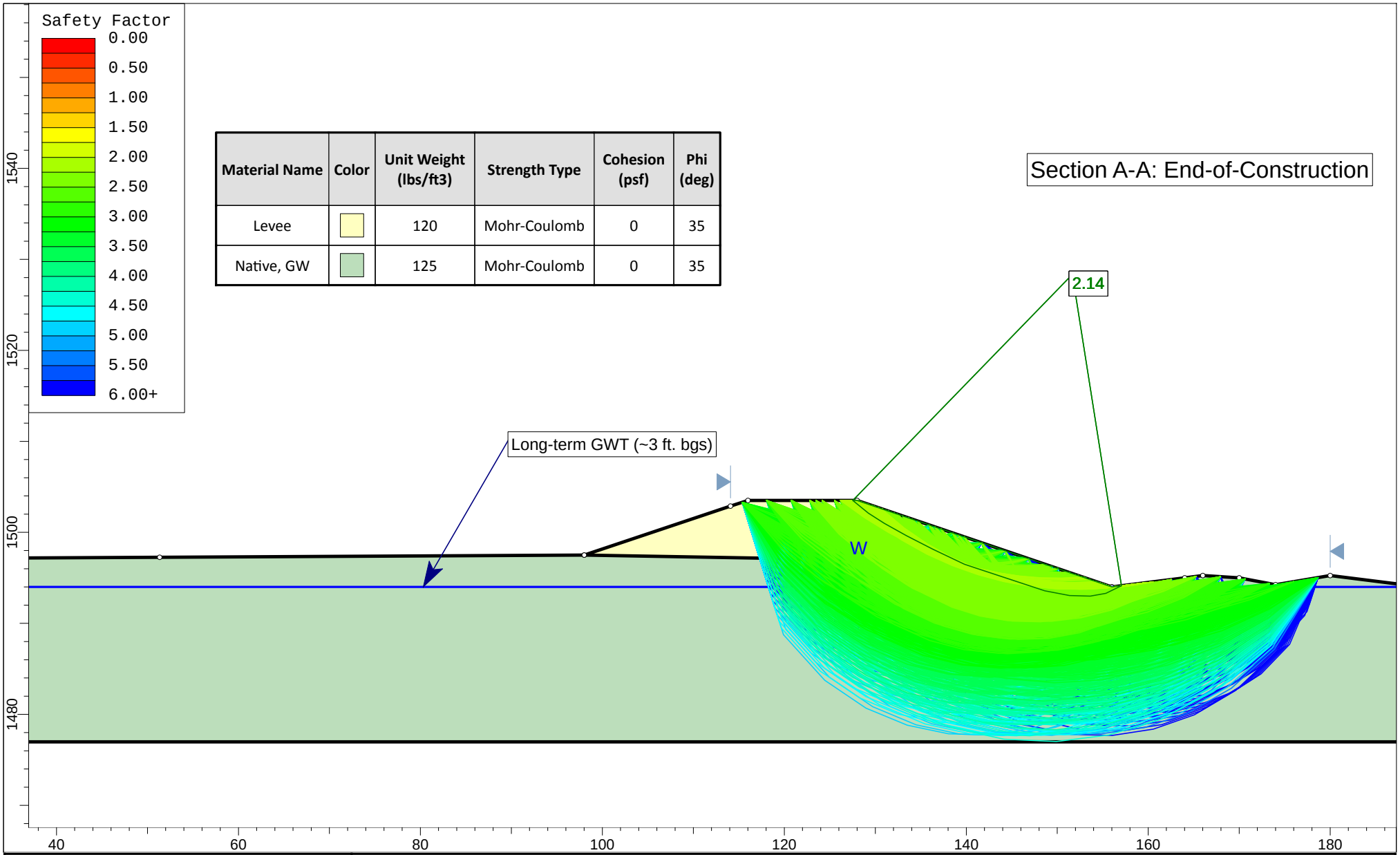

B 09
B 09
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743


B 12
B 12
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743


B 14
B 14
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743


TP 5
TP 5
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
0 -20 -40 -60 -80
1200
2500
Vs
(ft./sec.)
863 1177 1554 1931 2309 2686
3000
9000
Vp
(ft./sec.)
1314 3200 5086 6971 8857 10743

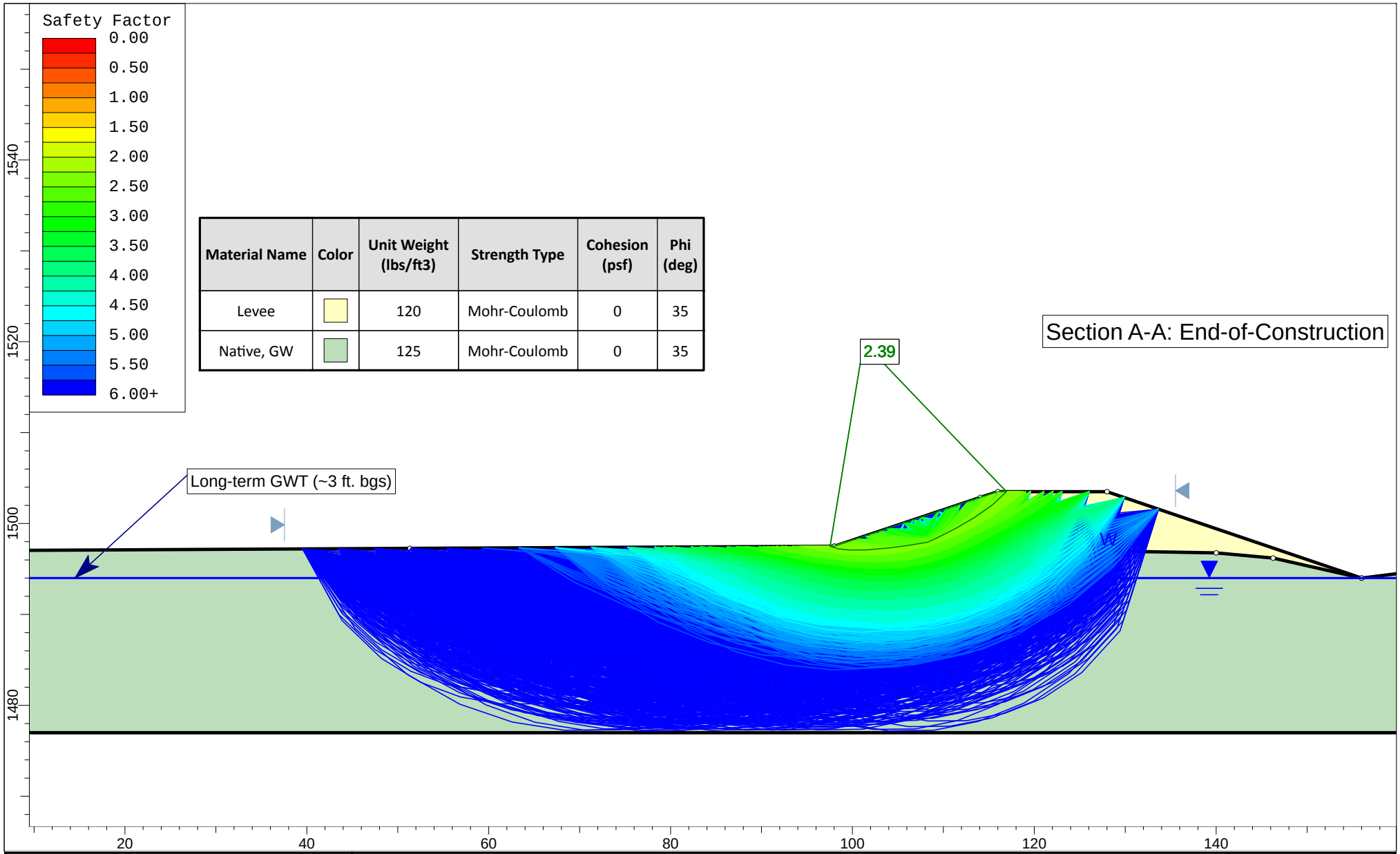
Appendix D
Geotechnical Analyses Summary Plots



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, GW		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

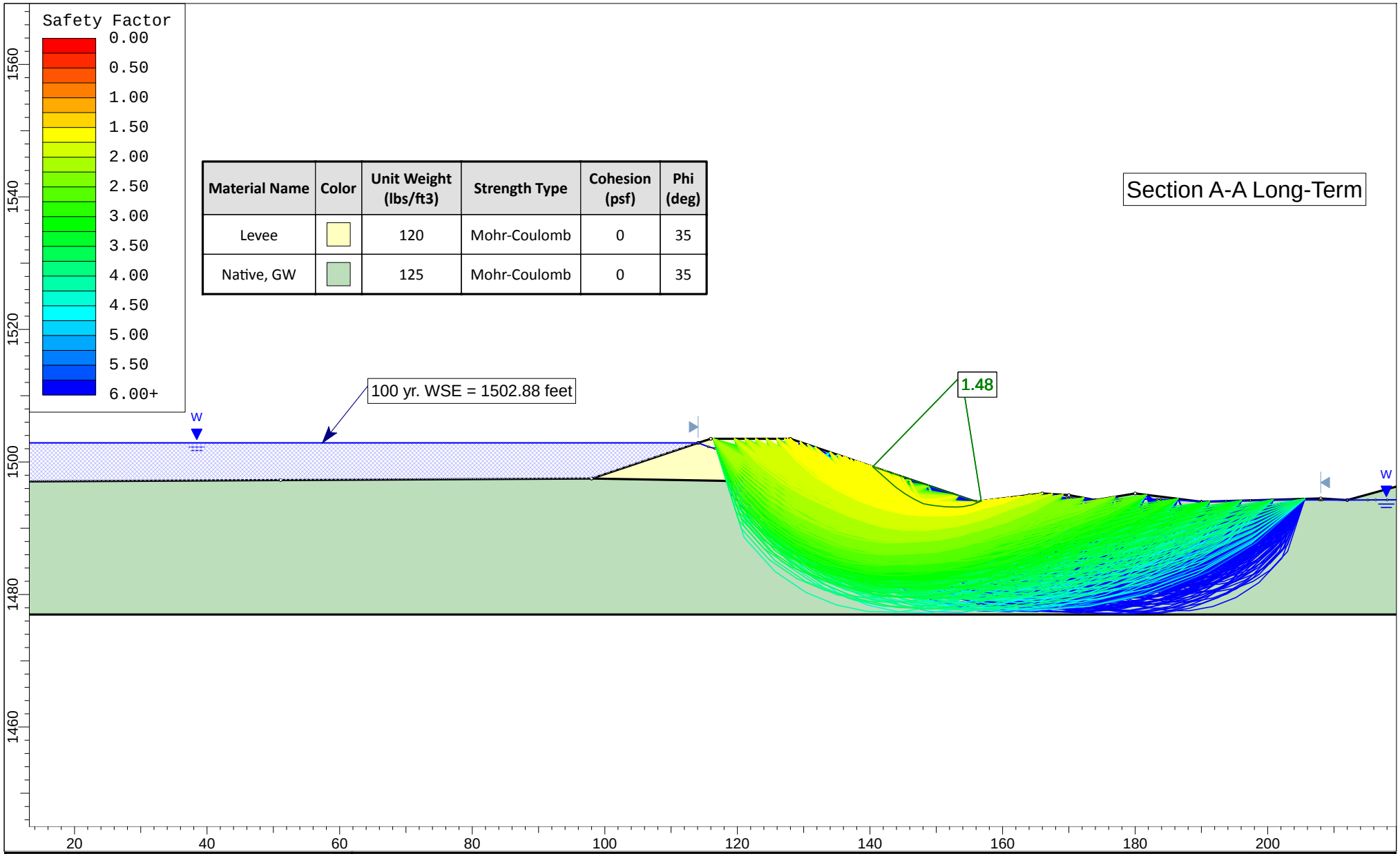
Project	Schaake Setback Levee: Section A-A		
Analysis Description	End-of-Construction Stability		
Drawn By	T. Kraupa	*Scale* 1:175	*Company* CH2M HILL Inc.
Date	10/10/2015		*File Name* Section A-A_eoc_landside.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, GW		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

Project	Schaake Setback Levee: Section A-A		
Analysis Description	End-of-Construction Stability		
Drawn By	T. Kraupa	Scale	1:175
Company	CH2M HILL Inc.		
Date	10/10/2015	File Name	Section A-A_eoc_waterside.slim

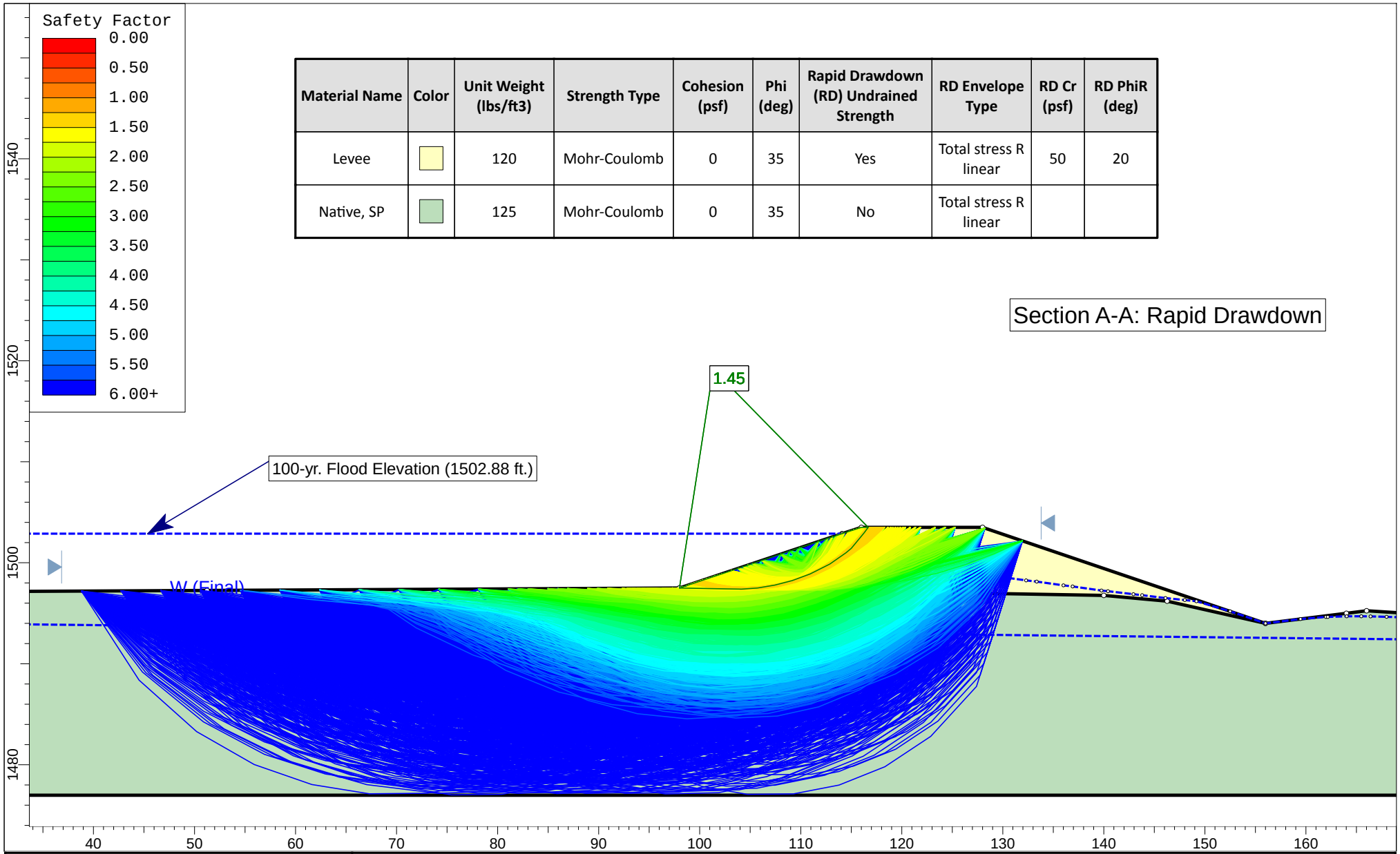


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, GW		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

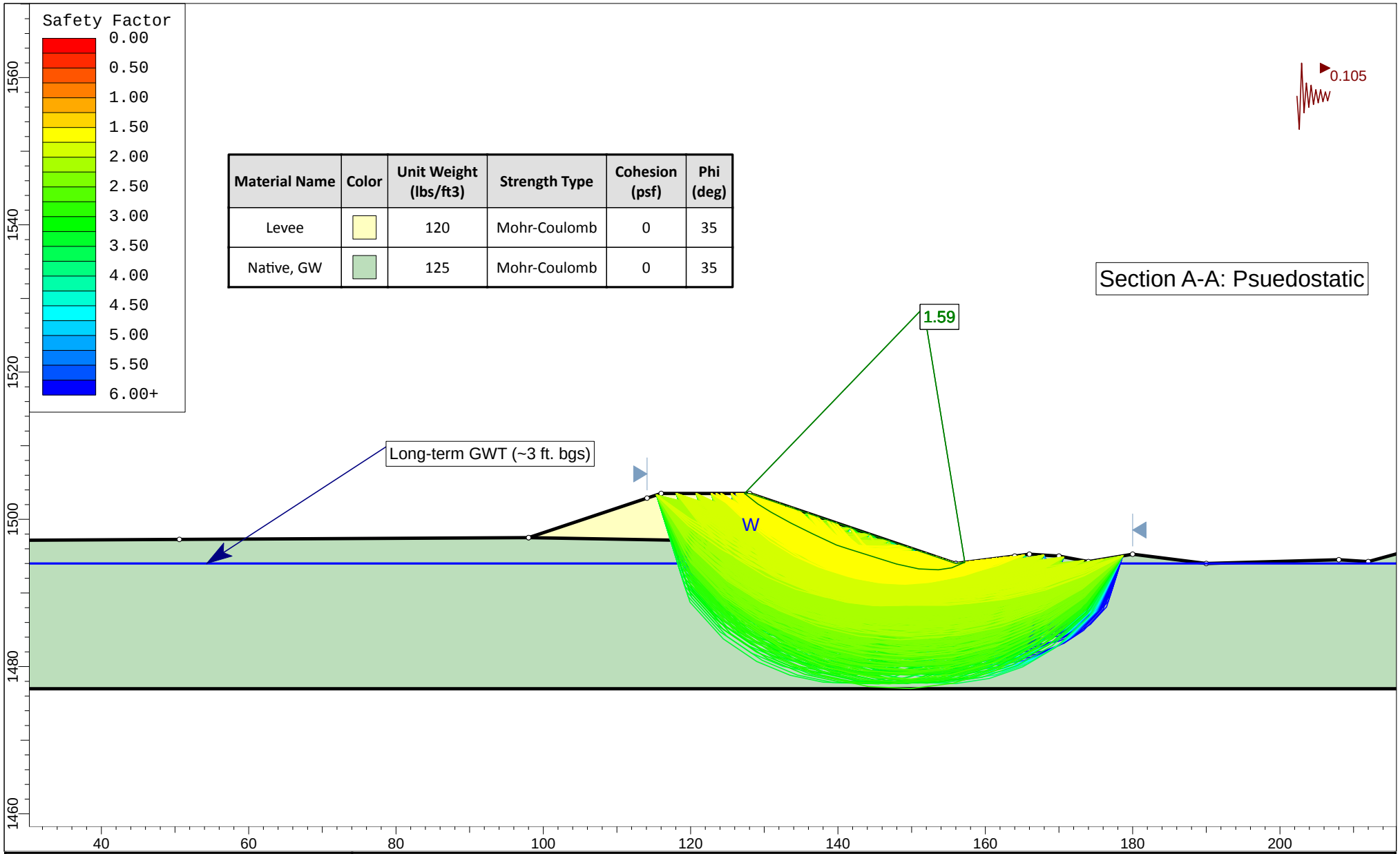
Project	Schaake Setback Levee: Section A-A		
Analysis Description	Long-term		
Drawn By	T. Kraupa	*Scale* 1:240	*Company* CH2M HILL
Date	10/10/2015		*File Name* Section A-A_steady_state_stability_landside.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Envelope Type	RD Cr (psf)	RD PhiR (deg)
Levee		120	Mohr-Coulomb	0	35	Yes	Total stress R linear	50	20
Native, SP		125	Mohr-Coulomb	0	35	No	Total stress R linear		



Project	Schaake Setback Levee: Section A-A		
Analysis Description	Rapid Drawdown		
Drawn By: T. Kraupa	Scale: 1:157	Company: CH2M HILL Inc.	
Date: 10/10/2015		File Name: Section A-A_rapid_dd_landside.slim	

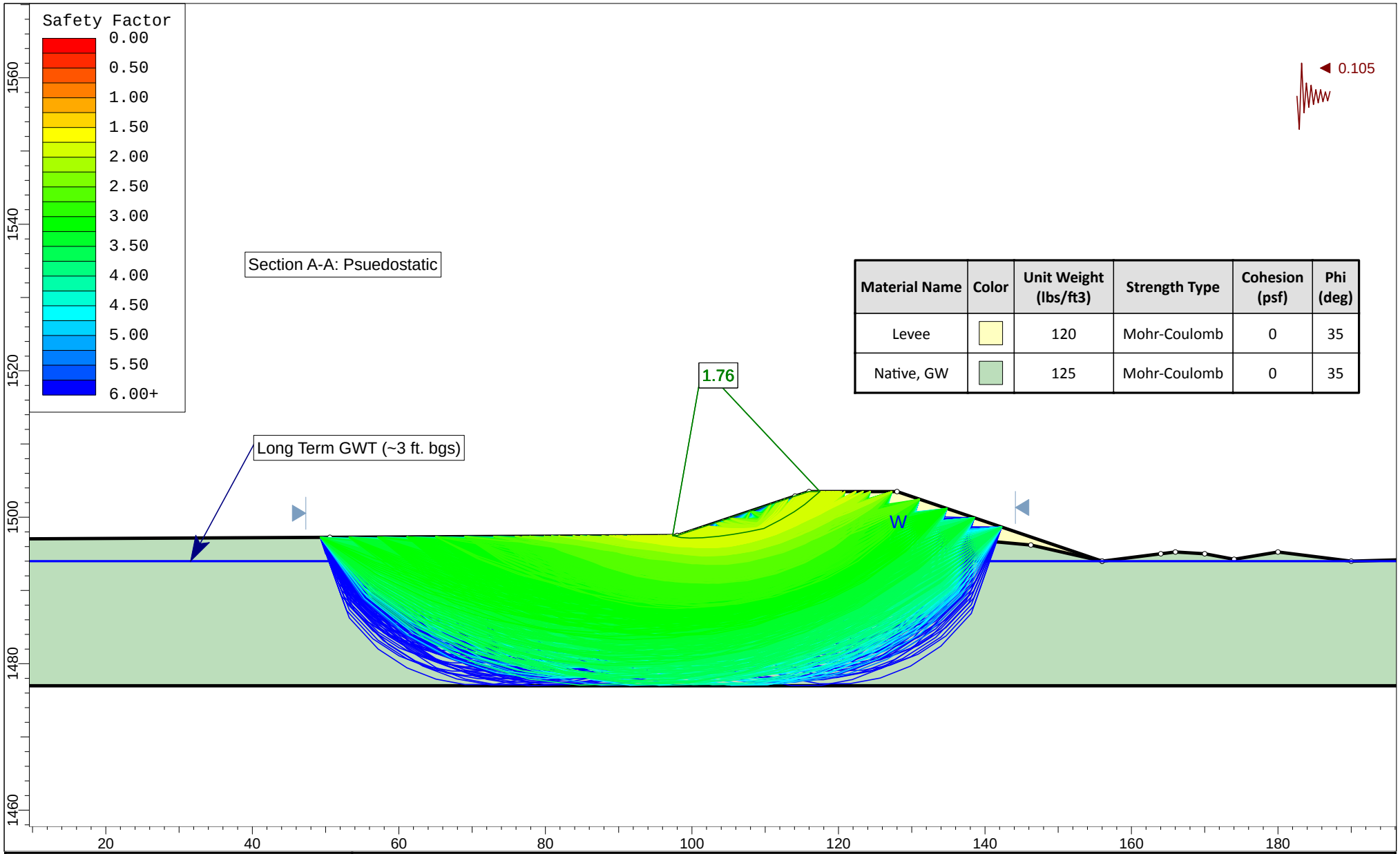
SLIDEINTERPRET 6.036



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, GW		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

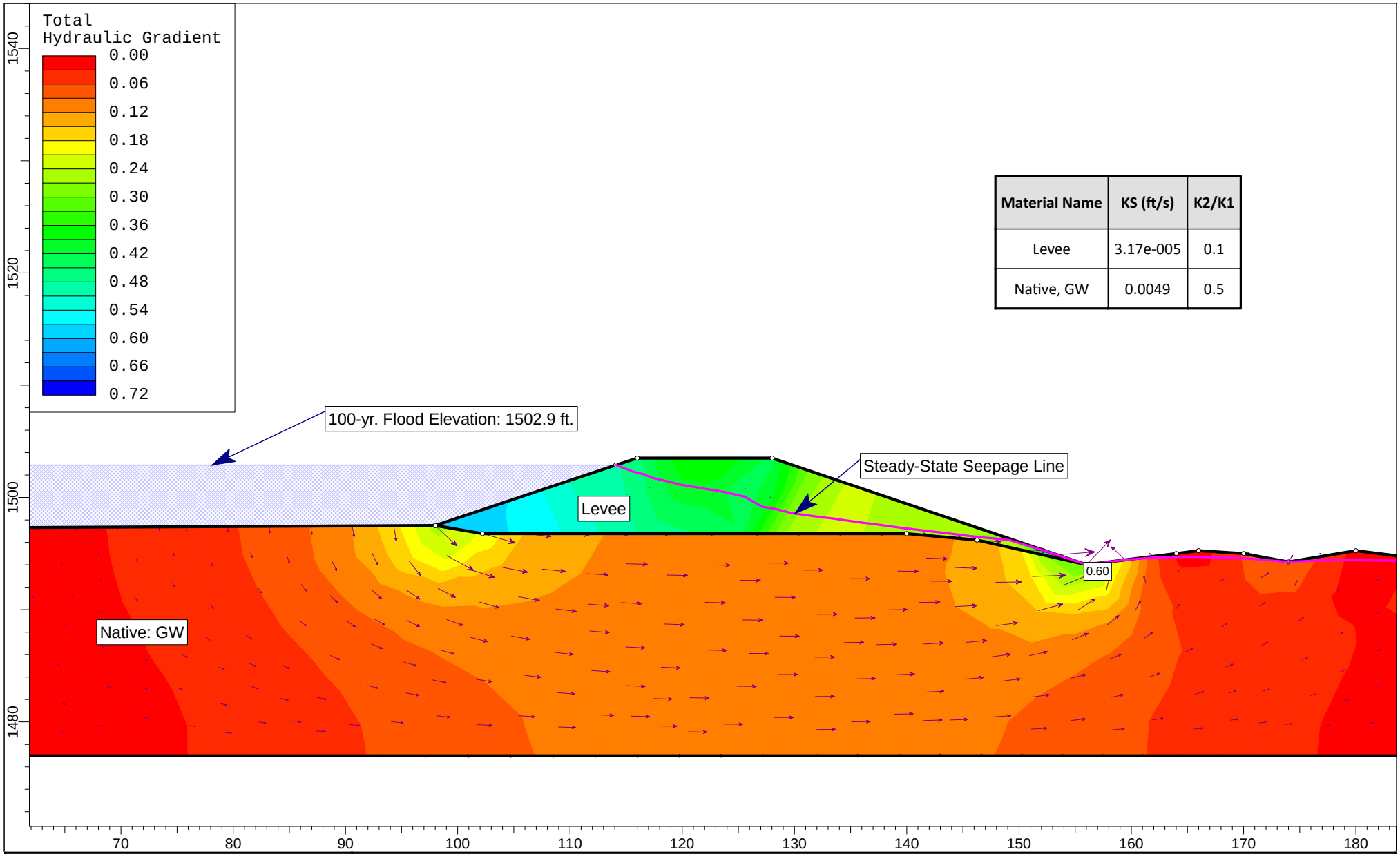
Project	Schaake Setback Levee: Section A-A		
Analysis Description	Psuedostatic		
Drawn By	T. Kraupa	*Scale* 1:216	*Company* CH2M HILL Inc.
Date	10/10/2015		*File Name* Section A-A_seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, GW		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

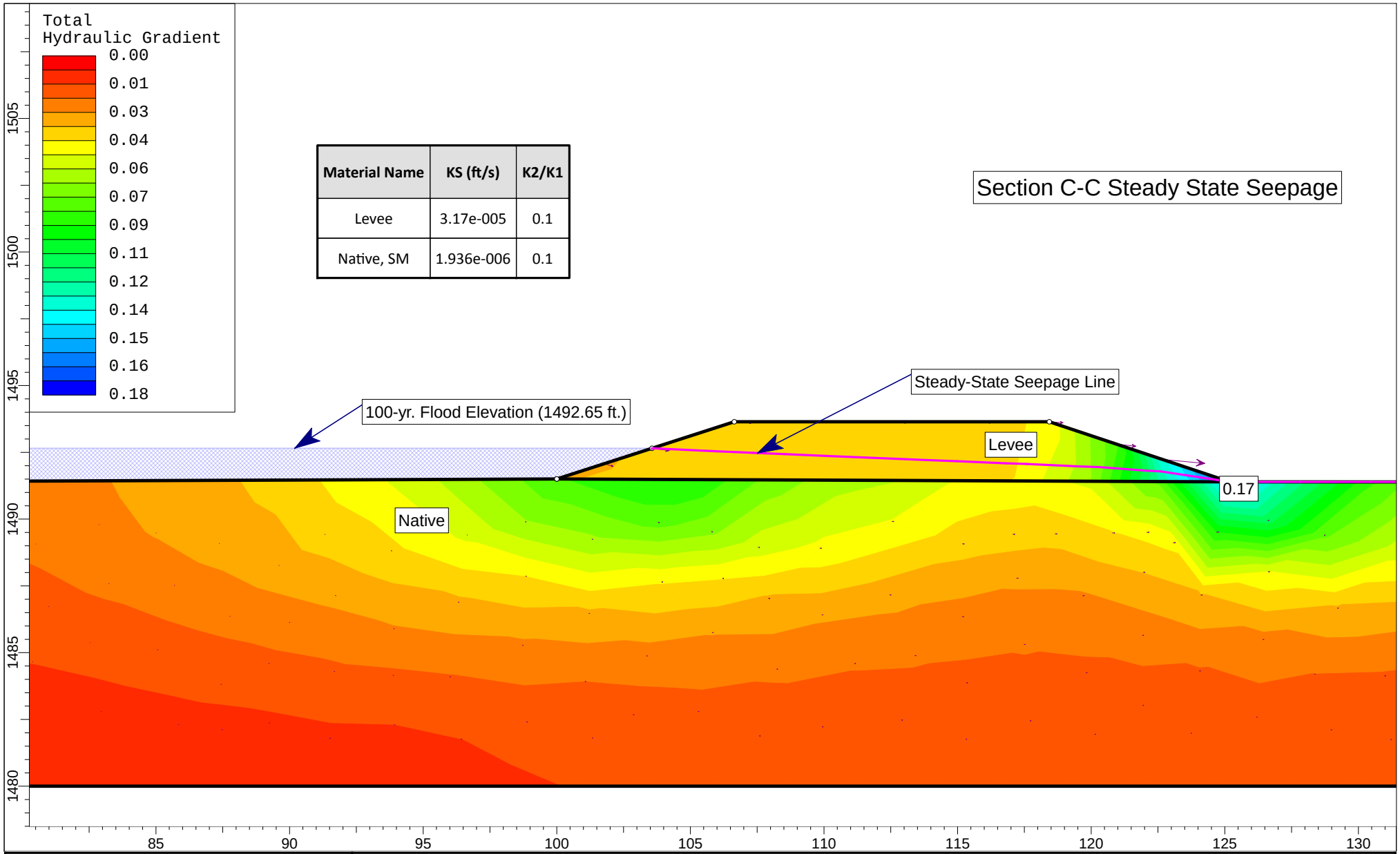
Project	Schaake Setback Levee: Section A-A		
Analysis Description	Psuedostatic		
Drawn By	T. Kraupa	Scale	1:217
Company	CH2M HILL Inc.		
Date	10/10/2015	File Name	Section A-A_seismic_riverside.slim



Material Name	KS (ft/s)	K2/K1
Levee	3.17e-005	0.1
Native, GW	0.0049	0.5

Project	Schaake Setback Levee: Section A-A		
Analysis Description	Steady State Seepage		
Drawn By: T. Kraupa	Scale: 1:142	Company: CH2M HILL Inc.	
Date: 10/10/2015		File Name: Section A-A_steady state.slim	

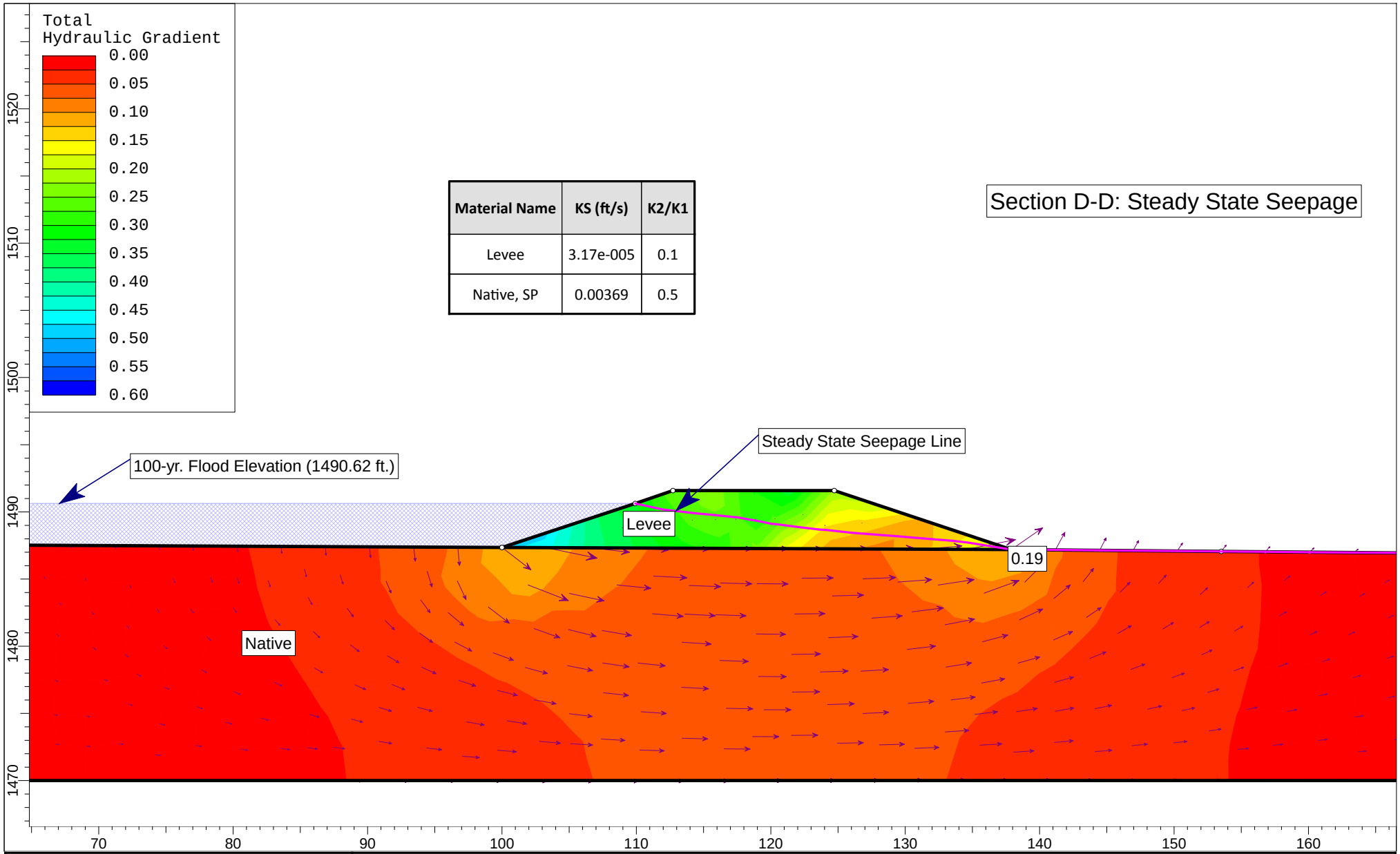
SLIDEINTERPRET 6.036



Material Name	KS (ft/s)	K2/K1
Levee	3.17e-005	0.1
Native, SM	1.936e-006	0.1

Project	Schaake Setback Levee: Section C-C		
Analysis Description	Steady State Seepage		
Drawn By: T. Kraupa	Scale: 1:60	Company: CH2M HILL Inc.	
Date: 10/11/15		File Name: Section C-C_steady state.slim	

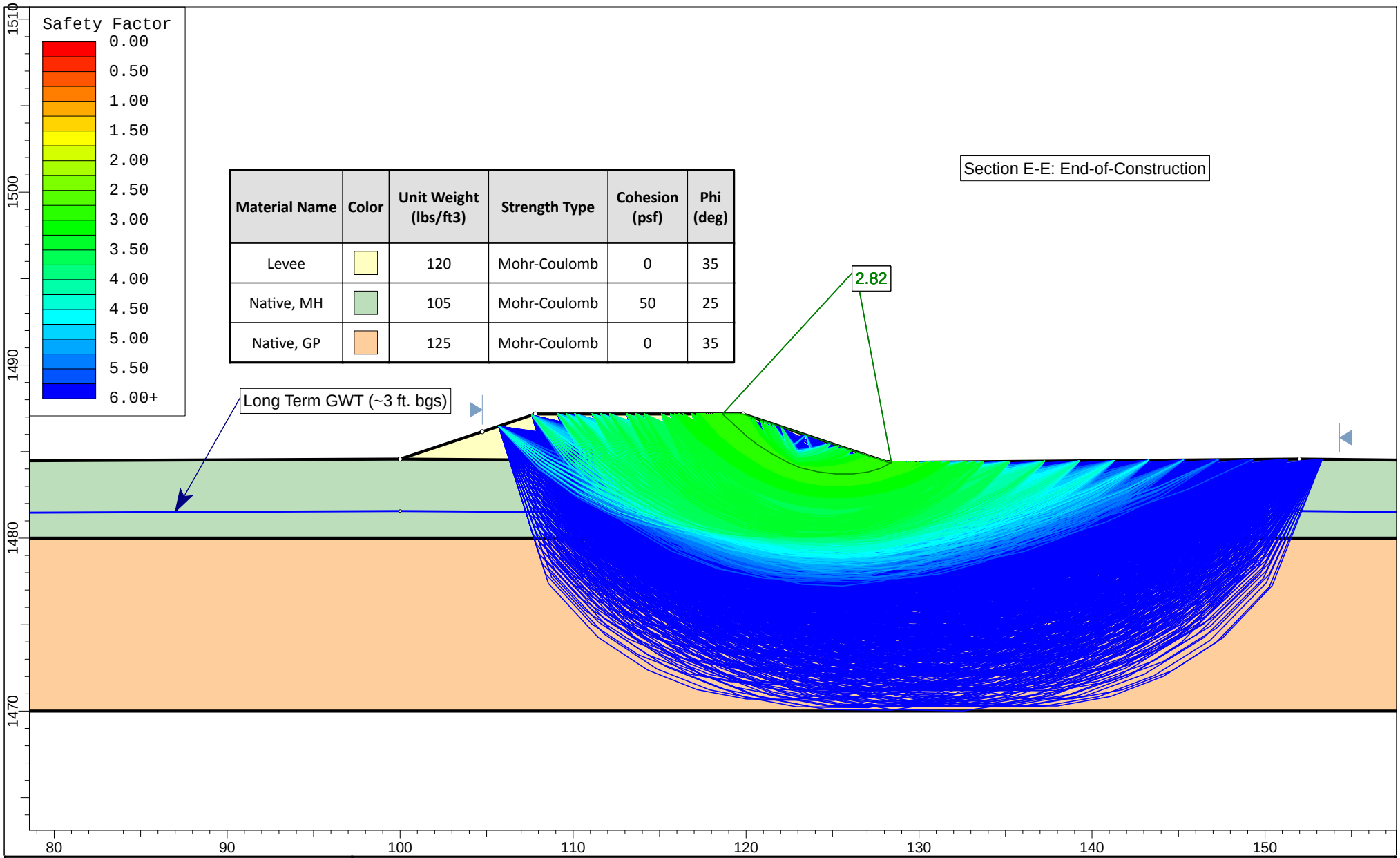
SLIDEINTERPRET 6.036



Material Name	KS (ft/s)	K2/K1
Levee	3.17e-005	0.1
Native, SP	0.00369	0.5

SLIDEINTERPRET 6.036

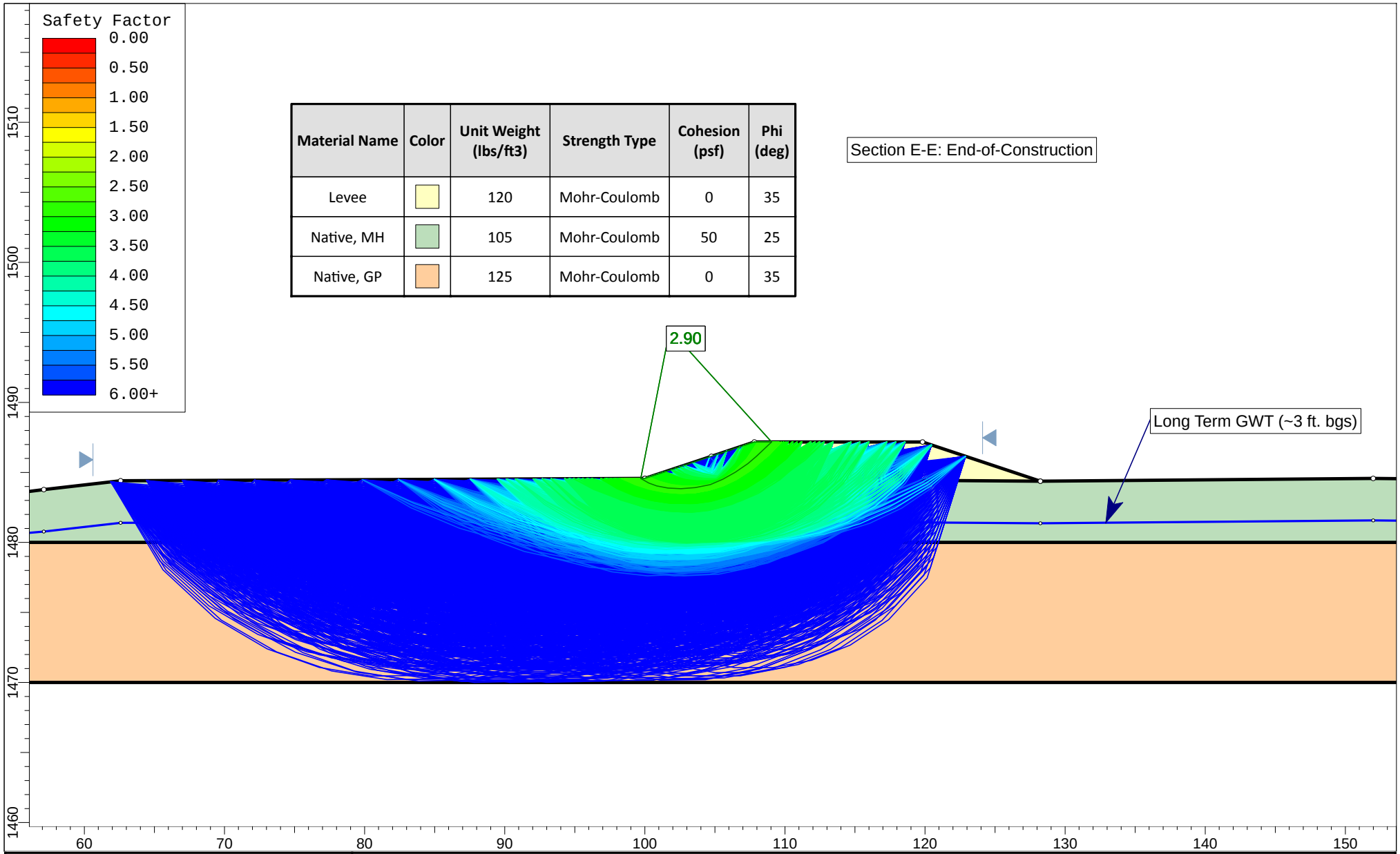
Project	Schaake Setback Levee: Section D-D		
Analysis Description	Steady State Seepage		
Drawn By	T. Kraupa	Scale 1:118	Company CH2M HILL Inc.
Date	10/12/15		File Name Section D-D_steady state.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, MH		105	Mohr-Coulomb	50	25
Native, GP		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

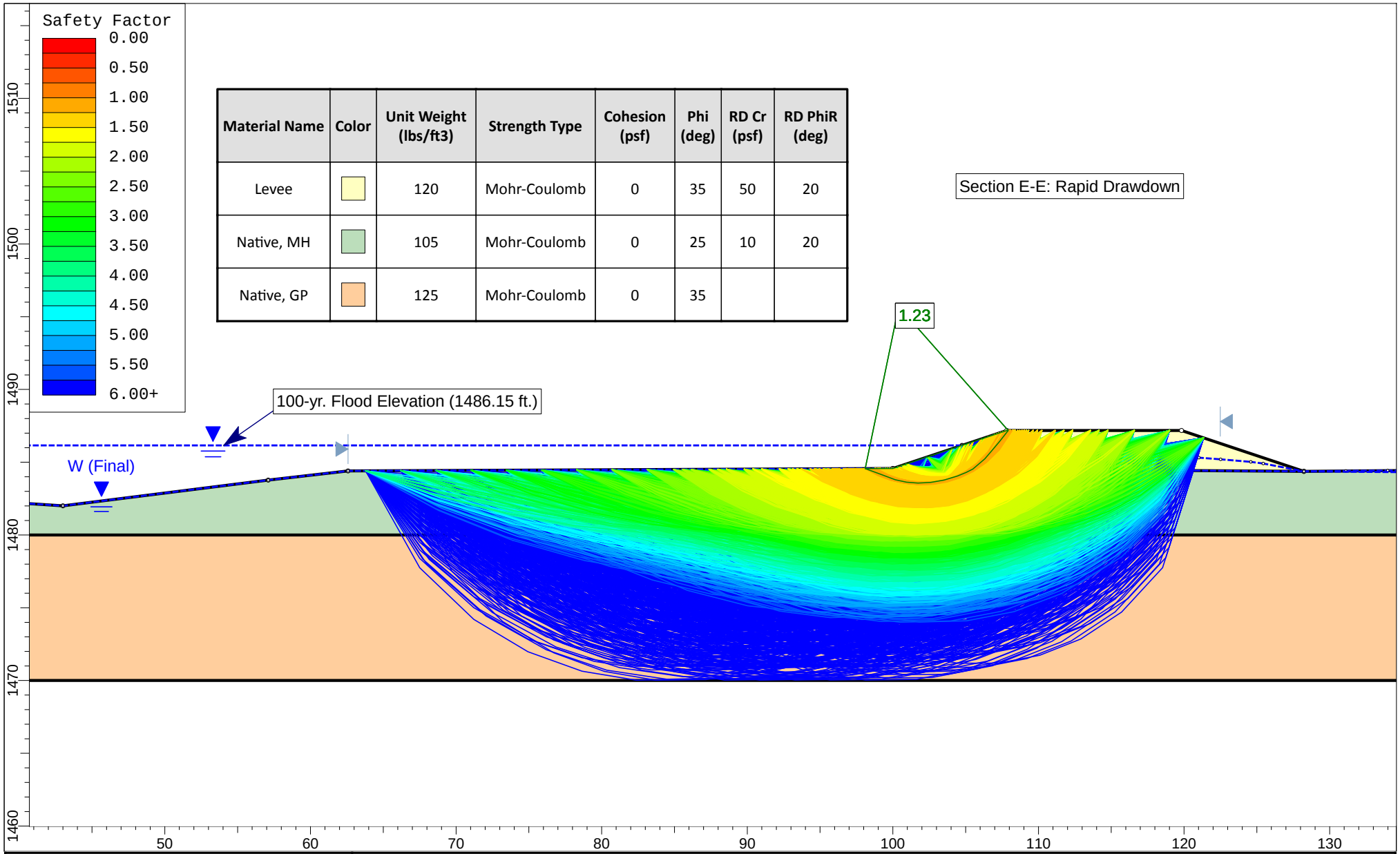
Project	Schaake Setback Levee: Section E-E		
Analysis Description	End-of-Construction Stability		
Drawn By: T. Kraupa	Scale: 1:92	Company: CH2M HILL Inc.	
Date: 10/11/2015		File Name: Section E-E_eoc_landside.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, MH		105	Mohr-Coulomb	50	25
Native, GP		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

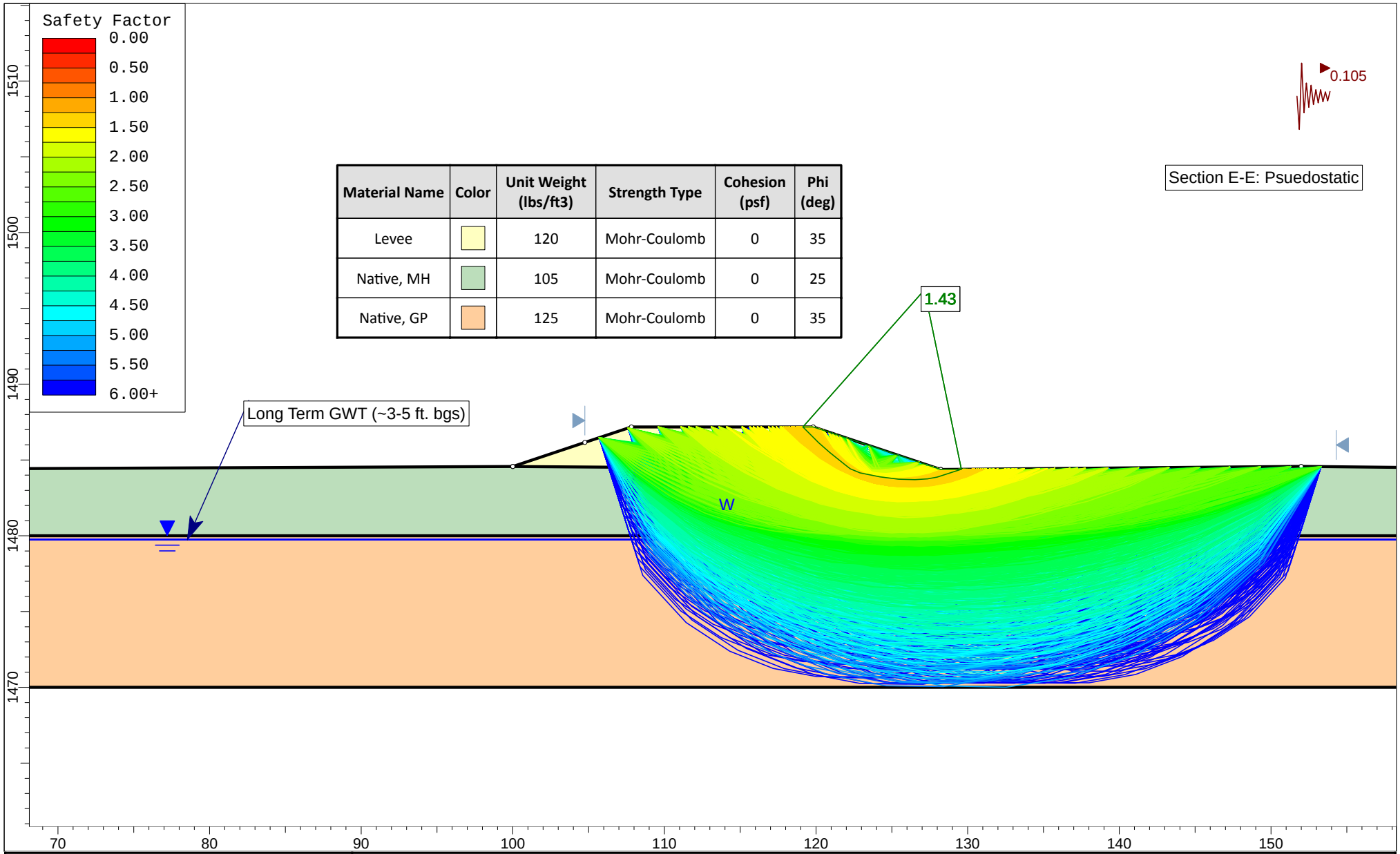
Project	Schaake Setback Levee: Section E-E		
Analysis Description	End-of-Construction Stability		
Drawn By	T. Kraupa	*Scale* 1:114	*Company* CH2M HILL Inc.
Date	10/11/2015		*File Name* Section E-E_eoc_poolside.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	RD Cr (psf)	RD PhiR (deg)
Levee		120	Mohr-Coulomb	0	35	50	20
Native, MH		105	Mohr-Coulomb	0	25	10	20
Native, GP		125	Mohr-Coulomb	0	35		

SLIDEINTERPRET 6.036

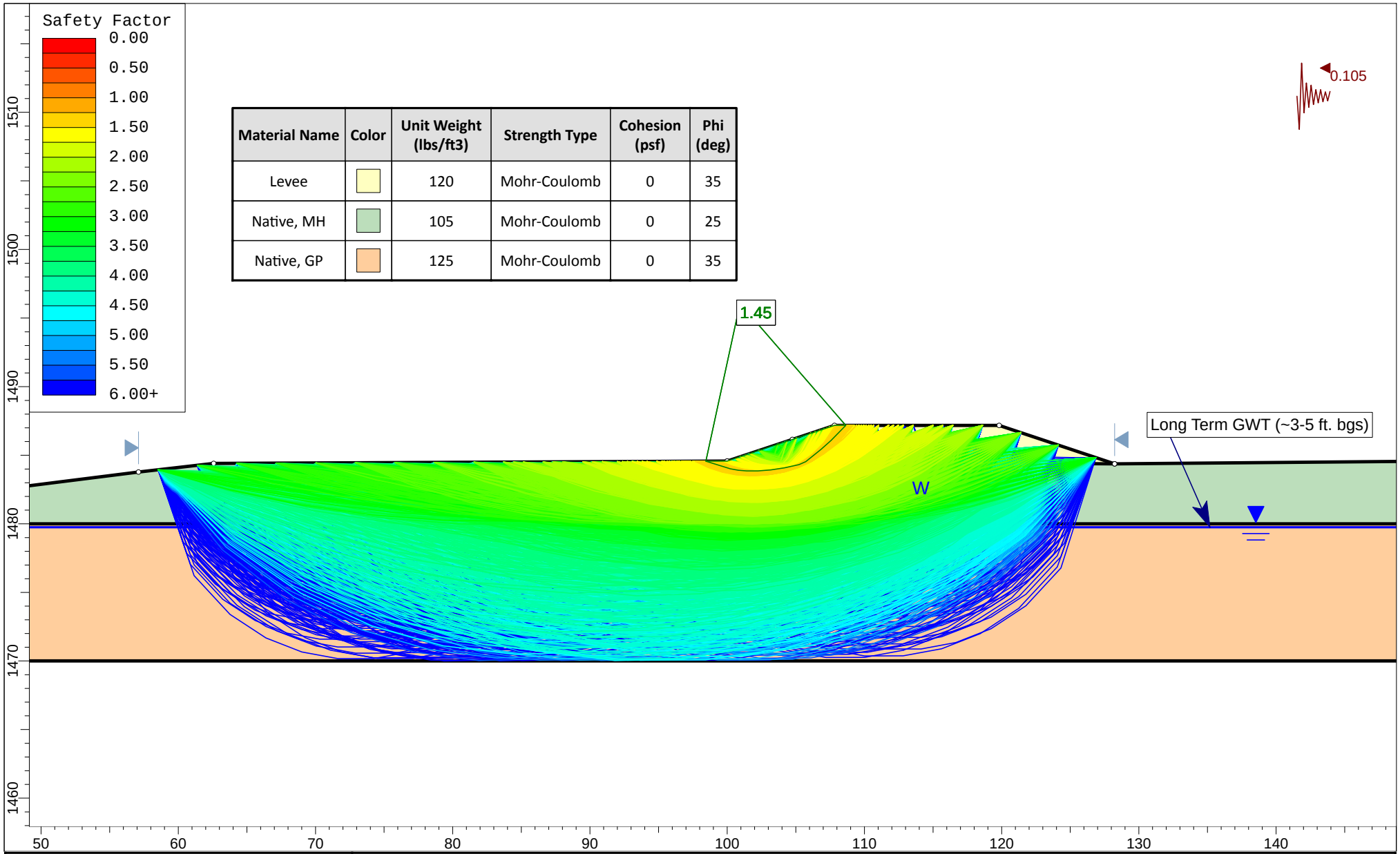
Project	Schaake Setback Levee: Section E-E		
Analysis Description	Rapid Drawdown		
Drawn By	T. Kraupa	*Scale* 1:109	*Company* CH2M HILL Inc.
Date	10/11/2015		*File Name* Section E-E_rapid_dd_poolside.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, MH		105	Mohr-Coulomb	0	25
Native, GP		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

Project	Schaake Setback Levee: Section E-E		
Analysis Description	Psuedostatic		
Drawn By T. Kraupa	*Scale* 1:105	*Company* CH2M HILL Inc.	
Date 10/11/2015		*File Name* Section E-E_seismic.slim	

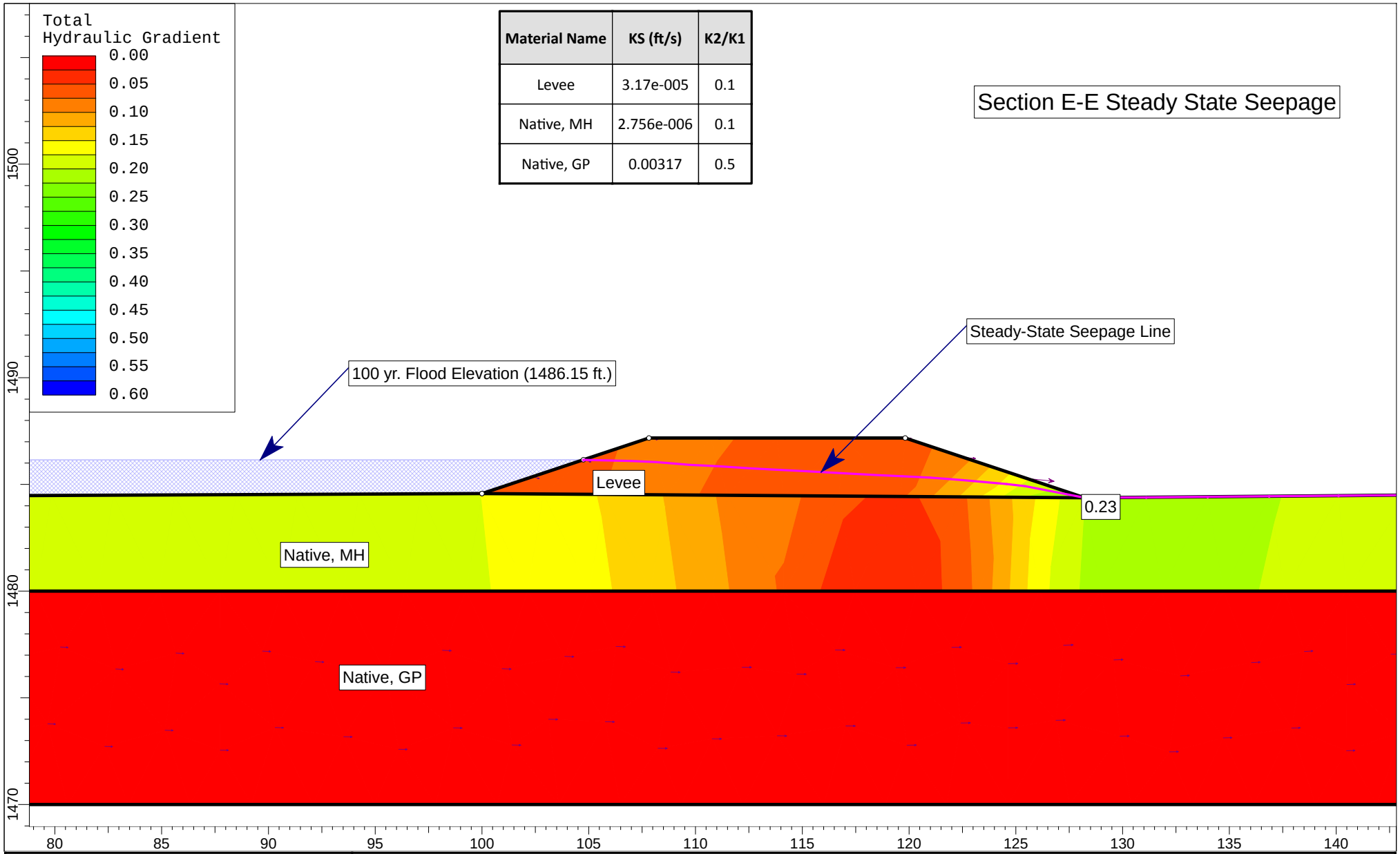


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, MH		105	Mohr-Coulomb	0	25
Native, GP		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

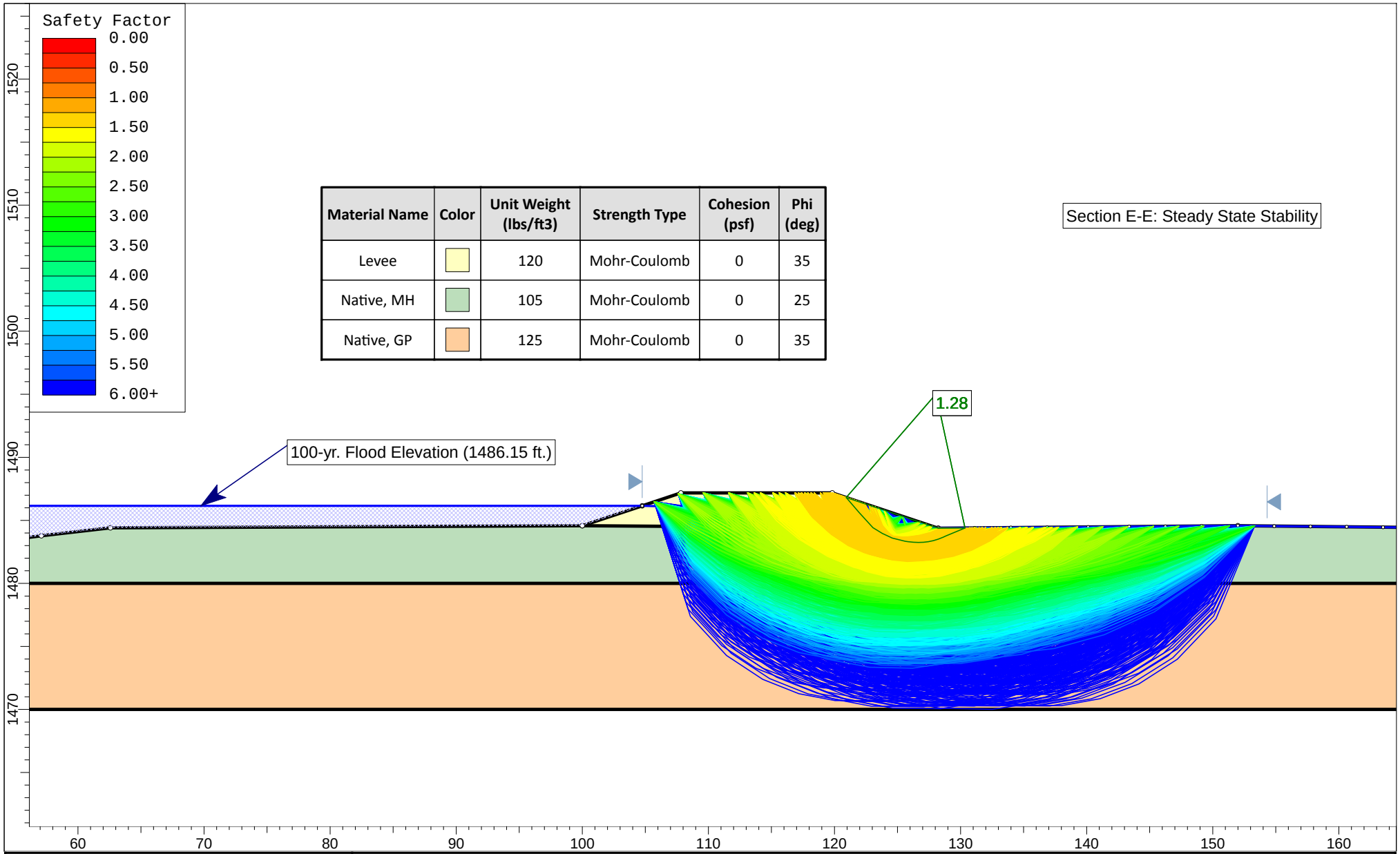
Project	Schaake Setback Levee: Section E-E		
Analysis Description	Psuedostatic		
Drawn By T. Kraupa	*Scale* 1:116	*Company* CH2M HILL Inc.	
Date 10/11/2015		*File Name* Section E-E_seismic_riverside.slim	

Material Name	KS (ft/s)	K2/K1
Levee	3.17e-005	0.1
Native, MH	2.756e-006	0.1
Native, GP	0.00317	0.5



Project	Schaake Setback Levee: Section E-E		
Analysis Description	Steady State Seepage		
Drawn By: T. Kraupa	Scale: 1:75	Company: CH2M HILL Inc.	
Date: 10/11/2015		File Name: Section E-E_steady state.slim	

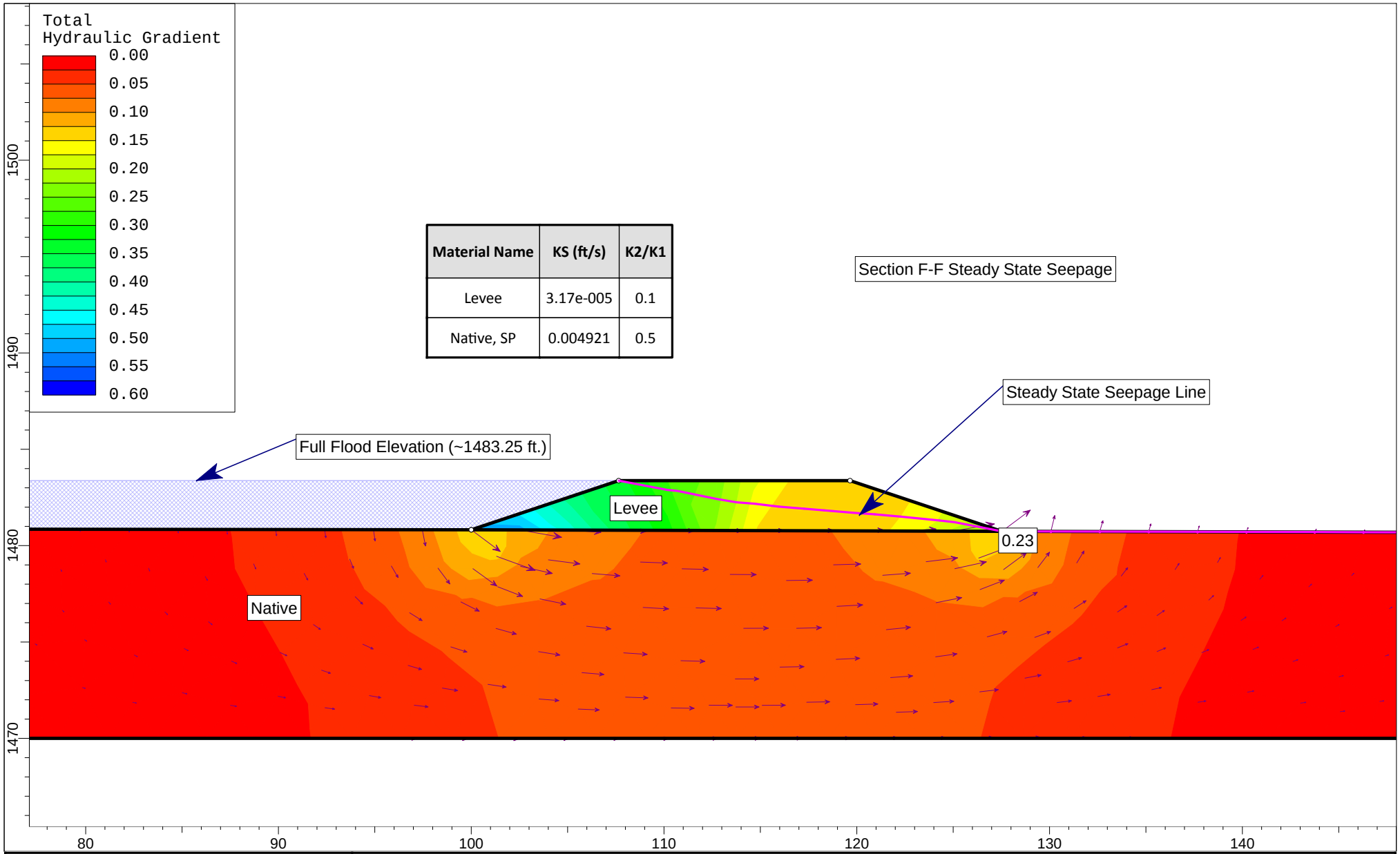
SLIDEINTERPRET 6.036



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Levee		120	Mohr-Coulomb	0	35
Native, MH		105	Mohr-Coulomb	0	25
Native, GP		125	Mohr-Coulomb	0	35

SLIDEINTERPRET 6.036

Project	Schaake Setback Levee: Section E-E		
Analysis Description	Long Term		
Drawn By T. Kraupa	*Scale* 1:126	*Company* CH2M HILL Inc.	
Date 10/11/2015		*File Name* Section E-E_steady_state_stability_landside.slim	



Material Name	KS (ft/s)	K2/K1
Levee	3.17e-005	0.1
Native, SP	0.004921	0.5

SLIDEINTERPRET 6.036

Project	Schaake Setback Levee: Section F-F		
Analysis Description	Steady State Seepage		
Drawn By	T. Kraupa	Scale 1:83	Company CH2M HILL Inc.
Date	10/12/2015		File Name Section F-F_steady state.slim