In Association with

Geotechnical Engineering Report: Embankment MP 10.84 to MP 10.99 and Grade Separation Barrier

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Geotechnical Engineering Report:
Embankment MP 10.84 to MP 10.99 and Grade Separation Barrier

WSDOT I-405 Renton to Bellevue Design-Build

Renton to Bellevue, Washington

Project # PS19-20316-0

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List of acronyms

ESU	Engineering Stratigraphic Unit
I-405	Interstate 405
MP	milepost
Project GDM	Project Geotechnical Design Manual, consisting of WSDOT's 2015 *Geotechnical Design Manual*, along with project-specific Chapters 6 (Seismic) and 15 (Retaining Walls) from Request for Proposal Addendum 9
RFP	Request for Proposal
Sta.	Station
Wood	Wood Environment & Infrastructure Solutions, Inc.
WSDOT	Washington State Department of Transportation

1.0 Description of Structures

This report presents our geotechnical engineering analysis, design, and recommendations for the widened embankment and new grade separation barrier located between milepost (MP) 10.84 and MP 10.99 in support of the Washington State Department of Transportation (WSDOT) Interstate 405 (I-405) Renton to Bellevue Design-Build project. This report has been prepared in accordance with the requirements presented in the I-405 Renton to Bellevue Widening Project Request for Proposal (RFP), specifically Section 2.6.5.3, and the applicable sections of the WSDOT *Geotechnical Design Manual* (WSDOT 2015). The Project Geotechnical Design Manual (GDM) consists of WSDOT's 2015 *Geotechnical Design Manual*, along with project-specific Chapters 6 (Seismic) and 15 (Retaining Walls) from RFP Addendum 9.

1.1 Embankment

The embankment will consist of part of the southbound lane and median between MPs 10.84 and 10.99, in addition to a grade separation barrier along the west edge of the middle northbound lane that will support the widening of I-405. The embankment will run along I-405 between approximately southbound Station (Sta.) 5876+64 to approximately Sta. 5884+68.55 (Figures 1 and 2 in Appendix A). The maximum thickness of fill is about 7.5 feet under the median at approximately southbound Sta. 5882+50, as shown in Figure 3 in Appendix A. In general, the embankment slopes down from the southbound lane at a 2 horizontal to 1 vertical (2H:1V) slope to a flat bench in front of the grade separation barrier. However, near southbound Sta. 5882+50, the slope is 4H:1V due to the presence of an instrumentation and traffic signal cabinet on the slope. The finished roadway height between the southbound lane and the middle northbound lane surfaces varies between 4.8 and 8.0 feet.

1.2 Grade Separation Barrier

The grade separation barrier is approximately 857 feet long. The location of the barrier and subsurface explorations are shown on Figures 1 through 3 in Appendix A.

The grade separation barrier will be used as a short gravity-retaining structure consisting of a 4.5 foot high cast-in place barrier along the west edge of the middle northbound lane, as shown in cross sections A–A' and B–B' (Figures 2 and 3 in Appendix A). The dimensions of the barrier base may be subject to change, based on design requirements for the barrier. Based on the design roadway drawings (Appendix A), the exposed grade separation barrier height (i.e., the distance between the top of the barrier and the finished grade in front of the barrier) is 3.5 feet and the maximum design height (i.e., the distance between the finished grade behind the barrier and the bottom of the barrier) is 4 feet. The grade separation barrier will consist of a barrier along the west edge of the middle northbound lane with a short, flat bench and 2H:1V slope from the southbound lane (cross section A–A'), with the exception of the area around Sta. 5882+50, where the slope will be 4H:1V due to the presence of the instrumentation and traffic signal cabinet (cross section B–B'). The minimum barrier embedment will be 6 inches. Details of the barrier are shown on Table 1.

Table 1: Summary of Grade Separation Barrier Structure

Cross Section	Cut/ Fill	Borings[1]	Design Station	Maximum Exposed Height/Design Height (feet)	Foreslope (deg)	Backslope[2] (deg)
A–A'	Fill	ALTCH-B6-06, H-62, and H-63	SB 5882+00	3.5 / 4	0	0
B–B'	Fill	ALTCH-B6-06, H-62, and H-63	SB 5882+50	3.5 / 4	0	14

Notes:

1. Borings W-171-20, CH-B3-06, F-4, F-5, F-6, F-7, F-8, GEO-9, H-60, H-61, H-64, H-65, S-36, S-37, S-38, and S-39 were also referenced in preparation of this report.
2. Backslope = 14 degrees near instrumentation and traffic signal cabinet only; backslope = 0 degrees along remainder of the grade separation barrier.

Abbreviations:

deg = degrees SB = southbound

1.3 Site Surface Conditions

The existing ground surface along the southbound lane of the embankment slopes upward from south to north at a slope of approximately 1 percent. Currently, there is an existing vegetated sloped median between the southbound and northbound lanes at the location of the proposed grade separation barrier. The median varies from 4.8 to 8.0 feet in height and has a slope of about 2H:1V.

1.4 Exploration and Laboratory Testing

Wood Environment & Infrastructure Solutions, Inc. (Wood) completed only one new boring in this area (W-171-20), to support the information obtained from historical borings. The borings are shown on Figures 1 and 2 in Appendix A. The soil boring logs used for design of the embankment and grade separation barrier are contained in Appendix B. Results of soil laboratory testing from these explorations are presented in Appendix C. The number, location, and depth of the explorations are compliant with the Project GDM for the design of the wall.

2.0 Subsurface Conditions

2.1 Regional and Site Geology

The project lies within the southern portion of the Puget Sound Lowland physiographic region. The Puget Sound Lowland has undergone physiographic and depositional changes due to at least five glacial episodes. The last glaciation that occurred in the region was the Vashon Stade of the Fraser Glaciation, which ended approximately 13,500 years ago.

The advance of the Vashon Glacier deepened and widened the north/south trending valleys situated between the Olympic Mountains and the Cascade Range in western Washington. In the Seattle area, the Vashon Stade is represented by four stratigraphic units (from oldest to youngest): Lawton Clay, Esperance Sand, Vashon Till, and Vashon recessional deposits, which make up the Vashon Drift (Galster and Laprade 1991).

As the Vashon glacial lobe advanced south and blocked the northern portion of the Puget Sound basin, a lake was formed, and fine-grained sediments were deposited. The glaciolacustrine deposit, known as the Lawton Clay, is reported to be present in the Seattle area as high as 150 feet above mean sea level. A fine-to-medium-grained sand unit was deposited above the Lawton Clay by meltwater streams issuing from the advancing ice sheet as it neared the Seattle area. That sand unit is called the Esperance Sand Member. The Lawton Clay and Esperance Sand are sometimes intermixed and interbedded, and the contact between the two soil types may be gradational. Both deposits were overridden by an estimated 3,000 feet of ice, which consolidated them into hard or dense layers. A mantle of the Vashon Till was deposited on top of the Esperance Sand and Lawton Clay. The Esperance Sand and Lawton Clay deposits were overlain by Vashon Till, also overridden by the ice sheet. These units are mantled by recessional deposits that were formed during the retreat of the ice sheet. Holocene modification of the glacial landscape in the last 11,700 years and recent activities helped sculpt the landform that is today.

The geologic unit descriptions and stratigraphy used by Wood are based on the mapped and structural geology (McKnight 1923, Waldron et al. 1962, Mullineaux 1965, Yount et al. 1993, Johnson et al 1994, Liberty and Pratt 2008, Troost 2012, and WSDOT 2018a and 2018b (and as described by others (Golder 1993, Shannon & Wilson 2000, and GeoEngineers 2008) in the project vicinity. Wood simplified the geologic units consisted of combining the Quaternary period Pleistocene and Holocene epoch soils.

The geologic units encountered at the subject site, along with a brief discussion of their descriptions used for the project geology are provided in Table 2.

Table 2: Geologic Unit Descriptions

Geologic Unit Name	Abbrev.	Geologic Unit Description
Fill	Af	Fill placed by humans, both engineered and uncontrolled fill consisting of various materials, including debris; typically dense or stiff if engineered, but very loose to dense or very soft to stiff if uncontrolled fill.
Recessional Deposits	Qvr	Sediments deposited after glacial ice retreated that have not been glacially overridden. These recessional deposits include: • Outwash—glaciofluvial sediment deposited off the retreating glacier consisting of sand or silty sand; locally gravelly; loose to dense; • Ablation Till—heterogeneous soils deposited during the wasting of glacial ice; generally not reworked, consisting of gravelly, silty sand, gravelly, sandy silt, or clayey silt; loose to dense or soft to very stiff; • Ice Contact Deposits—heterogeneous soils deposited against or adjacent to ice during the wasting of glacial ice; commonly reworked, consisting of stratified to irregular bodies of gravel, sand, and silt; loose to dense; and • Lacustrine Deposits—sediments deposited as glacial ice retreated, consisting of silt and clay; locally fine sand; soft to very stiff.
Vashon Glacial Till	Qvt	Lodgment till laid down along the base of the glacial ice and overridden by the weight of glacial ice, consisting of gravelly, silty sand, or gravelly, sandy silt ("hardpan"); boulders and cobbles common; gray and very dense, and in its weathered state may be oxidized brown and medium dense to dense. Sometimes referred to as a diamicton.
Advance Outwash	Qva	Glaciofluvial sediments deposited as the glacial ice advanced through the Puget Lowland and overridden by the weight of glacial ice; typically stratified, light brown to gray, sand, gravelly sand, and sandy gravel; dense to very dense.

2.2 Site Soil Conditions

Boring W-171-20, near the south end of the embankment was advanced to a depth of 16.5 feet below existing grade, with a fill thickness of approximately 16.5 feet. Historical borings ALTCH-B6-06, CH-B3-06, F-4, F-5, F-6, F-7, F-8, GEO-9, H-60, H-61, H-64, H-65, S-36, S-37, S-38, and S-39 were advanced to depths ranging between 18.8 feet and 90.0 feet below ground surface (at the time of drilling). The elevation of the borings drilled in the 1960s and 1980s were adjusted to the North American Vertical Datum of 1988 where required.

Borings F-4 to F-8 and S-36 to S-39 predate the construction of the current roadway surface. Comparison of these borings to the more recent borings suggests that much of the near-surface stratigraphy originally observed in the borings at these locations (such as organic and peat soils) has been removed and replaced with fill material.

The soil in the borings along this section of I-405 generally consists of medium dense to dense fill (predominantly silty sand) over dense to very dense silty sand glacial till.

2.3 Site Groundwater Conditions

Historical borings ALTCH-B6-06, CH-B3-06, F-4 to F-8, Geo-9, and S-36 to S-39 had water level readings between elevations 88 feet and 96 feet at the completion of drilling. Elevations referenced in this report are based on the North American Vertical Datum of 1988.

Groundwater levels in boring W-171-20 were dry at the time of drilling, indicating groundwater levels in this area are below approximately 118 feet. There are no current piezometers located near this area.

The maximum groundwater elevation has been assumed to be below elevation 96 feet, based on review of groundwater records from current and historical borings in this area. As such, groundwater conditions are considered to be dry for design of the embankment and grade separation barrier between MP 10.84 and MP 10.99.

3.0 Geologic Hazards

Based on the design roadway drawings (Appendix A), the maximum height of retained fill for the grade separation barrier (i.e., the distance between the finished grade behind the barrier and the finished grade in front of the barrier) is less than 4 feet. Based on the Released for Construction letter regarding project design requirements and geotechnical assessment of retaining walls (Wood 2021a), for walls not greater than 4 feet in exposed height, no assessment is required to improve global stability in the seismic case beyond that which would be required for a slope due to the low risk of life associated with a fall from this height. As discussed in Section 5.1, no assessment of the embankment slope stability, including for the seismic case, is required for this embankment.

4.0 Design Soil Properties

4.1 Engineering Stratigraphic Units

Table 3 summarizes encountered geological units and the assigned Engineering Stratigraphic Units (ESUs) used to develop engineering recommendations for this structure.

Table 3: ESUs and Descriptions

Geologic Unit Name	Assigned ESU	ESU Description
Fill	1B	Existing FILL, predominantly silty SAND, medium dense to dense
Glacial Till	4C	Silty SAND, dense to very dense

Abbreviations:
ESU = Engineering Stratigraphic Unit

4.2 Subgrade ESU Soil Profiles and Design Soil Properties

The ESU soil properties were assigned based on laboratory testing and the Geotechnical Soil Properties Methodology report (Wood 2020). Details of the ESU soil properties are included in Appendix D. The methodology is consistent with Chapter 5 of the Project GDM. The soil properties presented in Table 4 are the ESUs encountered in cross section A–A' and B–B' (I-405 southbound Sta. 5882+00 and Sta. 5882+50, respectively).

Table 4: Design Soil Properties

ESU	Soil Type (USCS)	Corrected SPT Blow Count, $(N_1)_{60}$ (blows per foot)	Moist Unit Weight (pcf)	ϕ' (deg)	c' (psf)	S_u (psf)
1B	SM	54	130	38	100[1]	NA
4C	SM	70	130	39	NA	NA

Notes:
1. Apparent cohesion of fill due to fines content between 15% and 25%.

Abbreviations:
ϕ' = effective peak friction angle
c' = effective peak cohesion
deg = degrees
ESU = Engineering Stratigraphic Unit
$(N_1)_{60}$ = SPT N-value corrected for effective overburden stress
NA = not applicable
pcf = pounds per cubic foot
psf = pounds per square foot
SPT = standard penetration test
S_u = undrained shear strength
USCS = Unified Soil Classification System

The soils in ESUs 1B and 4C are considered to be cohesionless, and as such, no soil consolidation parameters were determined.

4.3 Soil Parameters for Standard WSDOT Materials

Table 5 presents design soil properties selected from the range provided in Project GDM Table 5.2 to be used for typical WSDOT-specified backfill. These soil properties will be used in calculations to represent the backfill.

Table 5: WSDOT Backfill ESU Parameters

Material	WSDOT Standard Specification	Soil Type (USCS)	Soil Friction Angle (degrees)	Cohesion (psf)	Moist Unit Weight (pcf)
Common Borrow	9-03.14(3)	ML, SM, GM	32	0	120
Select Borrow	9-03.14(2)	GP, GP-GM, SP, SP-SM	36	0	125
Gravel Borrow	9-03-14(1)	GW, GW-GM, SW, SW-SM	38	0	130
Gravel Backfill for Wall	9-03.12(2)	GW, GP, SW, SP	38	0	130

Source: Project GDM 5.2—Presumptive Design Ranges for Compacted Borrow and WSDOT Standard Specifications (WSDOT 2018c).

Abbreviations
ESU = Engineering Stratigraphic Unit
pcf = pounds per cubic foot
psf = pounds per square foot
USCS = Unified Soil Classification System
WSDOT = Washington State Department of Transportation

The embankment should be constructed in accordance with Section 2-03.3(14) Method B in the Standard Specifications (WSDOT 2018c) unless otherwise noted.

5.0 Geotechnical Analyses and Recommendations for Embankment

5.1 Embankment Slope Stability

Section 9.2.3 of the Project GDM states that:

- Embankments 10 feet or less in height with 2H:1V or flatter side slopes may be designed based on past precedence and engineering judgement;
- Embankments over 10 feet in height or any embankment on soft soils require more in-depth stability analyses, as do any embankments with side slope inclinations steeper than 2H:1V; and
- Fill placed near or against a bridge abutment or foundation, or that can impact a nearby buried or aboveground structure, will likewise require stability analyses.

Based on our review of the project requirements, the embankment geometry, and the anticipated soil conditions, Wood determined that a slope stability analysis was not required for this section of the embankment based on the following criteria:

- The embankment height is less than 10 feet;
- The side slopes of the embankment are 2H:1V or flatter;
- No significant areas of soft soils were encountered; and
- There are no nearby underground or aboveground structures or foundation that would be affected by fill placement.

5.2 Embankment Settlement

The settlement limits for the embankment are based on Section 2.6.6.7 of the RFP, which states that the post-construction settlement, including both primary and secondary settlement, shall not exceed 2 inches over the 75-year design life of the project, and the post-construction differential settlement, including both primary and secondary settlement, shall not exceed 1 inch over the 75-year design life of the project. Additionally, differential settlement shall be measured between the centerline of the roadway embankment and the shoulder of the new embankment.

Wood's settlement analysis of the embankment is based on cross section A–A', which is located approximately at the location of greatest fill placement and slope height. Fill at this location is anticipated to be placed and compacted in sequential lifts, but

not placed in stages. Simplified fill geometries, where minor variations in the ground surface were ignored, were used to evaluate the anticipated settlement after fill is placed.

Wood used the modified Hough Method (Kimmerling 2002) to estimate immediate settlement at cross section A–A'. The ESUs derived for this area indicate that most of the stratigraphy is made of granular soils. Due to the cohesionless nature of the foundation soils, no estimate of long-term consolidation settlement has been performed.

Wood estimates that the total settlement at this location will be approximately 0.8 inch at the eastern edge of the southbound lane and about 0.9 inch at the median (where the fill thickness is the greatest), with most of the settlement occurring during or immediately after construction. Because post-construction settlement over the design life of the project is less than 2 inches and differential settlement is less than 1 inch, this section meets the project settlement criteria for construction of a widened embankment. A copy of the settlement analysis is included in Appendix E.

Buried utilities that may be affected by settlement due to the fill placement consist of the City of Bellevue water line (UI#0247) and a cased sewer line (UI#0239) near southbound Sta. 5878+00, Seattle Public Utility water line (UI#02040) near southbound Sta. 5879+00, and a new underdrain line and an existing stormwater line running parallel to the road below the median. Based on communication with the drainage team on November 19, 2021, it is understood that the new underdrain line shown on the plans will be installed at the same time as the grade separation barrier; thus, settlement of the line is not a concern. The top elevation of the water lines and stormwater line is between elevation 130 feet and 131 feet, and the bottom elevation of the sewer is about elevation 95 feet. The estimated thickness of new fill above the existing utilities is about 4.6 feet and the estimated settlement is about 0.6 inch at ground surface above the lines and less than 0.1 inch at the approximate elevation of the water lines. The sewer line is expected to be below the zone of influence for the fill placement. See Section 6.3 for discussion of anticipated settlement below the grade separation barrier.

Section 2.6.7.5 of the RFP requires that geotechnical instrumentation be installed if the settlement of new fill is predicted to be greater than 2 inches. As anticipated settlement of the embankment is less than 2 inches, no geotechnical instrumentation plan is required for this embankment.

6.0 Geotechnical Analyses and Recommendations for Grade Separation Barrier

Sections 6.1 through 6.5 describe results of geotechnical engineering analyses and recommendations for the grade separation barrier between MP 10.84 and MP 10.99. The recommendations are based on our interpretation of the subsurface conditions shown in the ESU cross section (Appendix A), as well as the elevation and/or geometry of the structures as shown in the structural plan sheets. However, if different subsurface conditions are encountered during the construction, the Geotechnical Engineer of Record should review the subsurface conditions and revise the recommendations, as appropriate. Structural design and drawings of the grade separation barrier can be found under separate cover.

The grade separation barrier was designed as a gravity barrier. Wood evaluated the maximum barrier design height (the distance between the finished grade in front of and behind the barrier plus embedment) based on barrier cross sections A–A' and the ESU properties listed in Table 4. The calculation methodology used in this report is in keeping with Calculation Methodology: Geotechnical Parameters for Special Barriers (Wood 2021b).

6.1 Resistance Factor

Per Section 10.5.5.1, Table 11.5.7-1, and Section 11.5.8 in the *LRFD Bridge Design Specifications* (AASHTO 2017), the geotechnical resistance factors for use in evaluating the different limit states for the barrier design are provided in Table 6.

Table 6: Geotechnical Resistance Factors for Grade Separation Barrier

Limit State	Resistance Factor	
	Bearing	Sliding
Service	1.00	1.00
Strength	0.55	1.00
Extreme	1.00	1.00

6.2 Geotechnical Design Parameters

Recommended geotechnical design parameters for the grade separation barrier and embankment are presented in Tables 4 and 5.

6.3 External Stability of Grade Separation Barrier

Checks of external stability for the grade separation barrier include bearing resistance, eccentricity, and sliding. The eccentricity and sliding checks will be performed by the Project Structural Engineer and will consider surcharge load due to traffic. For external stability in terms of bearing, results of the calculated factored bearing resistances for Service, Strength, and Extreme limit states (Appendix E) are summarized in Table 7.

Table 7: Factored Bearing Resistances of Grade Separation Barrier

B' (feet)	Calculated Factored Bearing Resistance (psf)[1]		
	Service Limit[2]	Strength Limit	Extreme Limit
2.0	6,700	9,075	16,500
3.0	4,950	11,583	21,550
4.0	4,050	14,658	26,650
5.0	3,550	17,435	31,700
6.0	3,150	20,240	36,800
7.0	2,900	23,018	41,850

Notes:
1. Calculations are presented in Appendix E.
2. Service bearing resistance is determined based on settlement no greater than 1 inch.

Abbreviations:
B' = effective base width
psf = pounds per square foot

Due to the length of the barrier and the variation in the soil profile along the barrier, the calculated nominal bearing resistance has been determined based on cross section A–A', as shown on Figure 3 in Appendix A. Conservatively, the assumptions for determination of the nominal bearing resistance included a minimum embedment depth of 1 foot and bearing on ESU 1B soils along the grade separation barrier.

Settlement is estimated to be about 0.1 inch at the location of the water lines and stormwater line due to placement of the grade separation barrier at the service limit and a maximum of 1 inch at ground surface, which exceeds the settlement caused by fill placement, as discussed in Section 5.2. The utility and drainage teams were notified of the estimated settlements on November 19, 2021. The drainage team reported no concerns regarding the anticipated settlement of the stormwater line. The utilities team is reviewing the estimated settlement and its impacts to the water and sewer utilities. No geotechnical inspection plan is required for placement of the grade separation barrier over the utilities.

6.4 Global Slope Stability

Wood performed two-dimensional, limit equilibrium analyses based on the method of slices according to the Spencer method using Slope/W software from Geo-Slope International, Ltd. This program employs limit equilibrium methods in accordance with the Project GDM Chapter 7 and Section 15.4.12. The results were also confirmed using the Morgenstern-Price method in Slope/W. The components required to carry out a Slope/W analysis, such as slope geometry, slip surfaces, and material properties, were established in this report and were input into the software. Trial slip surfaces were created using the entry and exit method. The material properties describe the shear strength of a soil, and are generally defined by unit weight, cohesion, and friction angle.

Wood analyzed static load with dry groundwater conditions and no excess pore pressures (long-term conditions) existing within the soil profile, which is appropriate because the soils are granular and will drain relatively quickly. This load case is analyzed using a single-stage analysis procedure with effective shear strengths.

A resistance factor of 0.75 (i.e., factor of safety of 1.3) was targeted for the Service Limit State and was used for the global stability analysis in accordance with Project GDM Section 15-4.12. A surcharge of 250 pounds per square foot was applied to the southbound lane for the static condition. It is noted that a surcharge load should also be applied to the flat surface behind the barrier in cross section A–A' or the 4H:1V slope in cross section B–B' to account for service vehicle travel on the median; however, application of this load on the slope results in a higher factor of safety. As such, this load was not applied to the design sections to be conservative. The critical cross section analyzed for the barrier is shown in Appendix A. Results of critical slip surface for static (Service 1) are presented in the Appendix E calculation package. The calculations and results of the global stability checks are presented in Appendix E and summarized in Table 8.

Table 8: Summary of Global Stability Factor of Safety

Cross Section	Southbound Station	Limit State FS	Minimum FS (Static)
A–A'	5882+00	1.3	1.7 (okay)
B–B'	5882+50		2.6 (okay)

Abbreviations:
FS = factor of safety

6.5 Lateral Earth Pressure Parameters

The lateral earth pressure parameters for the backfill materials on the side of and below the grade separation barrier are based on Section 3.11.5 in the *LRFD Bridge Design Specifications* (AASHTO 2017). Table 9 presents recommended passive lateral earth pressure coefficients for level material at the toe of the wall, assuming various backfill materials and using ESU 1B foundation soils. Calculations are presented in Appendix E.

Table 9: Passive Lateral Earth Pressure Parameters for Backfill and Natural Subgrade

Lateral Earth Pressure Parameter	Subgrade		Backfill	
	ESU 1B	Common	Select	Gravel
Kp, Passive Earth Pressure Coefficient (Level Backfill)	8.2	4.6	7.0	8.2
Kp, Passive Earth Pressure Coefficient (4H:1V Slope)	37.2	14.1	20.2	38.2

Abbreviations:
ESU = Engineering Stratigraphic Unit
H = horizontal
Kp = Passive earth Pressure Coefficient
V = vertical

Table 10 presents recommended active lateral earth pressure coefficients per Section 3.11.5.3 in the *LRFD Bridge Design Specifications* (AASHTO 2017). Calculations are presented in Appendix E.

Table 10: Lateral Earth Pressure for Level Backfill and Natural Subgrade

Lateral Earth Pressure Parameter	Subgrade	Backfill		
	ESU 1B	Common	Select	Gravel
Ka, Active Earth Pressure Coefficient (Level Backfill)	0.30	0.36	0.32	0.30
Ka, Active Earth Pressure Coefficient (4H:1V Slope)	0.36	0.45	0.39	0.36

Abbreviations:
ESU = Engineering Stratigraphic Unit
H = horizontal
Ka = Active Earth Pressure Coefficient
V = vertical

According to the Section 15-4.8 of the Project GDM, "*The type of earth pressure used for design depends on the ability of the wall to yield in response to the earth loads. For walls that are free to translate or rotate (i.e., flexible walls), active pressures shall be used in the retained soil. Flexible walls are further defined as being able to displace laterally at least 0.001H, where H*

is the height of the wall. Standard Plan reinforced concrete walls and anchored walls are generally considered to be flexible retaining walls." According to Table C3.11.1-1 in the *LRFD Bridge Design Specifications* (AASHTO 2017), the wall must move 0.01H to mobilize passive pressure, where H is the height of the wall.

Table 11 presents sliding coefficients for various soil types per article C10.6.3.4 in the *LRFD Bridge Design Specifications* (AASHTO 2017).

Table 11: Sliding Coefficients

Soil Type	Sliding Coefficient, μ[1]	
	Cast-in-Place Concrete	Precast Concrete[2]
Subgrade ESU1B	0.78	0.63
Common backfill	0.62	0.50
Select backfill	0.73	0.58
Gravel backfill	0.78	0.63

Notes:
1. Sliding coefficient (μ = tan[φ']).
2. Reduction factor of 0.80 is used for precast concrete based on Article C10.6.3.4 in the *LRFD Bridge Design Specifications* (AASHTO 2017).

Abbreviations:
Φ' = effective peak friction angle
μ = sliding coefficient
tan = tangent

7.0 Construction and Maintenance Considerations

In addition to the design recommendations, the construction and maintenance concerns addressed in Sections 7.1 through 7.4 should be considered.

7.1 Subgrade Preparation

Subgrade preparation for construction of the grade separation barrier will be addressed by the project Structural Engineer in the Released for Construction plans. Wood geotechnical inspectors should monitor any undercut or over-excavation.

7.2 Maintenance

The grade separation barrier will have a drainage system to prevent hydrostatic pressure and will require maintenance throughout its lifetime. This includes structural inspection, vegetation control, and ensuring that the drainage system remains functional.

8.0 References

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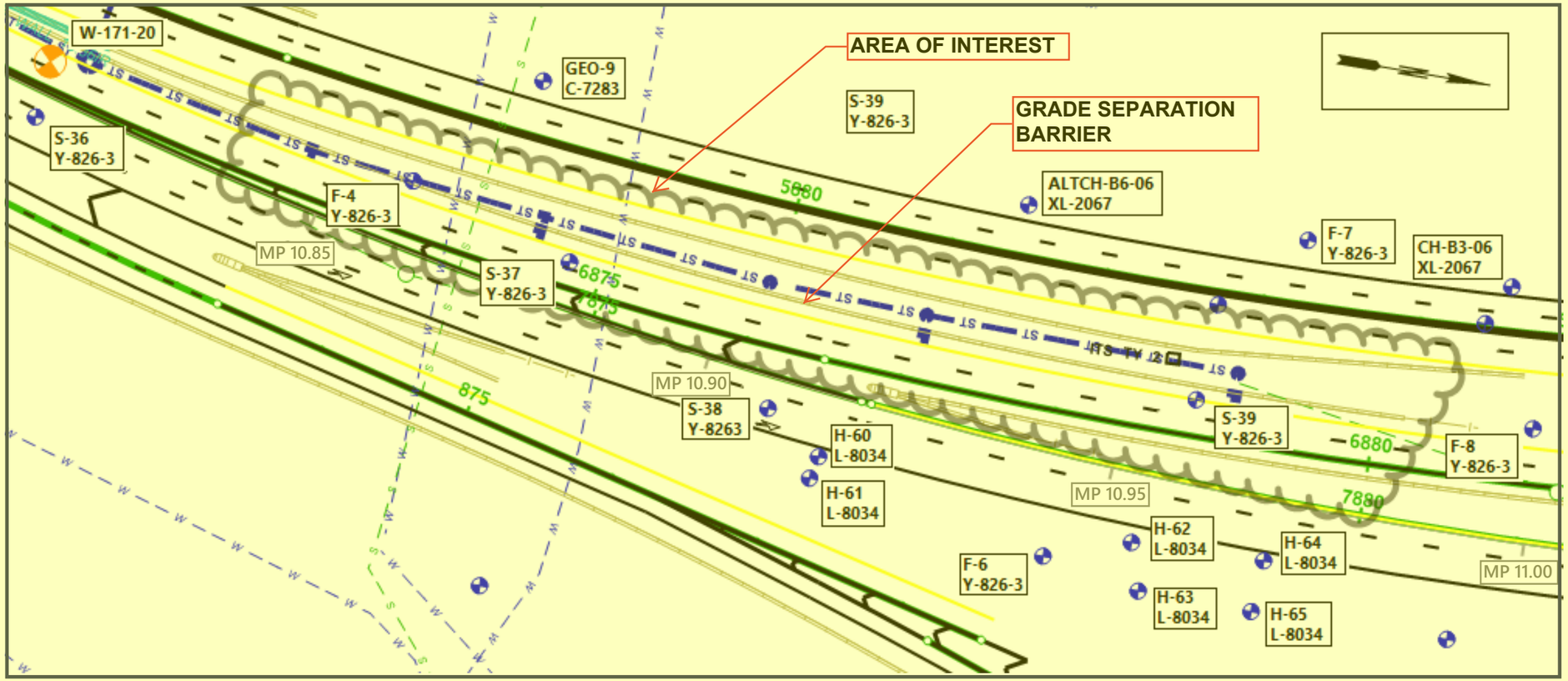
In Association with

Appendix A
Design Plan Sheets and
ESU Cross Sections and Profiles



LEGEND

- HISTORICAL BORE LOCATIONS
- CURRENT EXPLORATION LOCATIONS
- W – BURIED WATER (EXISTING)
- S – BURIED SEWER (EXISTING)
- ST – STORMWATER (EXISTING)
- ITS CABINET
- MILEPOST
- STATION

NOTE: ONLY BORINGS USED IN DEVELOPMENT OF THE ESU ARE LABELED.

FILE NAME						
TIME				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
DATE 4/6/2021						
PLOTTED BY LDN				JOB NUMBER		
DESIGNED BY LDN						
ENTERED BY						
CHECKED BY				CONTRACT NO.		LOCATION NO.
PROJ. ENGR.						
REGIONAL ADM.	REVISION	DATE	BY			

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

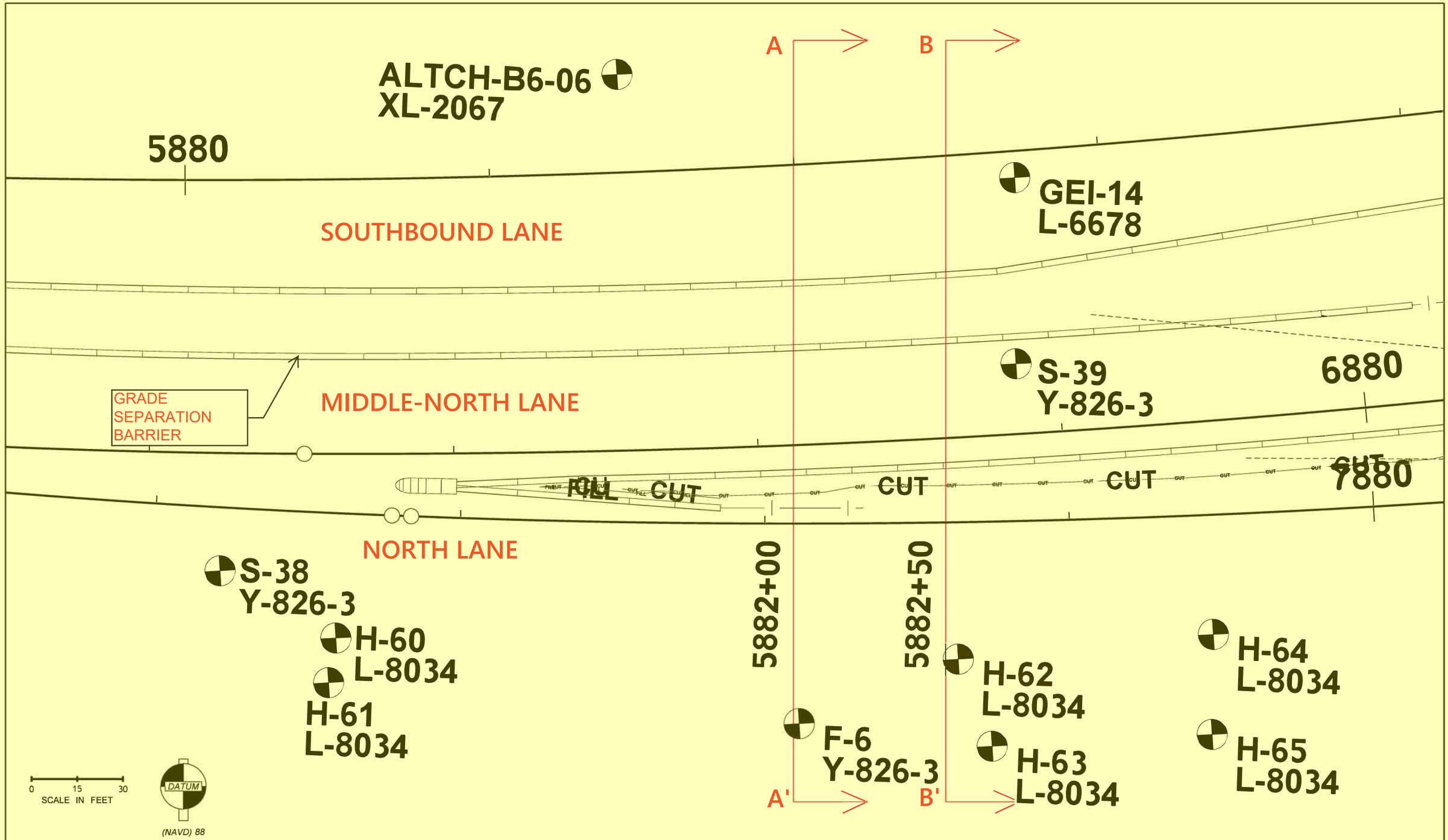
FLATIRON LANE wood.

1-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT
SB MP 10.82 TO 10.99

PLAN, UTILITY AND BORING LOCATIONS

PLAN REF NO

FIGURE 1



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DATE	11/29/2021				10	WASH	
PLOTTED BY	jose.milian				JOB NUMBER		
DESIGNED BY							
ENTERED BY					CONTRACT NO.		LOCATION NO.
CHECKED BY							
PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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P.E. STAMP BOX DATE

Washington State Department of Transportation

FLATIRON LANE

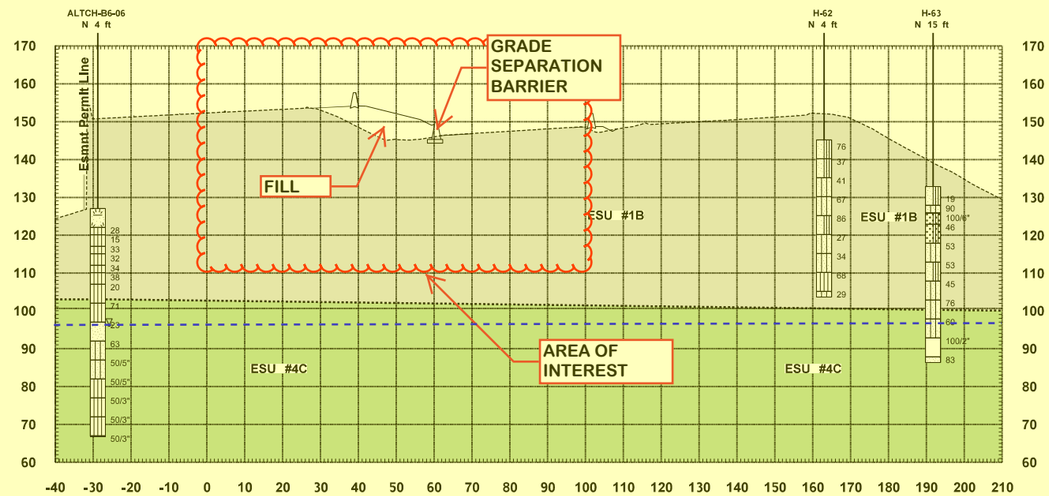
wood.

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT
SB MP 10.82 TO 10.99

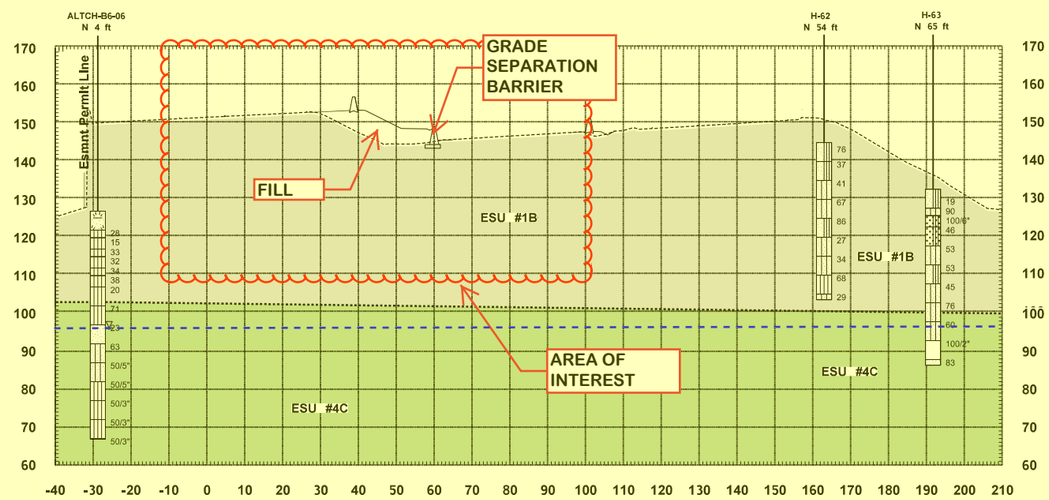
LOCATION OF CROSS SECTIONS

PLAN REF NO

FIGURE 2



a 5882+50



a 5882+00

THE ESU STRATIFICATION HAVE BEEN INTERPRETED, INTERPOLATED BETWEEN EXPLORATIONS, AND EXTRAPOLATED BEYOND EXPLORATIONS FOR ENGINEERING DESIGN PURPOSES. THE STRATA MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS. SEE THE EXPLORATION LOGS FOR DETAILED SUBSURFACE CONDITIONS AT THE LOCATION EXPLORED.

FILE NAME	c:\users\patrick.mccarthy\documents\projectwise\workingdir\wsdot\dms27756\Seg 2B XS 5882+00_5882+50.dgn						
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DATE	12/17/2021			JOB NUMBER			
PLOTTED BY	patrick.mccarthy						
DESIGNED BY							
ENTERED BY	P. MCCARTHY						
CHECKED BY				CONTRACT NO.		LOCATION NO.	
PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

FLATIRON LANE

wood.

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT
SB MP 10.82 TO 10.99

DESIGN CROSS SECTIONS

PLAN REF NO

FIGURE 3

In Association with

Appendix B
Boring Logs

WSDOT

Boring and Test Pit Legend

Sampler Symbols

	Standard Penetration Test
	Non-Standard Sized Penetration Test
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Seal
	Inclinometer Casing or PVC Pipe in Cement Bentonite Grout
	Sand
	Vibe Wire in Grout
	Miscellaneous, noted on boring log

Laboratory Testing Codes

AL	Atterberg Limits
CD	Consolidated Drained Triaxial
CN	Consolidation Test
CSS	Cyclic Simple Shear
CU	Consolidated Undrained Triaxial
DG	Degradation
DN	Density
DS	Direct Shear Test
DSS	Direct Simple Shear
GS	Grain Size Distribution
HT	Hydrometer Test
JS	Jar Slake
LA	LA Abrasion
LOI	Loss on Ignition
MC	Moisture Content
pH	pH of Soil
PT	Point Load Compressive Test
RES	Resistivity
RM	Resilient Modulus
RS	Torsional Ring Shear Test
SG	Specific Gravity
SL	Slake Test
UC	Unconfined Compression Test
UU	Unconsolidated Undrained Triaxial
HC	Hydraulic Conductivity

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0 - 4	Very Loose	0 - 1	Very Soft
5 - 10	Loose	2 - 4	Soft
11 - 24	Medium Dense	5 - 8	Medium Stiff
25 - 50	Dense	9 - 15	Stiff
> 50	Very Dense	16 - 30	Very Stiff
(REF)	Refusal	31 - 60	Hard
		> 60	Very Hard

Angularity

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6 mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6 mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCl Reaction

No HCl Reaction	No visible reaction.
Weak HCl Reaction	Some reaction with bubbles forming slowly.
Strong HCl Reaction	Violent reaction with bubbles forming immediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

WSDOT

Boring and Test Pit Legend

Grain Size

Fine Grained	< 0.04 in	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	0.04 to 0.2 in	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 0.2 in	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	0.15 to 3.6 ksi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3.6 to 7.3 ksi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	7.3 to 15 ksi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15 to 29 ksi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 29 ksi

Discontinuities

Spacing	
Very Widely	Greater than 10 ft
Widely	3 ft to 10 ft
Moderately	1 ft to 3 ft
Closely	2 inches to 12 inches
Very Closely	Less than 2 inches

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition	
Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 0.05 in, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 0.05 in, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 0.2 in thick, or open discontinuities 0.05 to 0.2 in.
Very Poor	Soft gouge greater than 0.2 in thick, or open discontinuities greater than 0.2 in.

Fracture Frequency (FF) is the average number of fractures per 1 ft of core. This does not include mechanical breaks caused by drilling or handling.

Datum:
NAD 83/91 HARN = North American Datum of 1983/1991 High Accuracy Reference Network
NAVD88 = North American Vertical Datum of 1988
SPN (ft) = State Plane North (ft)
SPS (ft) = State Plane South (ft)

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. ALTCH-B6-06

Job No. XL-2067 SR 405 Elevation 127.0 ft

Sheet 1 of 3

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Fetterly, James Lic# 2507

Site Address Vic. Of I-405 & I-90

Inspector Dave Nelson

Start November 8, 2006 Completion November 9, 2006 Well ID# ALM-456

Equipment CME 45 with Autohammer

Station Offset Hole Dia (Inches) 4

Method Wet Rotary

Northing 213780.00 Easting 1309341.00 Latitude Longitude

County King Subsection NE1/4 of SW1/4 Section 9 Range 5 EWM Township 24 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						D-0		ORGANIC Soil with sand, dark brown, top soil and organics		
	125.0									
5				12 16 12 (28)		D-1		Sandy SILT with gravel, sub-rounded, dense, gray, moist, homogenous, HCl not tested, glacier till. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
	120.0			8 8 7 (15)		D-2		Sandy SILT with gravel, sub-rounded, medium dense, gray, moist, homogenous, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
10				10 16 17 (33)		D-3		Sandy SILT with gravel, sub-rounded, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
	115.0			16 15 17 (32)		D-4		Sandy SILT with gravel, sub-rounded, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
15				10 10 24 (34)		D-5		Sandy SILT with gravel, sub-rounded, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
	110.0			12 14 24 (38)		D-6		Sandy SILT with gravel, sub-rounded, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.8 ft. Length Retained 0.8 ft.		
20										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. ALTCH-B6-06

Job No. XL-2067 SR 405 Elevation 127.0 ft

Sheet 2 of 3

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Fetterly, James Lic# 2507

Field SPT (N) / Moisture Content / RQD — 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			4 4 16 (20)		D-7		Sandy SILT with gravel, sub-rounded, medium dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.0 ft. Length Retained 1.0 ft.		
	105								
25			18 35 36 (71)		D-8		Sandy SILT with gravel, sub-rounded, very dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.0 ft. Length Retained 1.0 ft.		
	100								
30			10 11 12 (23)		D-9		Poorly graded SAND with gravel, sub-rounded, medium dense, brown, wet, homogenous, HCl not tested. Length Recovered 1.0 ft. Length Retained 1.0 ft.	▽ 11/09/2006	
	95								
35			25 37 26 (63)		D-10		Silty SAND with gravel, sub-rounded, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
	90								
40			24 50/5" (REF)		D-11		Silty SAND, stratified with sand silt, very dense, brown, wet, stratified, HCl not tested. Length Recovered 1.0 ft. Length Retained 1.0 ft.		
	85								
45									

SOILA XL-2067 SR-405 BEVELLUE DESIGN BUILD.GPJ SOIL.GDT 11/20/06,8:53:41 A11

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. ALTCH-B6-06

Job No. XL-2067 SR 405 Elevation 127.0 ft

Sheet 3 of 3

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Fetterly, James Lic# 2507

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			>>	50/5" (REF)		D-12		Sandy SILT, very dense, brown, wet, homogenous, HCl not tested. Length Recovered 0.3 ft. Length Retained 0.3 ft.		
	80									
50			>>	50/3" (REF)		D-13		Sandy SILT, very dense, gray, moist, homogenous, HCl not tested. Length Recovered 0.2 ft. Length Retained 0.2 ft.		
	75									
55			>>	50/3" (REF)		D-14		Sandy SILT with gravel, sub-rounded, very dense, gray, moist, homogenous, HCl not tested. Length Recovered 0.2 ft. Length Retained 0.2 ft.		
	70									
60			>>	50/3" (REF)		D-15		Sandy SILT, very loose, gray, moist, homogenous, HCl not tested, drilling behavior indicates stratified with sandy silt, sandy silt with gravel, from 2.5' to 60.2'. Length Recovered 0.2 ft. Length Retained 0.2 ft.		
	65							End of test hole boring at 60.2 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note REF = SPT Refusal		
65								Water level before bailing 1' Bailed bore hole water level to 34.8' Recharge after 5 minutes 32.5' Recharge after 10 minutes 32' Recharge after 15 minutes 31.8' Recharge after 20 minutes 31.5' Recharge after 25 minutes 31.5' Recharge after 30 minutes 31.5'		
	60									
70										

SOILA XL-2067 SR-405 BEVELLUE DESIGN BUILD.GPJ SOIL.GDT 11/20/06,8:53:42 A11

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. CH-B3-06

Sheet 1 of 4

Job No. XL-2067 SR 405 Elevation 121.0 ft

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

Site Address Vic. I-405 & I-90

Inspector Judd Joe

Start November 15, 2006 Completion November 17, 2006 Well ID# ALM-455

Equipment CME 45 with Autohammer

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 214089.00 Easting 1309341.00 Latitude Longitude

County King Subsection NE1/4 of SW1/4 Section 9 Range 5 EWM Township 24 N

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	120.0					
		4 9 25 (34)		D-1		Silty SAND with gravel, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.7 ft. Length Retained 0.7 ft.
5						
	115.0					
		14 17 22 (39)		D-2		Silty SAND with gravel, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.8 ft. Length Retained 0.8 ft.
		8 13 21 (34)		D-3		Silty SAND with gravel, Mottled with organics, dense, gray, moist, stratified, HCl not tested, Strat in color. Length Recovered 0.4 ft. Length Retained 0.4 ft.
10						
	110.0					
		10 17 22 (39)		D-4	GS MC	SM, MC=11% Silty SAND, dense, gray, moist, homogenous, HCl not tested. Length Recovered 0.9 ft. Length Retained 0.9 ft.
		18 24 44 (68)		D-5		No Recovery
15						
	105.0					
		20 19 23 (42)		D-6		Silty SAND, with trace gravel, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.5 ft. Length Retained 0.5 ft.
		11 17		D-7		Silty SAND with gravel, and organic debris throughout, very dense, gray, moist, homogenous, HCl not tested.
20						

Groundwater

Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. CH-B3-06

Job No. XL-2067 SR 405 Elevation 121.0 ft

Sheet 2 of 4

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater
		50 (67)				Length Recovered 0.7 ft. Length Retained 0.7 ft.	
	100						
25		13 12 7 (19)		D-8	GS MC	SM, MC=20% Silty SAND, medium dense, gray, wet, homogenous, HCl not tested. Length Recovered 0.4 ft. Length Retained 0.4 ft.	
	95						
30		11 20 32 (52)		D-9		Silty SAND with gravel, and poorly graded sand strati, FEO stains throughout, very dense, grayish brown, moist, stratified, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.	
	90						
						11/16/2006	
35		18 28 21 (49)		D-10		Silty SAND with gravel, and poorly graded sand strati, dense, dark grayish brown, moist, stratified, HCl not tested. Length Recovered 0.5 ft. Length Retained 0.5 ft.	
						11/17/2006	
	85						
40		>> 20 50/6" (REF)		D-11		No Recovery	
	80						
45		>> 50/4" (REF)		D-12		Silty SAND with gravel, very dense, dark grayish brown, moist, homogenous, HCl not tested, Water reading 33.6	

Instrument

SOILA XL-2067 SR-405 BEVELLUE DESIGN BUILD.GPJ SOIL.GDT 12/21/06,12:22:57 P12

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. CH-B3-06

Job No. XL-2067 SR 405 Elevation 121.0 ft

Sheet 3 of 4

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								ft. AM. Length Recovered 0.3 ft. Length Retained 0.3 ft.		
	75									
			>>	50/6" (REF)		D-13	GS MC	SM, MC=10% Silty SAND with gravel, very dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.5 ft. Length Retained 0.5 ft.		
50										
	70									
			>>	50/4" (REF)		D-14		Silty SAND with gravel, very dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.3 ft. Length Retained 0.3 ft.		
55										
	65									
			>>	39 50/5" (REF)		D-15	GS MC	SM, MC=19% Silty SAND, very dense, olive brown, moist, stratified, HCl not tested, Note gray silt at bottom of sample. Length Recovered 0.8 ft. Length Retained 0.8 ft.		
60										
	60									
			>>	50/6" (REF)		D-16		SILT, very dense, grayish brown, moist, stratified, HCl not tested. Length Recovered 0.5 ft. Length Retained 0.5 ft.		
65										
	55									
			>>	22 50/6"		D-17	GS MC	ML, MC=26% SILT, very dense, dark grayish brown, moist,		
70										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68362

HOLE No. CH-B3-06

Job No. XL-2067 SR 405 Elevation 121.0 ft

Sheet 4 of 4

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				(REF)				homogenous, HCl not tested, Water reading 34.7 ft. AM. Length Recovered 0.5 ft. Length Retained 0.5 ft.		
	50									
			>>	50/4" (REF)		D-18		Silty SAND with gravel, very dense, olive brown, moist, stratified, HCl not tested. Length Recovered 0.3 ft. Length Retained 0.3 ft.		
75	45									
				24 23 50 (73)		D-19		SILT, with sandy silt and gravel strati, very dense, olive brown, moist, stratified, HCl not tested. Length Recovered 1.5 ft. Length Retained 1.5 ft.		
80	40									
			>>	50/5" (REF)		D-20		Silty SAND with gravel, very dense, olive brown, moist, stratified, HCl not tested. Length Recovered 0.4 ft. Length Retained 0.4 ft.		
85	35									
			>>	24 50/6" (REF)		D-21		Silty SAND, very dense, dark grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.7 ft. Length Retained 0.7 ft.		
90	30							End of test hole boring at 90 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note REF = SPT Refusal		
95										

H. F. 26,66 (Rev. 10,64)

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STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

LOG OF TEST BORING

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S.R. No. 90
P.S.H.
~~S.S.H.~~ No. 2 Section ECB to EUL Job No. ~~Y-826-6~~ 3 X
Hole No. F-4 Station 185+45 I-405 SB Lanes Offset 32' Rt Ground Elev. 91' +3.6' = 94.6'
Type of Boring ~~Hollow Stem Auger~~ Water Table 1' depth Casing
Inspector DF Kellum Date 10.24.66 Sheet No. 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		Black soft PEAT	S-1	3" shelby 2.5'-4.5'
				Bottom : Black finely divided PEAT to 4.3'
5				
		Yellow gray soft silty CLAY	S-2	Standard penetration 4.5'-6.0' 1/12" 1/6"
				Yellow gray soft silty CLAY with roots and stem fragments
			S-3	3" shelby 7.5'-9.5'
				Bottom yellow gray soft silty CLAY (Top is peat;
10				presumed slough)
			S-4	Standard penetration 9.5'-11.0' 17/6" 35/6" 43/6"
		TILL-LIKE well-graded gravelly silty SAND		Clay to 10.5'; Gray fine to medium silty SAND
			S-5	Standard penetration 12.5'-14.0' 19/6" 30/6" 29/6"
				Well graded gray brown fine silty to coarse gravelly SAND
15				
		Brown fine to coarse gravelly SAND water worked	S-6	Standard penetration 17.5'-19.0' 14/6" 23/6" 41/6"
				Brown fine-coarse silty SAND traces gravel wet
20				
		Hard brown gravelly SAND probable TILL	S-7	Standard penetration 22.5'-24.0' 9/6" 21/6" 31/6"
				Same as above scattered gravel, wet
25				
			S-8	Standard penetration 27.5'-27.9' 50/5"
27.9'		END OF HOLE		TILL : gray well graded gravelly silty SAND

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~~S.S.H.~~ No. 2 Section ECB to EUL Job No. Y-826-3 +3.6' = 87.6'
Hole No. F-6 Station 188+83 I-405 SB Lanes Offset 120' Rt Ground Elev. 84'
Type of Boring Hollow Stem Auger Water Table -0.5' (stands @ surface in pond to West) Casing
Inspector DF Kellum Date 10.25.66 Sheet No. 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		FILL gravelly SAND with blocks asphalt		
		Traces peat		
			S-1	3" shelby 2.5'-4.5' Bottom : Buff to yellow gray silty CLAY with root fragments
5		Yellow gray silty CLAY		
			S-2	Standard penetration 4.5'-6.0' 2/6" 2/6" 2/6" Yellow-gray silty CLAY with root fragments
			S-3	3" shelby 7.5'-8.2' black organic sandy clayey SILT silty CLAY.No RECOVERY (traces in jar) tube bent.
10		Probable water worked TILL silty sandy GRAVEL and GRAVELLY fine-medium silty SAND	S-4	Standard penetration 8.2'-9.7' 23/6" 32/6" 43/6" Gray well graded silty sandy GRAVEL irregular silt patches, wet
			S-5	Standard penetration 12.5'-14.0' 21/6" 24/6" 27/6" Gray gravelly silty fine-medium SAND, damp
15				
			S-6	Standard penetration 17.5'-17.8' 50/3"
17.8		END OF HOLE		Same as above.

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LOG OF TEST BORING

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P.S.H.
~~S.S.H.~~ No. 2 Section ECB to EUL Job No. Y-826-6 3
Hole No. F-7 Station 190+03 I-405 SB Lanes Offset 109' Lt Ground Elev. 84' +3.6' = 87.6'
Type of Boring Washbore Water Table Ground surface Casing
Inspector D.F. Kellum Date 10.25.66 Sheet No. 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		Gray locally rusty silty CLAY, firm		
			S-1	3" shelby 2.5'-5.0'
				Gray, rusty streaks, layered clayey SILT, silty CLAY with plant fragments
5			S-2	Standard penetration 5.0'-6.5' 6/6" 6/6" 7/6"
				Gray silty CLAY
			S-3	3" shelby 7.5'-10.0'
				Gray silty CLAY, rusty streaks, plant fragments
10			S-4	Standard penetration 10.0'-11.5' 3/6" 5/6" 2/6"
				Gray silty CLAY and clayey SILT layered.
		Rocky	S-5	Standard penetration 12.5'-14.0' 35/6" 37/6" 42/6" (BC high, rock in bit)
15		TILL gravelly well graded silty SAND		Gray silty firm CLAY increasing amount of rocks - trace sand at bottom
			S-6	Standard penetration 17.5'-19.0' 24/6" 44/6" 41/6"
19.0'		END OF HOLE		Gray gravelly well graded silty SAND, TILL.
			Note :	S-5 Attempt shelby could not drive. Changed and took a standard penetration @ 12.5'. Shelby tube damaged.

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LOG OF TEST BORING

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S.R. No. 90
P.S.H.
S.S.H. No. 2 Section FCD to EUL Job No. Y-826-3
Hole No. F-8 Station 191+74 I-405 SB Lanes Offset 22' Lt Ground Elev. 97' +3.6' = 100.6'
Type of Boring Hollow Stem Auger Water Table 12' depth Casing
Inspector DF Kellum Date 10.24.66 Sheet No. 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		FILL gravelly SAND 2" PEAT		
			S-1	Standard penetration 2.5'-4.0' 2/6" 2/6" 1/6"
				Brown pea gravelly silty SAND. 2" peat @ 3.5'
5		TILL brown to gray well graded silty SAND with scattered GRAVEL		Hard drilling at 4.0'
			S-2	Standard penetration 7.5'-9.0' 16/6" 24/6" 31/6"
10				Brown well graded gravelly fine to coarse silty SAND TILL
			S-3	Standard penetration 12.5'-13.0' 52/6"
15				Same as above smaller rock fragments
17.9'			S-4	Standard penetration 17.5'-17.9' 50/5"
		END OF HOLE		Brown to gray well graded silty SAND traces pebbles. Probable TILL

Date(s) Drilled	04/16/07	Logged By	ASB	Checked By	KGO
Drilling Contractor	Gregory Drilling	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	6-inch ID	Hammer Data	140 lb hammer/30 in drop automatic	Drilling Equipment	CME-85 Truck-mounted Drill Rig
Total Depth (ft)	46.5	Surface Elevation (ft)	128.0	Groundwater Elevation (ft)	95
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1637416.97 541556.24

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							ML	Brown sandy silt with trace gravel (stiff, moist) (fill)			
125			5	16	1							
	5		18	12	2					17		SA
								ML	Brown silty fine to medium sand with gravel and trace organic matter (medium dense, moist to wet)			
120			12	33	3							Pieces of asphalt
	10		18	10	4					11		Layer with increased gravel content
115			12	6	5				Grades to loose			
	15		1	2	6							Augers sunk under own weight (15 to 17 feet)
110			6	3	7				(wet, very loose)			
	20		12	3	8							
105			18	17	9							
	25		13	8	10							Trace organic matter
100												
	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-9

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-10
Sheet 1 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/10/08

Elevation feet	Depth feet	SAMPLES Interval Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	30	18	20	11			SP-SM	Grayish brown fine to medium sand with silt (medium dense, wet) (fill?)	15		%F = 8
95					▼		CH	Brown fat clay (medium stiff, moist)			
	35	18	6	12					42		AL
90							SM	Grayish brown silty fine to medium sand with gravel (very dense, wet) (advance outwash)			
	40	18	97/11"	13							
85							SP-SM	Grayish brown fine to medium sand with silt (very dense, moist to wet)			
	45	18	72/11"	14					18		2-inch layer of silt %F = 14
80	50										
75	55										
70	60										
65	65										

LOG OF BORING GEO-9 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-10
Sheet 2 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/10/08

LOG OF TEST BORING **WASHINGTON STATE DEPARTMENT OF TRANSPORTATION**

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L-8034

Hole No. H-60 Sub Section LR² South Wall Cont. Sec. 1744/1745

Station LR 186+50 Offset 6.5' Rt. of EOP Ground El. 136.0' +3.6' = 139.6'

Type of Boring Augers Casing ____ W.T. El. Not encountered

Inspector ____ Date December 9, 1985 Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				ACP CSTC
			26 STD	SP/SM. M.C.=4.4%
	77		34 PEN 43 1	Very dense, brown, dry, slightly silty, gravelly, fine to coarse SAND. Retained 1.1'.
5				
	110		44 STD 50 PEN 60 2	SM, M.C.=2.4% Very dense, brown, dry, gravelly, silty, fine to coarse SAND. Retained 1.3'.
10				
	47		26 STD 24 PEN 23 3	SM, M.C.=7.6% Dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.9'.
15				
	33		11 STD 18 PEN 15 4 30	SM, M.C.=9.2% Dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.9'.
20				

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Hole No. H-60 Sub Section Factoria to Northrup HOV Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	98		55 STD 38 PEN 60 5	SM, M.C. = 11.4% Very dense, brown, moist, very silty, fine to medium SAND. Retained 1.3'.
25	19		7 STD 8 PEN 11 6 16	SM, M.C.=15.6% Medium dense, brown, moist, gravelly, very silty, fine to coarse SAND with silt lenses and organic material. Retained 1.0'.
30	67		19 STD 36 PEN 31 7	SM, M.C.=8.5% Very dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.8'.
35				
				Note: After pulling augers, hole stayed open to drilled depth.
				End of boring at 31.5' below ground elevation.
				This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

DOT FORM 351-003A REVISED 4/80

LOG OF TEST BORING **WASHINGTON STATE DEPARTMENT OF TRANSPORTATION**

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L-8034

Hole No. H-61 Sub Section LR2 South Wall Cont. Sec. 1744/1745

Station LR2 South Wall 10+50 Offset LR2 South Wall ℄ Ground El. 131.2' +3.6' = 134.8'

Type of Boring Wash Boring Casing 3" x 20.0' W.T. El. Not determined

Inspector ____ Date October 25/26, 1985 Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			4 STD	SP/SM, M.C.=9.9%
	17		6 PEN	Medium dense, brown, dry, silty, gravelly, fine to coarse SAND.
			11 1	Retained 1.2'.
			30	
5				
			10 STD	SW/SM, M.C.=0.4%
	58		21 PEN	Very dense, brown, dry, silty, gravelly, fine to coarse SAND.
			37 2	Retained 1.0'.
10				
			63 STD	SP/SM, M.C.=0.7%
	115		51 PEN	Very dense, brown, dry, silty, gravelly, fine to coarse SAND.
			64 3	Retained 0.2'.
15				
			76 STD	SM, M.C.=9.7%
	152		59 PEN	Very dense, brown, dry, gravelly, very silty, fine to coarse SAND.
			93 4	Retained 0.8'.
20				

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Hole No. H-61 Sub Section LR2 South Wall Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.		DESCRIPTION OF MATERIAL
	52		22 26	STD PEN	SM, M.C.=7.0% Very dense, brown, dry, gravelly, silty, fine to coarse SAND.
			26 18	5	Retained 1.1'.
25					End of boring at 22.0' below ground elevation.
					This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

DOT FORM 351-003A REVISED 4/80

LOG OF TEST BORING

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L-8034

Hole No. H-62 Sub Section LR2 South Wall Cont. Sec. 1744/1745

Station LR 188+50 Offset 8.0' Rt. of EOP Ground El. 141.5' +3.6' = 145.1'

Type of Boring Augers Casing ____ W.T. El. Not encountered

Inspector ____ Date December 9, 1985 Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				ACP CSTC
	76		32 STD 36 PEN 40 1	SP/SM, M.C.=2.9% Very dense, brown, dry, slightly silty, gravelly, fine to coarse SAND. Retained 1.1'.
5	37		14 STD 21 PEN 16 2	SP/SM, M.C.=6.2% Dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 1.1'.
10	41		11 STD 16 PEN 25 3	SM, M.C.=8.0% Dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.8'.
15	67		24 STD 34 PEN 33 4	SM, M.C.=5.0% Very dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.8'.
20				

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Hole No. H-62 Sub Section Factoria to Northrup HOV Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	86		23 STD 36 PEN 50 5	SP/SM, M. C.=5.4% Very dense, brown, dry, silty, gravelly, fine to coarse SAND with silt lenses. Retained 1.1'.
25				
	27		7 STD 14 PEN 13 6 19	SM, M.C.=10.2% Dense, brown, moist, gravelly, very silty, fine to coarse SAND with silt lenses and organic material. Retained 1.3'.
30				
	34		24 STD 15 PEN 19 7	SM, M.C.=9.3% Dense, brown, dry, gravelly, silty, fine to coarse SAND with organic material. Retained 1.0'.
35				
	68		17 STD 22 PEN 46 8	ML, M.C.=8.8% Very dense, brown, dry, gravelly, fine to medium sandy SILT with silt lenses. Retained 1.0'.
40				
	29		13 STD 14 PEN 15 9	SM, M.C.=3.4% Medium dense, brown, dry, gravelly, silty, fine to coarse SAND. Retained 0.8'.
				Note: After pulling augers, hole caved in at -13.5'.
				End of boring at 41.5' below ground elevation.
45				This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

LOG OF TEST BORING **WASHINGTON STATE DEPARTMENT OF TRANSPORTATION**

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L -804

Hole No. H-63 Sub Section LR2 South Wall Cont. Sec. 1744/1745

Station LR2 South Wall 12+60 Offset LR2 South Wall ℄ Ground El. 129.2' +3.6' = 132.8'

Type of Boring Wash Boring Casing 3" x 30.0' W.T. El. Not determined

Inspector ____ Date October 28/November 5, 1985 Sheet 1 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			3 STD	SP/SM, M.C.=5.8%
	15		6 PEN	Medium dense, brown, dry, silty, gravelly, fine to coarse SAND.
			9 1	Retained 1.1'.
			10	
5				
			31 STD	SM, M.C.=2.9%
	90		40 PEN	Very dense, brown, dry, silty, gravelly, fine to coarse SAND.
			50 2	Retained 0.8'.
			STD	SW/SM, M.C.=0.6%
	100/6"		100 PEN	Very dense,brown/gray, dry, silty, gravelly, fine to coarse SAND.
			3	Retained 0.3'.
10				
			25 STD	SW/SM, M.C.=6.6%
	46		26 PEN	Dense, brown, dry, gravelly, silty, fine to coarse SAND. Retained 0.5'.
			20 4	
15				
			18 STD	SM, M.C.=10.2%
	53		29 PEN	Very dense, brown/gray, moist, gravelly, silty, fine to coarse SAND.
			24 5	Retained 1.0'.
20				

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Hole No. H-63 Sub Section LR 2 South Wall Sheet 2 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	53		50 STD 28 PEN 25 6	SP/SM, M.C.=2.7% Very dense, brown, dry, silty, gravelly, fine to coarse SAND with traces of organic material. Retained 0.7'.
25	45		24 STD 15 PEN 30 7	SM, M.C.=9.6% Dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.3'.
30	76		34 STD 42 PEN 34 8	SM, M.C. =6.4% Very dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.4'.
35	60		39 STD 36 PEN 24 9	SM, M.C.=5.9% Very dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.7'.
40	100/2"		100/2" STD PEN 10	No recovery.
45				

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1986b WSDOT Fact-northrup

Hole No. H-63 Sub Section LR 2 South Wall Sheet 3 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			82 STD	SP, M.C.=8.3%
	83		49 PEN	Very dense, brown, dry, slightly silty, gravelly, fine to coarse SAND.
			39 11	Retained 0.4'.
50				
				Note: Used a slurry of Bentonite drilling fluid from -30.0' to 45.0'.
				End of boring at 46.5' below ground elevation.
				This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

DOT FORM 351-003A (X) REVISED 4/80

LOG OF TEST BORING

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L-8034

Hole No. H-64 Sub Section LR2 South Wall Cont. Sec. 1744

Station LR2 189+54 Offset 17.5' Lt. LR2 Ground El. 143.5' +3.6' = 147.1'

Type of Boring Augers Casing ____ W.T. El. Not encountered

Inspector ____ Date D cember 10, 1985 Sheet 1 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				ACP CSTC
			24 STD	SW/SM, M.C.=1.3%
	102		52 PEN 50 1	Very dense, brown, dry, silty, gravelly,fine to coarse SAND. Retained 1.2'.
5				
	59		14 STD 23 PEN 36 2	SP/SM, M.C.=7.4% Very dense, brown, dry, gravelly, silty, fine to coarse SAND. Retained 1.1'.
10				
	99		25 STD 38 PEN 61 3	SW/SM, M.C.=5.3% Very dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 1.0'.
				Gravelly from -12.0' to -13.5' with cobbles
15				
	38		15 STD 20 PEN 18 4 20	SM, M.C.=9.0% Dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 1.0'.
20				

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1986b WSDOT Fact-northrup

Hole No. H-64 Sub Section LR2 South Wall Sheet 2 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	118		27 STD 52 PEN 66 5	SM, M.C.= 5.2% Very dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.5'.
25	146		31 STD 58 PEN 88 6	SP/SM, M.C.=7.7% Very dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 1.0'.
30	121		42 STD 69 PEN 52 7	SM, M.C.=9.3% Very dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.8'.
35	100/6"		100 STD PEN 8	SM, M.C. =10.1% Very dense, brown, moist, gravelly, very silty, fine to medium SAND. Retained 0.2'.
40	38		9 STD 16 PEN 22 9	SM, M.C.=13.6% Dense, brown, moist, gravelly, very silty, fine to medium SAND. Retained 1.2'.
45				

1986b WSDOT Fact-northrup

Hole No. H-64 Sub Section LR2 South Wall Sheet 3 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	41		5 STD 18 PEN 23 10	Dense, brown, moist, gravelly, very silty, fine to medium SAND. Retained 0.2'.
50				
				Note: After pulling auger, hole caved in at -20.0'.
				End of boring at 46.5' below ground elevation.
				This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

DOT FORM 351-003A REVISED 4/80

LOG OF TEST BORING WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

1986b WSDOT Fact-northrup

S.H. ____ S.R. 405 SECTION Factoria to Northrup HOV Job No. L-8034

Hole No. H-65 Sub Section LR2 South Wall Cont. Sec. 1744

Station LR2 189+50 Offset 17' Rt. LR2 Ground El. 128.0' +3.6' = 131.6'

Type of Boring Wash Boring Casing 3" x 15.0' W.T. El. Not determined

Inspector ____ Date October 5-7, 1985 Sheet 1 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			3 STD	SP/SM, M.C.=3.4%
	26		10 16 PEN 1	Dense, brown, dry, silty, gravelly, fine to coarse SAND with boulder. Retained 0.4'.
5				
	35		14 11 24 STD PEN 2	SP/SM, M.C.=5.1% Dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 1.0'.
10				
	145		25 68 77 STD PEN 3	SW/SM, M.C.=6.4% Very dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.6'
15				
	26		16 11 15 STD PEN 4	SP/SM, M.C.=5.9%. Dense, brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.3'.
20				

DOT FORM 351-003 REVISED 12/79

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Hole No. H-65 Sub Section LR2 South Wall Sheet 2 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.		DESCRIPTION OF MATERIAL
	35		24 16 19	STD PEN 5	SM, M.C.=9.0% Dense, brown, dry, gravelly, very silty, fine to coarse SAND. Retained 0.4'.
25					
	29		12 13 16 11	STD PEN 6	SM, M.C.=9.1% Dense, brown, dry, gravelly, very silty, fine to coarse SAND Retained 0.3'.
30					
	24		26 12 12 12	STD PEN 7	No recovery.
35					
	16		16 10 6 24	STD PEN 8	SM, M.C.=9.3% Medium dense, brown, dry, gravelly, silty, fine to coarse SAND. Retained 0.6'.
40					
	74		74 43 31	STD PEN 9	SM, M.C.=2.6% Very dense, gray-brown, dry, silty, gravelly, fine to coarse SAND. Retained 0.5'.
					End of boring at 41.5' below ground elevation.
					See attached sheet 3 of 3 for note
45					

DOT FORM 351-003A REVISED 4/80

1986b WSDOT Fact-northrup

Hole No. H-65 Sub Section LR2 South Wall Sheet 3 of 3

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				Note: Drilled with Bentonite drilling fluid from -15.0'. Had minor loss of drilling fluid from -15.0' to -40.0' coming up outside of casing.
				This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

DOT FORM 351-003A REVISED 4/80

H. F. 26.66 (Rev. 10-64)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

LOG OF TEST BORING

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S.R. No. I-90
P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-36 Station 131#73 PSH 1 (Alt) Offset 156' Rt Ground Elev. 93.5 +3.6' = 97.1'
Type of Boring Hollow Stem Auger Water Table see sheet #2 Casing
Inspector DF Kellum Date 4-22-66 Sheet No. 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		organic top soil		Traces peat upper 18" in disturbed top soil.
	V	Brown silty SAND traces gravel wet	1	Standard penetr. 2.5'-4.0' 7/6" 11/6" 16/6" 0.4' rec. Brown organic silty SAND soil
5			2	Standard penetr. 5.0'-6.5' 8/6" 11/6" 11/6" 0.5' recov Brown wet silty SAND
			3	Standard penetr. 7.5'-9.0' 12/6" 17/6" 21/6" 1.0' recov Brown wet slightly medium SAND.
10		------		
		sandy GRAVEL wet	4	Standard penetr. 10.0'-11.5' 37/6" 28/6" 45/6" 1.5' rec. Gray-brown silty coarse sandy GRAVEL wet.
			5	Standard penetr. 12.5'-13.3' 53/6" 50/3" 0.8' recov. Gray brown fine-coarse silty sandy GRAVEL, wet.
15		------		
		Gray with brown zones fine to coarse SAND occas. sandy GRAVEL all saturated	6	Standard penetr. 17.5'-18.3' 25/6" 50/3" 0.8' recov. Gray clean fine-very coarse SAND? wet.
20				
			7	Standard penetr. 22.5'-22.8' 50/3" 0.3' recov. Gray brown clean very coarse sandy GRAVEL wet.
25				
			8	Standard penetr. 27.5'-28.3' 34/6" 50/3" 0.2' recov. Gray brown clean very coarse SAND, wet.
30				
			9	Standard penetr. 32.5'-33.2' 55/6" 50/2" 0.7' recov. Brown silty well graded fine-very coarse SAND, saturated.
35				

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P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-36 Station 131+73 PSH 1 (Alt) Offset 156' Rt Ground Elev. 93.5
Type of Boring Hollow Stem Auger Water Table see sheet #2 Casing
Inspector DF Kellum Date 4-22-66 Sheet No. 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		(cont.) see sheet # 1		
			10	Standard penetr. 37.5'-38.5 66/6" 75/6" 1.0' recov.
				Gray silty SAND, wet.
40		Gray well graded silty sand to sandy SILT TILL-LIKE		
			11	Standard penetr. 42.5'-42.9' 50/4" 0.4' recov.
				Gray well graded sandy SILT
45				
			12	Standard penetr. 47.5'-47.6' 50/1" 0.2' recov.
				Gray well graded sandy SILT TILL-LIKE
50				
			13	Standard penetr. 53.0'-53.3' 50/3" 0.2' recov.
				Gray hard SILT with scattered pebbles.
53.3		END OF HOLE		
				Ground saturated below depth 3'
				13 Standard penetrometer sample attempts
				13 " " " recoveries
				No other sampling.

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S.R. No. I-90
P.S.H.
~~S.S.H.~~ No. 2 Section ECB to EUL Job No. Y-826-3
~~Hole~~ No. S-37 Station 184+03 ℄ PSH 1 (Alt) Offset 156' Rt Ground Elev. 92.5 +3.6' = 95.1'
Type of Boring Hollow Stem Auger Water Table Casing
Inspector DF Kellum Date 4-21-66 Sheet No. 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		PEAT and soil		
?	V			
			1	~~2¼" Shelby 2.5'-4.5'~~
5				
		Gray brown to GRAY silty to clean fine to coarse SAND saturated	2	~~Standard penetr. 5.0'-6.5' 4/6" 9/6" 14/6" 1.5' recov.~~ Brown saturated SAND with organic material
			3	~~xStandard 2¼" Shelby 7.5'-9.5'~~ sand
10				
			4	~~Standard penetr. 10.0'-11.5' 6/6" 19/6" 24/6" 1.0' rec.~~ Brown-gray slightly silty coarse SAND, wet.
			5	~~Standard penetr. 12.5'-14.0' 6/6" 11/6" 20/6" 1.0' rec.~~
15				~~Brown-gray silty to fairly clean fine coarse SAND, wet~~
			6	~~Standard penetr. 15.0'-16.5' 19/6" 30/6" 50/6" 1.0' rec.~~ Gray brown silty fine-coarse SAND, wet
			7	~~Standard penetr. 17.5'-19.0' 27/6" 31/6" 45/6" 1.5' rec.~~ Gray silty fine-coarse SAND, wet.
20				
			8	~~Standard penetr. 20.0'-21.0' 20/6" 40/6" 1.0' recov.~~ Clean gray medium to very coarse SAND, wet.
		Gray sandy GRAVEL saturated	9	~~Standard penetr. 22.5'-23.5' 25/6" 57/6" no rec.~~ (Gravelly material)
25				
			10	~~Standard penetr. 25.0'-25.8' 40/6" 50/3" 0.7' recov.~~ Gray fairly clean fine-very coarse sandy GRAVEL.
			11	~~Standard penetr. 27.5-28.8' 36/6" 42/6" 50/3" 1.3' rec.~~ Gray SILT
30				
		Probable TILL see sheet # 2	12	~~Standard penetr. 30.0'-30.3' 75/3" 0.3' recov.~~ Gray well graded very silty fine-coarse SAND with pea gravel. TILL-LIKE
			13	~~Standard penetr. 32.5'-32.8' 75/3" 0.2' recov.~~
35				Gray well graded very silty fine-medium SAND trace very coarse sand

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P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-37 Station 184+03 ℄ Ex PSH 1 (Alt) Offset 156' Rt Ground Elev. 92.5
Type of Boring Hollow Stem Auger Water Table see sheet #2 Casing
Inspector DF Kellum Date 4.21.66 Sheet No. 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		(cont.)	14	Standard penetr. 35.0'-35.3' 75/3" 0.3' recov.
				Gray well graded very silty SAND TILL-LIKE
		Probable	15	Standard penetr. 37.5'-37.8' 75/4" 0.3' recov.
		TILL		Gray very silty well graded medium SAND, SILT.
40		gray		
		well	16	Standard penetr. 40.0'-40.3' 75/4" 0.3' recov.
				Gray well graded sandy SILT TILL-LIKE
		graded	17	Standard penetr. 42.5'-42.8' 75/4" 0.3' recov.
				Gray very silty well graded SAND TILL-LIKE
		sand		
45		and	18	Standard penetr. 45.0'-45.4' 75/5" 0.4' recov.
				Gray silty well graded SAND
		sandy	19	Standard penetr. 47.5'-47.8' 75/3" 0.3' recov.
		SILT		Gray silty fine-medium SAND saturated
50		with		
		water	20	Standard penetr. 50.0'-50.3' 75/4" 0.3' recov.
				Gray very silty fine SAND saturated.
		bearing	21	Standard penetr. 52.5'-52.8' 75/4" no recov.
			22	Standard penetr. 55.0'-55.3' 75/3" 0.3' recov.
		zones		Gray well graded very silty SAND, sandy SILT, TILL-LIKE
55				
55.3		END OF HOLE		Water bearing sands crop out on hill side adjacent to drill site materials, wet or saturated from about 3' downward to depth 30'. Water bearing zones in probable TILL below depth 30'.
				20 standard penetrometer sample attempts 2 shelby sample attempts.

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S.R. No. I-90
P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-38 Station 186+42 ℄ Ex PSH 1 (Alt) Offset 267' Rt Ground Elev. 93.7'
Type of Boring Hollow Stem Auger Water Table see sheet #2 Casing
Inspector DF Kollum Date 4-6-66 Sheet No. 1 of 2

+3.6'
= 97.3'

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		FILL BROWN silty gravelly SAND	1	Standard penetr. 2.5'-4.0' 8/6" 7/6" 7/6" 1.5' recov.
PERCHED				Brown very silty well graded fine-medium gravelly SAND damp.
5		silty SAND wet	2	Standard penetr. 5.0'-6.5' 2/6" 15/6" 1.5' recov.
				Gray brown fine-coarse saturated SAND, with streaks very silty dryer SAND, trace gravel.
			3	2¼" Shelby 7.5'-9.5' 1.2' recov.
10				Gray brown medium silty SAND traces gravel
		Gray clayey SILT and CLAY	4	Standard penetr. 10.0'-11.5' 1/18" 1.5' recov.
				Gray clayey SILT with plant stems.
			5	2¼" Shelby 12.5'-14.5' 2.0' recov.
15				Gray CLAY
			6	Standard penetr. 15.0'-16.5', 1/18" 1.5' recov.
				Gray CLAY
		Gray brown silty SAND traces to gravelly all saturated	7	2¼" Shelby 17.5'-19.5' 2.3 recov.
20				Bottom : fine-medium SAND. (4" heave)
			8	Standard penetr. 20.0'-21.5' 13/6" 28/6" 32/6" 1.5' recov
				Gray with rusty streaks, slightly silty fine-medium SAND traces pea gravel. Saturated.
			9	Standard penetr. 22.5'-24.0' 13/6" ~~14/6"~~ 43/6" 50/6" 1.5' recov
25				Brown-gray, rusty in part, silty fine-coarse SAND, trace pea gravel. Wet.
			10	Standard penetr. 25.0'-26.5' 3/6" 14/6" 39/6" 1.5' recov
				Brown, wet, silty SAND - streaks fine and coarse
		TILL gravelly SAND to sandy GRAVEL with zones sandy SILT	11	Standard penetr. 27.5'-28.3' 8/6" 60/4" 0.8' recov
30				Sand to 28.0'. Gray very silty well graded gravelly SAND (TILL)
			12	Standard penetr. 30.0'-30.5' 60/6" 0.5' recov.
				Gray, damp, well graded slightly clayey silty sandy GRAVEL (TILL)
			13	Standard penetr. 32.5'-33.5' 16/6" 60/6" 1.0' recov.
35				Gray well graded gravelly fine-coarse sandy SILT (TILL)

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S.R. No. I-90
P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-38 Station 186+42 ℄ Ex PSH 1 (Alt) Offset 267' Rt Ground Elev. 93.7'
Type of Boring Hollow stem auger Water Table see sheet 2 Casing
Inspector DF Kellum Date 4-6-66 Sheet No. 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		(cont.) TILL	14	Standard penetr. 35.0'-35.4' 60/5" 0.5' recov.
		Gray very silty gravelly SAND		Gray very silty fine-coarse SAND trace gravel, damp (TILL)
			15	Standard penetr. 37.5'-37.9' 60/5" 0.4' recov.
				Gray very silty fine-very coarse gravelly SAND damp (TILL)
40				
		with zones silty SAND damp throughout		
			16	Standard penetr. 42.5'-42.8' 60/4" 0.4' recov.
				Gray very silty fine-cery coarse SAND and layer silty
45				medium SAND (TILL) Damp.
			17	Standard penetr. 47.5'-47.8 60/4" 0.3' recov.
				Gray very silty fine-very coarse SAND damp (TILL)
50				
		Layered fine and fine-medium SAND very silty	18	Standard penetr. 52.5'-53.4' 33/6" 60/5" 0.9' recov.
				Gray tratified fine and fine to medium very silty SAND.
55				
		Gray very fine sandy SILT	19	Standard penetr. 57.5'-58.4' 30/6" 60/5" 0.9' recov.
				Gray very fine sandy SILT.
60			20	Standard penetr. 62.5'-64.0' 11/6" 14/6" 22/6" 1.5' recov
				Gray very silty CLAY with sattered fine-very coarse sand.
		Gray very silty CLAY	21	2¼" Shelby 64.5'-66.0' 1.5' recov.
				Gray CLAY with scattered fine-very coarse SAND.
65				
66.0				17 standard penetrometer sample attempts
				4 Shelby sample attempts
				Perched water @ depth 4'-28' No other definite water table

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S.R. No. I-90
P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3
Hole No. S-39 Station 189+12 ℄ Ex PSH 1 (Alt) Offset 225' Rt Ground Elev. 93.7'
Type of Boring Hollow Stem Auger Water Table see sheet 2 Casing +3.6' = 97.3'
Inspector DF Kellum Date 4.4.66 Sheet No. 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		Dark brown gravelly SAND		
				Standard penetr. 2.5' to 4.5' 1/6" 1/6" 1/6" 1/6" 1.0' recov.
			1	Dark brown silty gravelly SAND (FILL) damp
5				
		FILL wet	2	Standard penetr. 5.0'-6.5' 1/6" 1/6" 2/6" 0.5' recov.
				As above (FILL)
PERCHED		V	3	Std. Penet. 7.5'-9.0' 2/6" 3/6" 3/6" 1.0 rec. (Fill)
			4	2¼" Shelby 10.0'-12.0' 0.5' recov.
10		PEAT		Top SAND slough sample in poor condition
				Bottom PEAT Last layer : 0.5' clayey material
		sandy CLAY	5	Standard penetr. 12.5'-14.0' 2/6" 1/6" 3/6" (no recov.)
				Probable gray sandy CLAY.
15				
		Gray clayey silty SAND	6	Standard penetr. 15.0'-16.5' 8/6" 32/6" 38/6" 1.5' recov
				Gray clayey silty SAND damp.
			7	Standard penetr. 17.5'-19.0 21/6" 33/6" 35/6" 1.5' rec.
20				Gray very clayey silty SAND well graded, damp.
		TILL Gray very silty to well graded slightly clayey SAND traces gravel	8	Standard penetr. 22.5'-23.3' 25/6" 50/3" 0.8' recov.
				Gray well graded slightly clayey silty fine-very coarse
25				SAND. Saturated
			9	Standard penetr. 27.5'-28.3' 25/6" 50/3" 0.7' recov.
				Gray very silty fine-coarse SAND trace gravel, wet.
30				
			10	Standard penetr. 32.5'-32.9' 50/5" 0.8' recov.
				Gray well graded silty slightly clayey SAND trace gravel
35				slightly damp (TILL)

H. F. 26.66 (Rev. 10-64)

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DEPARTMENT OF HIGHWAYS
LOG OF TEST BORING

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P.S.H.
S.S.H. No. 2 Section ECB to EUL Job No. Y-826-3

Hole No. S-39 Station 189+12 ℄ Ex PSH 1 (Alt) Offset 225' Rt Ground Elev. 93.7'

Type of Boring Hollow Stem Auger Water Table see sheet #2 Casing

Inspector DF Kellum Date 4-4-66 Sheet No. 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
		(cont.)		
		TILL		
		Gray well graded silty to slightly clayey SAND with occasional trace gravel	11	Standard penetr. 37.5'-37.8' 50/3" 0.5' recov.
40				Gray well graded slightly clayey very silty fine to coarse SAND, trace small gravel. Slightly damp (TILL)
			12	Standard penetr. 42.5'-42.8' 50/3" 0.2' recov.
45				Gray well graded very silty fine-coarse SAND (TILL)
			13	Standard penetr. 47.5'-47.8' 50/3" 0.2' recov.
50				Same as above (TILL)
			14	Standard penetr. 52.5'-52.8' 50/4" 0.3' recov.
55				Gray well graded very silty fine-very coarse SAND (TILL)
		V		
			15	Standard penetr. 57.5'-57.8' 50/3" 0.4' recov.
60				Gray well graded very silty fine-very coarse SAND, saturated (TILL)
61.0			15	Standard penetr. 60.0'-61.0' 20/6" 50/6" 0.8' recov.
		END OF HOLE		Gray very fine, very silty SAND, wet, no free water.
				15 standard penetrometer sample attempts
65				14 " " " recoveries
				1 shelby sample
				Perched water @ 7.5'
				Water table beneath TILL @ depth 57.0'

Field Soil Description

wood.

ORDER OF CLASSIFICATION TERMS

1. Soil classification
2. Relative density/consistency
3. Color (based on Munsell Color Chart)
4. Moisture
5. Structure
6. Other - plasticity, dilatancy, organics, odor

Geologic Name: Fill, Glacial Till, etc. (optional - ask project manager)

EXAMPLES

Well graded GRAVEL, with cobbles and boulders, subrounded, medium dense, grayish brown, wet, homogeneous, no HCL reaction or HCL not tested (Alluvium) SM

Silty fine SAND with gravel, prevalent roots and fine organics, subrounded, loose, brownish black, moist, no HCL reaction or HCL not tested (Relict Topsoil) SM

Fibrous or amorphous PEAT with or without some silt/clay; PT

Fat CLAY with sand, medium stiff, dark gray, wet, blocky, no HCL reaction or HCL not tested (Lawton Clay) CH

RELATIVE DENSITY OF GRANULAR SOILS (Cohesionless Silt, Sand, and Gravel)

N, SPT, BLOWS/FT	RELATIVE DENSITY	FIELD TEST FOR RELATIVE DENSITY OF SAND*
0-4	Very loose	Penetrated 3 feet or more by hand probe
4-10	Loose	Penetrated 1 to 2 feet by hand probe
11-24	Med-dense	Penetrated 3 to 12 inches by hand probe
25-50	Dense	Penetrated 1 to 3 inches by hand probe
Over 50	Very Dense	Penetrated less than 1 inch by hand probe * varies with soil type

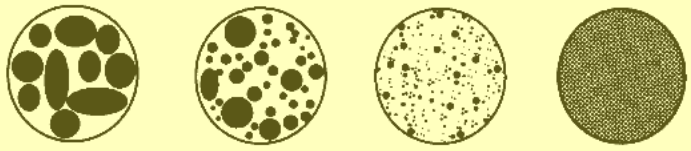
RELATIVE CONSISTENCY OF COHESIVE SOILS (Cohesive, Silt, and Clay)

N, SPT, BLOWS/FT	RELATIVE DENSITY	TORVANE, tsf SHEAR STR.	POC. PEN., tsf UNCONF. STR.	MANUAL PENETRATION TEST
0-1	Very soft	<0.13	<0.25	Easy several inches by fist
2-4	Soft	0.13 - 0.25	0.25 - 0.5	Easy several inches by thumb
5-8	Medium stiff	0.25 - 0.5	0.5 - 1	Moderate several inches by thumb
9-15	Stiff	0.5 - 1	1 - 2	Readily indented by thumb
16-30	Very stiff	1 - 2	2 - 4	Readily Indented by thumbnail
30-60	Hard	>2	>4	Difficulty by thumbnail

SOIL STRUCTURE

Stratified	Alternating layers of varying material or color with layers at least 6mm (1/4") thick
Laminated	Alternating layers of varying material or color with layers less than 6 mm (1/4") thick
Seam	2 to 13 mm (1/16" - 1/2") thick
Layer	13 to 305 mm (1/2" - 12") thick
Occasional	One or less per foot of thickness
Frequent	More than one per foot of thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear to be polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, generally discontinuous, such as small lenses of sand through out a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout

GRAIN SIZE



Coarse Sand | Medium Sand | Fine Sand | Fine <#200

UNIFIED SOIL CLASSIFICATION SYSTEM (From ASTM D-2488 & 2487-90)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
Coarse-Grained Soils (more than 50% retained on No. 200 sieve)	Gravels (more than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (less than 10% fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixutres
		Gravels with Fines (>10% fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Clean Sands (<10% fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sand, Gravelly Sands, Little or No Fines
		Sands with Fines (>10% fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (liquid limit less than 50)	Inorganic	ML	Inorganic silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		Organic	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays (liquid limit 50 or more)	Inorganic	CH	Inorganic Clays of Medium to High Plasticity, Sandy Fat Clay, Gravelly Fat Clay
			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils, Elastic Silt
		Organic	OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils	Primarily organic matter, dark in color, and organic ordor		PT	Peat, Humus, Swamp Soils with High Organic Content (See D 4427-92)

MOISTURE CONTENT

Dry - Dusty, dry to touch

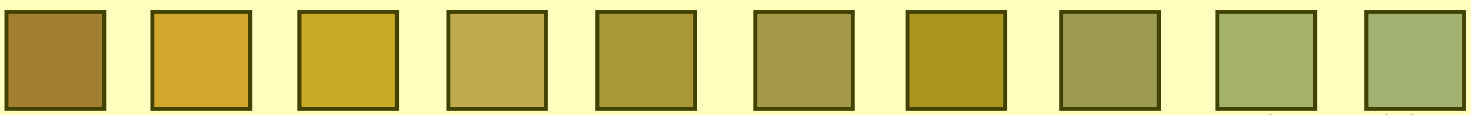
Moist - Damp but no visible water

Wet - Visible free water

ORGANIC CONTENT

ADJECTIVE	PERCENT BY VOLUME
Scattered	1 - 10
Numerous	10 - 30
Organic	30 - 50 minor constituent
PEAT	50 - 100 MAJOR constituent
Describe type and size of organic debris	

MUNSELL COLORS:



Reddish Brown | Brownish Yellow | Olive Yellow | Light Yellow Brown | Light Olive Brown | Grayish Brown | Olive | Grey | Greenish Gray | Bluish Grey

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (GREATER THAN 12% FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50 OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (GREATER THAN 12% FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	INORGANIC		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		ORGANIC		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50	INORGANIC		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
		ORGANIC		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS
FILL SOILS				FILL (AF)	HUMAN ALTERED SOIL OR MODIFIED LAND

NOTES:

1. SOIL DESCRIPTIONS ARE BASED ON THE GENERAL APPROACH PRESENTED IN THE STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE), AS OUTLINED IN ASTM D 2488. WHERE LABORATORY INDEX TESTING HAS BEEN CONDUCTED, SOIL CLASSIFICATIONS ARE BASED ON THE STANDARD TEST METHOD FOR CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES, AS OUTLINED IN ASTM D 2487.

2. SOIL DESCRIPTION TERMINOLOGY IS BASED ON VISUAL ESTIMATES (IN THE ABSENCE OF LABORATORY TEST DATA) OF THE PERCENTAGES OF EACH SOIL TYPE AND IS DEFINED AS DESCRIBED BELOW:

3. DUAL SYMBOLS (E.G. SP-SM, OR GP-GM) ARE USED TO INDICATE A SOIL WITH AN ESTIMATED 5-12% FINES.

   PRIMARY CONSTITUENT: >50% - "GRAVEL", "SAND", "SILT", "CLAY", etc.
   SECONDARY CONSTITUENTS: >12% and ≤50% - "gravelly", "sandy", "silty", etc.
   ADDITIONAL CONSTITUENTS: >5% and ≤12% - "some gravel", "some sand", "some silt", etc.
   ≤5% - "trace gravel", "trace sand", "trace silt" etc. or not noted.

4. RELATIVE DENSITY OF SOIL IS BASED ON STANDARD TEST METHOD FOR PENETRATION TEST (SPT) AND SPLIT-BARREL SAMPLING OF SOILS ASTM D 1586 OR CORRELATIONS FOR OTHER SIMPLER TYPES AND METHODS FOR SPT SAMPLING, THE FOLLOWING BLOW COUNT CORRELATION APPLIES.

   A. RELATIVE DENSITY OF COARSE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
   - VERY LOOSE: N = ≤4
   - LOOSE: N = >4 AND ≤10
   - MEDIUM DENSE: N = >10 AND ≤30
   - DENSE: N = >30 AND ≤50
   - VERY DENSE: N = >50

   B. RELATIVE CONSISTENCY OF FINE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
   - VERY SOFT: N = <2
   - SOFT: N = ≥2 AND ≤4
   - MEDIUM STIFF: N = >4 AND ≤8
   - STIFF: N = >8 AND ≤15
   - VERY STIFF: N = >15 AND ≤30
   - HARD: N = >30

Wood Environment & Infrastructure Solutions, Inc.
4020 Lake Washington Blvd. NE, Suite 200
Kirkland, Washington 98033

wood.

SOIL CLASSIFICATION CHART / KEY

DATE: JUNE 2018
SCALE: NOT TO SCALE
PROJECT NO.
FIGURE: B-1

DRAWN BY: JRS CHECKED BY: JD

wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-171-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 7/20/20 **COMPLETED** 7/20/20 **GROUND ELEVATION** 135.3 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Holt Services **DRILL RIG** Mobile B-58 ID: 916 **SPT HAMMER EFFICIENCY** 86%

DRILLING METHOD HSA **STATION (FT)** 5875+27.84 **OFFSET (FT)** 55.4 R

LOGGED BY Patricia Reed **CHECKED BY** Bill Lockard **NORTHING** 213156.431 **EASTING** 1309355.252

NOTES **GW LEVEL (ATD)** Dry

ELEVATION (ft)	DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
135	0		ASPHALT (2 inches) over CONCRETE (12 inches) over				
			Poorly graded SAND, dense, grayish brown, moist, [FILL] (SP)	22	SPT-1 11 23 19	▲ 42	
			Silty SAND, dense, light grayish brown, moist, [FILL] (SM)				
130	5			100	SPT-2 12 10 20	● ☐ 30	MC = 10% Fines = 31%
				56	SPT-3 3 5 7	▲ 12	
125	10			83	SPT-4 7 12 9	▲ 21	
120	15		Becomes with gravel 4" interlayer of damp sand	67	SPT-5 6 22 18	● ▲ 40	MC = 9%

Bottom of borehole at 16.5 feet.

WSDOT GEOTECH DRILLING - I405 WSDOT.GDT - 9/10/20 19:07 - C:\USERS\CHELSEA.FOSTER\DOCUMENTS\PROJECTWISE\WORKINGDIR\WSDOT\DMS08722\I405 WSDOT - SEG.2.GPJ

In Association with

Appendix C
Laboratory Testing Procedures and Results

Job No. **XL-2067** Date **December 12, 2006**

Hole No. **ALTCH-B6-06** Sheet **1** of **1**

Project **112th Ave SE I/C to SE 8th Street I/C**

Laboratory Summary

Washington State Department of Transportation

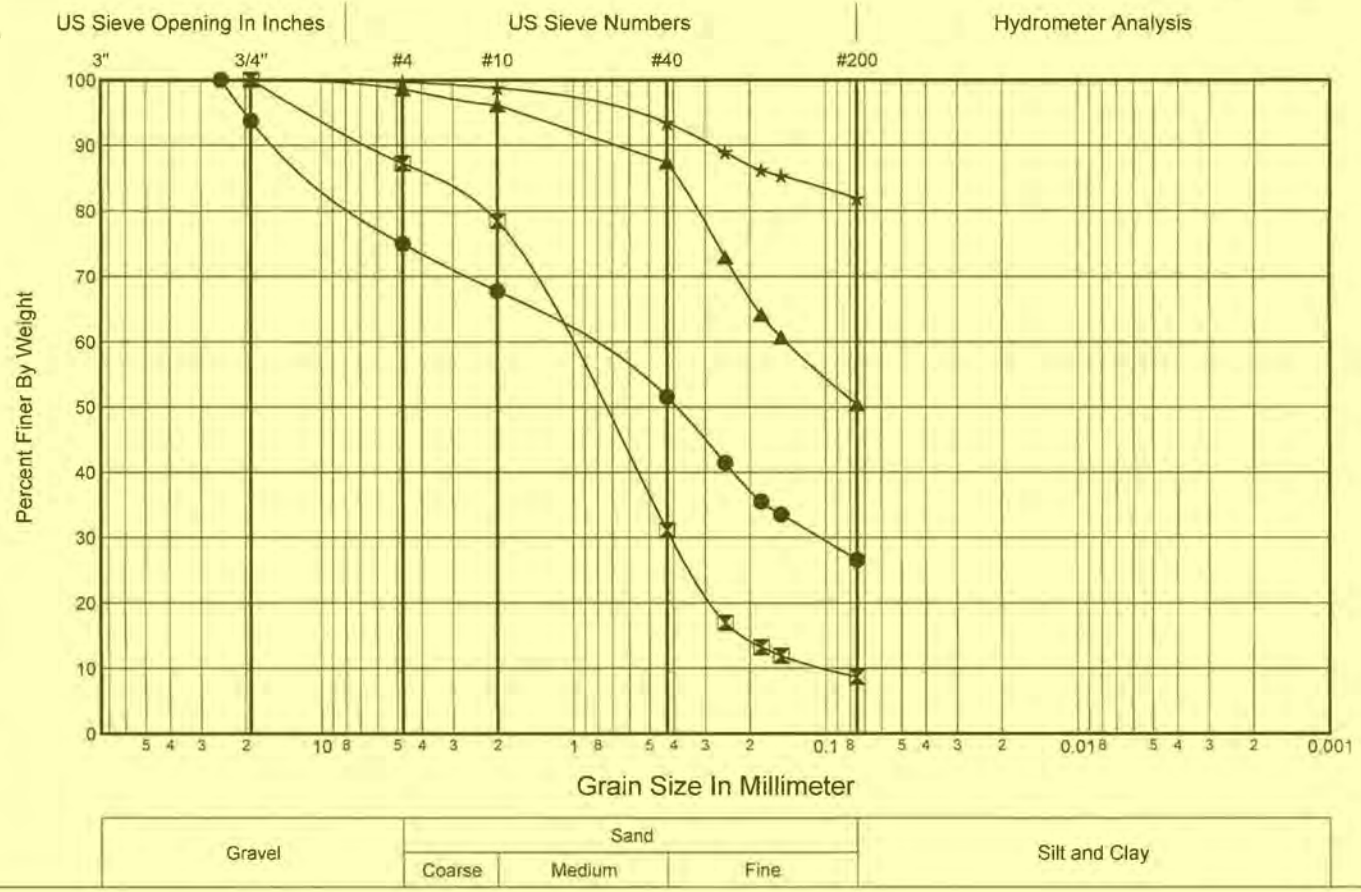
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	12.0	3.66	D-4	SM	See Boring Log	SILTY SAND with GRAVEL	11	15	NP	NA
⊠	30.0	9.14	D-9	SW-SM	See Boring Log	WELL-GRADED SAND with SILT	18			
▲	45.0	13.72	D-12	ML	See Boring Log	SANDY SILT	18			
★	50.0	15.24	D-13	ML	See Boring Log	SILT with SAND	15			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	25.0	48.4	26.6		
⊠	12.7	78.6	8.7	1.5	11.0
▲	1.4	48.2	50.4		
★	0.3	17.8	81.9		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.953	0.39	0.11		
⊠	1.094	0.79	0.41	0.28	0.099
▲	0.143				
★					



Job No. **XL-2067**
Hole No. **BX-13-05**
Project **Bellevue - Nickel Project**

Date **April 15, 2005**
Sheet **1** of **1**

Laboratory Summary

Washington State Department of Transportation

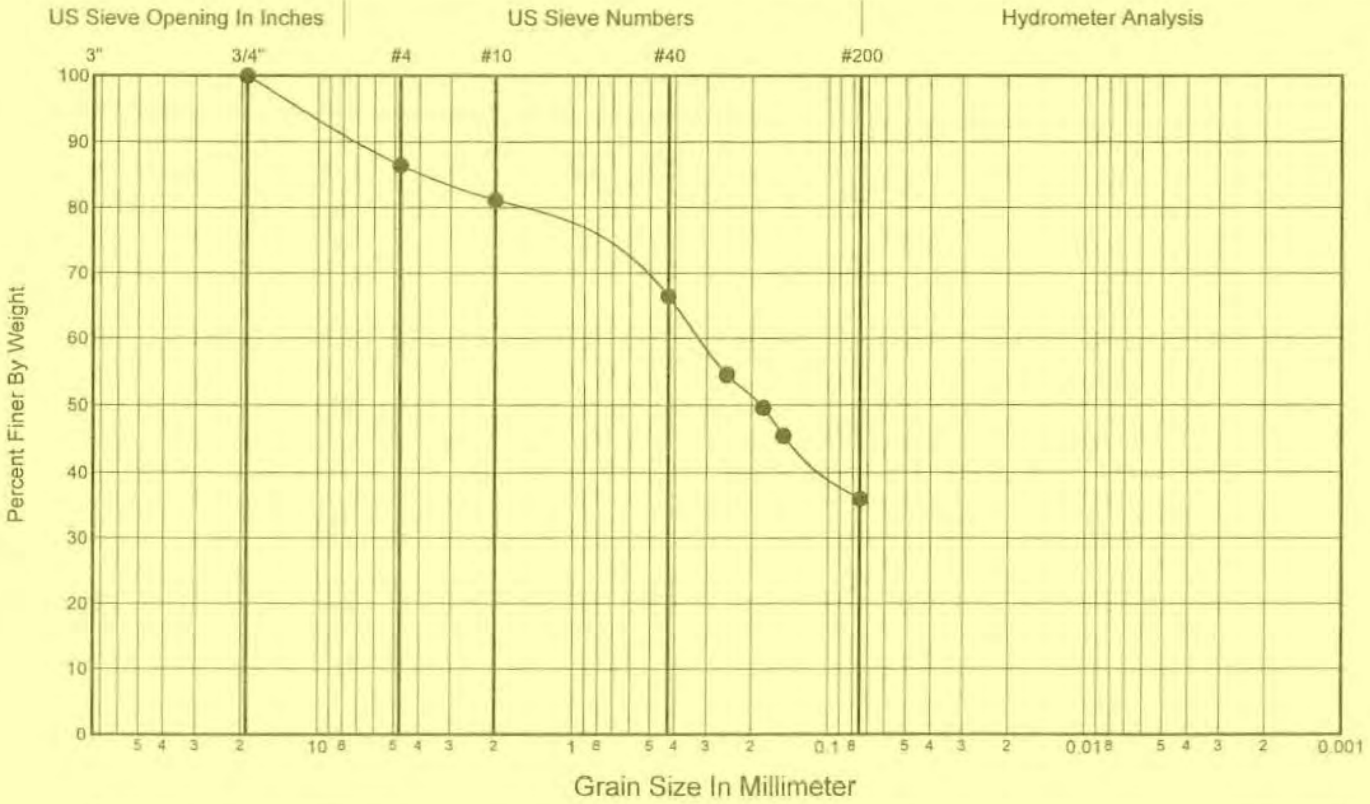
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	9.0	2.74	D-2	SM	See Boring Log	SILTY SAND	13			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	13.6	50.4	36.0		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.319	0.18			



Job No.	**XL-2067**	Date	**December 21, 2006**
Hole No.	**CH-B3-06**	Sheet	**1** of **1**
Project	**112th Ave SE I/C to SE 8th Street I/C**		

Laboratory Summary

Washington State Department of Transportation

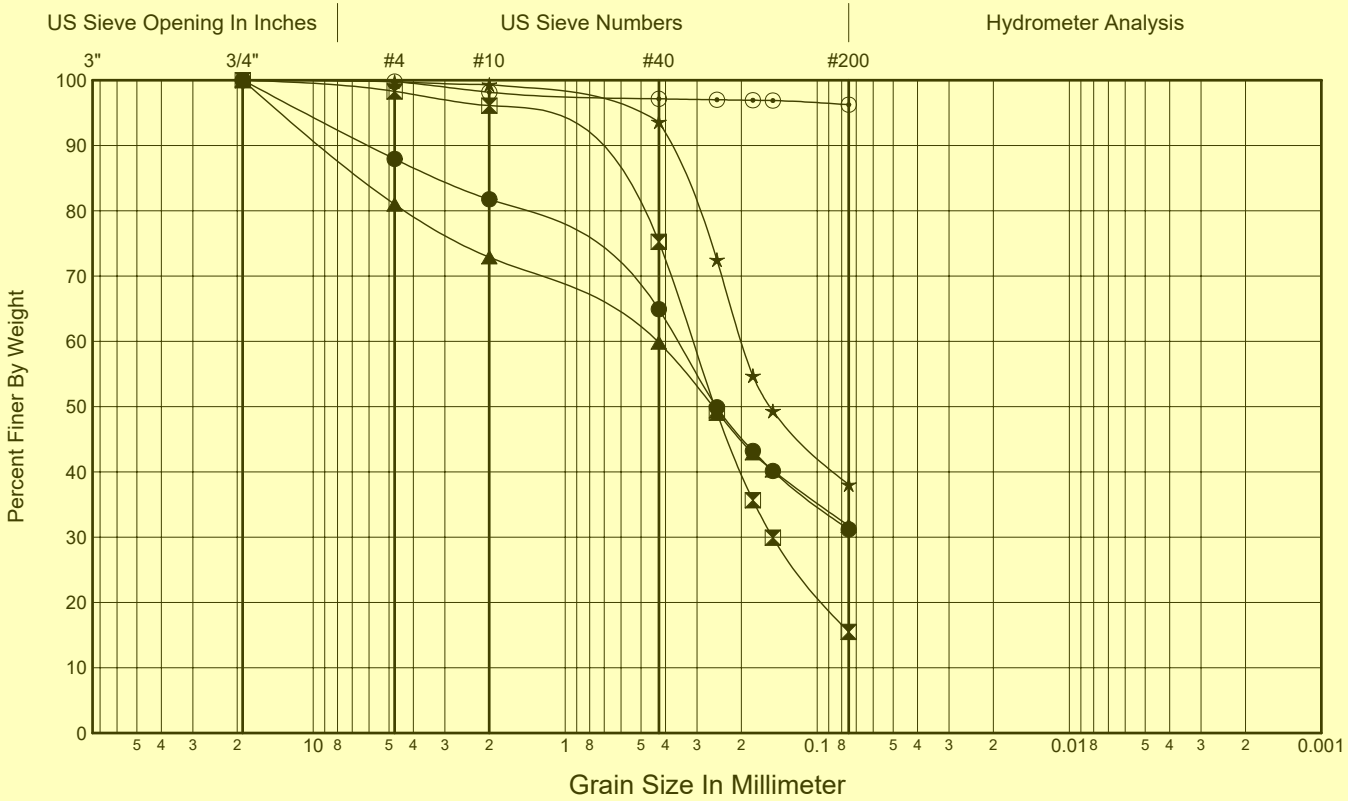
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**11.5**	**3.51**	**D-4**	**SM**	**See Boring Log**	**SILTY SAND**	**11**			
⧗	**24.0**	**7.32**	**D-8**	**SM**	**See Boring Log**	**SILTY SAND**	**20**			
▲	**49.0**	**14.94**	**D-13**	**SM**	**See Boring Log**	**SILTY SAND with GRAVEL**	**10**			
★	**59.0**	**17.98**	**D-15**	**SM**	**See Boring Log**	**SILTY SAND**	**19**			
⊙	**69.0**	**21.03**	**D-17**	**ML**	**See Boring Log**	**SILT**	**26**			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**12.1**	**56.7**	**31.2**		
⧗	**1.7**	**82.8**	**15.5**		
▲	**19.0**	**49.2**	**31.7**		
★	**0.2**	**61.7**	**38.1**		
⊙	**0.2**	**3.5**	**96.3**		

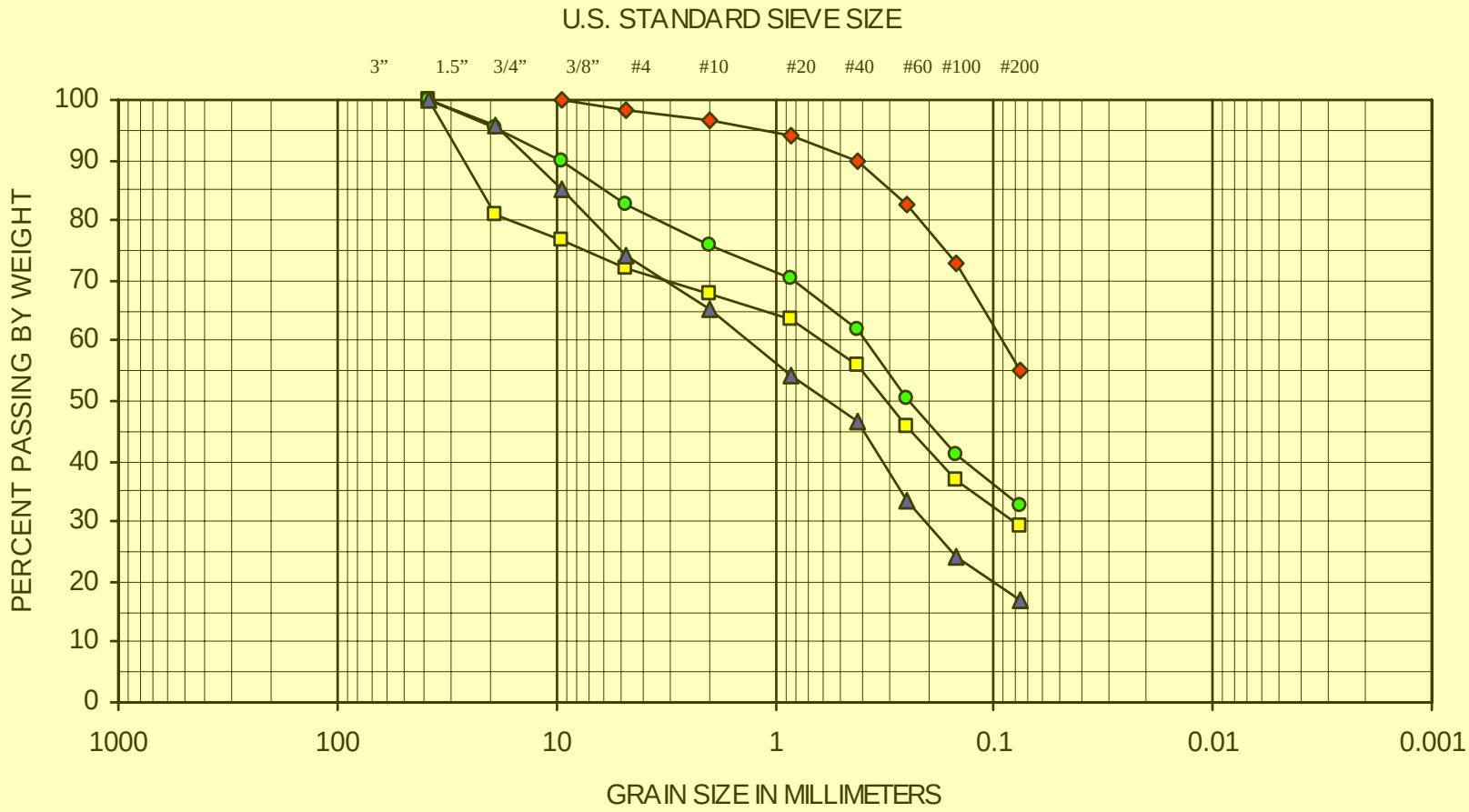
GRADATION VALUES

	D60	D50	D30	D20	D10
●	**0.357**	**0.25**			
⧗	**0.312**	**0.25**	**0.15**	**0.09**	
▲	**0.434**	**0.26**			
★	**0.198**	**0.15**			
⊙					



0180-197-01 KGO : MJP : cts 5-0707 (Sieve.ppt)

GEOENGINEERS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEO-9	5.0	Brown sandy silt with trace gravel (ML)
□	GEO-10	2.5	Brown silty fine sand with gravel (SM)
●	GEO-11	2.5	Gray silty fine to medium sand with gravel (SM)
▲	GEO-12	7.5	Brown silty fine to medium sand with gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-7

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

MATERIALS ENGINEER
Materials Laboratory
P. O. Box 167, Olympia, WA 98504 (Mailing Address)
1655 So. 2nd Ave.
Tumwater, Washington 98504 (Shipping Address)

Place SEATTLE
Date 4-16-86
DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOU
SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset LR 186+50 6.50' RT OF E.O.P. Hole # 60

E- Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
6686-1	P-1	-1.5' to -3.0'	H2O= 4.4	SP SM	
-2	P-2	-5.0' to -6.5'	H2O= 2.4	SM	
-3	P-3	-10.0' to -11.5'	H2O= 2.6	SM	
-4	P-4	-15.0' to -17.0'	H2O= 9.2	SM	
-5	P-5	-20.0' to -21.5'	H2O= 16.4	SM	
-6	P-6	-25.0' to -27.0'	H2O= 15.6	SM	
-7	P-7	-30.0' to -31.5'	H2O= 8.5	SM	

1 copy with samples
1 copy to addressee

Yours very truly, R. L. WESS[illegible]

Inspector.

DOT FORM 351-002 REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66-8C-1 JOB NO. 80034 HOLE NO. 60

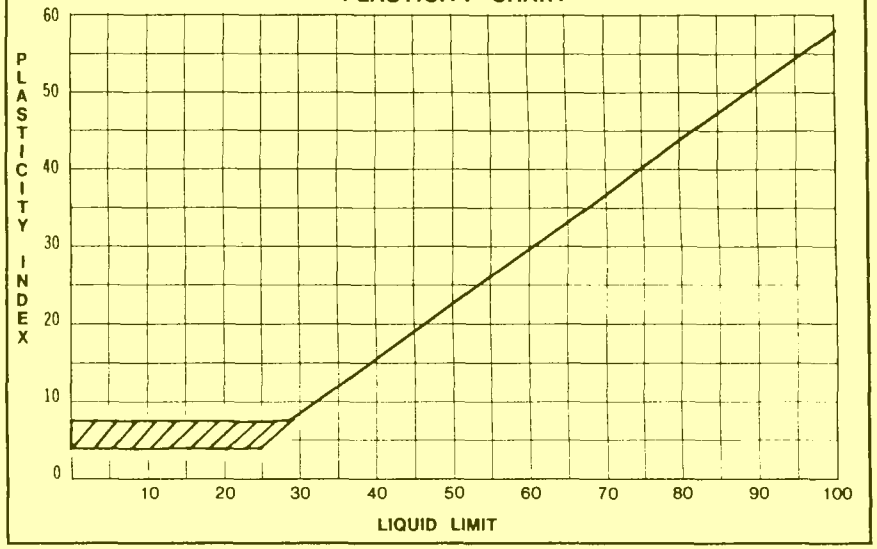
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, Sl+ Slty, gravelly, C-m-F SAND

PLASTICITY CHART

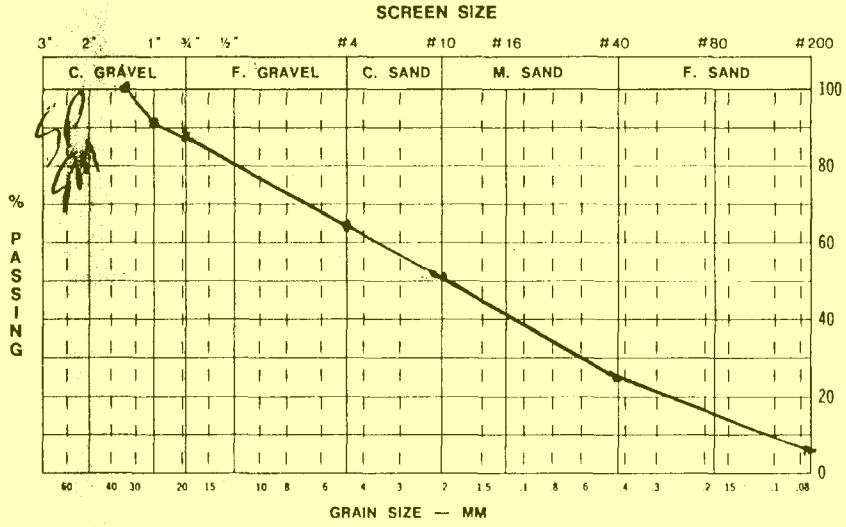


43.3 45.4 4.4

SIEVE ANALYSIS

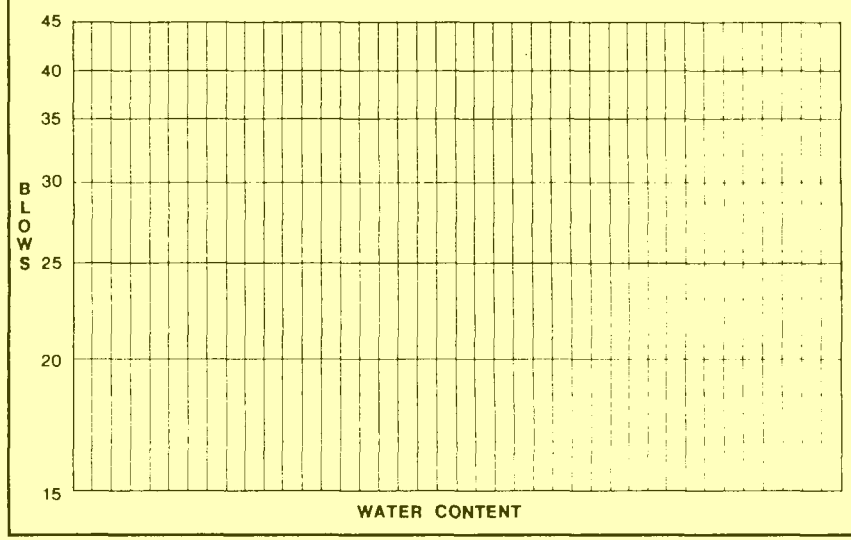
			% Passing		
1½ 27.5				316.9	
-1	100	91.2	-40	58.8	24.4
-¾	77.7	86.0	-80		
-4	42.8	63.5	-140		
-10	81.3	50.0	-200	18.4	5.8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6686-2 JOB NO. 5034 HOLE NO. 60

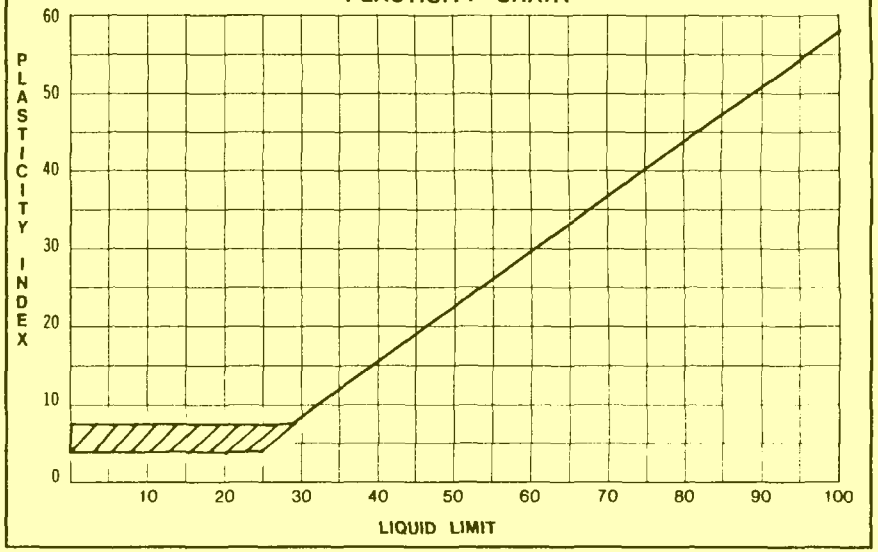
DATE 8-7-86 OPERATOR SO

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Gm, Dry, gravelly, SLTY, C-M-F SAND

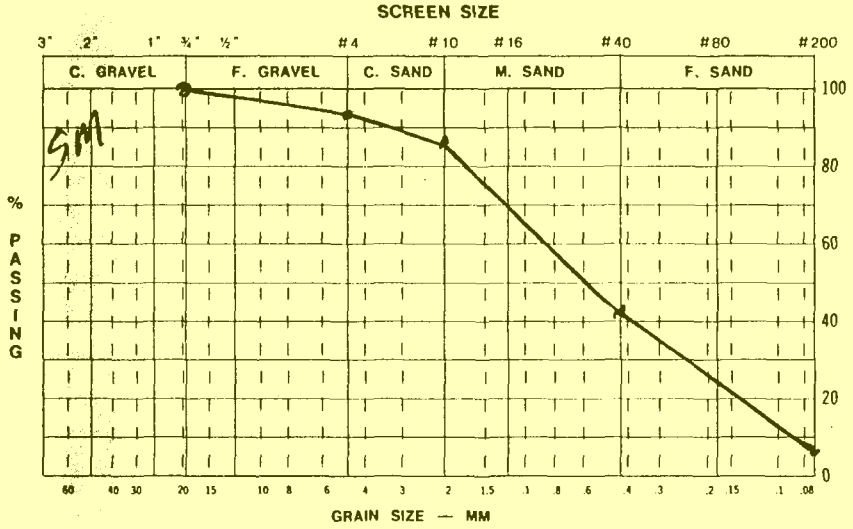
PLASTICITY CHART



49.5 50.7 2.4

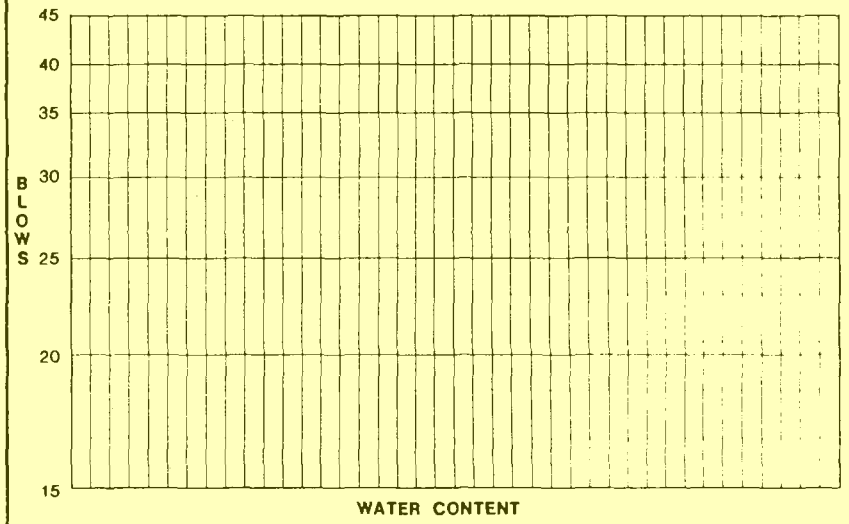
SIEVE ANALYSIS		% Passing 212.9	
		-40 20.7	41.0
-¾ 19.8	100	-80	
-4 10.9	93.0	-140	
-10 100.0	87.9	-200 16.5	7.8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 1686-3 JOB NO. 8034 HOLE NO. 60

DATE 8-7-86 OPERATOR [illegible]

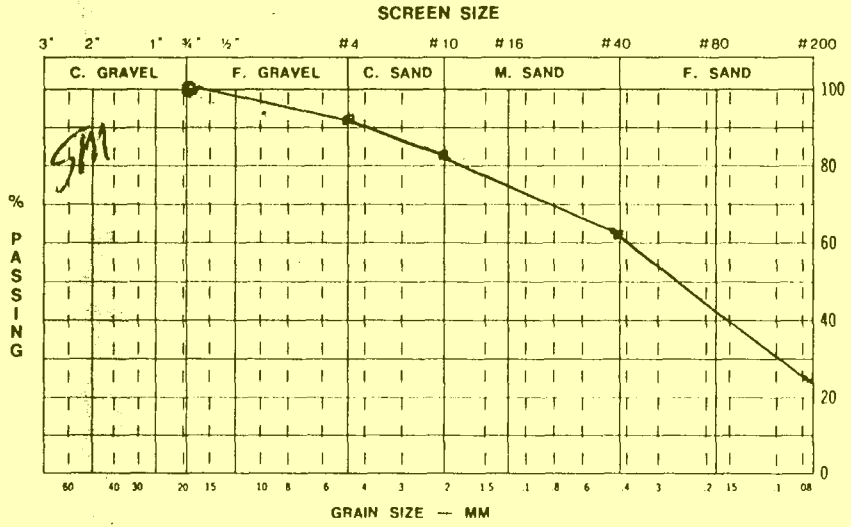
SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION Brn, Dry, gravelly, VSLTY, C M-F SAND

34.4 37.0 7.6

SIEVE ANALYSIS		% Passing 77.9	
		-40 96.0	60.5
-¾ 23.7	100.0	-80	
-4 30.6	91.3	-140	
-10 63.2	83.7	-200 68.4	25.2

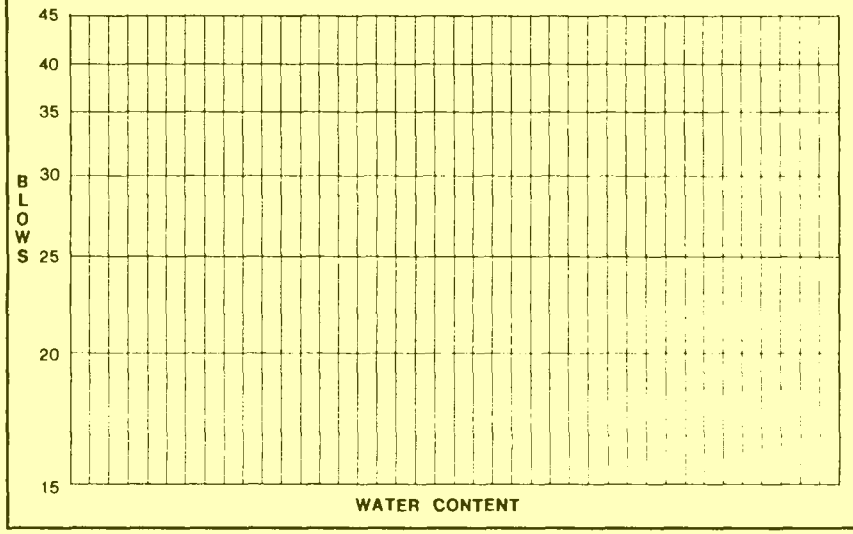
GRAIN SIZE CURVE



PLASTICITY CHART

LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6686-4 JOB NO. 8034 HOLE NO. 60

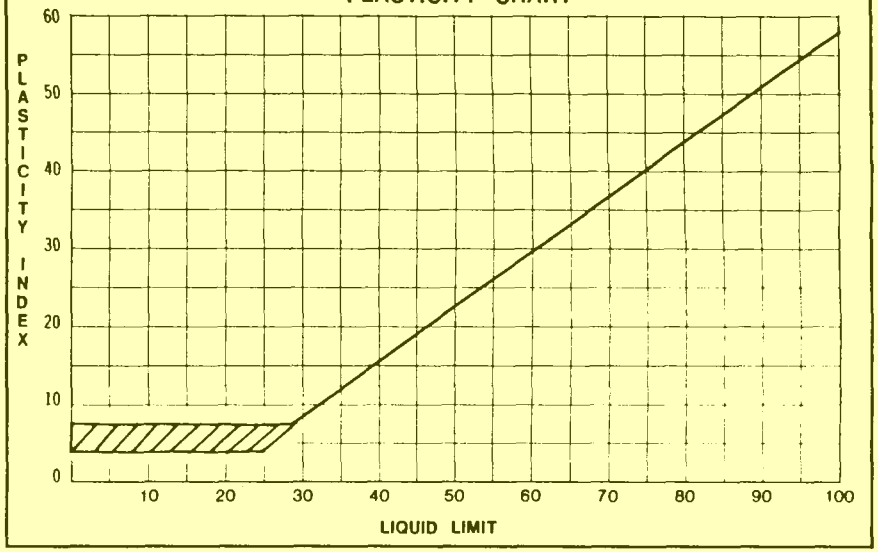
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, gravelly, VSLTY, C-M-F SAND

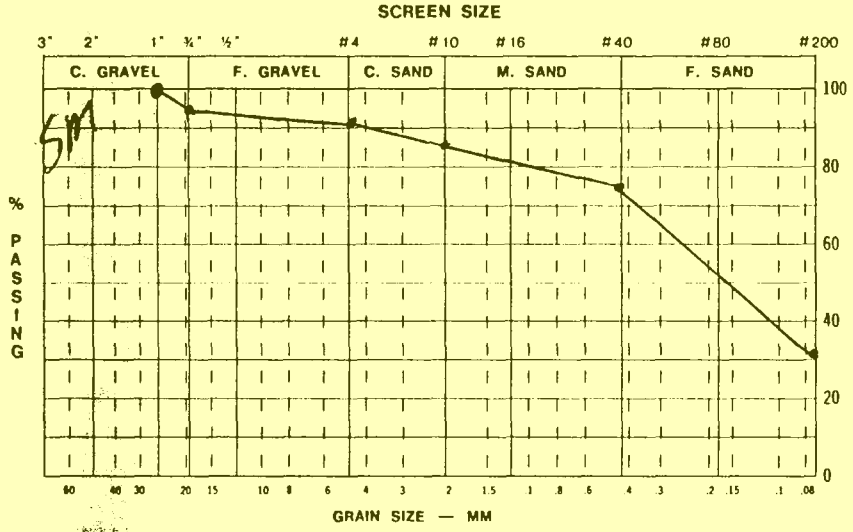
PLASTICITY CHART



38.1 41.6 9.2

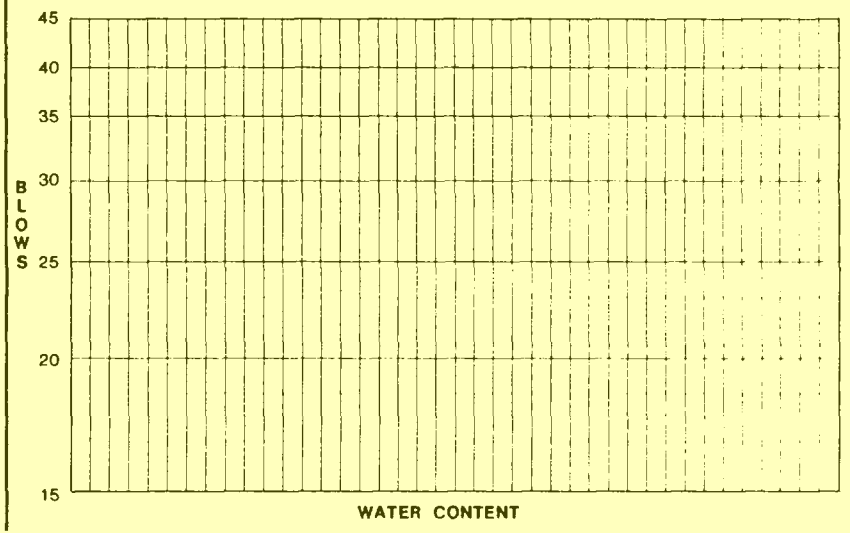
SIEVE ANALYSIS			% Passing 286.2		
-1	15.6	100	-40	127.1	75.3
-¾	11.6	94.5	-80		
-4	8.5	90.5	-140		
-10	35.1	87.5	-200	88.3	30.9

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66865 JOB NO. 8034 HOLE NO. 60

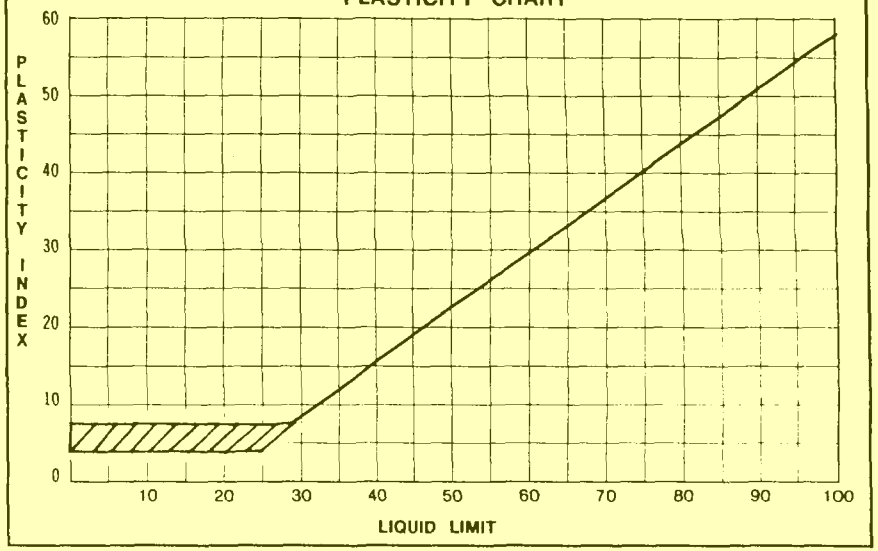
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL			
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, moist, v.sl.ty, m-F SAND

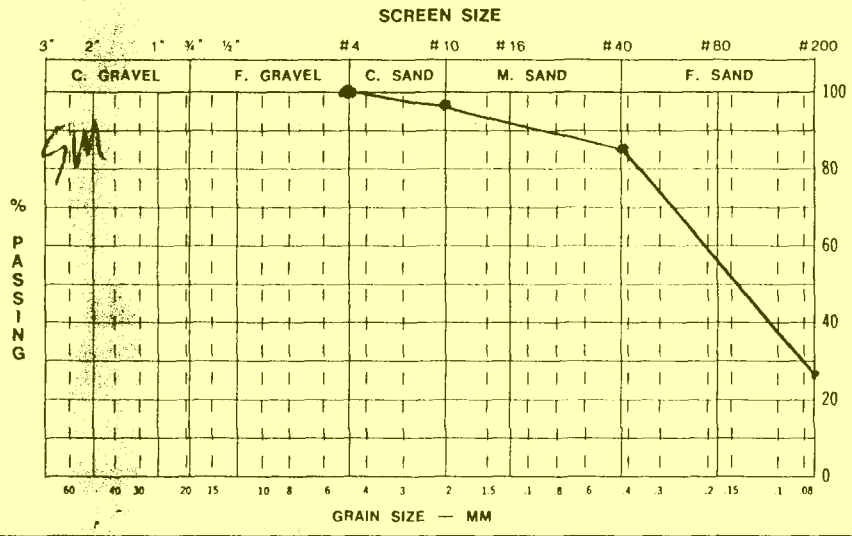
PLASTICITY CHART



33.2 37.0 11.4

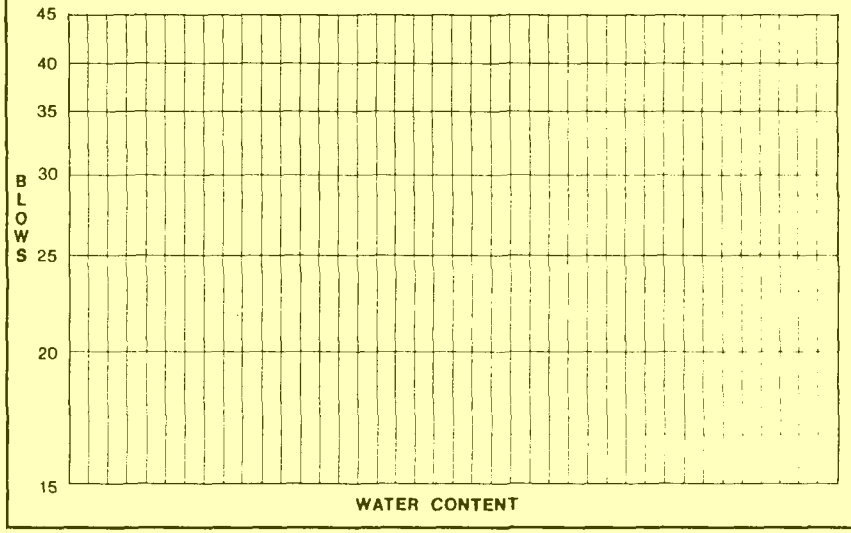
SIEVE ANALYSIS		% Passing 211.2	
		-40 122.5	85.4
-¾		-80	
-4 3.4	100	-140	
-10 27.5	94.4	-200 57.8	27.4

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

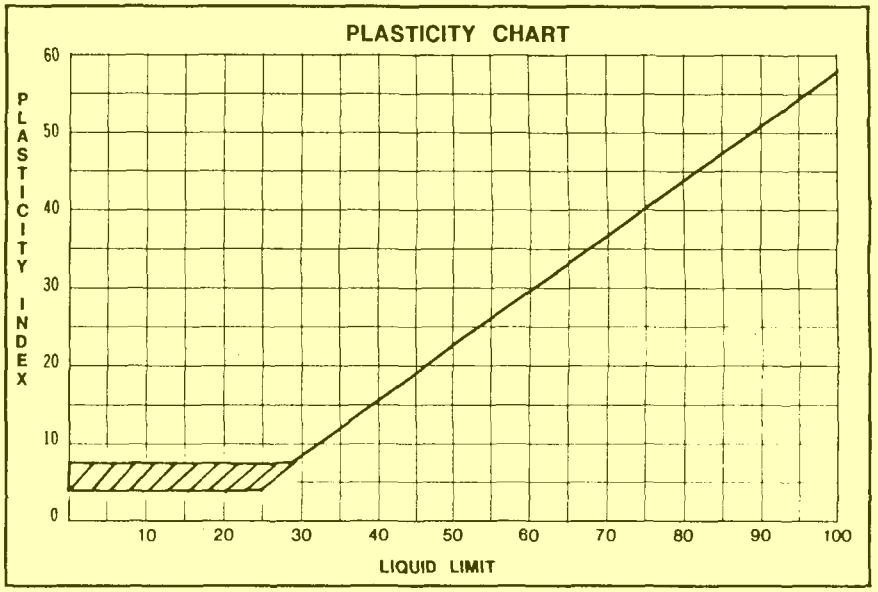
A-LINE

SAMPLE NO. 66 86-6 JOB NO. 8031 HOLE NO. 60

DATE 8-7-86 OPERATOR SC

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

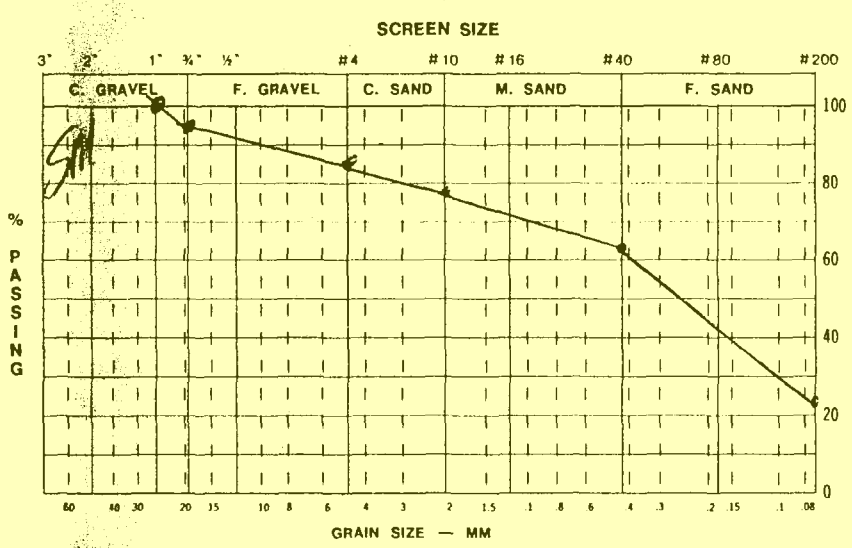
DESCRIPTION: Dry moist, gravely, v silty C-M-F SAND



69.0 74.0 15.6

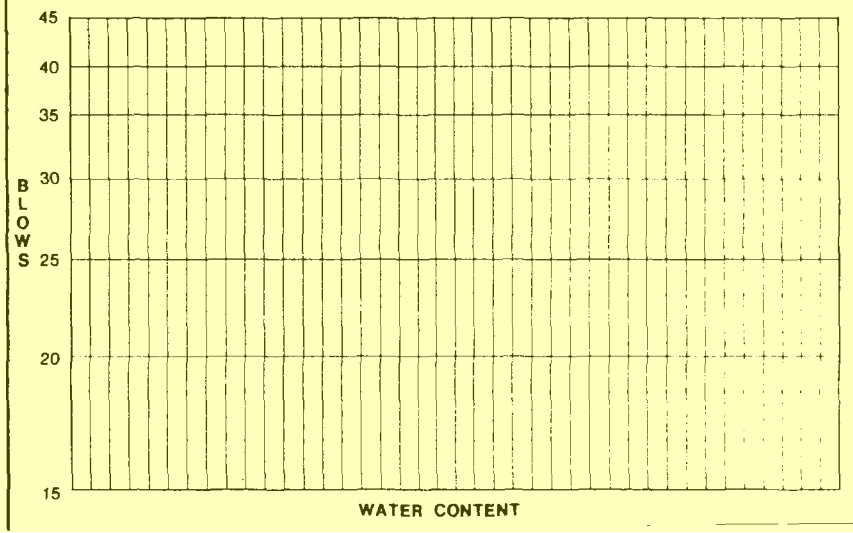
SIEVE ANALYSIS			% Passing 316.2		
-1	16.3	100	-40	122.4	62.3
-3/4	33.3	94.8	-80		
-4	18.1	84.3	-140		
-10	51.4	76.4	-200	74.7	23.6

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66867 JOB NO. 8034 HOLE NO. 60

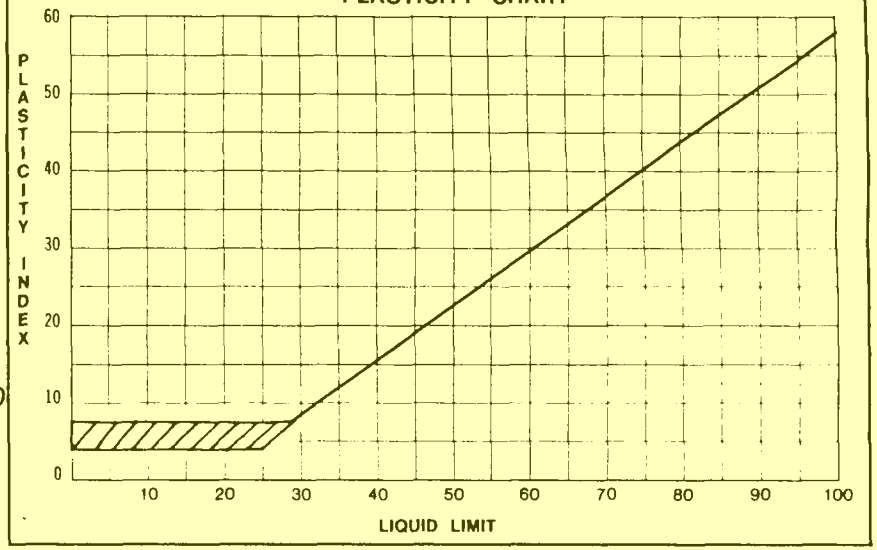
DATE 8-7-86 OPERATOR SD

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, gravely, VSLTY, C-M-F-SAND

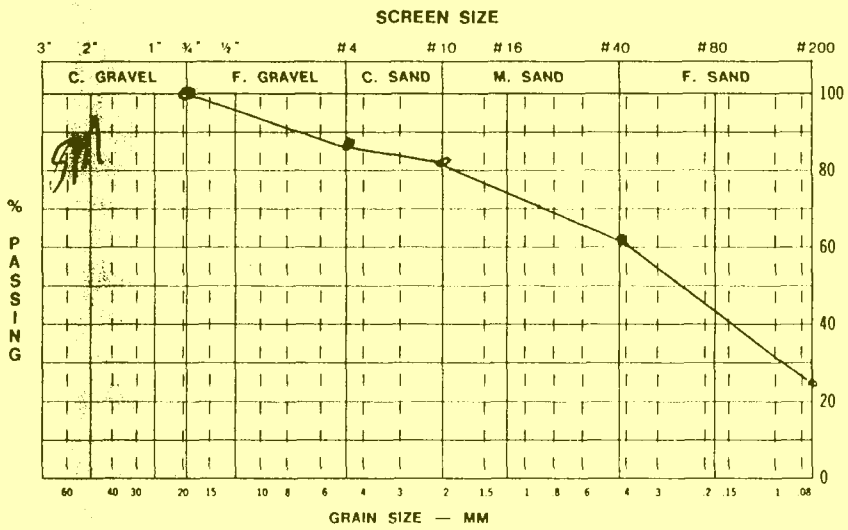
PLASTICITY CHART



45.7 49.6 8.5

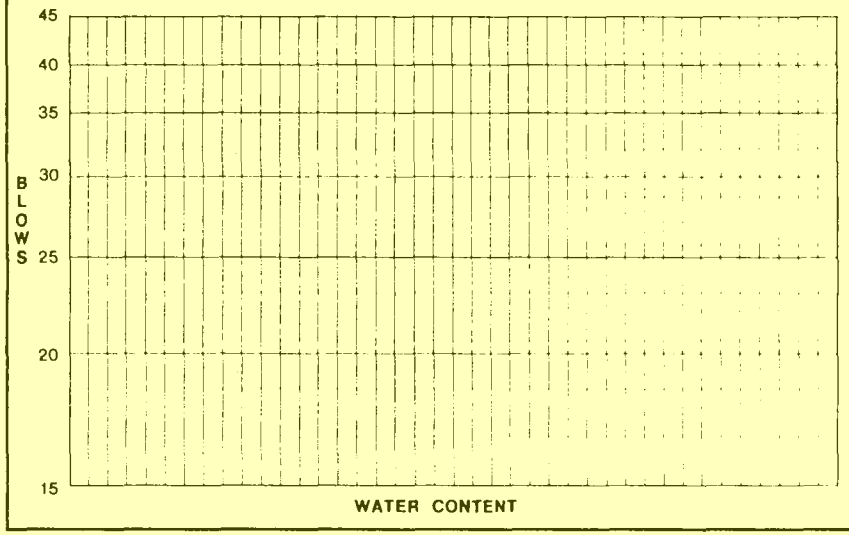
SIEVE ANALYSIS		% Passing 294.2	
		-40 107.6	60.4
-¾ 35.7	100	-80	
-4 18.3	87.9	-140	
-10 62.4	81.6	-200 73.2	24.9

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

MATERIALS ENGINEER
Materials Laboratory
P. O. Box 167, Olympia, WA 98504 (Mailing Address)
1655 So. 2nd Ave.
Tumwater, Washington 98504 (Shipping Address)

Place SEATTLE
Date 4-16-86
DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOV
SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset 10+50 LR2 SOUTH WALL ℄ Hole # 61

E- Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
6688-1	P-1	-2.5' +0 -4.5'	H2O = 9.9	SP SM	
-2	P-2	-5.0' +0 -6.5'	H2O = .4	SW SM	
-3	P-3	-10.0' +0 -11.5'	H2O = .7	SP SM	
-4	P-4	-15.0' +0 -16.5'	H2O = 9.7	SM	
-5	P-5	-20.0' +0 -22.0'	H2O = 7.0	SM	

1 copy with samples
1 copy to addressee

Yours very truly,

R. L. WESSELS
DIST. MAT'LS. ENGR.
450 So. Spokane St.
Seattle, WA
Inspector.

DOT FORM 351-002 REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. GGBB-1 JOB NO. 8034 HOLE NO. 61

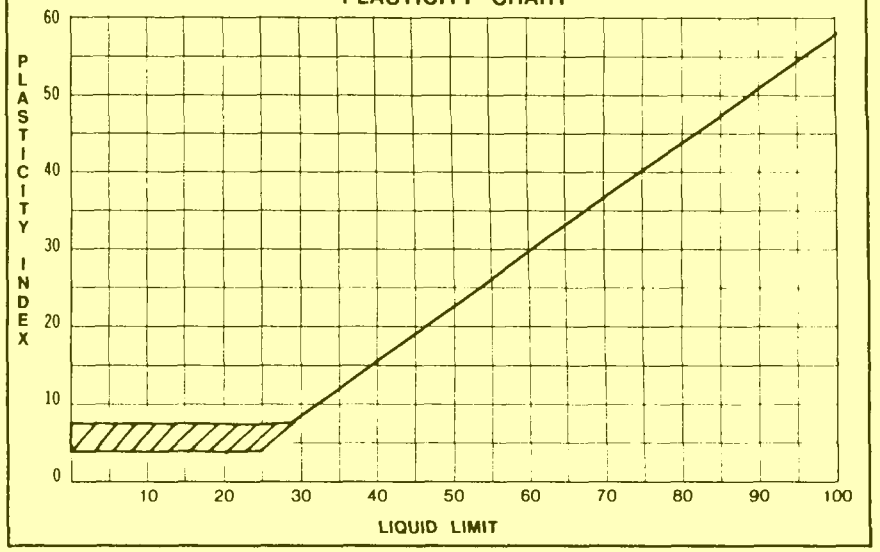
DATE 8-7-86 OPERATOR LD

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SILTY, gravelly, crm-F SAND

PLASTICITY CHART

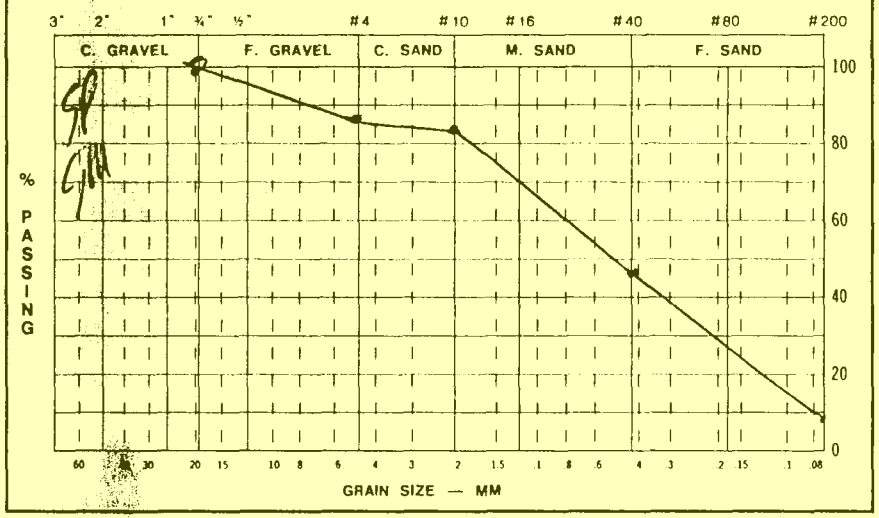


45.4 49.9 9.9

SIEVE ANALYSIS

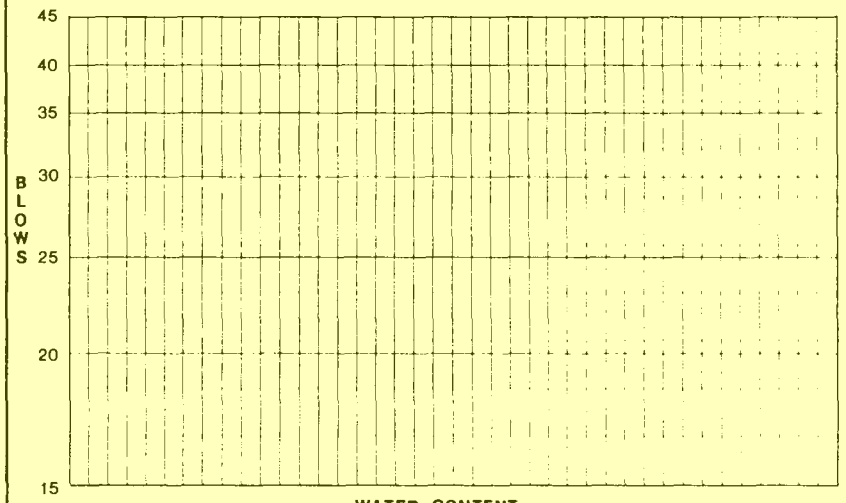
		% Passing		
		-40	90.2	242.7 46.4
-¾ 34.0	100	-80		
-4 8.7	66.0	-140		
-10 57.3	52.4	-200	22.5	9.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

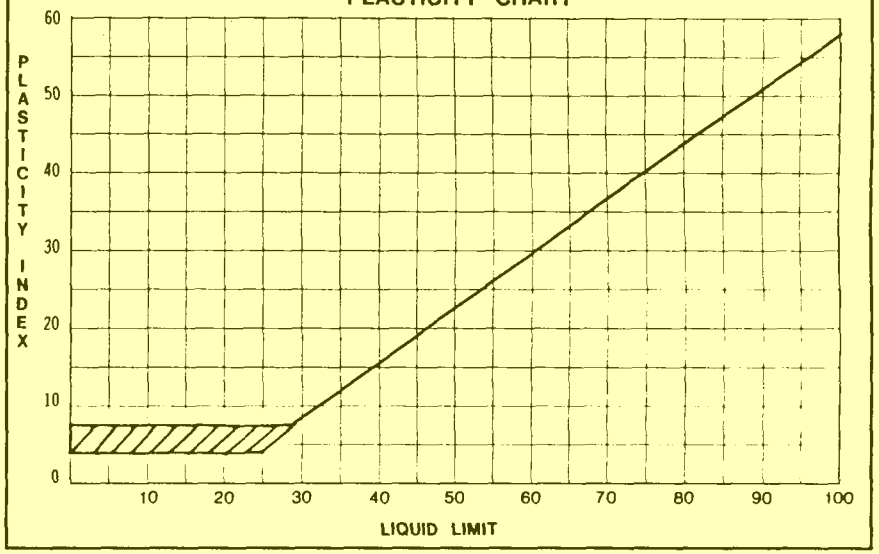
SAMPLE NO. 6688-2 JOB NO. 8034 HOLE NO. 61

DATE 8-7-86 OPERATOR SD

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION Gn, Dry, SLTY, gravely, C-M-F SAND

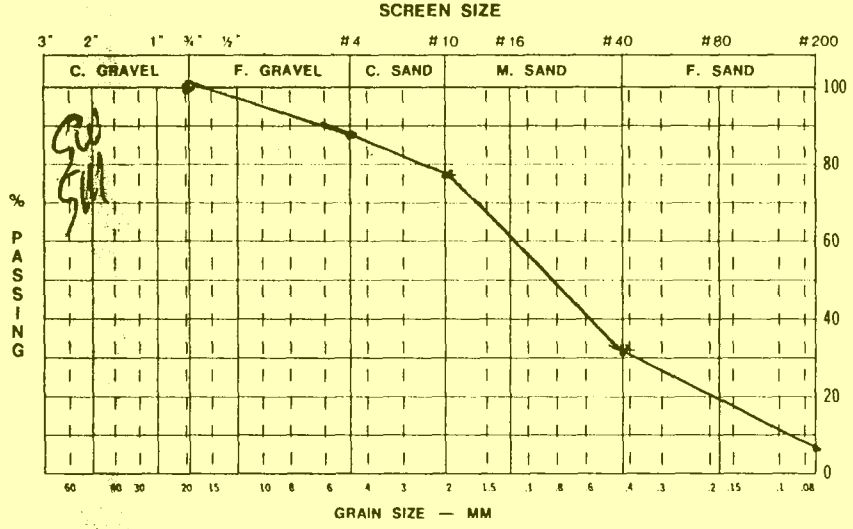
PLASTICITY CHART



49.3 49.5 .4

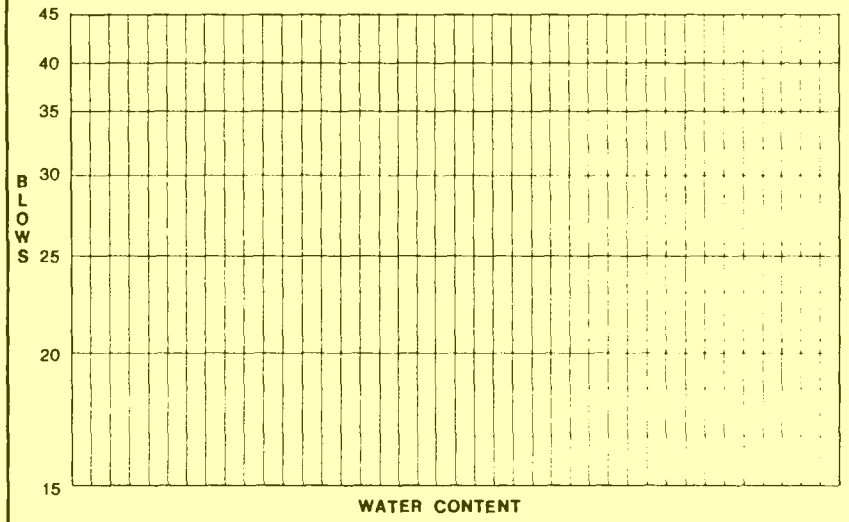
SIEVE ANALYSIS		% Passing 228.4	
		-40 56.0	31.9
-¾ 25.9	100	-80	
-4 22.9	88.7	-140	
-10 106.8	78.6	-200 16.8	7.4

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6688-3 JOB NO. 8034 HOLE NO. 61

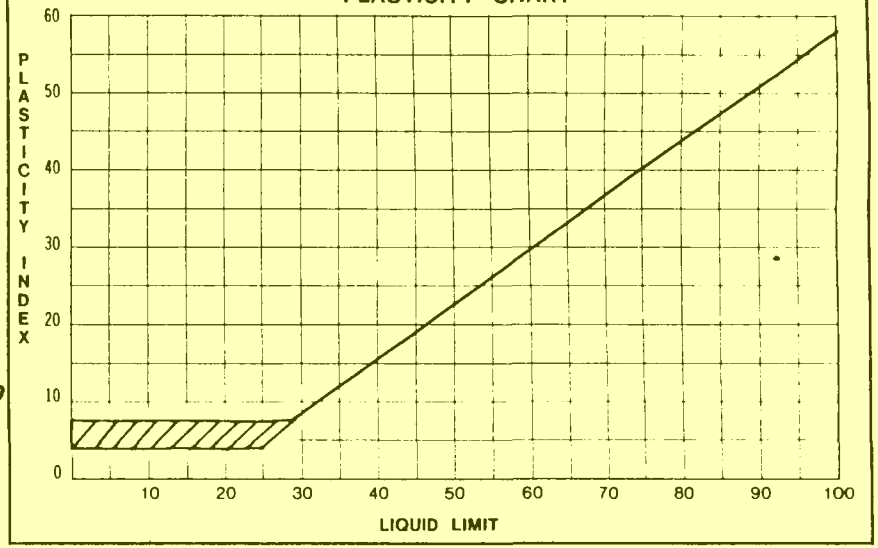
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn Dry, SILTY, gravelly, C-M-F SAND

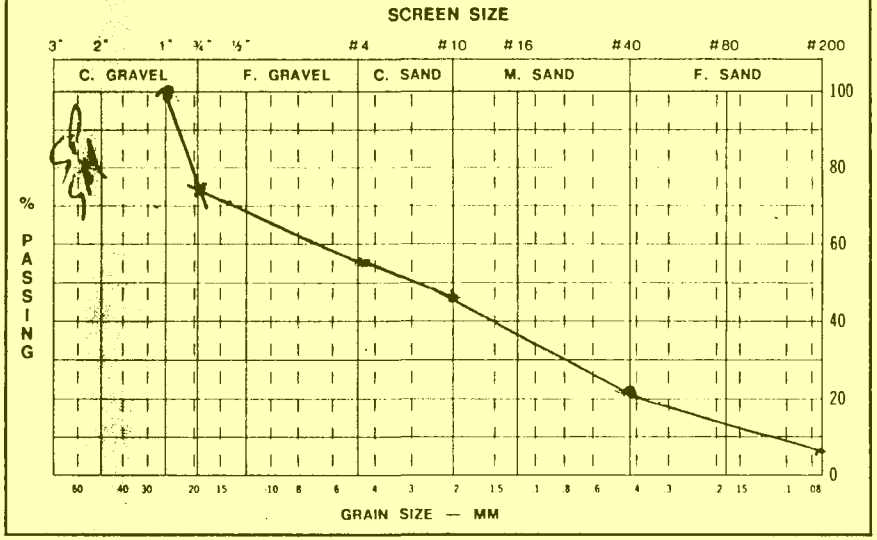
PLASTICITY CHART



30.4 30.6 .7

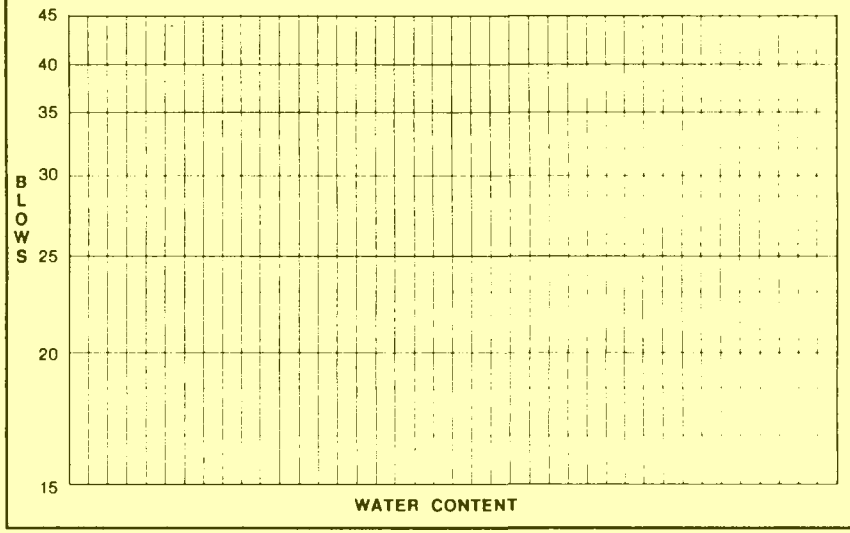
SIEVE ANALYSIS		% Passing	139.8	
-1 37.0	100	-40	20.8	21.6
-3/4 24.6	77.5	-80		
-4 11.5	55.9	-140		
-10 36.5	47.7	-200	9.4	6.7

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6688-4 JOB NO. 8034 HOLE NO. 61

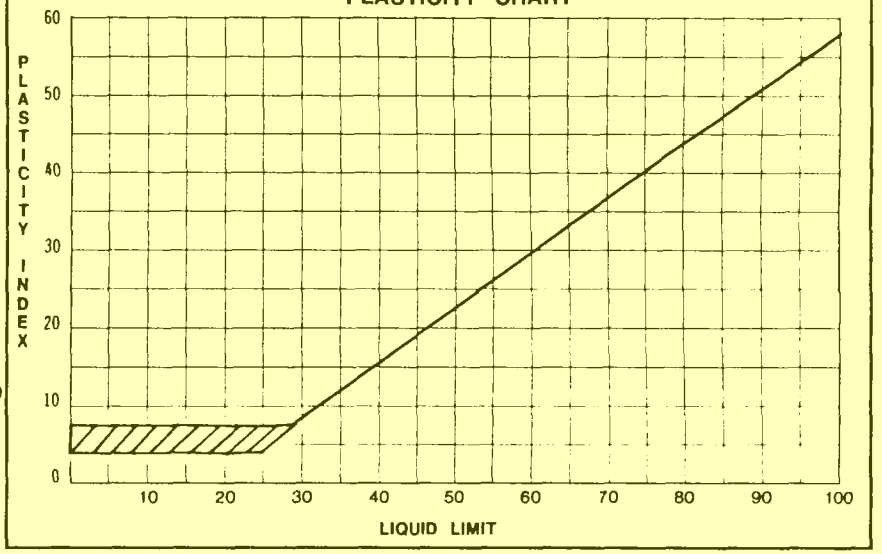
DATE 8-7-84 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Br, Dry, gravelly, V SILTY, C-M-F SAND

PLASTICITY CHART

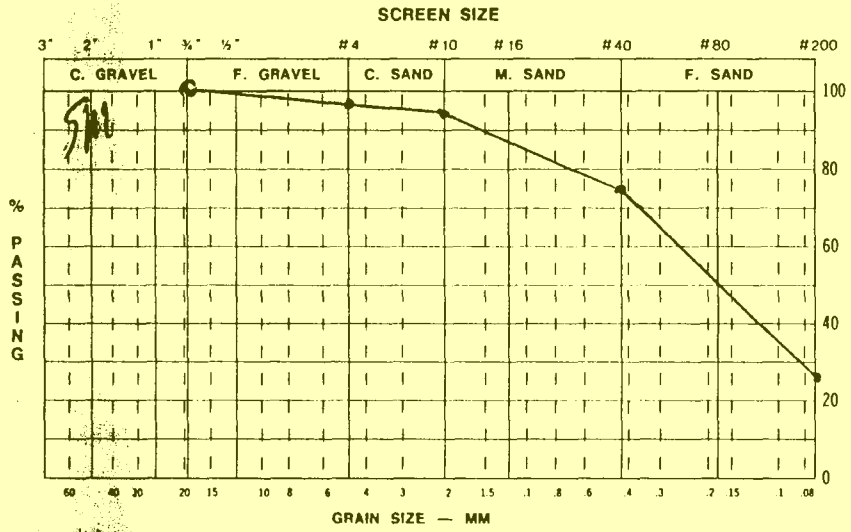


47.5 52.1 9.7

SIEVE ANALYSIS

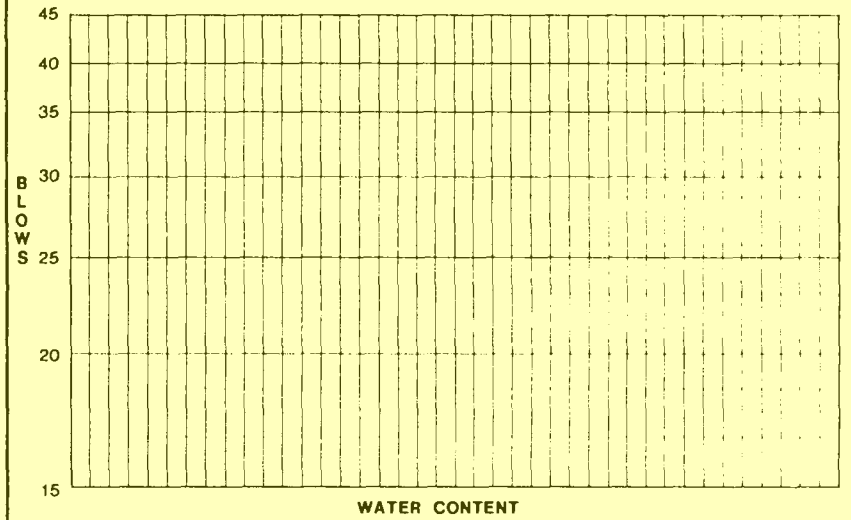
		% Passing 171.4	
		-40 86.9	75.5
-¾ 5.3	1000	-80	
-4 4.35	960.9	-140	
-10 32.3	941.4	-200 42.05	24.8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6688-5 JOB NO. 8034 HOLE NO. 61

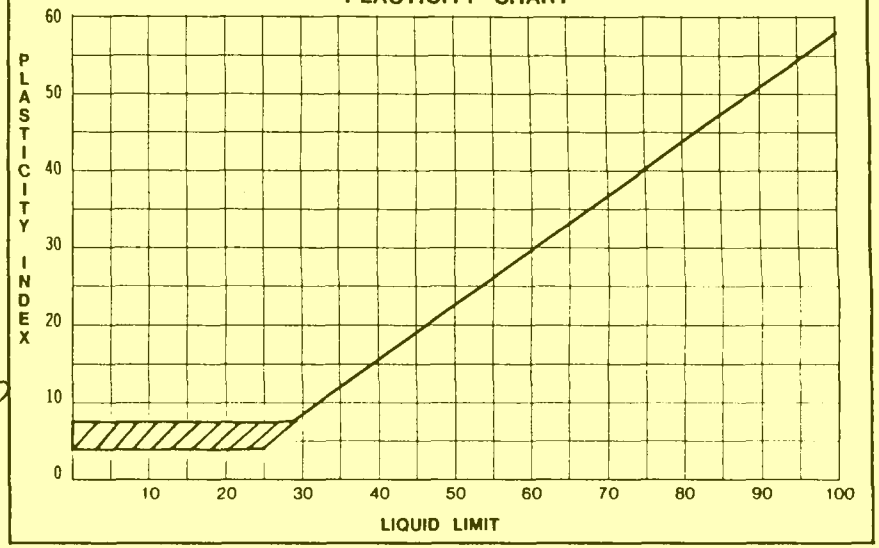
DATE 8-7-86 OPERATOR AD

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, gravely, SLTY, C-M-F SAND

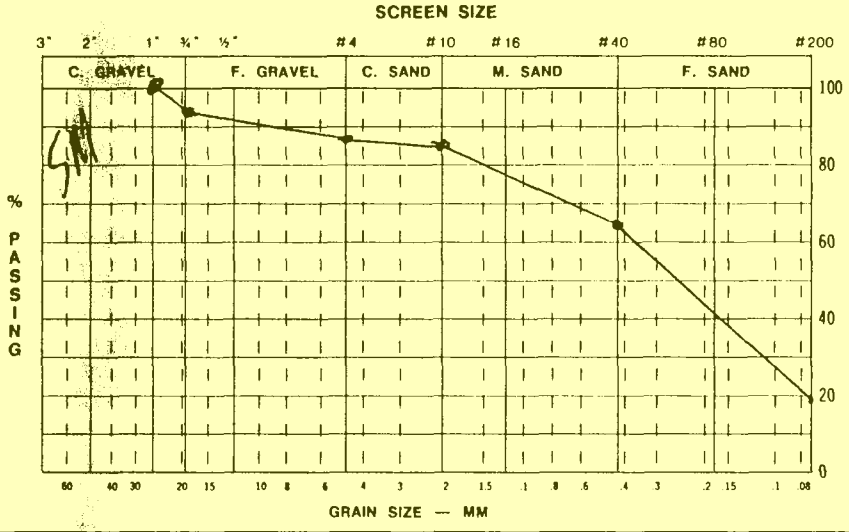
PLASTICITY CHART



47.1 50.4 7.0

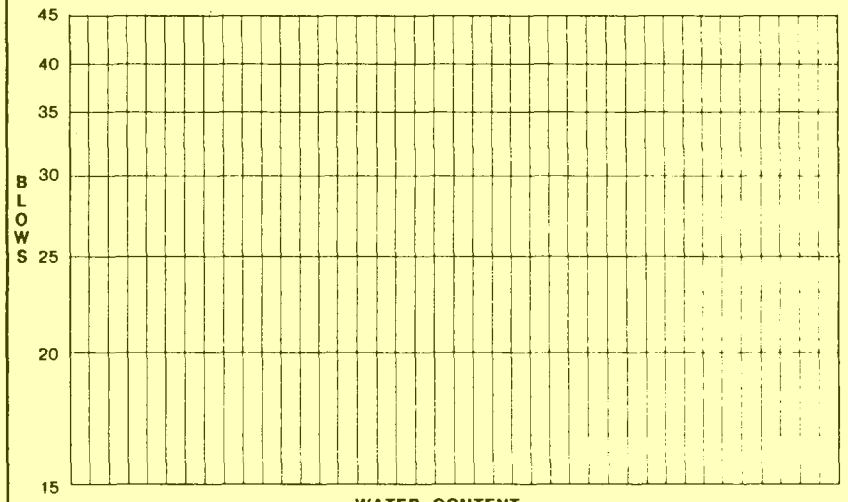
SIEVE ANALYSIS		% Passing 206.9	
-1 13.8	100	-40 94.6	65.6
-3 9.7	93.3	-80	
-4 5.6	88.6	-140	
-10 42.1	85.9	-200 41.1	19.9

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

MATERIALS ENGINEER
Materials Laboratory
P. O. Box 167, Olympia, WA 98504 (Mailing Address)
1655 So. 2nd Ave.
Tumwater, Washington 98504 (Shipping Address)

Place SEATTLE

Date 4-16-86

DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOU SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset LR 188+50 8.0 RT OF E.O.P. Hole # 62

E- Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
6676-1	P-1	-1.0' +0 -2.5'	H2O = 2.9	SP SM	
-2	P-2	-5.0' +0 -6.5'	H2O = 6.2	SP SM	
-3	P-3	-10.0' +0 -11.5'	H2O = 8.0	SM	
-4	P-4	-15.0' +0 -16.5'	H2O = 5.0	SM	
-5	P-5	-20.0' +0 -21.5'	H2O = 5.4	SP SM	
-6	P-6	-25.0' +0 -27.0'	H2O = 10.2	SM	
-7	P-7	-30.0' +0 -31.5'	H2O = 9.3	SM	
-8	P-8	-35.0' +0 -36.5'	H2O = 8.8	ML	
-9	P-9	-40.0' +0 -41.5'	H2O = 3.4	SM	

1 copy with samples
1 copy to addressee

Yours very truly,

R. L. WE[illegible]
DIST. MAT'LS. E[illegible]
450 So. Spokane St.
Seattle, WA 98134
Inspector.

DOT FORM 351-002 REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66X-1 JOB NO. 8034 HOLE NO. 62

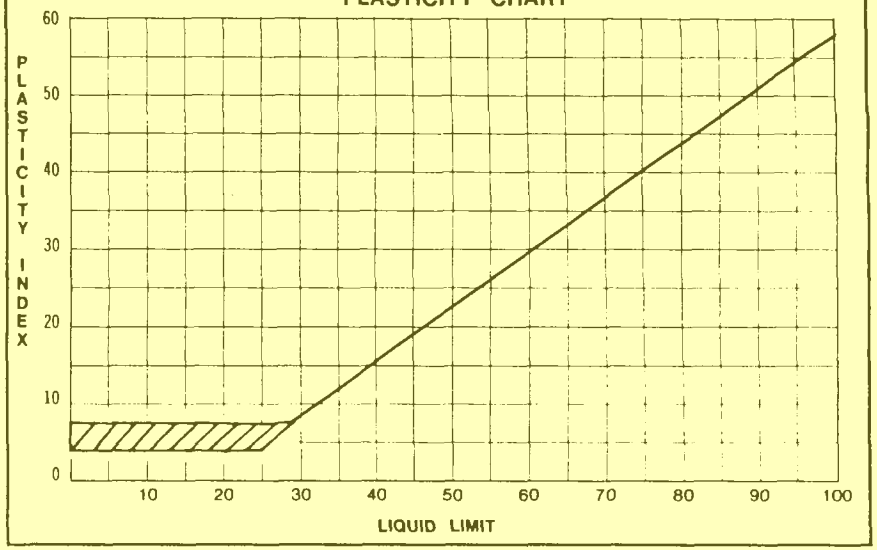
DATE 8-7-86 OPERATOR AD

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SILTY, gravelly, Crs-F SAND

PLASTICITY CHART

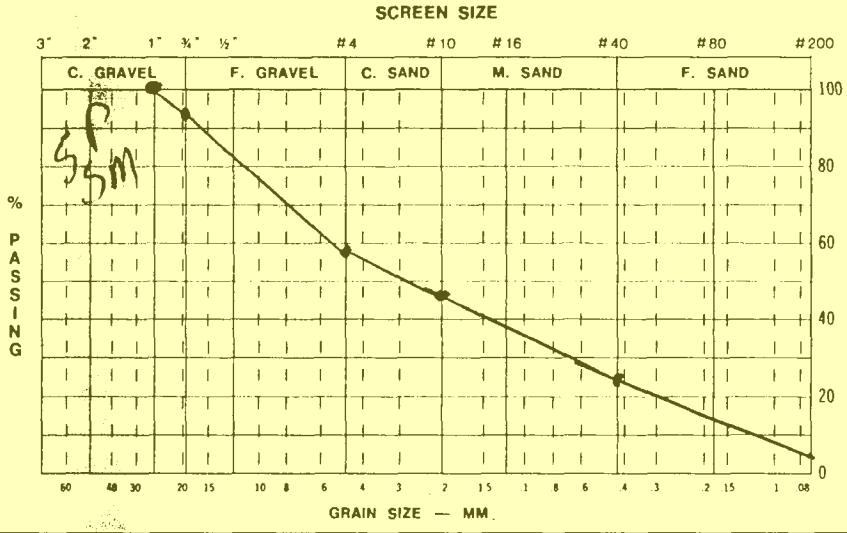


43.1 41.9 2.9

SIEVE ANALYSIS % Passing 3/5.7

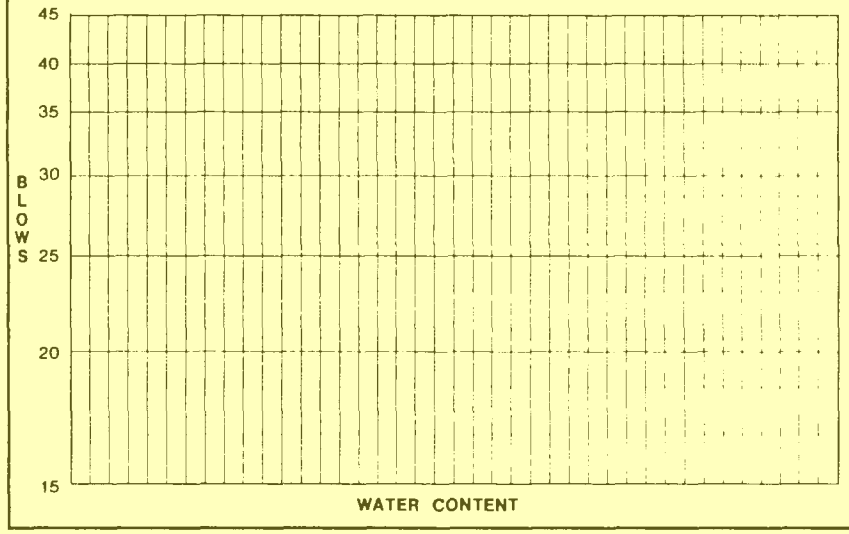
-1	22.5	100	-40	56.3	23.1
-3/4	68.8	92.9	-80		
-4	37.4	58.4	-140		
-10	74.0	46.6	-200	16.7	5.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

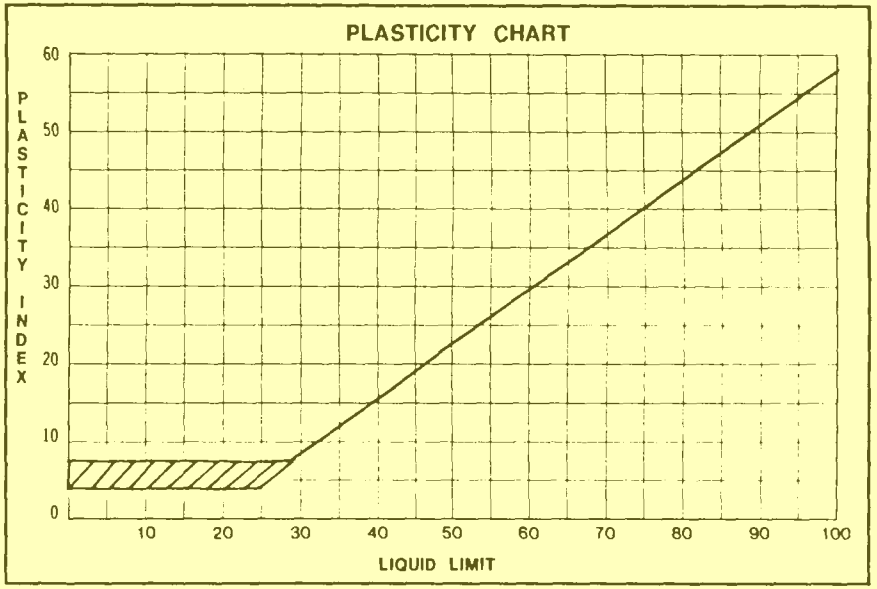
A-LINE

SAMPLE NO. 6676-2 JOB NO. 8034 HOLE NO. 62

DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

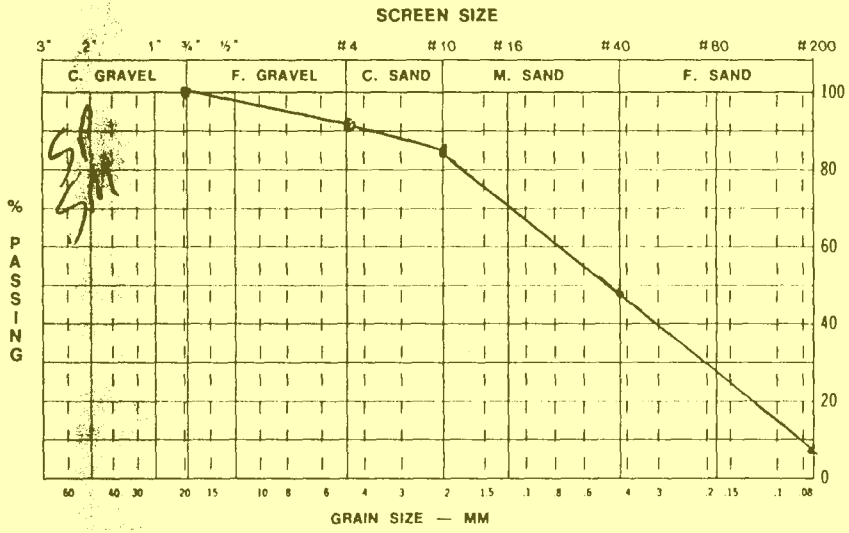
DESCRIPTION: Brn, Dry, SLTY, gravelly, C-M-F SAND



435 46.2 6.2

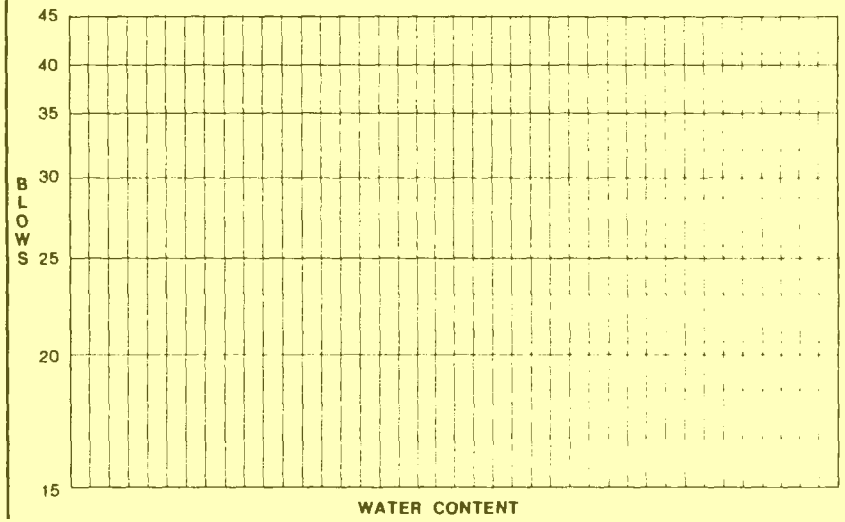
SIEVE ANALYSIS		% Passing 262.0		
		-40	104.5	48.4
-¾ 26.2	100	-80		
-4 14.8	90.0	-140		
-10 94.1	44.4	-200 22.04		8.5

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66-76-3 JOB NO. 8071 HOLE NO. 62

DATE 8-7-86 OPERATOR [illegible]

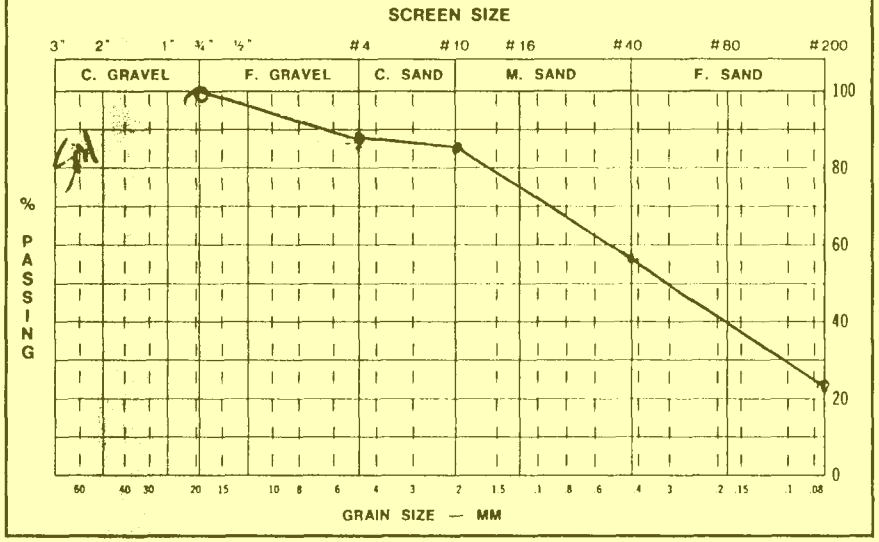
SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, gravelly, VSLTY, C-M-F SAND

50.3 54.3 8.0

SIEVE ANALYSIS		% Passing 277.3	
		-40 96.3	57.6
-¾ 30.1	100	-80	
-4 10.7	89.1	-140	
-10 76.8	85.3	-200 63.4	22.9

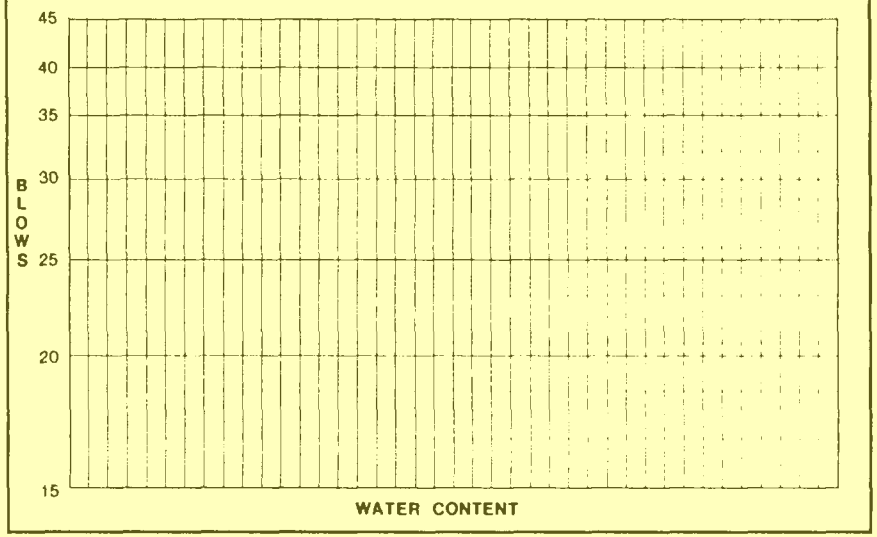
GRAIN SIZE CURVE



PLASTICITY CHART

LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66X6-4 JOB NO. 8034 HOLE NO 62

DATE 8-7-86 OPERATOR SD

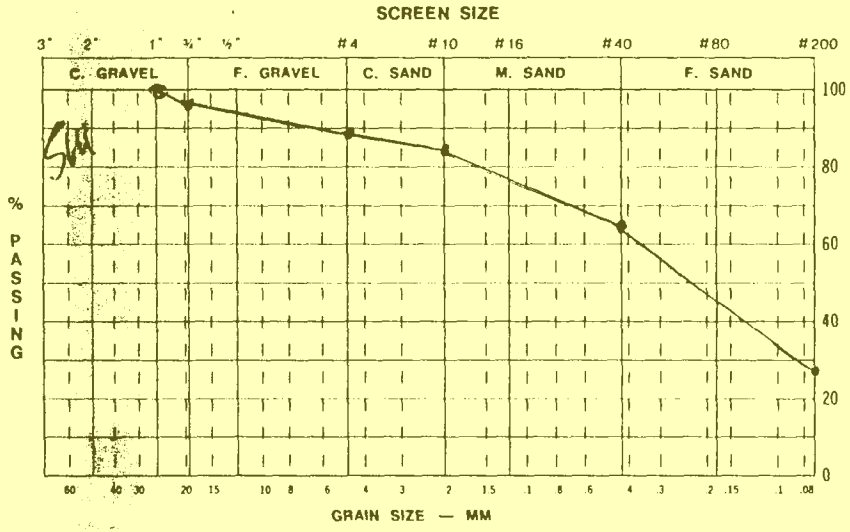
SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Br, Dry, gravelly, v SILTY, C-M-F SAND

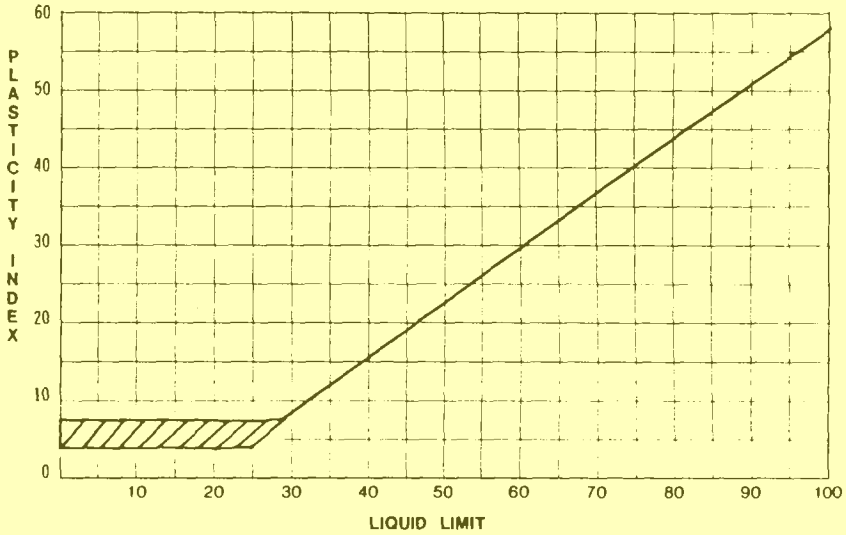
54.2 56.9 500

SIEVE ANALYSIS			% Passing 314.3		
-1	10.8	100	-40	114.0	64.8
-¾	22.8	96.6	-80		
-4	13.1	89.3 85.7	-140		
-10	64.0		-200	89.6	28.5

GRAIN SIZE CURVE

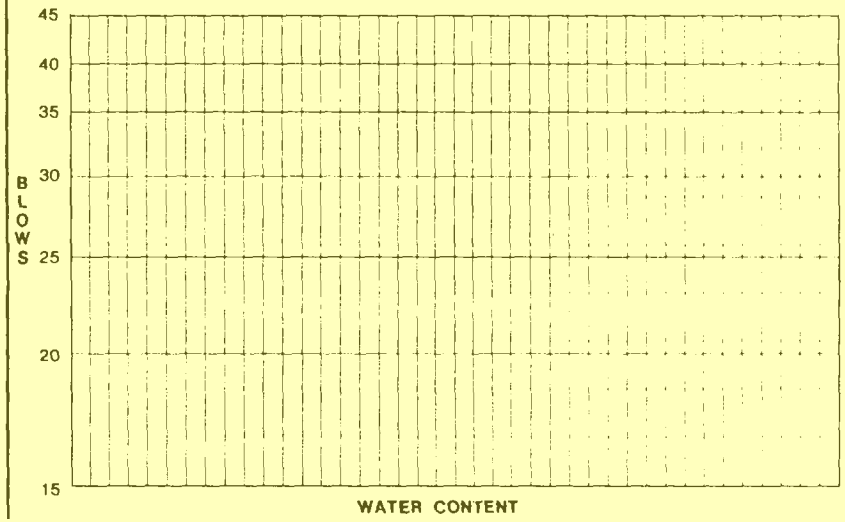


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66765 JOB NO. 8034 HOLE NO. 6-2

DATE 8-7-86 OPERATOR RD

SOIL FIELD IDENTIFICATION

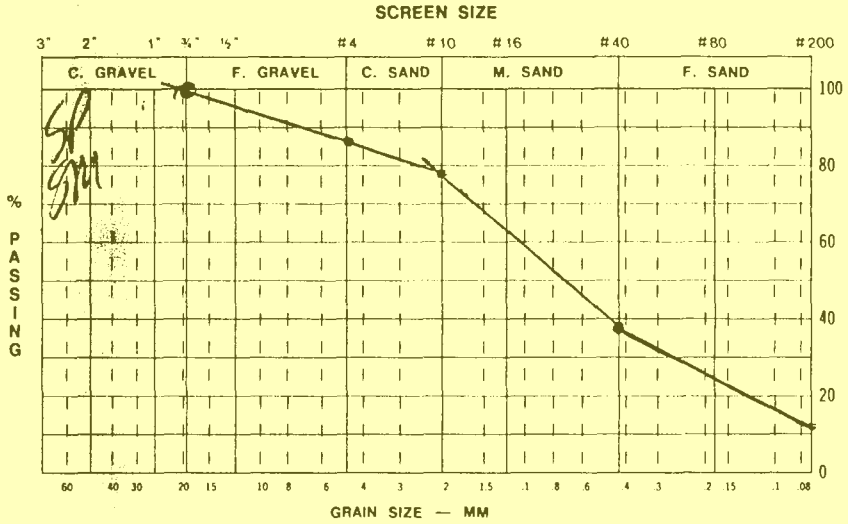
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravelly, C-M-F SAND

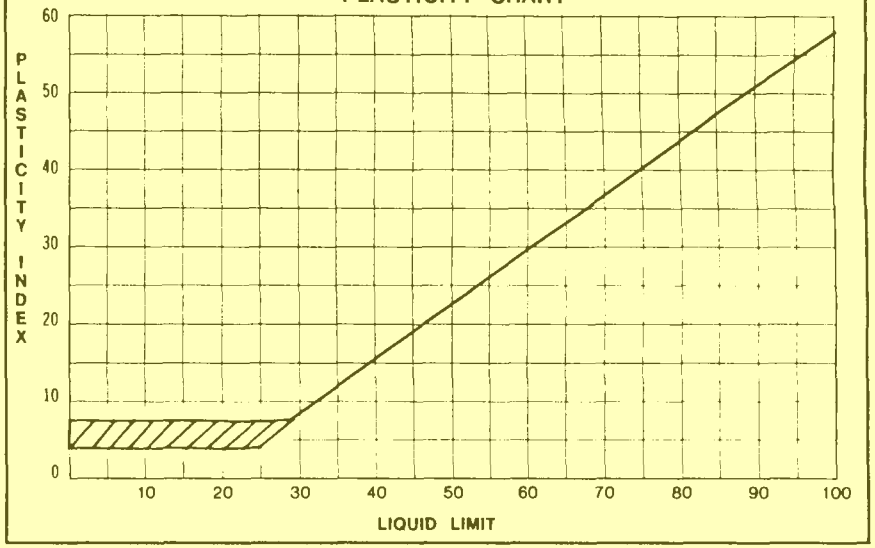
63.0 66.4 5.4

SIEVE ANALYSIS		% Passing 425.4	
		-40 116.8	38.6
-3/4 53.5	100	-80	
-4 36.6	87.4	-140	
-10 171.0	78.8	-200 47.5	11.2

GRAIN SIZE CURVE

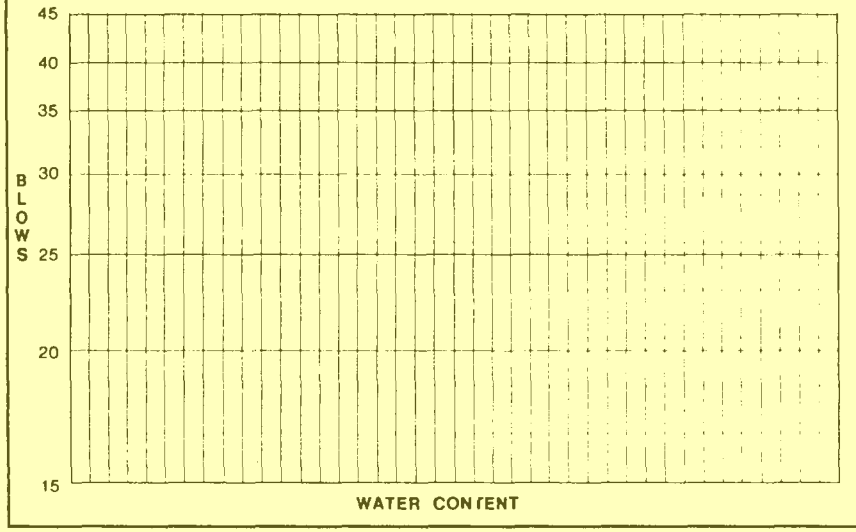


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

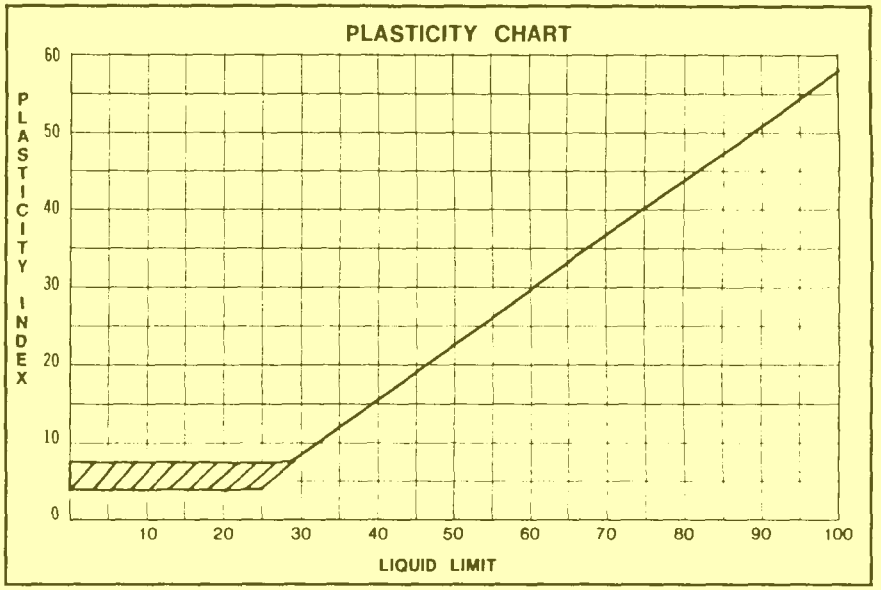
SAMPLE NO. 66-76-6 JOB NO. 8034 HOLE NO. 67

DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

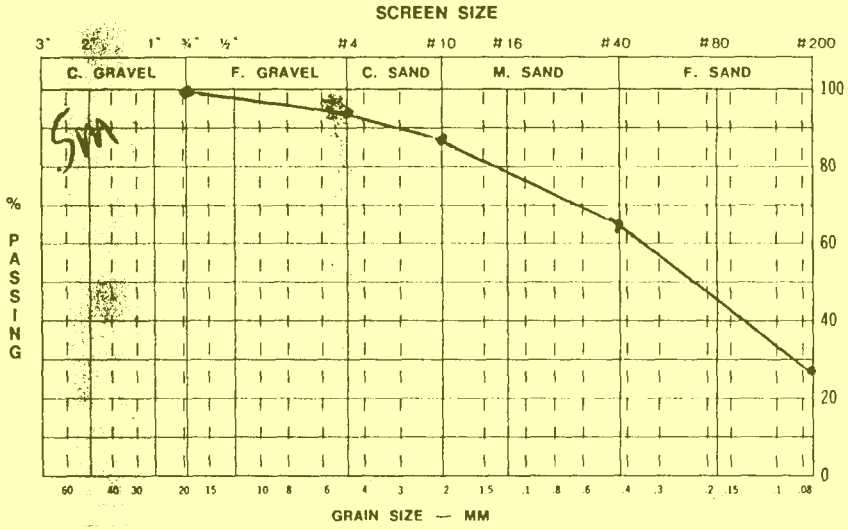
DESCRIPTION: Brn, moist, gravelly, V.SILTY, C-M-F SAND



62.08 68.2 10.2

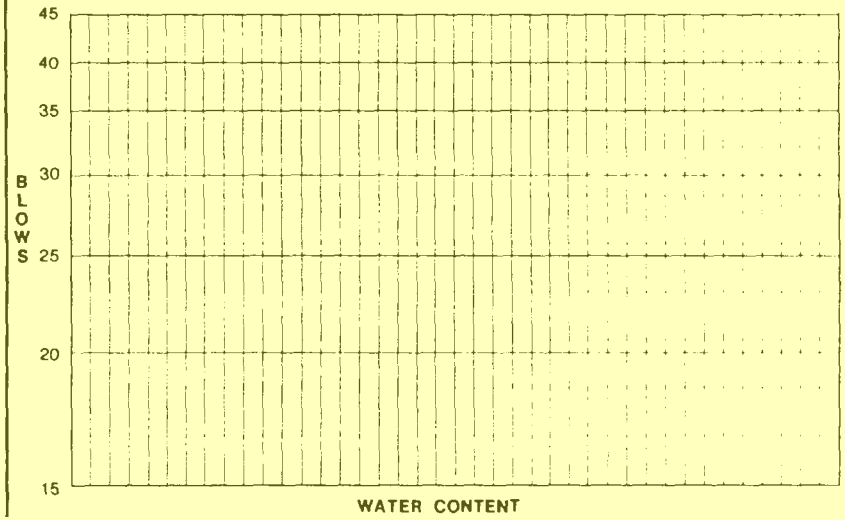
SIEVE ANALYSIS		% Passing 332.7	
		-40 116.4	64.9
-¾ 80.4	100	-80	
-4 15.0	93.7	-140	
-10 74.9	88.1	-200 93.0	28.8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6676-7 JOB NO. 8034 HOLE NO. 62

DATE 8-7-86 OPERATOR RJ

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

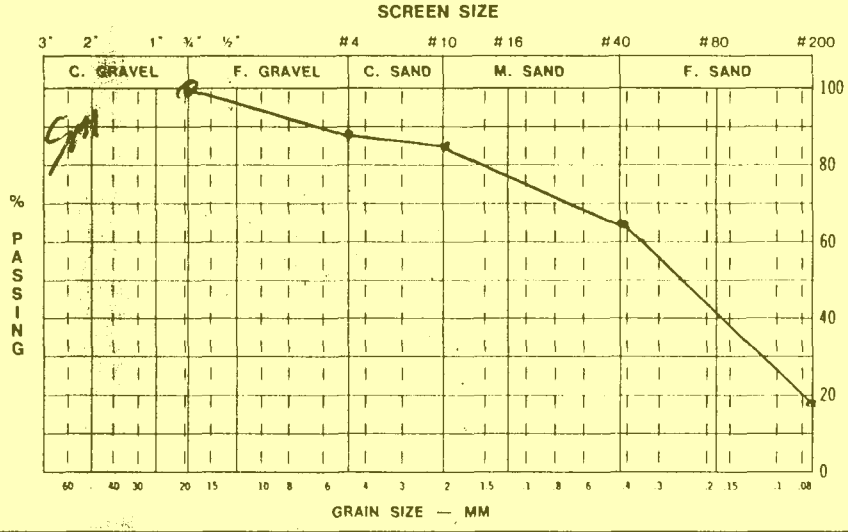
DESCRIPTION Bn, Dry, gravelly, SLTY, Cum-F SAND w/organic

PLASTICITY CHART

55.7 60.9 9.3

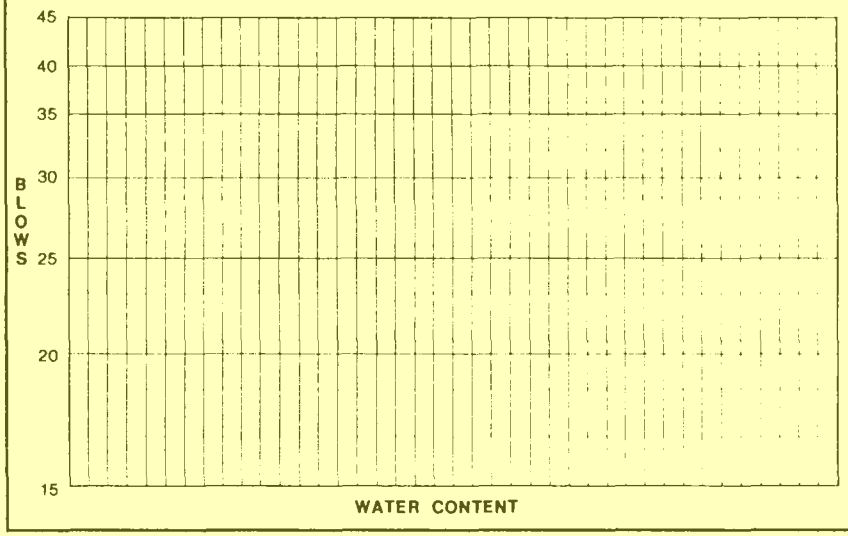
SIEVE ANALYSIS		% Passing 334.0	
		-40 150.9	64.2
-¾ 35.7	100	-80	
-4 13.1	89.3	-140	
-10 20.9	85.4	-200 63.4	19.0

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6676-8 JOB NO. 8034 HOLE NO. 62

DATE 8-7-86 OPERATOR [illegible]

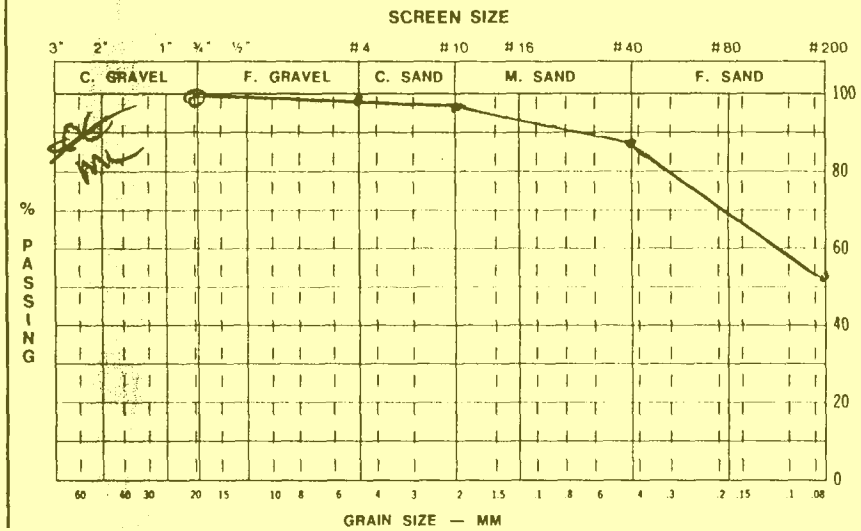
SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION Brn, Dry, gravelly, M-F SANDY, SILT

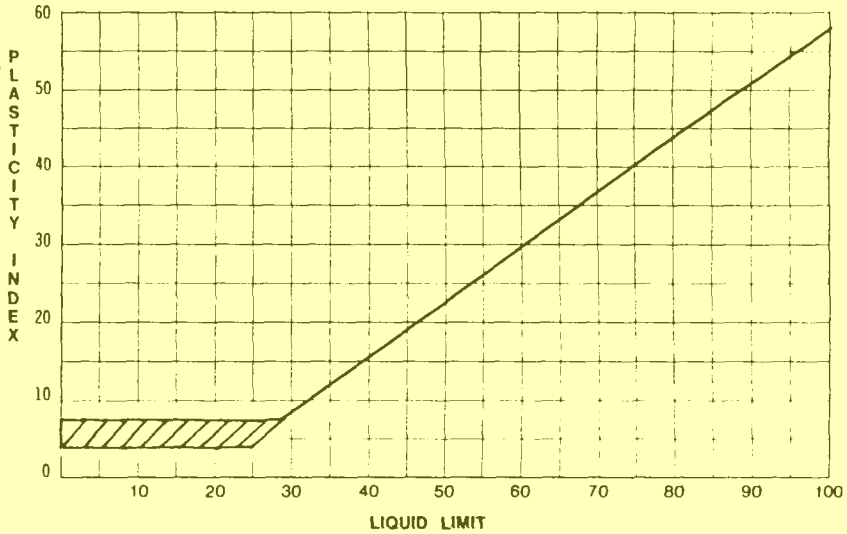
57.8 62-9 8.8

SIEVE ANALYSIS			% Passing 340.3		
			-40	125.4	68.0
-¾	2.2	100	-80		
-4	2.8	99.4	-140		
-10	35.7	98.5	-200	174.2	51.2

GRAIN SIZE CURVE

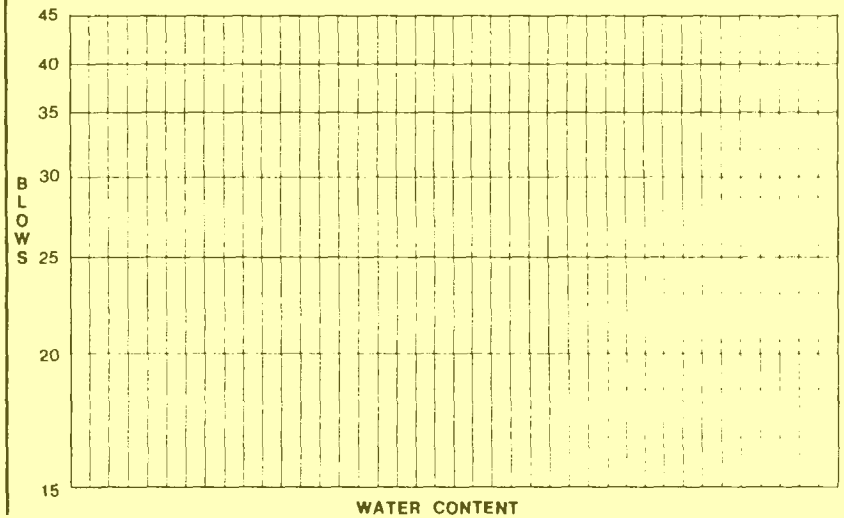


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6676-9 JOB NO. 8034 HOLE NO. 62

DATE 8-7-86 OPERATOR P

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

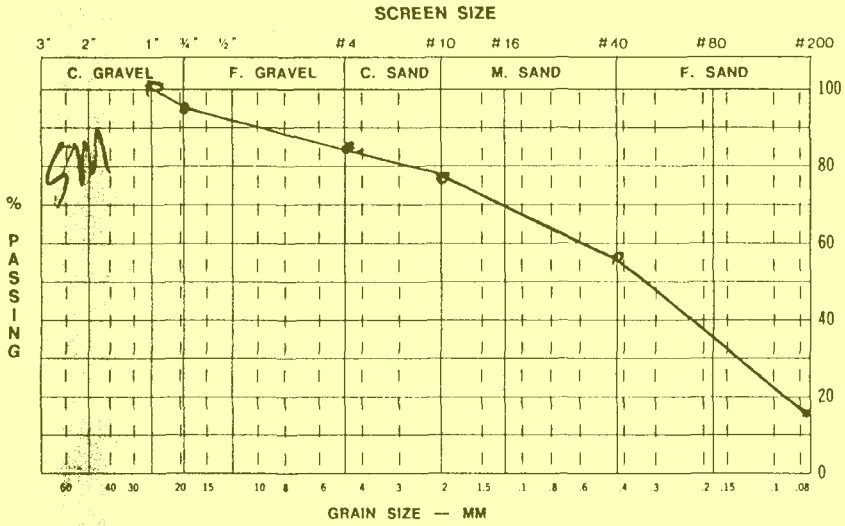
DESCRIPTION: Brn, Dry, SLTY, gravely, CRM-F SAND

PLASTICITY CHART

25.7 78.3 3.4

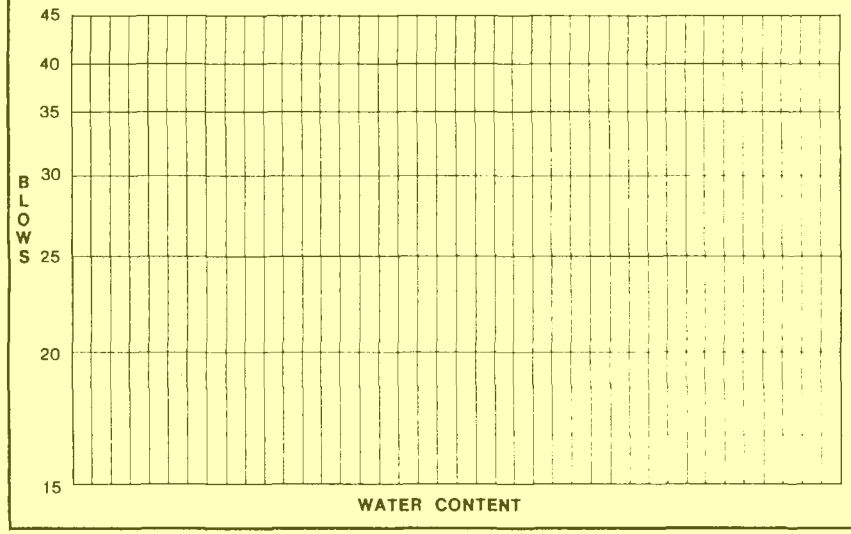
SIEVE ANALYSIS		% Passing 335.5		
# 18.9	100	-40	29.1	56.1
-¾ 35.2	94.4	-80		
-4 17.8	83.9	-140		
-10 75.3	78.6	-200	59.2	17.6

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

ATERIALS ENGINEER
terials Laboratory
O. Box 167, Olympia, WA 98504 (Mailing Address)
5 So. 2nd Ave.
nwater, Washington 98504 (Shipping Address)

Place SEATTLE
Date 4-16-86
DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOU
SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset 12+60 LR2 SOUTH WALL ℄ Hole # 63

Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
—	P-10	NO REC.			
87-10	P-11	-45.0' to -46.5'	H2O= 8.3	SP	

py with samples
py to addressee

Yours very truly,

R. L. WESSELS
DIST. MAT'LS. ENGR.
450 So. Spokane St.
Seattle, WA 98134
Inspector.

T FORM 351-002
REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6689-1 JOB NO. 8034 HOLE NO. 63

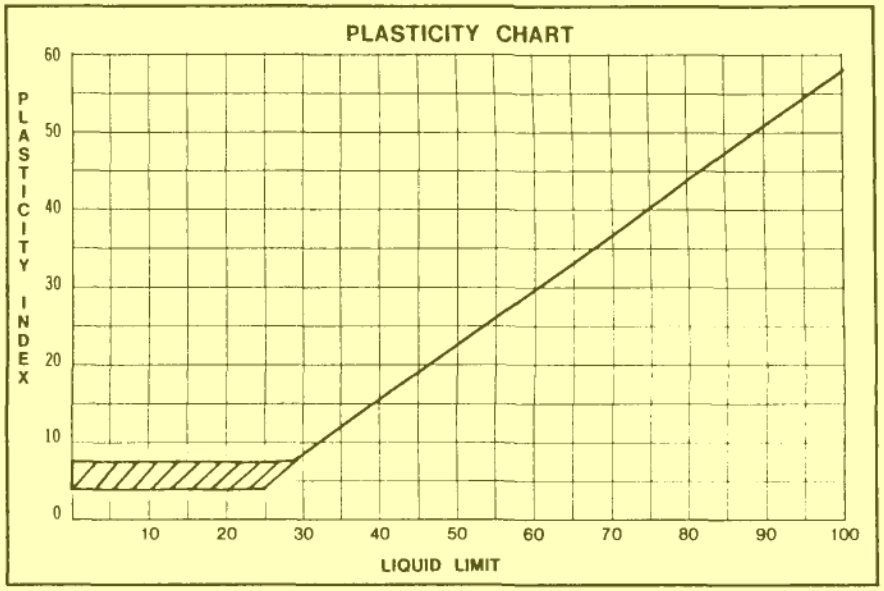
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Dn, Dry, SLTY, gravely, C-M-F SAND

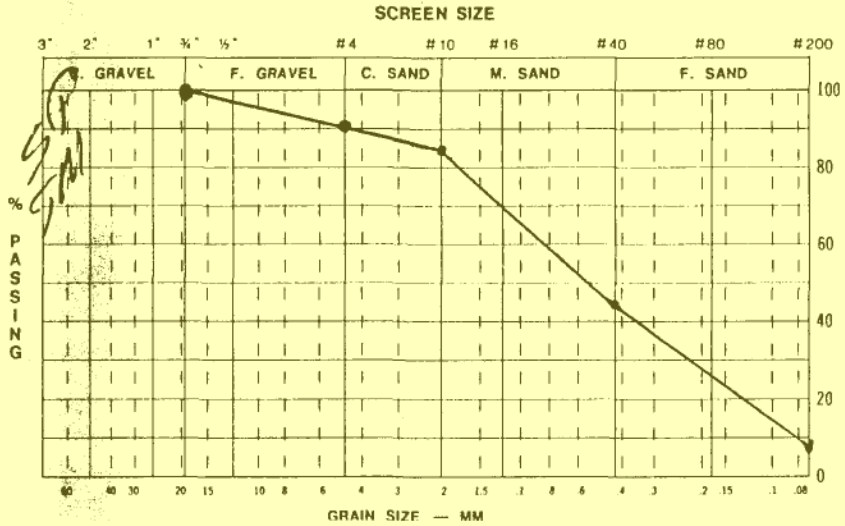
PLASTICITY CHART



45.1 47.7 5.8

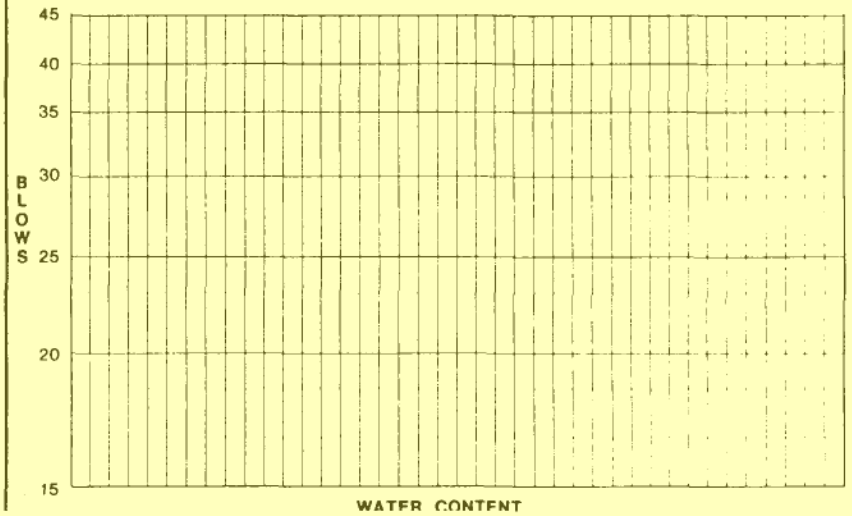
SIEVE ANALYSIS		% Passing 201.4	
		-40 68.8	43.8
-¾ 20.0	100	-80	
-4 11.7	90.1	-140	
-10 81.5	84.3	-200 19.4	9.6

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL =
Blows					PI =



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66892 JOB NO. 8034 HOLE NO. 63

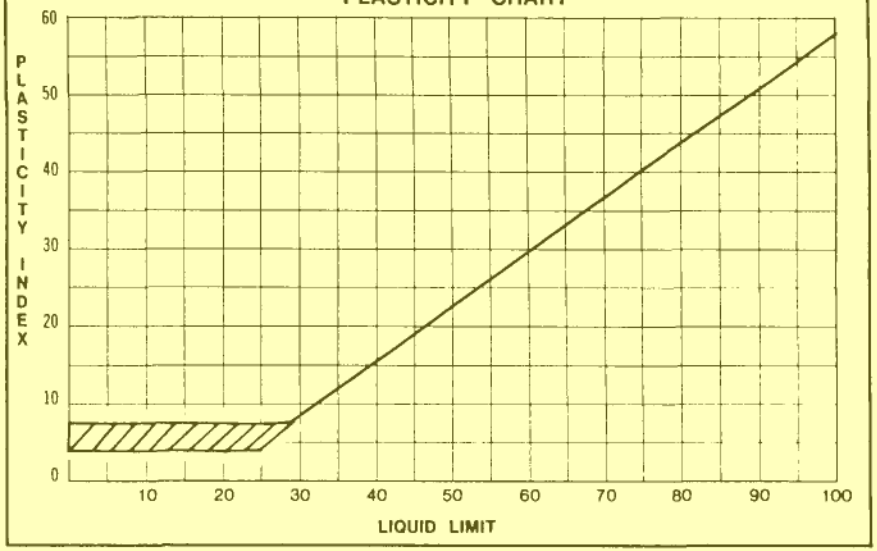
DATE 8-7-86 OPERATOR SC

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravely, CM-F SAND

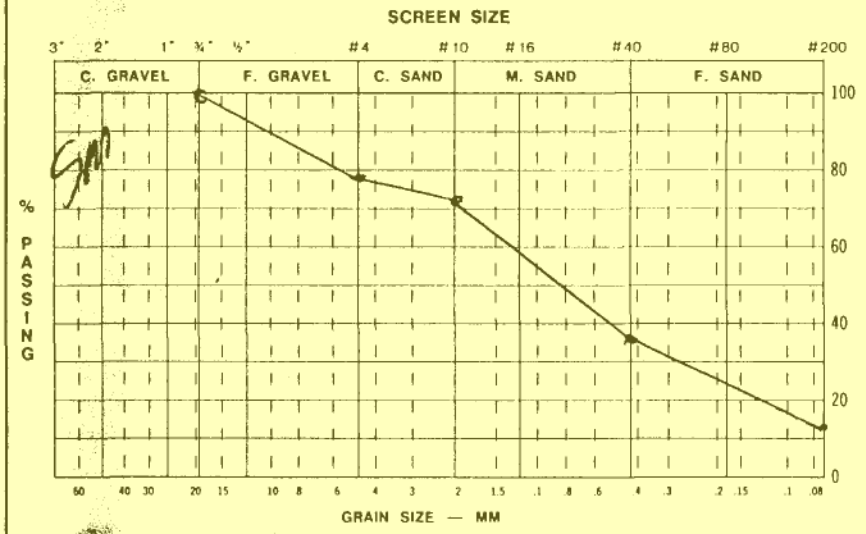
PLASTICITY CHART



37.5 38.6 2.9

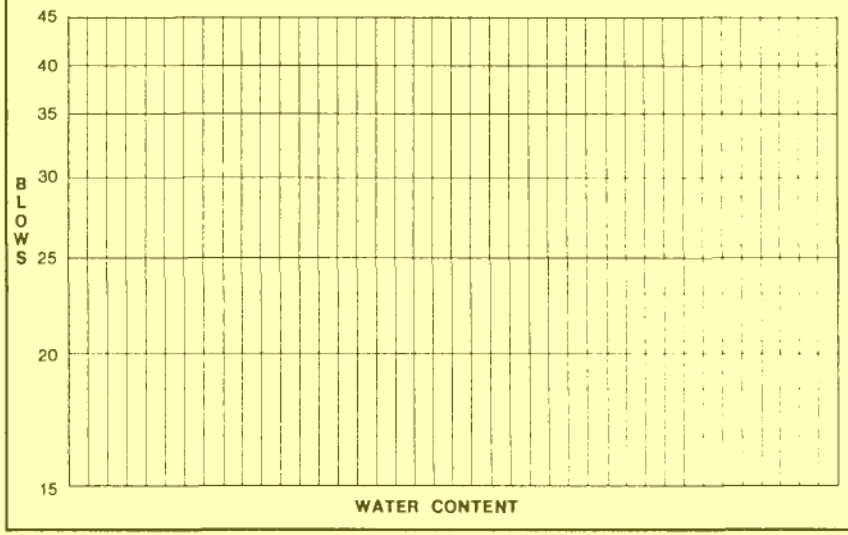
SIEVE ANALYSIS		% Passing 214.9	
		-40 54.8	37.6
-¾ 43.1	100	-80	
-4 18.5	79.9	-140	
-10 72.4	71.3	-200 26.1	12.1

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6689-3 JOB NO. 8034 HOLE NO. 63

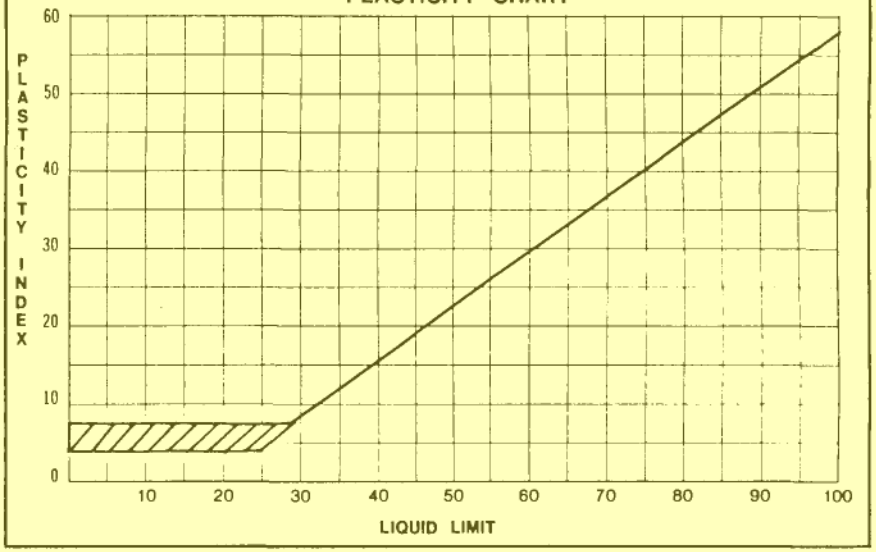
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravely, C-M-F SAND

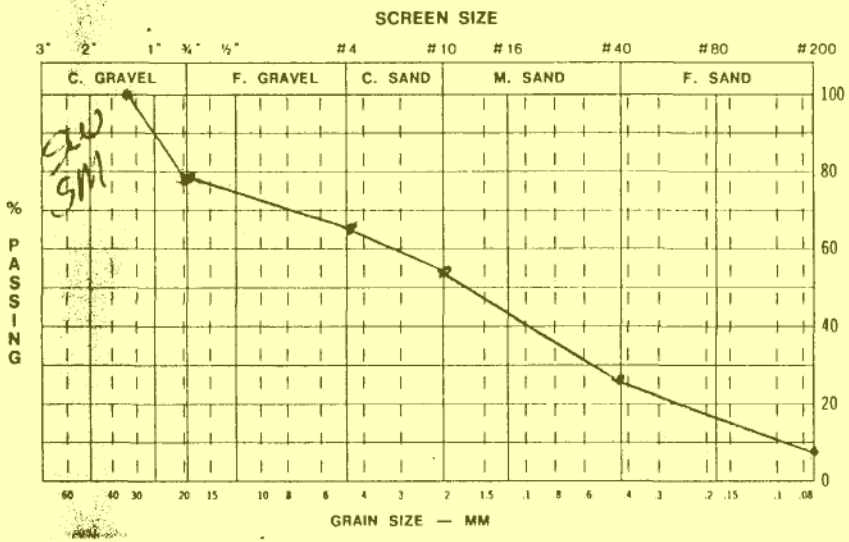
PLASTICITY CHART



34.1 34.3 .6

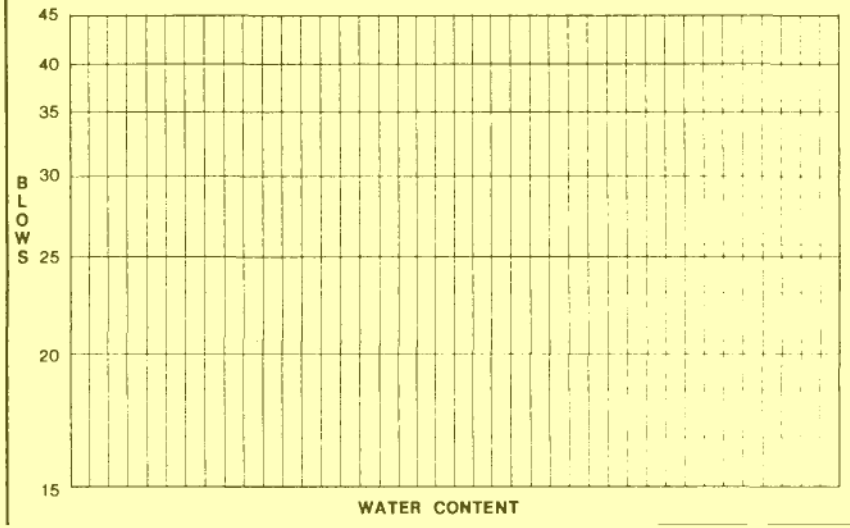
1½ 43.7 SIEVE ANALYSIS		% Passing 21.3 2	
		-40 37.4	26.5
-¾ 33.6	79.5	-80	
-4 20.5	64.2	-140	
-10 59.9	54.6	-200 19.1	9.0

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO 6689-4 JOB NO 8C34 HOLE NO 63

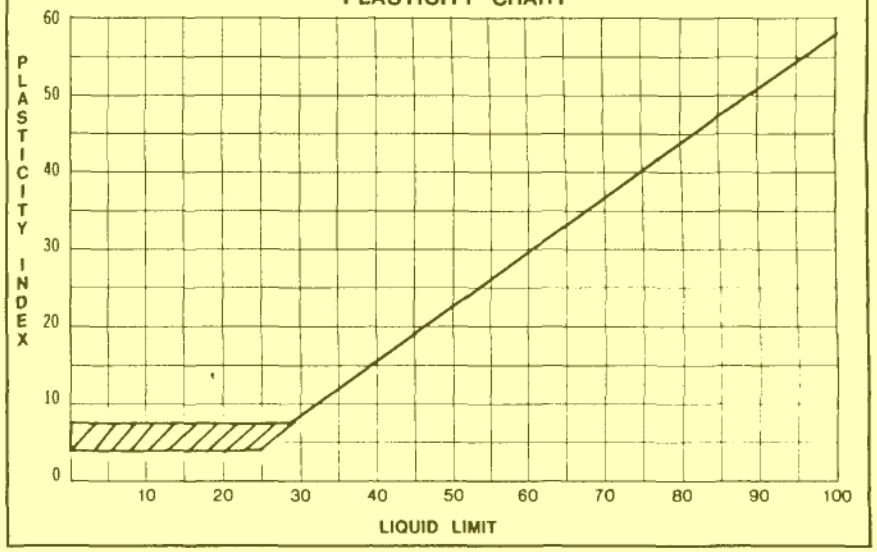
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, gravely, SLTY, C-M-F SAND

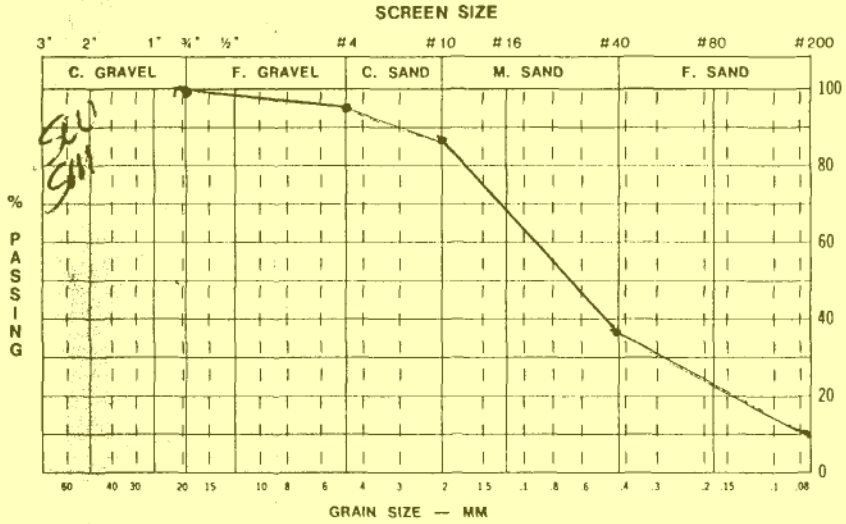
PLASTICITY CHART



39.6 4202 6.6

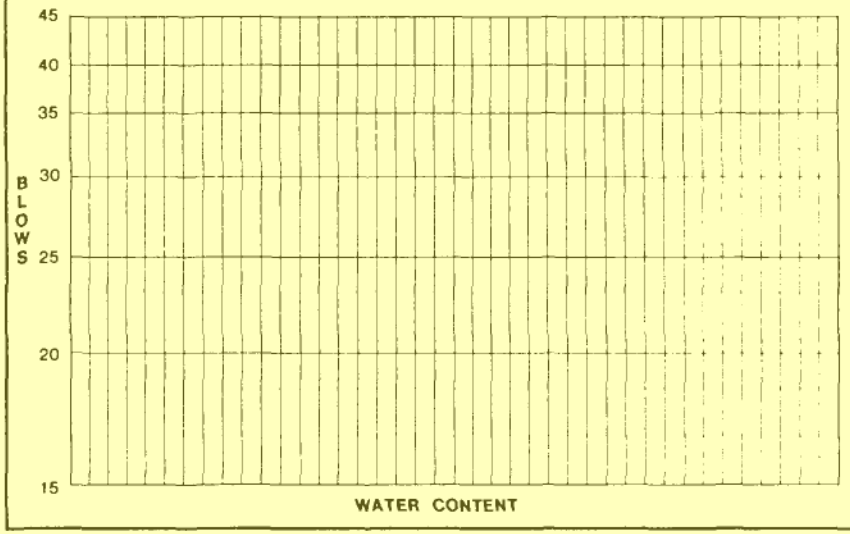
SIEVE ANALYSIS		% Passing 224.4	
		-40 58.5	36.4
-¾ 11.6	100	-80	
-4 15.2	94.8	-140	
-10 116.0	88.1	-200 23.1	10.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO 6689-5 JOB NO. 5341 HOLE NO 63

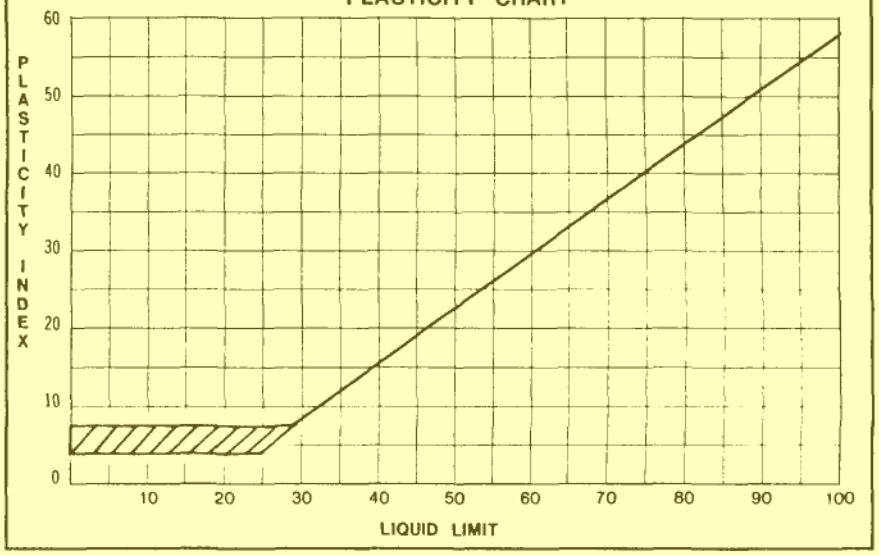
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION Br, moist, gravelly, SLTY, CVM-F SAND

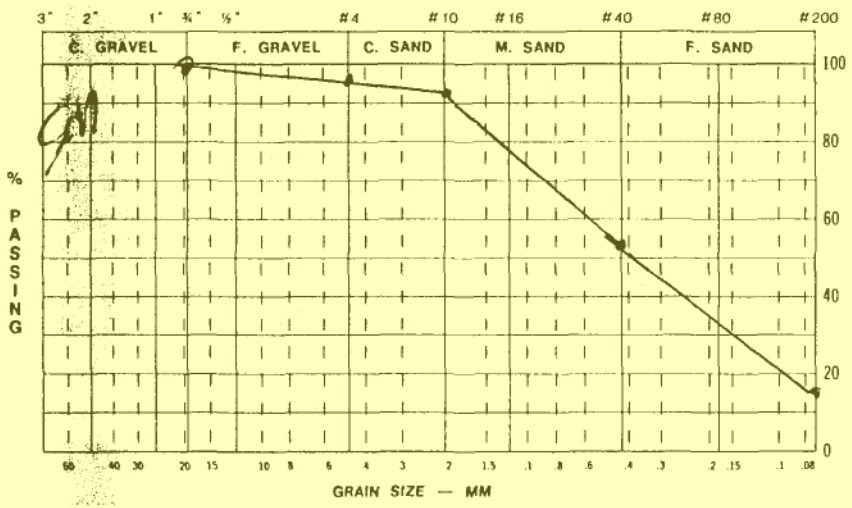
PLASTICITY CHART



56.8 62.6 10.2

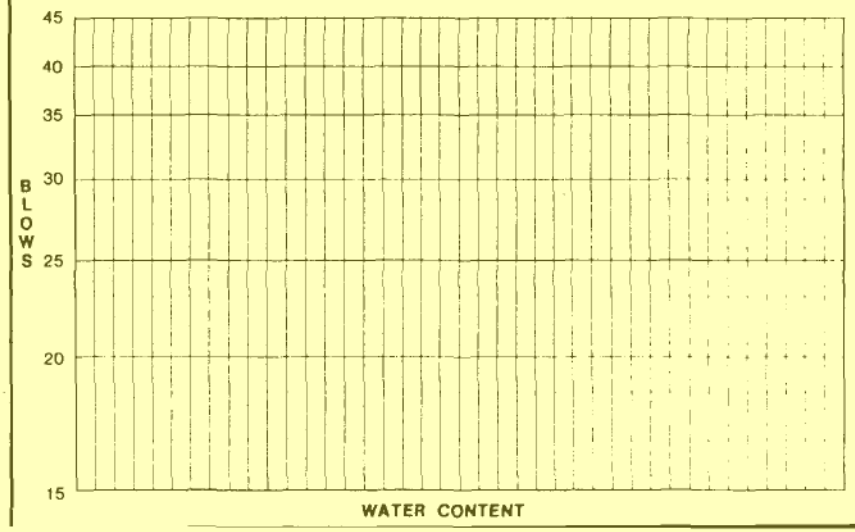
SIEVE ANALYSIS		% Passing 212.0	
		-40 80.5	52.8
-¾ 7.4	100	-80	
-4 11.7	96.5	-140	
-10 81.0	91.0	-200 31.4	M8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO 6689-6 JOB NO 8534 HOLE NO 63

DATE 8-7-86 OPERATOR AO

SOIL FIELD IDENTIFICATION

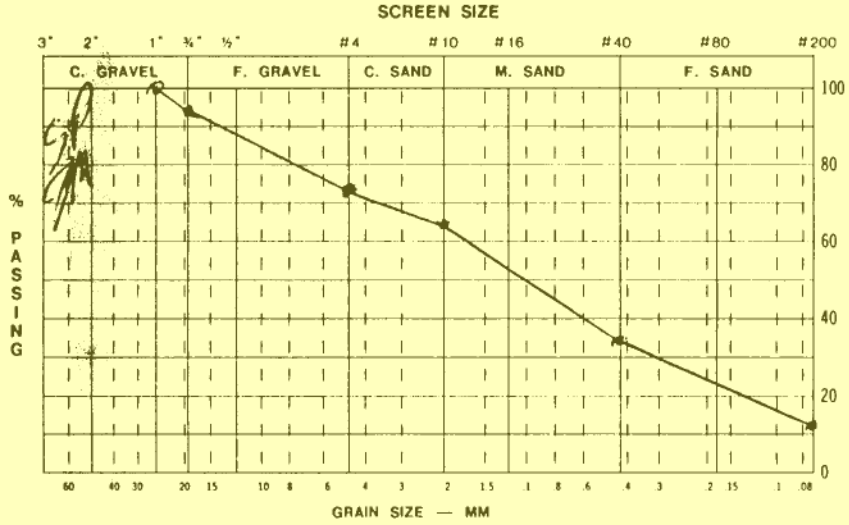
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravely, C-M-F SAND

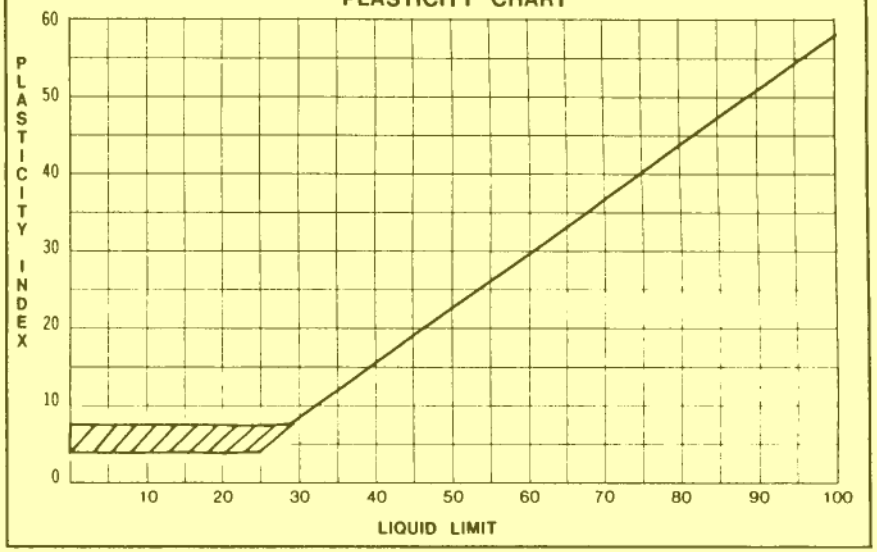
43.9 45.1 2.7

SIEVE ANALYSIS			% Passing 188.0	
-1 11.6	160		-40 43.5	34.6
-¾ 41.1	938		-80	
-4 16.5	720		-140	
-10 53.7	632		-200 21.6	11.5

GRAIN SIZE CURVE

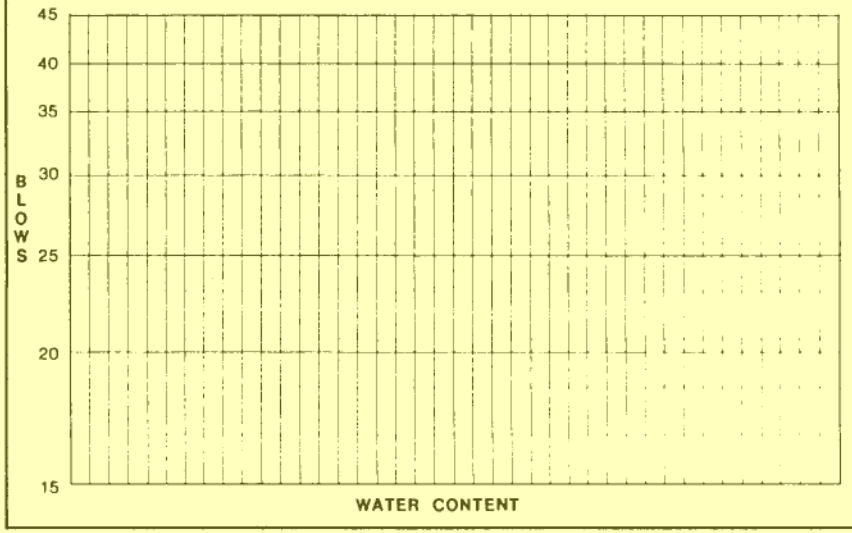


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6689-7 JOB NO. 8534 HOLE NO. 63

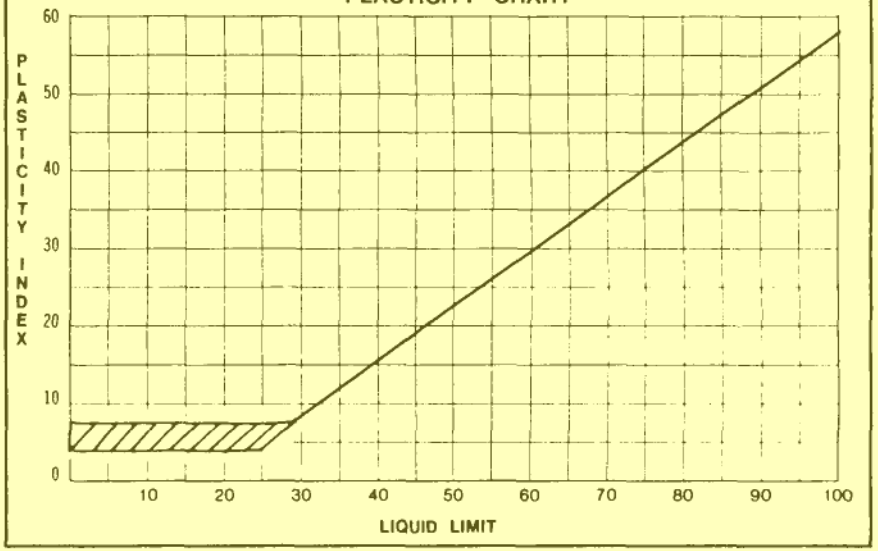
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravelly, C-M-F SAND

PLASTICITY CHART

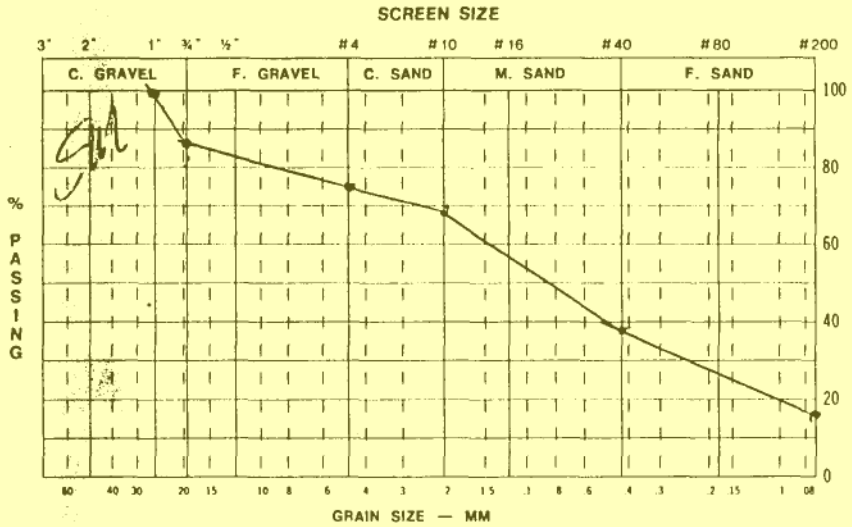


31.2 34.2 9.4

SIEVE ANALYSIS

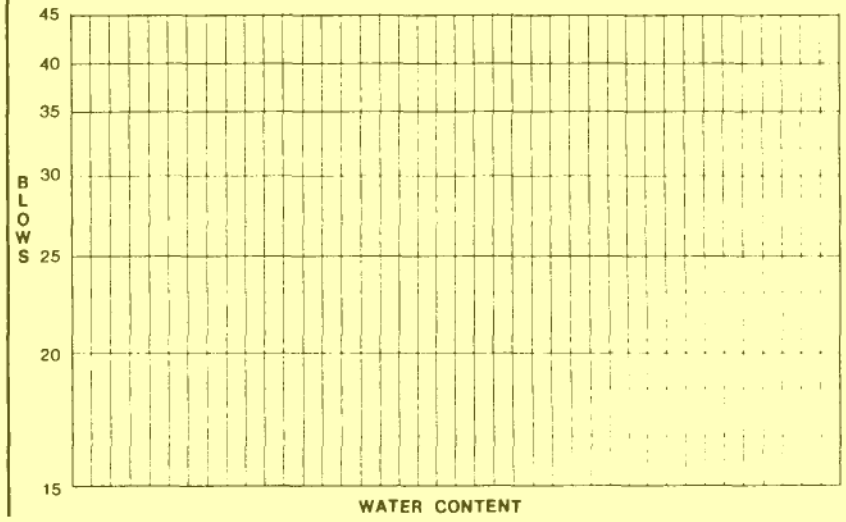
		% Passing		
			182.8	
-1	25.6	100	-40 42.7	38.8
-4	18.4	66.0	-80	
-4	11.8	75.9	-140	
-10	56.1	69.5	-200 28.2	15.4

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6689-8 JOB NO. 8034 HOLE NO. 63

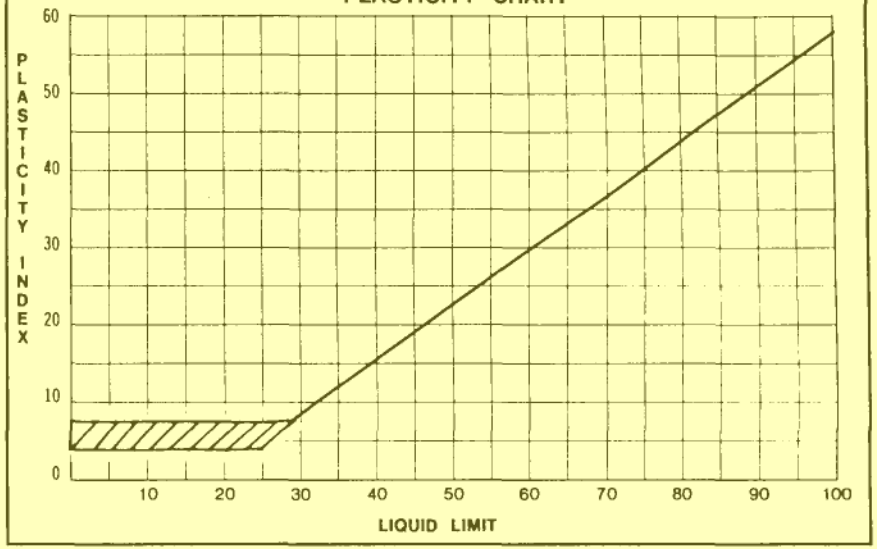
DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION Brn, dry, silty, gravelly, C-m-F sand

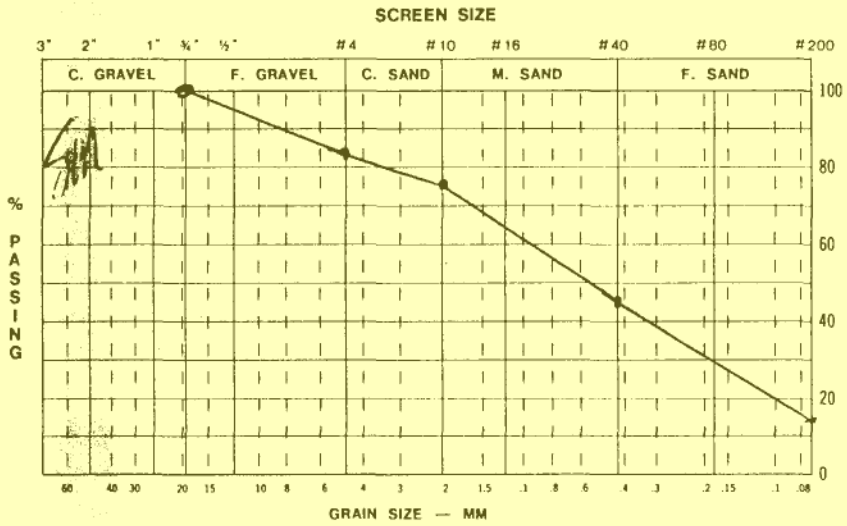
PLASTICITY CHART



36.2 38.5 64 183.3

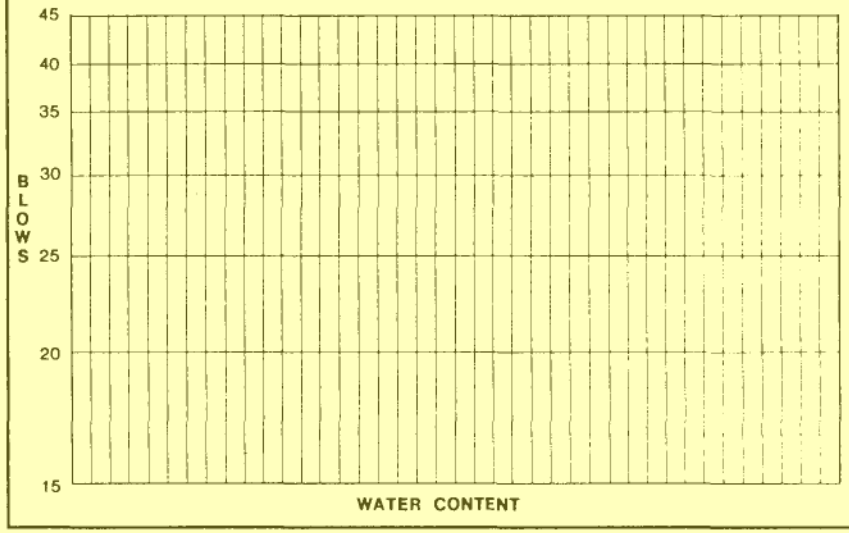
SIEVE ANALYSIS		% Passing	
		-40 56.1	43.9
-¾ 31.35	100	-80	
-4 11.6	82.9	-140	
-10 59.85	76.6	-200 74.4	13.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6689-9 JOB NO. 8031 HOLE NO. 63

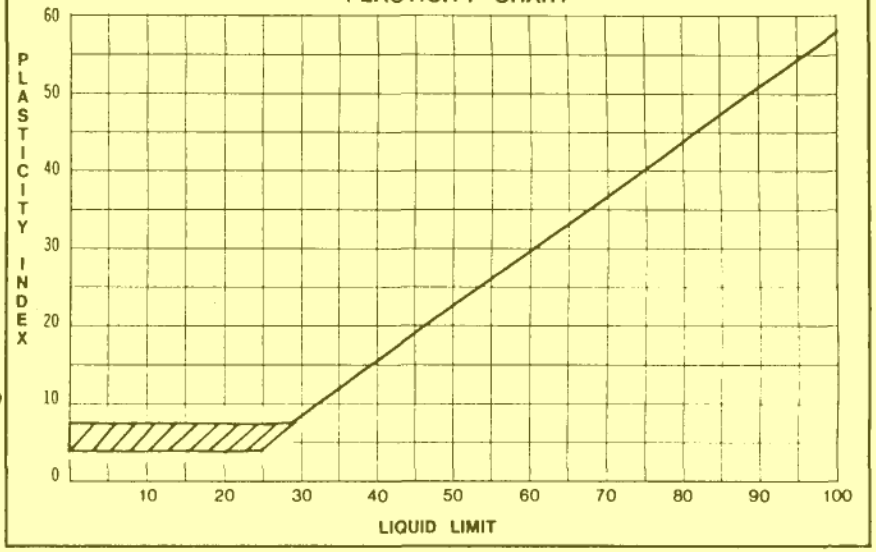
DATE 8-2-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Br, Dry, gravelly, VSLTY, C-M-F SAND

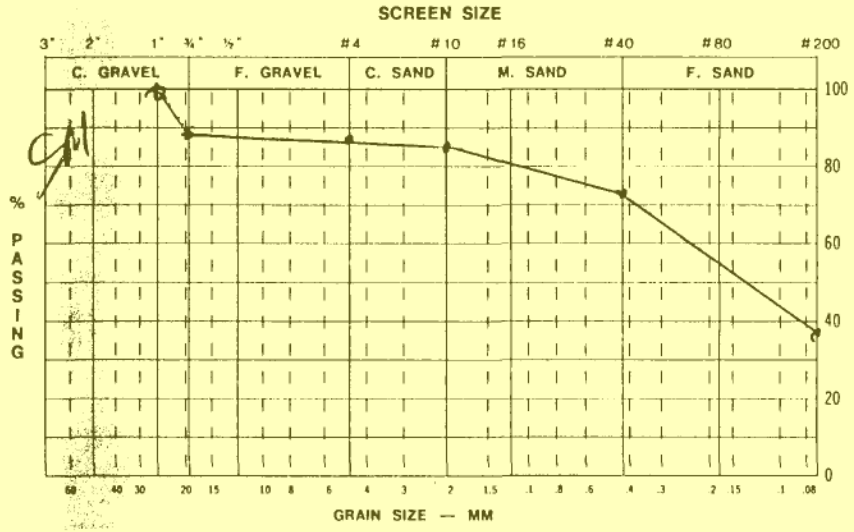
PLASTICITY CHART



52.2 55.3 5.9

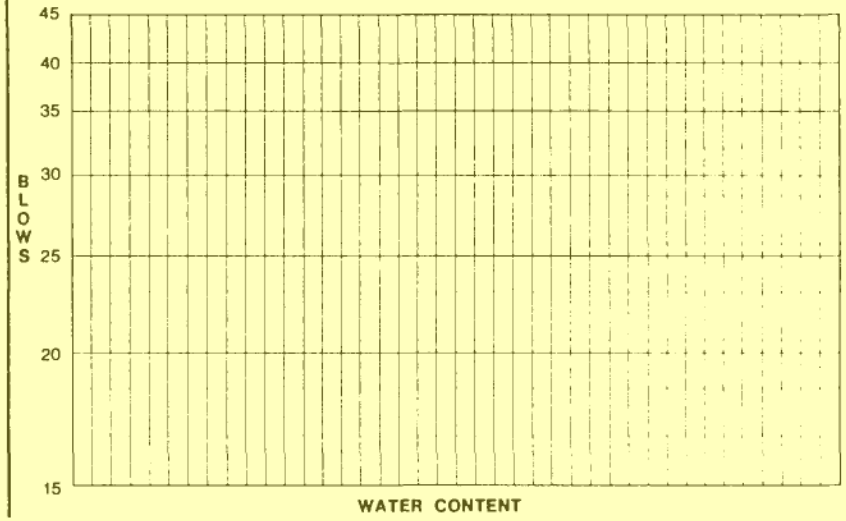
SIEVE ANALYSIS			% Passing 189.65		
-1	19.4	100	-40	66.9	72.4
-¾	3.4	84.8	-80		
-4	3.9	58.0	-140		
-10	25.6	85.9	-200	70.45	37.1

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO 6689-10 JOB NO 8034 HOLE NO 63

DATE 8-7-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

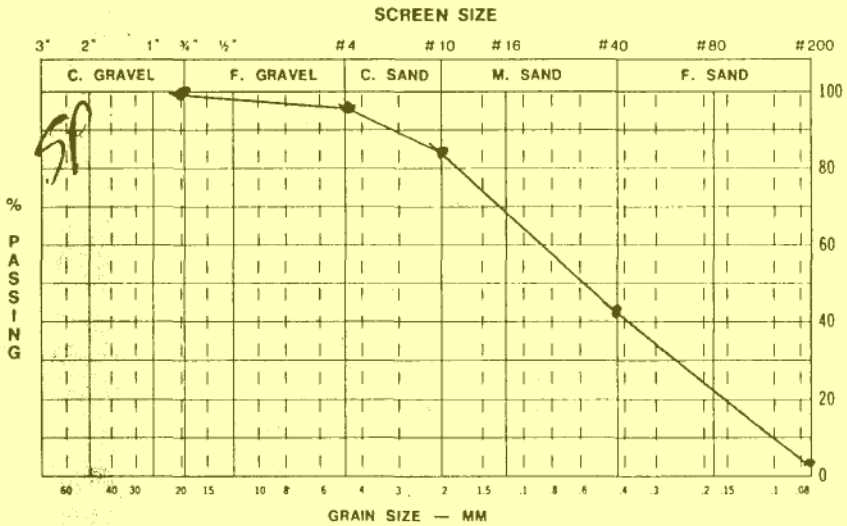
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Dr, Dry, SL4SLTY, gravely, C-M-F SAND

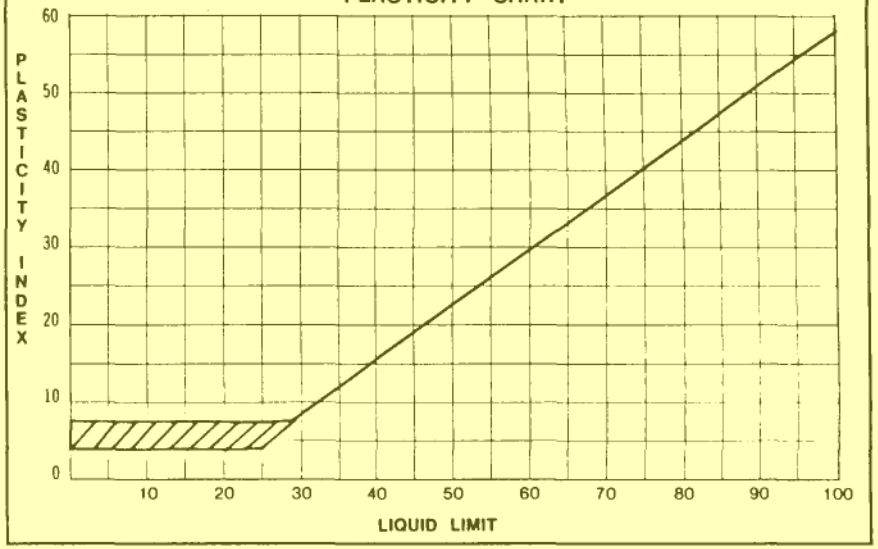
39.7 43.0 8.3

SIEVE ANALYSIS		% Passing 149.1	
		-40 55.7	41.2
-¾ 6.8	100	-80	
-4 19.9	95.4	-140	
-10 60.9	82.1	-200 5.8	3.9

GRAIN SIZE CURVE

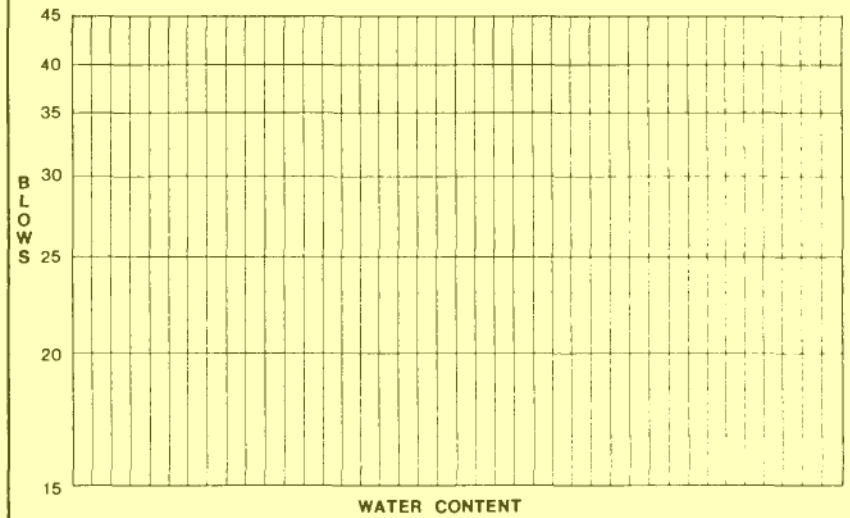


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 790-

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

MATERIALS ENGINEER
Materials Laboratory
P. O. Box 167, Olympia, WA 98504 (Mailing Address)
1655 So. 2nd Ave.
Tumwater, Washington 98504 (Shipping Address)

Place SEATTLE
Date 4-16-86
DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOU
SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset LR 189+50 6.50' RT OF E.O.P. Hole # 64

E- Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
66T1-1	P-1	-1.5' +0 -3.0'	1.3%	SP SM	
-2	P-2	-5.0' +0 -6.5'	7.4%	SP SM	
-3	P-3	-10.0' +0 -11.5'	5.3%	SW SM	
-4	P-4	-15.0' +0 -16.5'	9.0%	SM	
-5	P-5	-20.0' +0 -21.5'	5.2%	SM	
-6	P-6	-25.0' +0 -26.5'	7.7%	SP SM	
-7	P-7	-30.0' +0 -31.5'	9.3%	SM	
-8	P-8	-35.0' +0 -35.5'	10.1%	SM	
-9	P-9	-40.0' +0 -41.5'	13.6%	SM	

1 copy with samples
1 copy to addressee

Yours very truly,

R. L. WESSELS
DIST. MAT'LS. ENGR.
450 So. Spokane St.
Seattle, WA
By Inspector

DOT FORM 351-002 REVISED 2/80

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

TERIALS ENGINEER
erials Laboratory
). Box 167, Olympia, WA 98504 (Mailing Address)
5 So. 2nd Ave.
ıwater, Washington 98504 (Shipping Address)

Place SEATTLE

Date 4-16-86

DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOU SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset LR 189+50 6.50' RT OF E.O.P. Hole # 64

Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
6677-10	P-10	-45.0' to -46.5'			
					LL 6677-9

by with samples
by to addressee

Yours very truly,

R. L. WESSELS
DIST. MAT'LS. ENGR.
450 So. Spokane St.
Seattle, WA 98134
Inspector.

FORM 351-002
REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

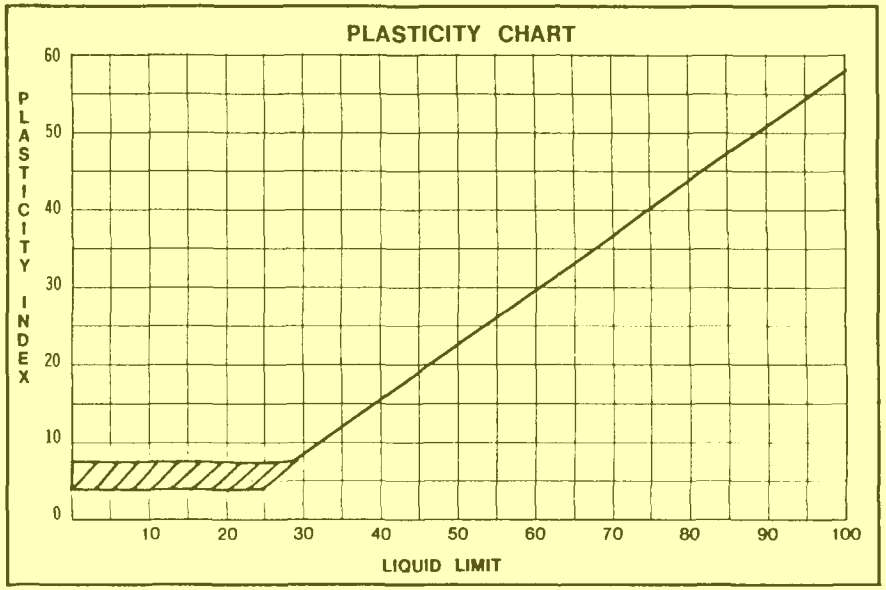
A-LINE

SAMPLE NO. 6077-1 JOB NO. L-8634 HOLE NO. 69-

DATE 8-5-86 OPERATOR JM

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	L	L	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: BRN, DRY, SILTY, GRAVELLY, F-C SAND

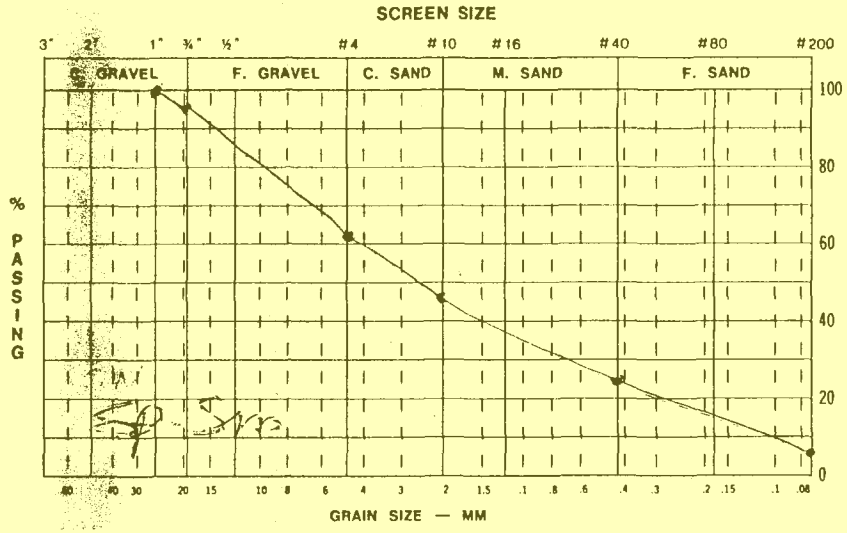


75.3 76.3 H2O = 1.3 %

SIEVE ANALYSIS			% Passing		
-1"	18.1	100	-40	74.7	23.6
-¾	14.5.0	95.7	-80		
-4	65.4	61.5	-140		
-10	95.5	46.1	-200	25.40	6.0

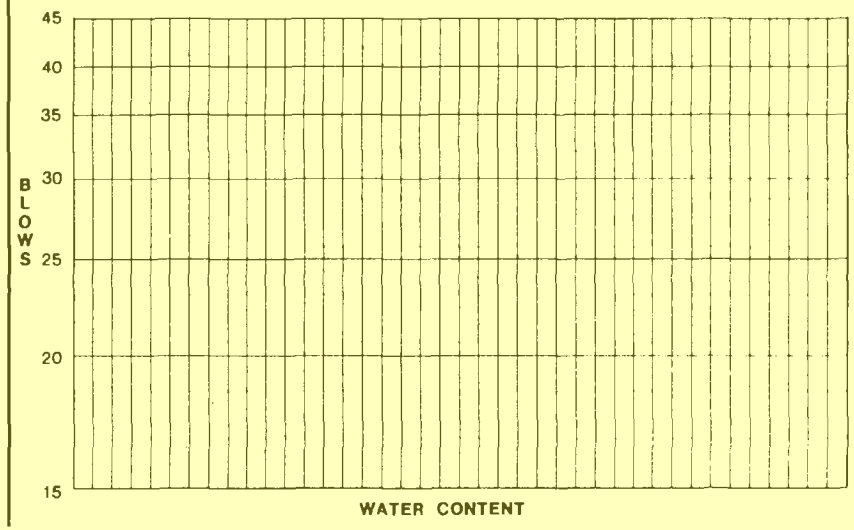
424.1

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



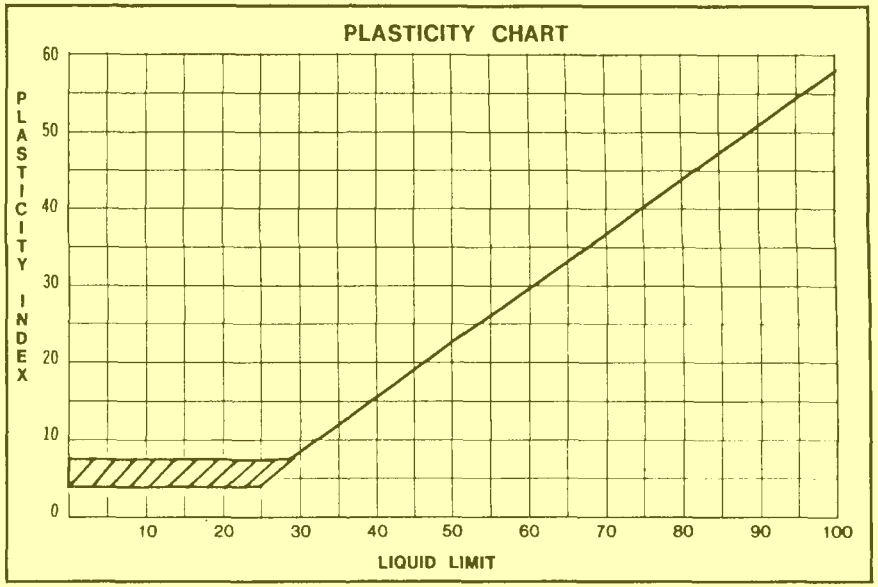
SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

SAMPLE NO. 6677-2 JOB NO. L-8034 HOLE NO. 64-

DATE 8-5-86 OPERATOR JM

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

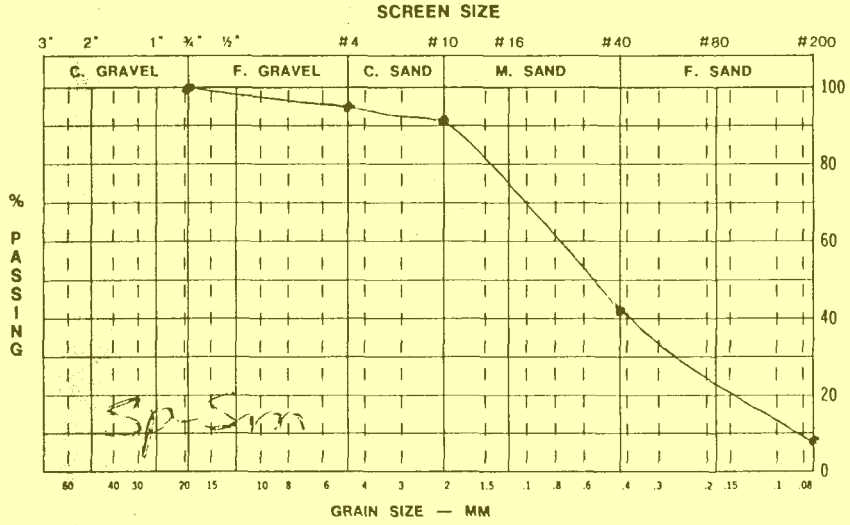
DESCRIPTION: BRN, DRY, SILTY, GRAVELLY, F-M SAND



62.0 66.6 W20= 7.4 %

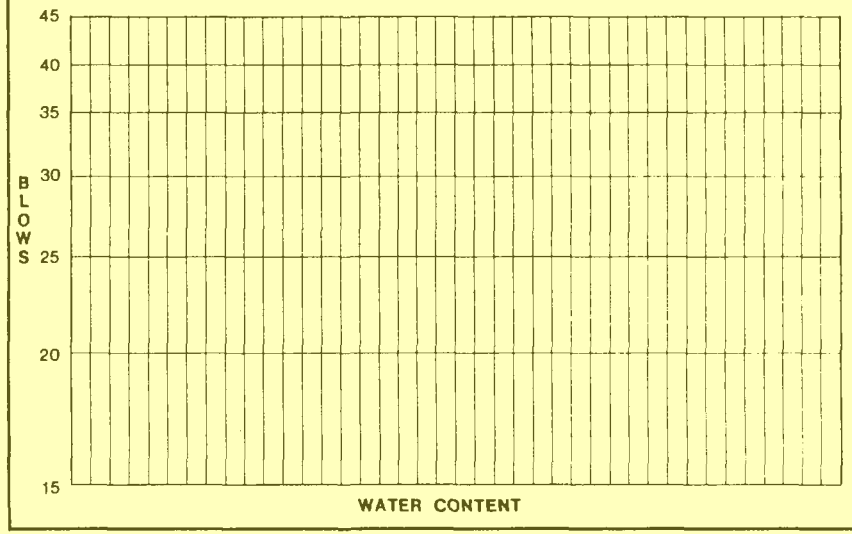
SIEVE ANALYSIS		% Passing 312.4		
		-40	106.6	42.3
-¾	16.8	100	-80	
-4	12.1	94.6	-140	
-10	151.4	90.7	-200	25.50	8.2

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

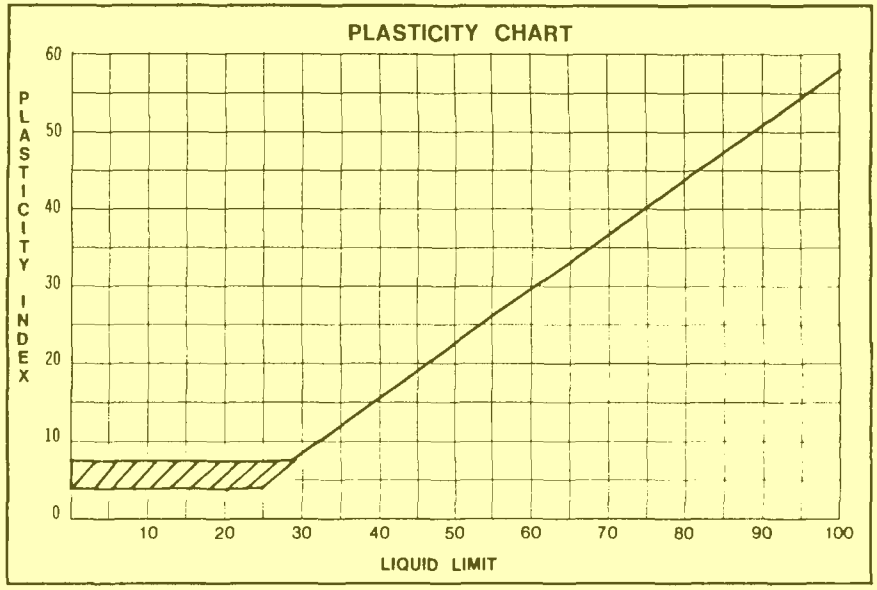
A-LINE

SAMPLE NO. 6677-3 JOB NO. L-8034 HOLE NO. 64-

DATE 8-5-86 OPERATOR JM

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

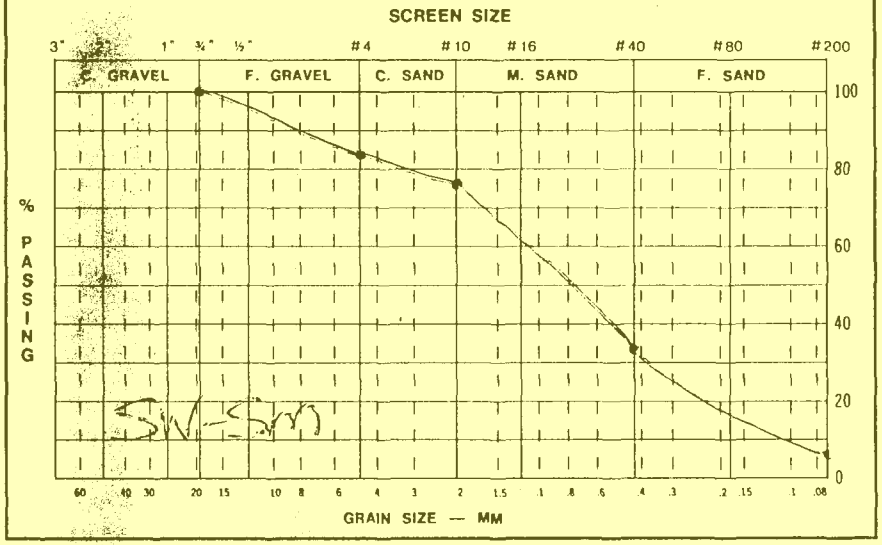
DESCRIPTION: BCN, DEF, SILTY, GRAVELLY, F-C SAND



62.2 65.5 H2O 5.3 %

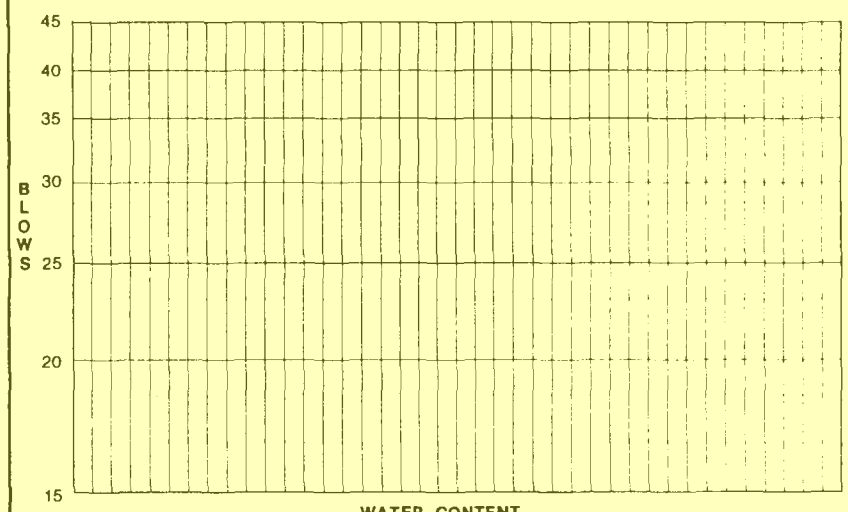
SIEVE ANALYSIS		% Passing	385.0	
		-40	100.5	32.6
-¾ 65.8	100	-80		
-4 27.4	82.9	-140		
-10 166.1	75.8	-200	25.20	6.5

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

SAMPLE NO. 677-B JOB NO. L-8034 HOLE NO. 64

DATE 8-5-86 OPERATOR Jm

SOIL FIELD IDENTIFICATION

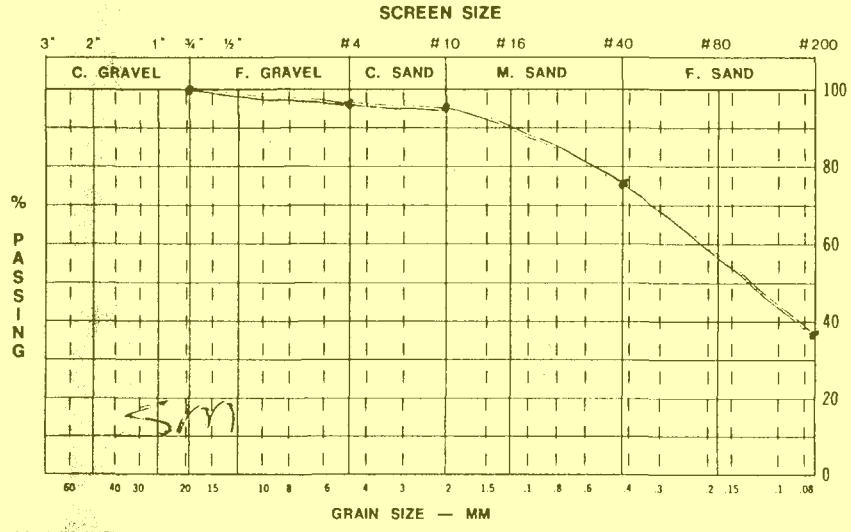
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: GEN., MOIST., U. SILTY, F-M SAND

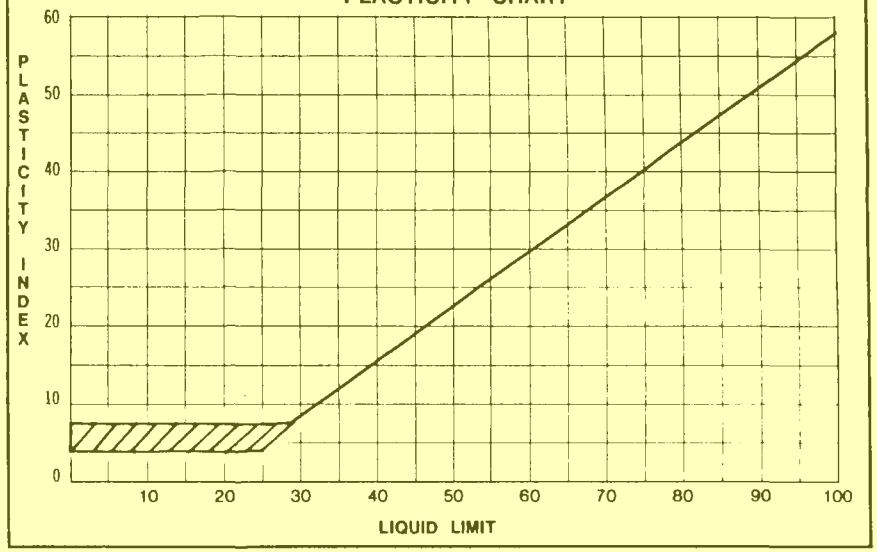
49.3 54.3 N20= 10.1 %

SIEVE ANALYSIS		% Passing (39.1)	
		-40	52.3 74.9
-¾	3.8 100	-80	
-4	2.0 97.3	-140	
-10	29.1 95.8	-200	51.9 37.3

GRAIN SIZE CURVE

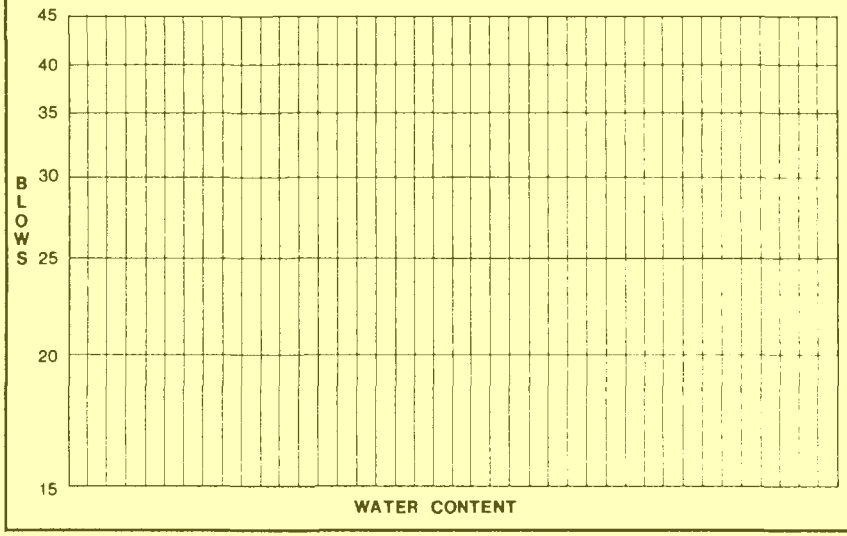


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6577.9 JOB NO. L-8634 HOLE NO. 64-

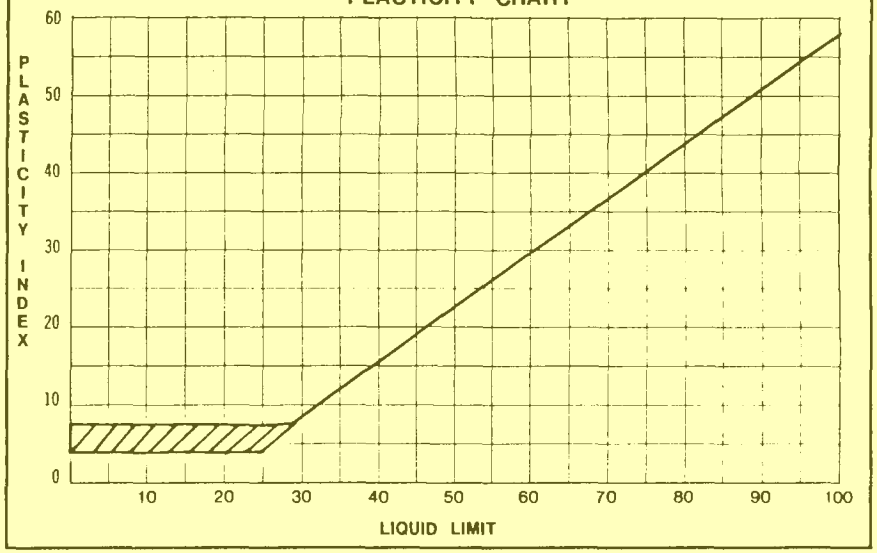
DATE 8-5-86 OPERATOR JM

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: BRN., MOIST, V. SILTY, F-M SAND

PLASTICITY CHART

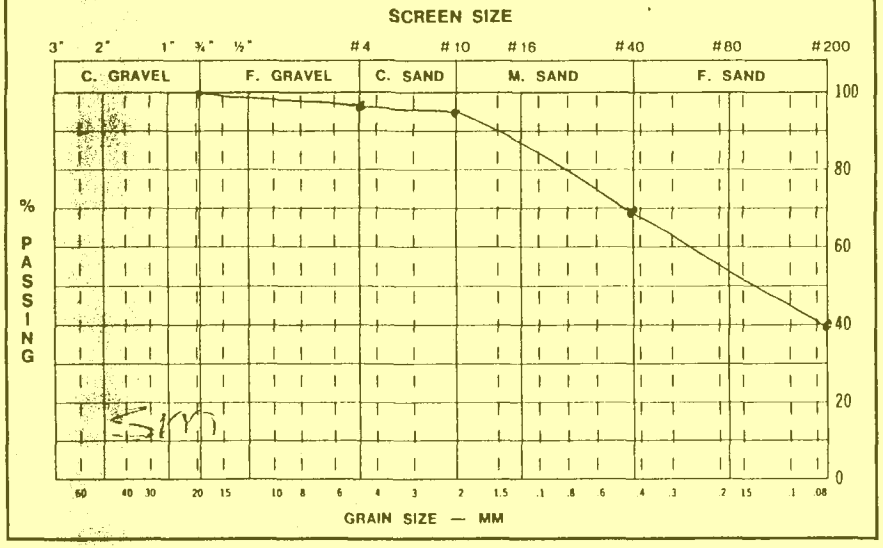


57.4 65.2 H2O=13.6 %

SIEVE ANALYSIS

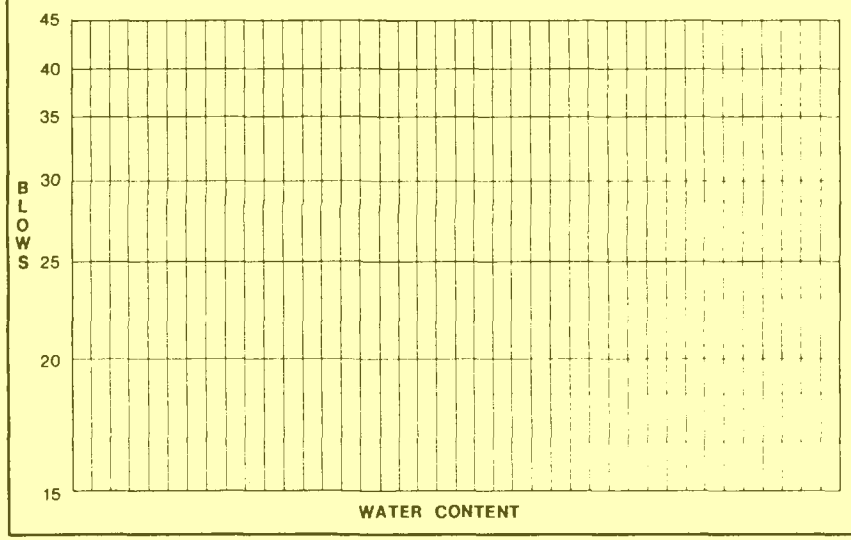
			% Passing 319.3	
			-40	95.1 69.7
-¾	9.2	100	-80	
-4	7.3	97.1	-140	
-10	80.1	94.8	-200	127.60 40.0

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

SAMPLE NO. 6677-4 JOB NO. 68034 HOLE NO. 64

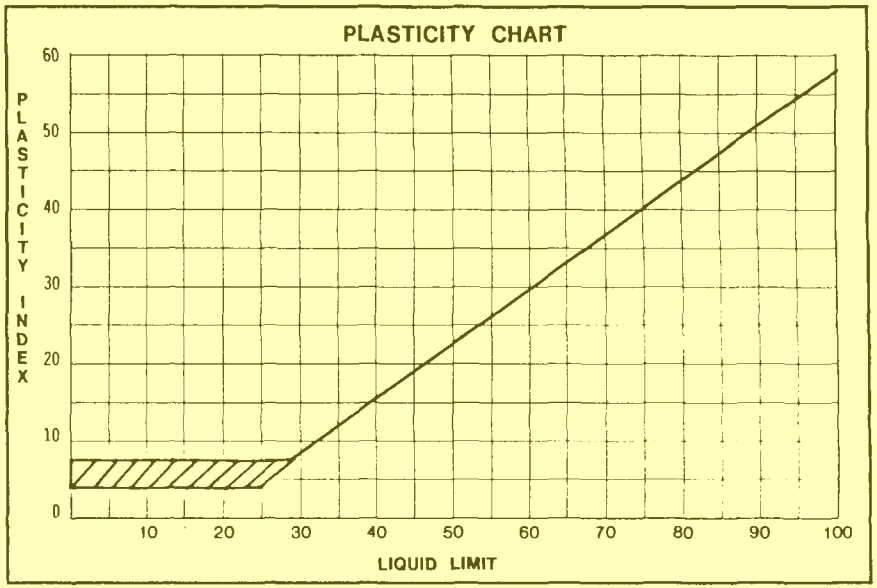
DATE 8-5-86 OPERATOR JM

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: BRN., DRY, SILTY, GRAVELLY, F-C SAND

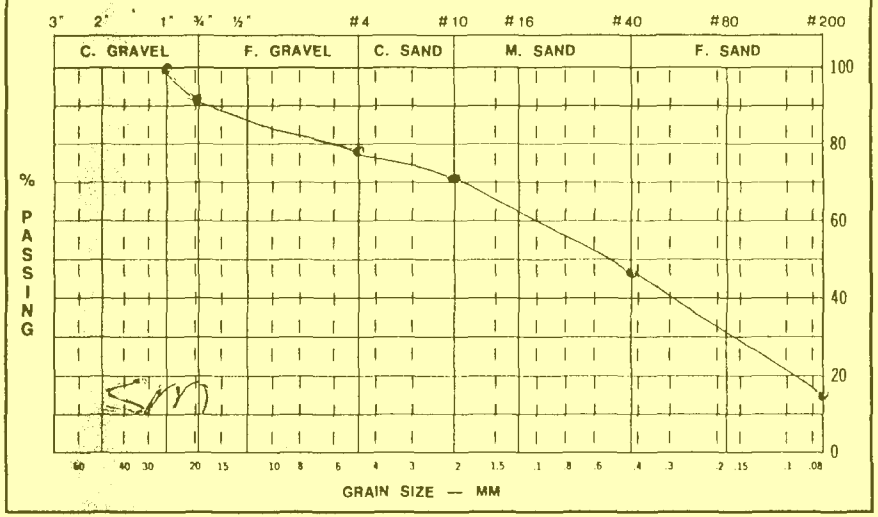
PLASTICITY CHART



74.6 81.3 H2O = 9.0 %

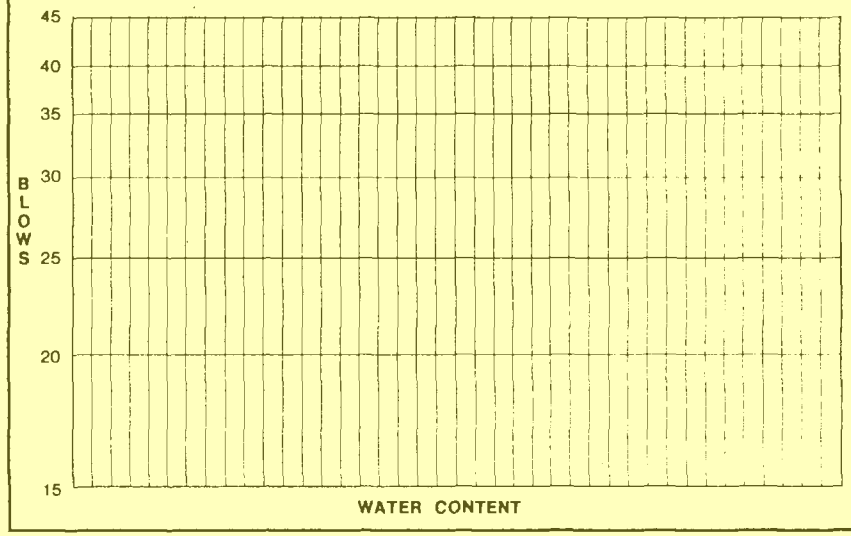
SIEVE ANALYSIS			% Passing 499.3		
-1"	42.4	100	-40	164.8	46.6
-¾	68.5	91.5	-80		
-4	37.7	77.8	-140		
-10	118.2	70.2	-200	67.70	13.6

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6TT-5 JOB NO. L-8034 HOLE NO. 64

DATE 8-5-86 OPERATOR JTM

SOIL FIELD IDENTIFICATION

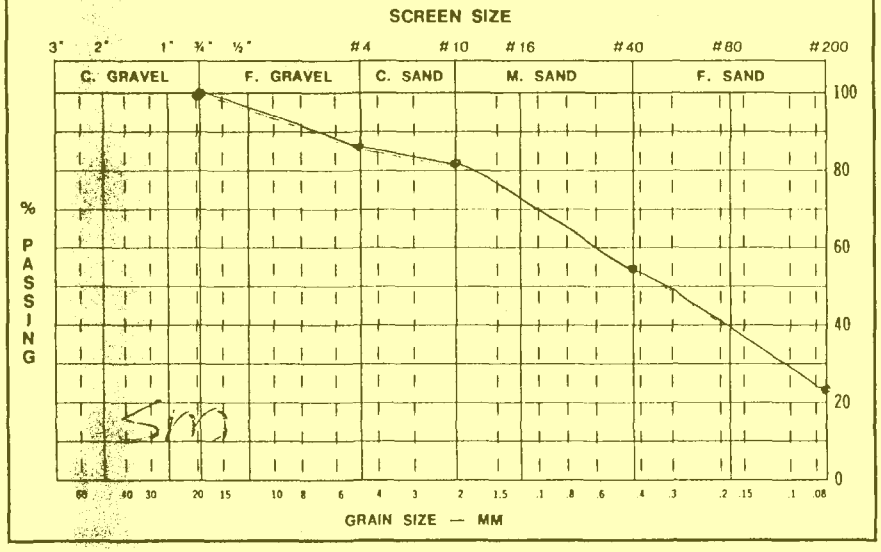
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: BRN, DRY, V. SILTY, GRADELLY, F-C SAND

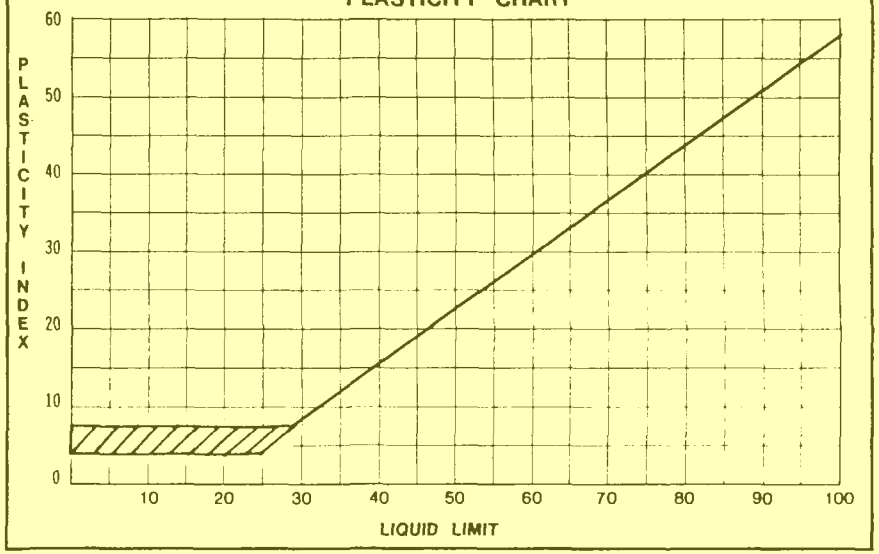
59.9 63.0 H_2O = 5.2 %

SIEVE ANALYSIS			% Passing 212.6
			-40 65.8 53.7
-¾	28.5	100	-80
-4	11.4	86.6	-140
-10	58.6	81.2	-200 48.30 22.7

GRAIN SIZE CURVE

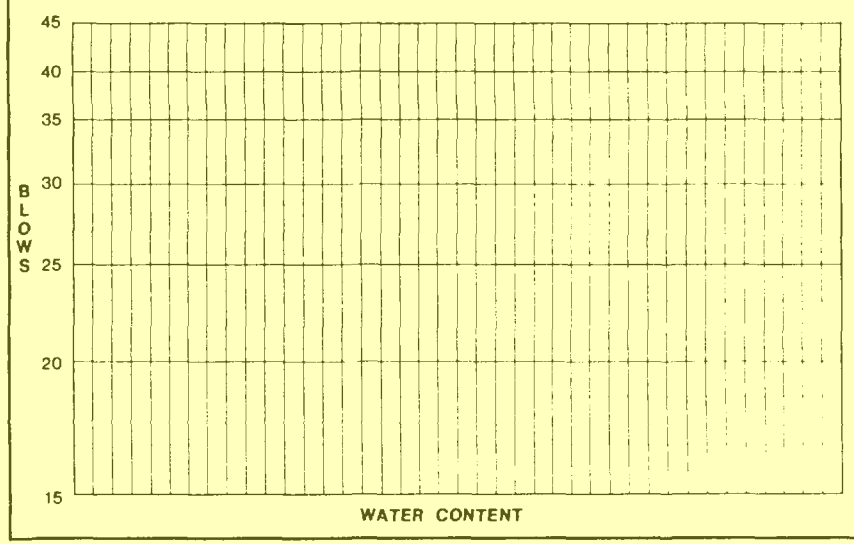


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



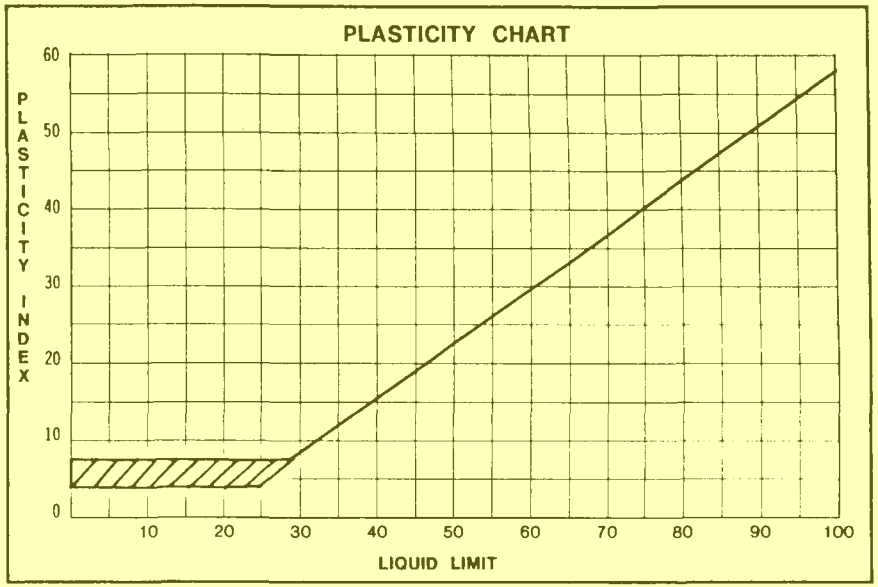
SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

SAMPLE NO. 6677-6 JOB NO. L8034- HOLE NO. 64-

DATE 8-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

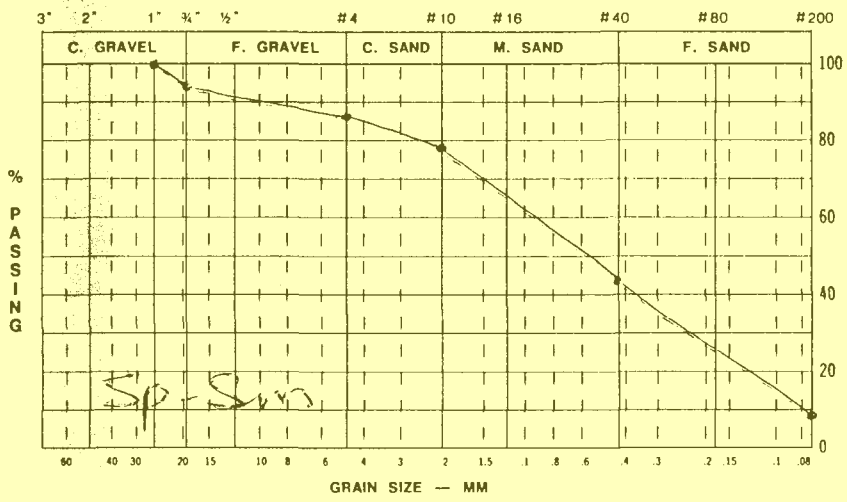
DESCRIPTION: BRN., DRY, SILTY, GRAVELLY, F-C SAND



60.9 65.6 Wet 7.7 %

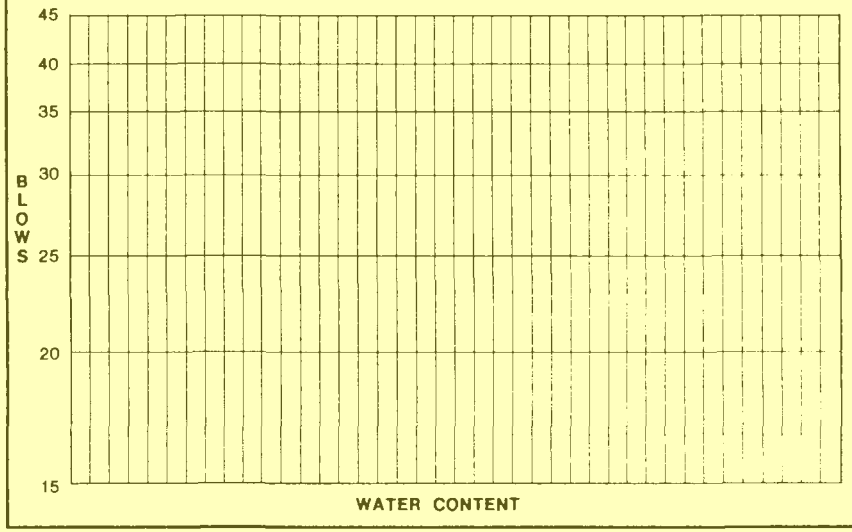
SIEVE ANALYSIS			% Passing 369.3		
-1"	21.8	100	-40	125.6	42.7
-¾	26.7	94.1	-80		
-4	34.1	86.9	-140		
-10	129.0	77.6	-200	32.10	8.7

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6677-7 JOB NO. L-8034 HOLE NO. 64

DATE 8-5-86 OPERATOR Jm

SOIL FIELD IDENTIFICATION

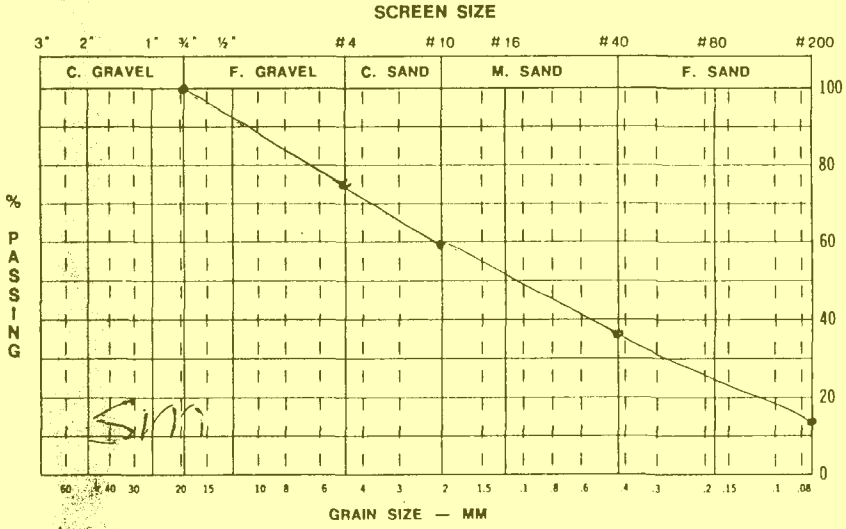
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: BRN., DRY, SILTY, CORDVELLY, F-C SAND.

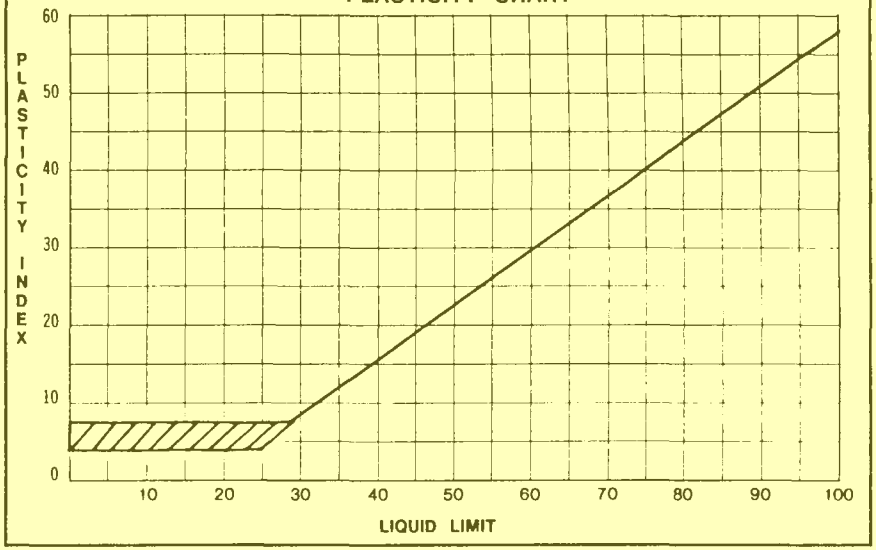
64.2 70.2 H2O= 9.3 %

SIEVE ANALYSIS		% Passing 243.5	
		-40	55.4 36.1
-¾ 60.8	100	-80	
-4 37.3	75.0	-140	
-10 57.4	59.7	-200	32.60 13.4

GRAIN SIZE CURVE

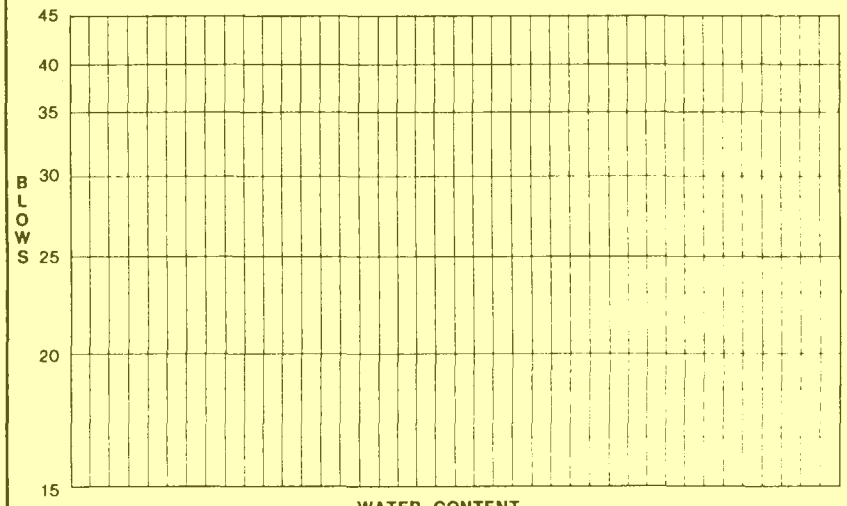


PLASTICITY CHART



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

ATERIALS ENGINEER
aterials Laboratory
O. Box 167, Olympia, WA 98504 (Mailing Address)
5 So. 2nd Ave.
mwater, Washington 98504 (Shipping Address)

Place SEATTLE

Date 4-16-86

DISTURBED

Dear Sir:

I have forwarded by today's STATE CAR the following Foundation Samples.

Contract or Job No. L-8034 Section FACTORIA TO NORTHRUP HOV SR No. 405 Sub-Section LR2 SOUTH WALL

Station & Offset 63+50 LR2 SOUTH WALL ℄ Hole # 65

Lab No.	Drive #	Depth	Tube Position in Sampler	Clas.	Description
685-1	P-1	-2.5' to -4.0'	H2O= 3.4	SP SM	
-2	P-2	-5.0' to -6.5'	H2O= 5.1	SP SM	
-3	P-3	-10.0' to -11.5'	H2O= 6.4	SP SM	
-4	P-4	-15.0' to -16.5'	H2O= 5.9	SP SM	
-5	P-5	-20.0' to -21.5'	H2O= 9.0	SM	
-6	P-6	-25.0' to -27.0'	H2O= 9.1	SM	
~~-7~~	P-7	NO REC.			
-7 ~~-8~~	P-8	-35.0' to -37.0'	H2O= 9.3	SM	
-9	P-9	-40.0' to -41.5'	H2O= 2.6	SM	

opy with samples
opy to addressee

Yours very truly,

R. L. WESSELS
DIST. MAT'LS. ENGR.
450 So. Spokane St.
Seattle, WA 98134

Inspector.

DT FORM 351-002
REVISED 2/80

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6685-1 JOB NO. 8034 HOLE NO. 65

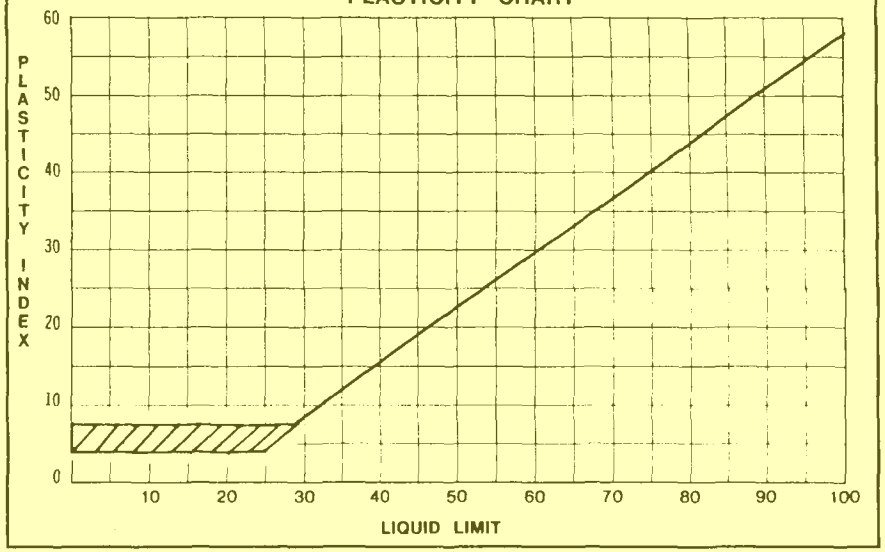
DATE 8-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, Silty, gravelly, C-M-F SAND

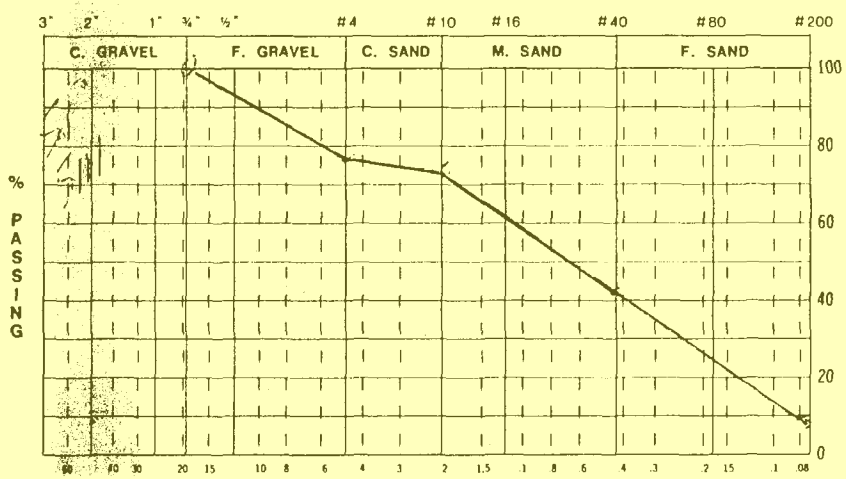
PLASTICITY CHART



37.8 39.1 39

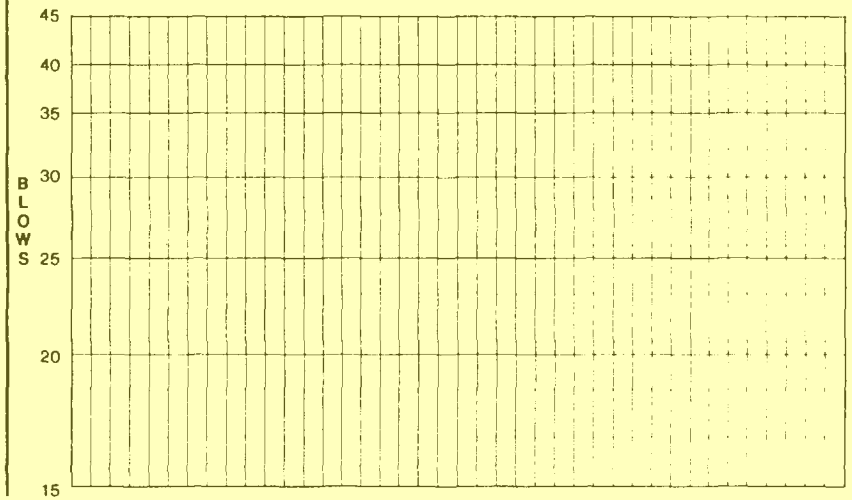
SIEVE ANALYSIS		% Passing 162.8	
		-40 55.9	42.9
-¾ 37.6	100	-80	
-4 8.1	77.6	-140	
-10 50.4	72.8	-200 15.0	9.4

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 66852 JOB NO. 8034 HOLE NO. 65

DATE 8-5-86 OPERATOR SO

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

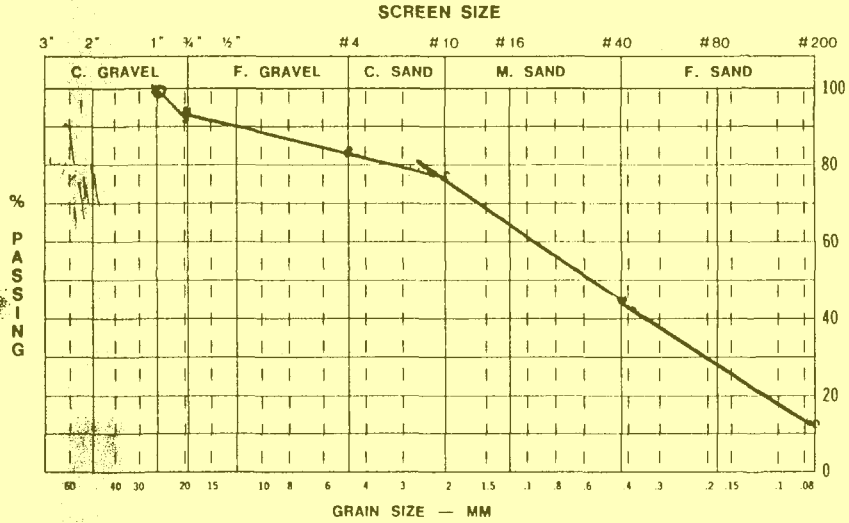
DESCRIPTION: Brn, Dry, SLTY, gravely, C-M-F SAND

PLASTICITY CHART

57.5 57.3 5.1

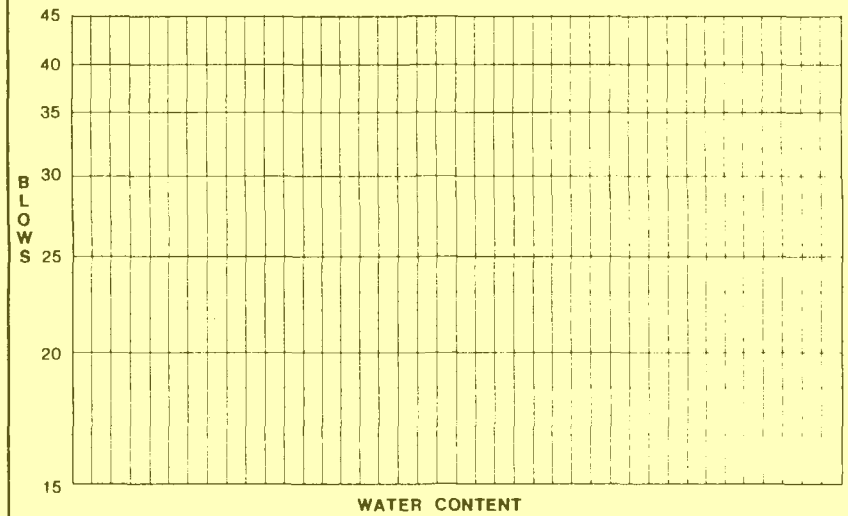
SIEVE ANALYSIS			% Passing 27.9	
-1½ 44.7	100		-40 70.8	100
-¾ 80.7	93.2		-80	
-4 73.9	83.9		-140	
-10 73.9	77.6		-200 25.9	1.8

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

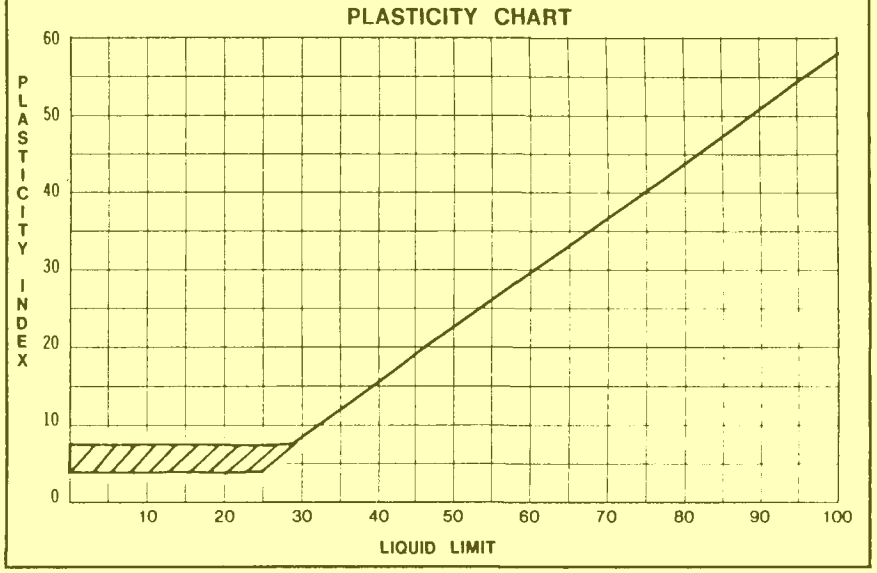
SAMPLE NO. 6685-3 JOB NO. 8031 HOLE NO. 65

DATE 6-5-86 OPERATOR JO

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravelly, CM-F SAND

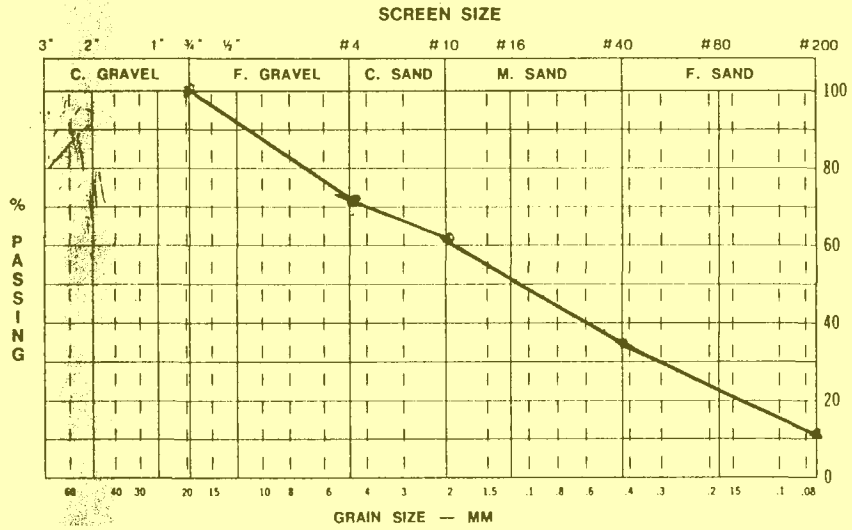
PLASTICITY CHART



47.1 50.1 6.4

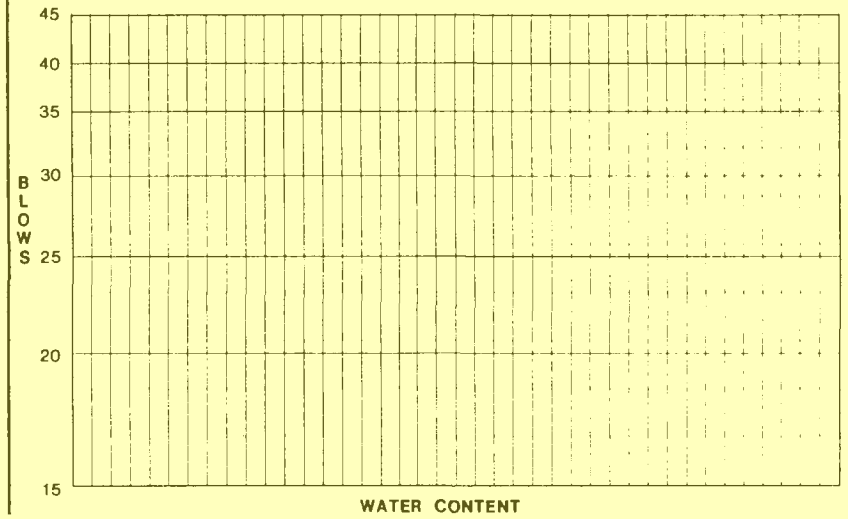
SIEVE ANALYSIS		% Passing 233.2	
		-40 53.5	34.4
-¾ 68.2	100	-80	
-4 23.6	70.8	-140	
-10 61.2	60.6	-200 66.7	11.4

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6655-4 JOB NO. 8034 HOLE NO. 65

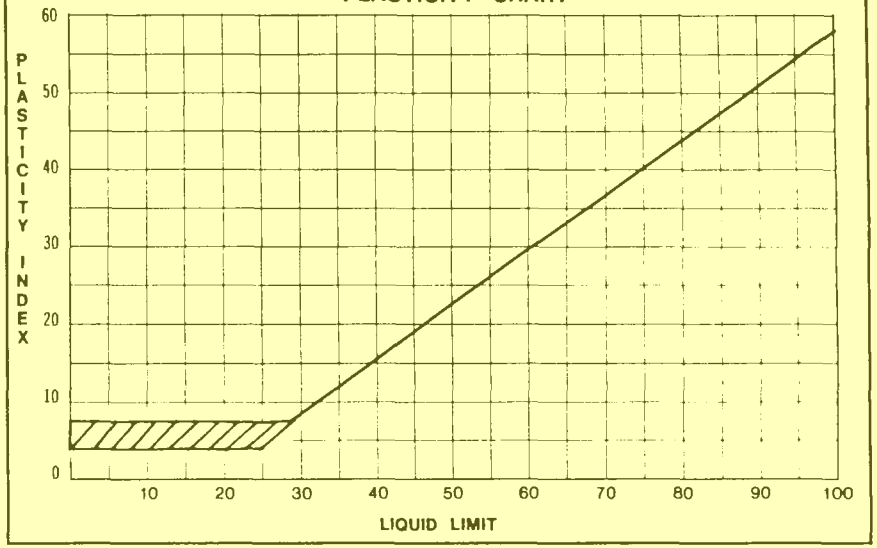
DATE 8-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Bn, Dry, SLTY, gravely, C-M-F SAND

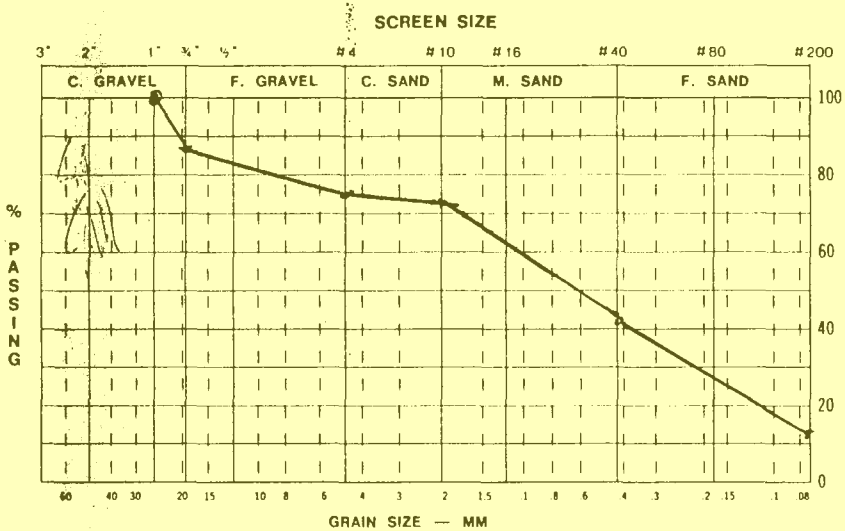
PLASTICITY CHART



45.7 48.4 5.9

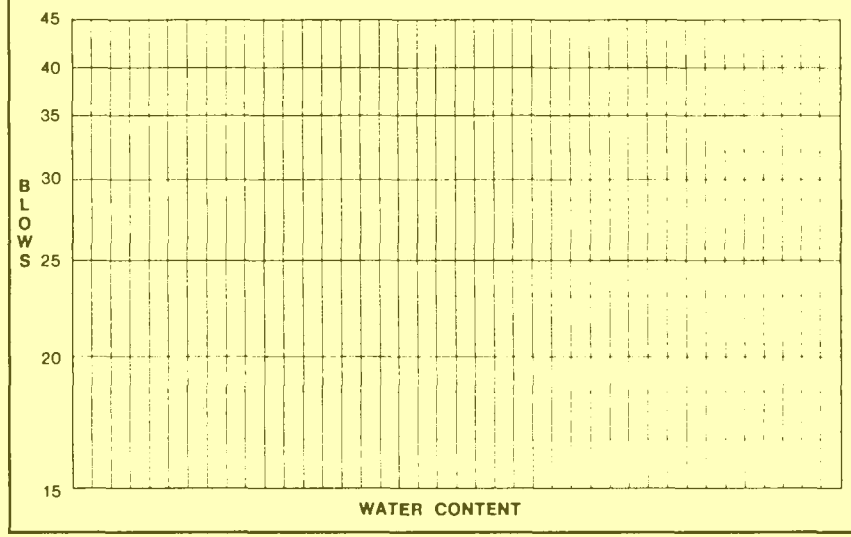
SIEVE ANALYSIS		% Passing 192.9	
-1 23.7	690	-40 56.8	40.7
-¾ 23.5	87.7	-80	
-4 7.6	75.5	-140	
-10 55.5	71.6	-200 21.8	11.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

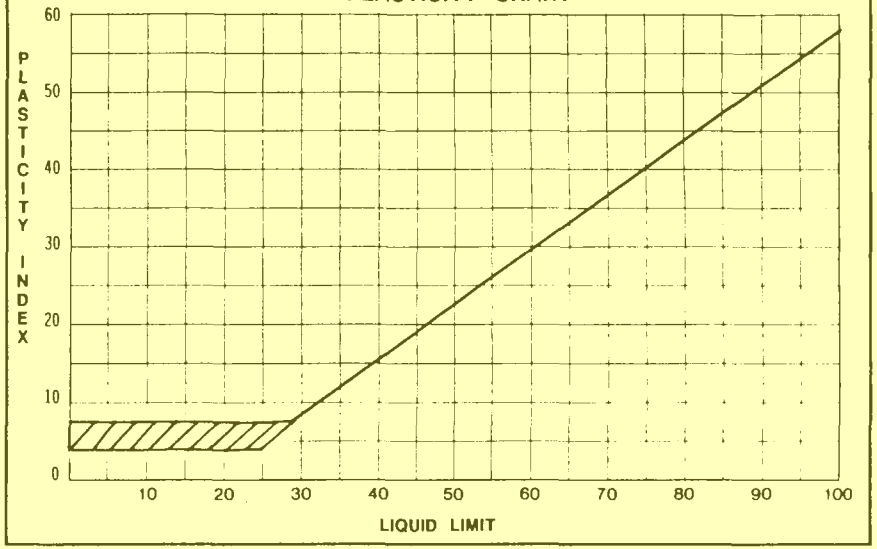
SAMPLE NO. [illegible] JOB NO. [illegible] HOLE NO. [illegible]

DATE 6-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION			
TEST	SAND	SILT	CLAY
VISUAL	[illegible]	[illegible]	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

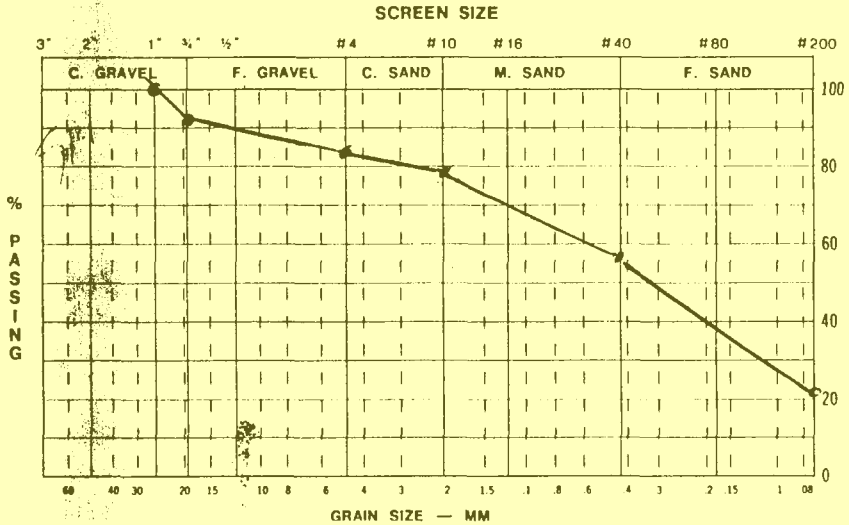
DESCRIPTION: Brn, Dry, gravely, VSLTY, CM-F SAND

PLASTICITY CHART



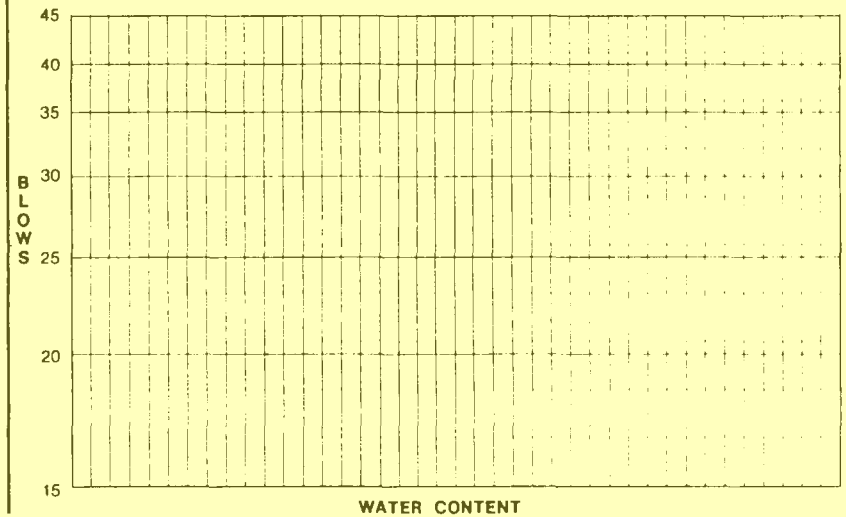
SIEVE ANALYSIS		% Passing	
[illegible]	[illegible]	-40	[illegible]
-¾ [illegible]	[illegible]	-80	
-4 [illegible]	[illegible]	-140	
-10 [illegible]	[illegible]	-200 [illegible]	[illegible]

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6685-6 JOB NO. 5034 HOLE NO. 65

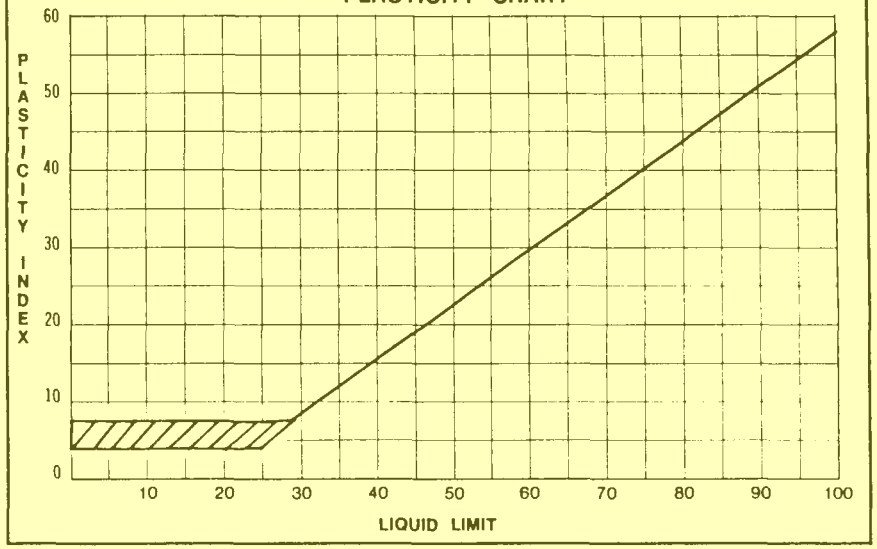
DATE 6-5-86 OPERATOR SD

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Bry, Dry, gravely, VSLTY, C-m-F SAND

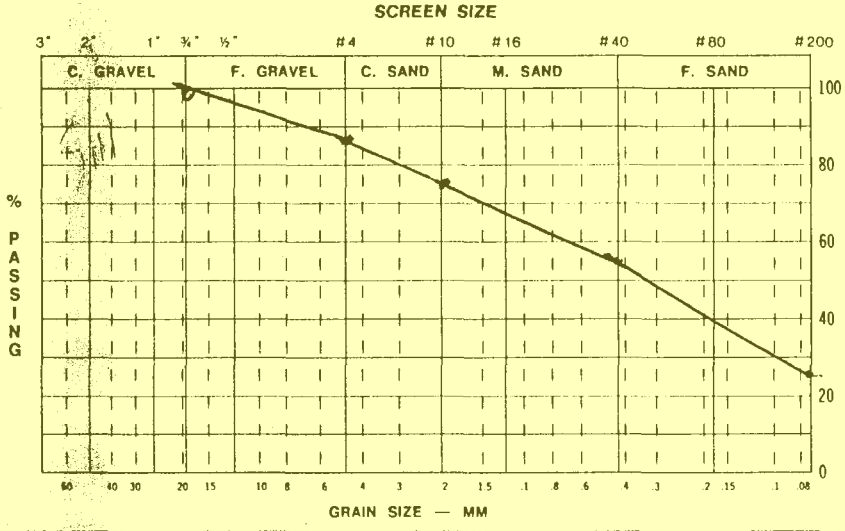
PLASTICITY CHART



23.1 25.2 9.1

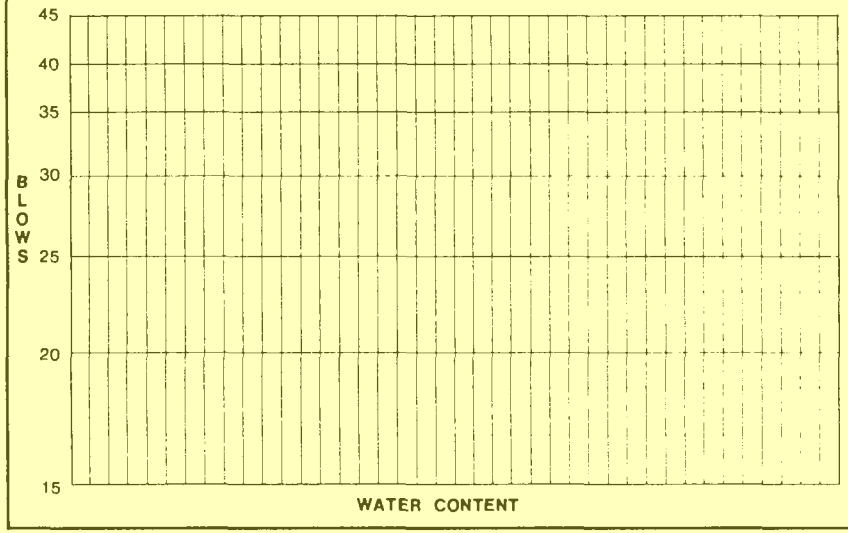
SIEVE ANALYSIS		% Passing	
		-40	55.5
-¾	2.4 100	-80	
-4	6.3 86.2	-140	
-10	32.6 75.8	-200	25.6

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019

SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6685-7 JOB NO. 5034 HOLE NO. 65

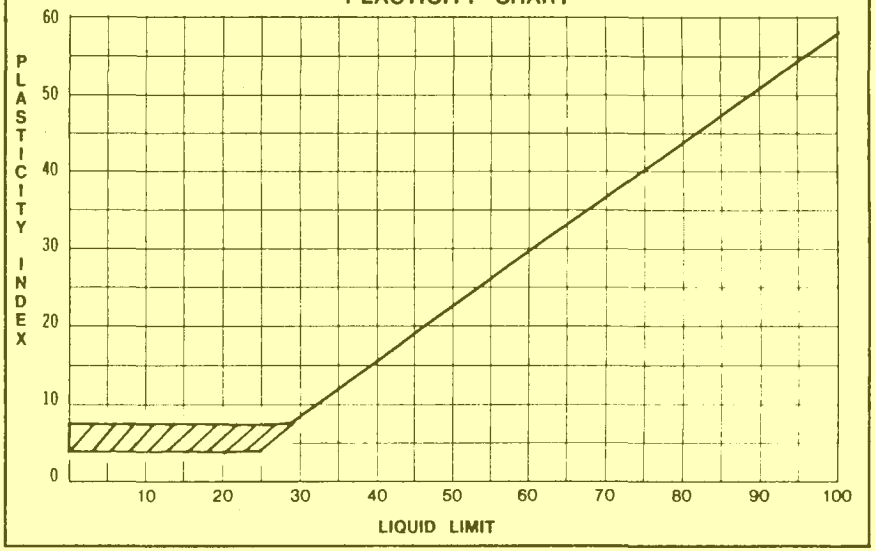
DATE 8-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dy, gravelly, SLTY, c-m-F SAND

PLASTICITY CHART



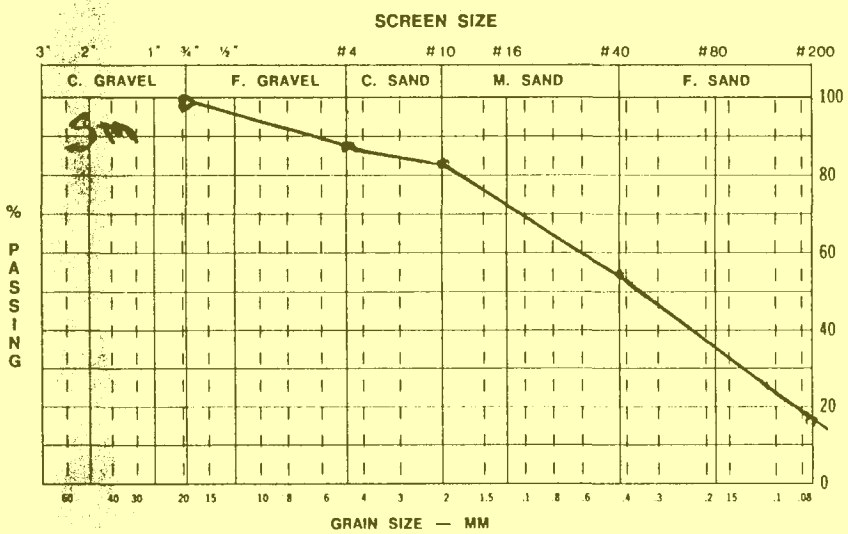
48.2 52.7 96.3

SIEVE ANALYSIS

		% Passing		
		-40	102.3	54.2
-¾ 32.3	100	-80		
-4 16.3	88.4	-140		
-10 78.4	82.4	-200	48.0	17.3

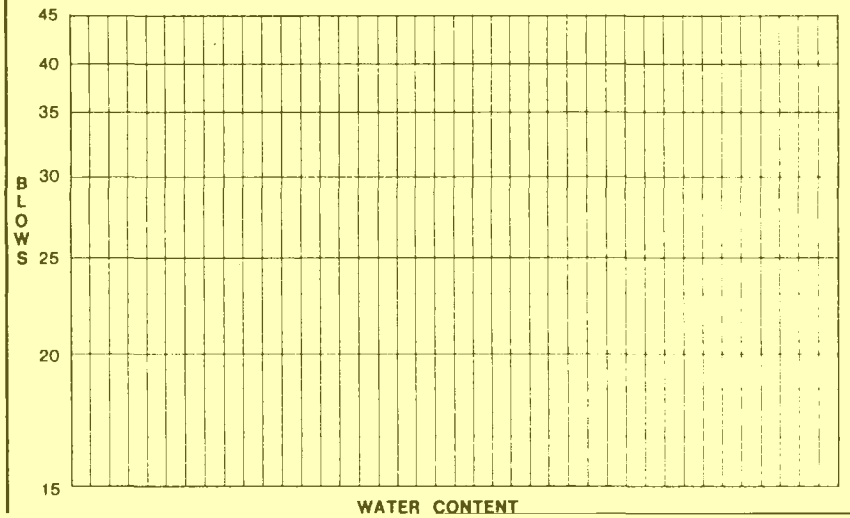
277.3

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

	LIQUID LIMIT				PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



SOIL CLASSIFICATION AND IDENTIFICATION WORKSHEET

A-LINE

SAMPLE NO. 6655-8 JOB NO. 5034 HOLE NO. 65

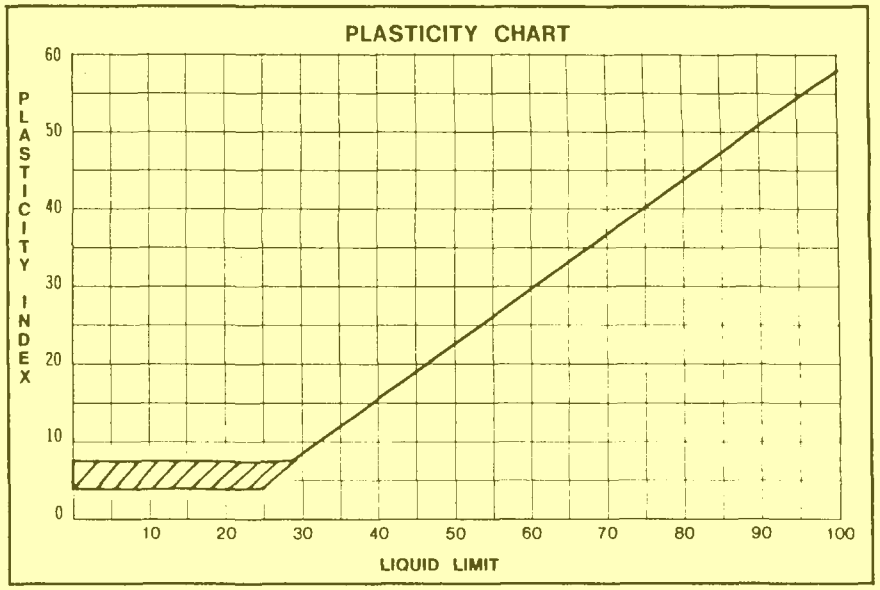
DATE 8-5-86 OPERATOR [illegible]

SOIL FIELD IDENTIFICATION

TEST	SAND	SILT	CLAY
VISUAL	✓	✓	
DRIED CAST			
DILATANCY			
BITE			
TOUGHNESS			

DESCRIPTION: Brn, Dry, SLTY, gravely, C-M-F SAND

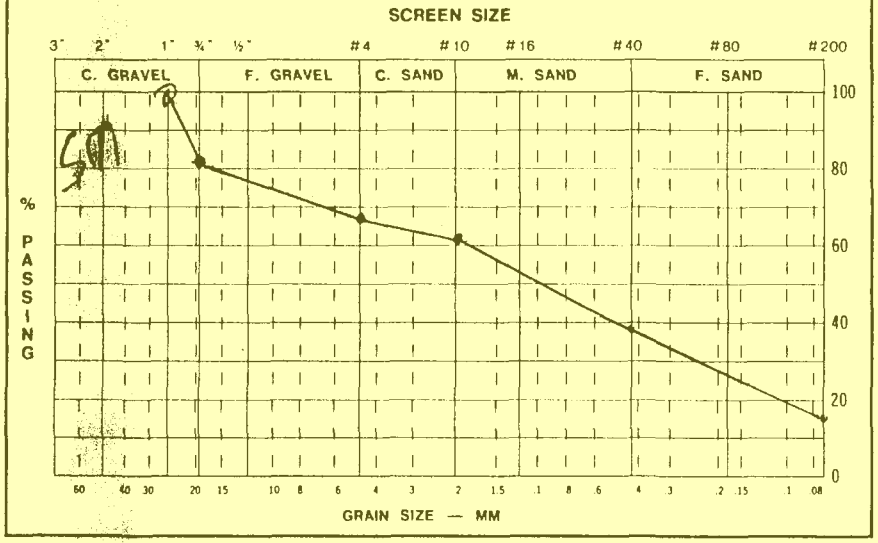
PLASTICITY CHART



57.7 59.2 2.4

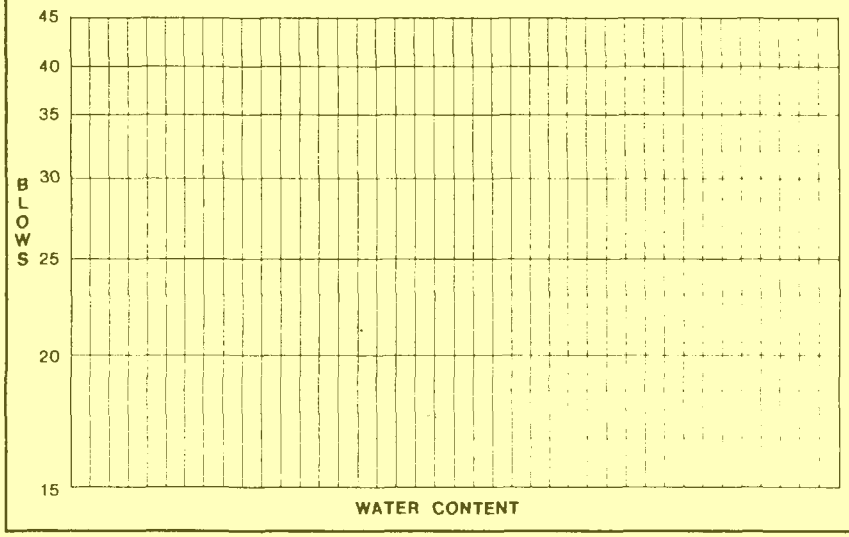
SIEVE ANALYSIS		% Passing	
4 45.4	100	-40	58.1 39.2
-¾ 30.3	80.3	-80	
-4 16.0	67.1	-140	
-10 48.1	60.1	-200 32.1	140

GRAIN SIZE CURVE



LIQUID LIMIT DETERMINATION

LIQUID LIMIT					PLASTIC LIMIT
Can No.					
Wet Wt.					
Dry Wt.					
% H_2O					PL=
Blows					PI=



DOT FORM 351-019 5/80 -790-

In Association with

Appendix D
ESU Soil Properties

Tab	Description
Summary	Input available information on historic boring log ID, location, elevation, drill rig ID and hammer efficiency
Summary	Correct to NAVD88 vertical datum
Samples	Input each SPT sample and 6-inch interval blow count; formula calculates N Field
Samples	Input available lab test data and USCS classification from Lab
Samples	For R2B borings, this is all listed in Table B-1 of the GDR
Samples	Use lab data and boring log information to estimate USCS for all samples
Calc $(N_1)_{60}$	Input for other fields in yellow highlight
Calc $(N_1)_{60}$	Use Coduto (2001) to estimate Unit weight for all samples (Unless we have Unit weight measurements)
Calc $(N_1)_{60}$	Use GDM to estimate Unit weight for organic / peat samples (Unless we have Unit weight measurements)
Calc $(N_1)_{60}$	Assign ESUs based on SPM for borings being used for specific structure design
ESU 1, 2, etc.	1 - List data with $(N_1)_{60}$ values; give justification for deleting any values. Find Average, Std Deviation, Geomean.
ESU 1, 2, etc.	2 - Check COV is within limits (15 to 45% for N values); consider if ESU needs subdividing or if OK.
ESU 1, 2, etc.	3 - Plot Histogram and visually compare to GEOMEAN.
ESU 1, 2, etc.	4 - Correlate $(N_1)_{60}$ with friction angle; use average unless other factors. Select design friction angle.
ESU 1, 2, etc.	5 - Assign predominent USCS classification for ESU.
ESU 1, 2, etc.	6 - Select design unit weight. Use CALTRANS, Chart 2 (2014) and correlate with Table 3.2 Coduto (2001).
ESU 1, 2, etc.	7, 8, etc. (if needed) Select/ assign other soil properties for ESUs per I-405 Soil Property Methodology report.

REFERENCES:

California Department of Transportation (Caltrans). 2014. *Geotechnical Manual.*

Coduto, D.P. 2001. *Foundation Design Principles and Practices.* 2nd Edition. Prentice-Hall, Inc., New Jersey.

BOREHOLE SUMMARY

PointID	Hole Depth	Elevation	Northing	Easting	Date End	Hole Size	Method	Equipment	Historical Efficiency
W-171-20	16.5	135.3	213156.4	1309355.3	7/20/2020	8	HSA	Mobile B-58 ID: 916	86
ALTCH-B6-06	60.2	127.0	213780.0	1309341.0	11/9/2006	4	Wet Rotary	CME 45	80
CH-B3-06	90.0	121.0	214089	1309341	11/17/2006	6	Wet Rotary	CME 45	80
F-4	27.9	94.6	Note 1	Note 1	10/24/1966	6	HSA	Note 1	60
F-6	17.8	87.6	Note 1	Note 1	10/25/1966	6	HSA	Note 1	60
F-7	19.0	87.6	Note 1	Note 1	10/25/1966	6	HSA	Note 1	60
F-8	17.9	100.6	Note 1	Note 1	10/24/1966	6	HSA	Note 1	60
GEO-9	46.5	128.0	Note 1	Note 1	4/16/2007	6	HSA	CME-85	80
H-60	31.5	136.0	Note 1	Note 1	12/9/1985	3	Wash Boring	Note 1	60
H-61	22.0	131.2	Note 1	Note 1	10/26/1985	3	Wash Boring	Note 1	60
H-62	41.5	141.5	Note 1	Note 1	12/9/1985	3	Wash Boring	Note 1	60
H-63	46.5	129.2	Note 1	Note 1	11/5/1985	3	Wash Boring	Note 1	60
H-64	46.5	143.5	Note 1	Note 1	12/10/1985	3	Wash Boring	Note 1	60
H-65	41.5	128.0	Note 1	Note 1	10/7/1985	3	Wash Boring	Note 1	60
S-36	53.3	97.1	Note 1	Note 1	4/22/1966	8	HSA	Note 1	60
S-37	55.3	96.1	Note 1	Note 1	4/21/1966	8	HSA	Note 1	60
S-38	66.0	97.3	Note 1	Note 1	4/6/1966	8	HSA	Note 1	60
S-39	61.0	97.3	Note 1	Note 1	4/4/1966	8	HSA	Note 1	60

Note 1 - Information not available

SAMPLE SUMMARY

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
W-171-20	WOOD	2.5	SPT-1	11	23	19	6	6	6	42	SP		SP	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-171-20	WOOD	5	SPT-2	12	10	20	6	6	6	30	SM		SM	--	--	--	--	--	--	--	--	10.3	59.1	30.6	--	--	--
W-171-20	WOOD	7.5	SPT-3	3	5	7	6	6	6	12	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-171-20	WOOD	10	SPT-4	7	12	9	6	6	6	21	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-171-20	WOOD	15	SPT-5	6	22	18	6	6	6	40	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	5	SPT-1	12	16	12	6	6	6	28	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	7	SPT-2	8	8	7	6	6	6	15	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	10	SPT-3	10	16	17	6	6	6	33	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	12	SPT-4	16	15	17	6	6	6	32	ML		ML	--	15	NP	NP	--	--	--	--	25	48.4	26.6	--	--	--
ALTCH-B6-06	Historic	15	SPT-5	10	10	24	6	6	6	34	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	17	SPT-6	12	14	24	6	6	6	38	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	20	SPT-7	4	4	16	6	6	6	20	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	25	SPT-8	18	35	36	6	6	6	71	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	30	SPT-9	10	11	12	6	6	6	23	SW-SM		SW-SM	--	--	--	--	--	--	--	--	12.7	78.6	8.7	--	--	--
ALTCH-B6-06	Historic	35	SPT-10	25	37	26	6	6	6	63	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	40	SPT-11	24	50		6	5		120	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	45	SPT-12	50			5			120	ML		ML	--	--	--	--	--	--	--	--	1.4	48.2	50.4	--	--	--
ALTCH-B6-06	Historic	50	SPT-13	50			3			200	ML		ML	--	--	--	--	--	--	--	--	0.3	17.8	81.9	--	--	--
ALTCH-B6-06	Historic	55	SPT-14	50			3			200	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALTCH-B6-06	Historic	60	SPT-15	50			3			200	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	4	SPT-1	4	9	25	6	6	6	34	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	6.5	SPT-2	14	17	22	6	6	6	39	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	9	SPT-3	8	13	21	6	6	6	34	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	11.5	SPT-4	10	17	22	6	6	6	39	SM		SM	--	--	--	--	--	--	--	--	12.1	56.7	31.2	--	--	--
CH-B3-06	Historic	14	SPT-5	18	24	44	6	6	6	68	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	16.5	SPT-6	20	19	23	6	6	6	42	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	19	SPT-7	11	17	50	6	6	6	67	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	24	SPT-8	13	12	7	6	6	6	19	SM		SM	--	--	--	--	--	--	--	--	1.7	82.8	15.5	--	--	--
CH-B3-06	Historic	29	SPT-9	11	20	32	6	6	6	52	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	34	SPT-10	18	28	21	6	6	6	49	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	39	SPT-11	20	50		6	6		100	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	44	SPT-12	50			4			150	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	49	SPT-13	50			6			100	SM		SM	--	--	--	--	--	--	--	--	19	49.3	31.7	--	--	--
CH-B3-06	Historic	54	SPT-14	50			4			150	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	59	SPT-15	39	50		6	5		120	SM		SM	--	--	--	--	--	--	--	--	0.2	61.7	38.1	--	--	--
CH-B3-06	Historic	64	SPT-16	50			6			100	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	69	SPT-17	22	50		6	6		100	ML		ML	--	--	--	--	--	--	--	--	0.2	3.5	96.3	--	--	--
CH-B3-06	Historic	74	SPT-18	50			4			150	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	79	SPT-19	24	23	50	6	6	6	73	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	84	SPT-20	50			5			120	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CH-B3-06	Historic	89	SPT-21	24	50		6	6		100	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	4.5	SPT-1	0	1	1	6	6	6	2	CH		CH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	9.5	SPT-2	17	35	43	6	6	6	78	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	12.5	SPT-3	19	30	29	6	6	6	59	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	17.5	SPT-4	14	23	41	6	6	6	64	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	22.5	SPT-5	9	21	31	6	6	6	52	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-4	Historic	27.5	SPT-6	50			5			120	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-6	Historic	4.5	SPT-1	2	2	2	6	6	6	4	CH		CH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-6	Historic	8.2	SPT-2	23	32	45	6	6	6	77	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-6	Historic	12.5	SPT-3	21	24	27	6	6	6	51	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-6	Historic	17.5	SPT-4	50			3			200	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
F-7	Historic	5	SPT-1	6	6	7	6	6	6	13	CH		CH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-7	Historic	10	SPT-2	3	5	2	6	6	6	7	CH		CH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-7	Historic	12.5	SPT-3	35	37	42	6	6	6	79	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-7	Historic	17.5	SPT-4	24	44	41	6	6	6	85	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-8	Historic	2.5	SPT-1	2	2	1	6	6	6	3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-8	Historic	7.5	SPT-2	16	24	31	6	6	6	55	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-8	Historic	12.5	SPT-3	52			6			104	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F-8	Historic	17.5	SPT-4	50			5			120	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	2.5	SPT-1	16			12			16	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	5	SPT-2	12			12			12	ML		ML	--	--	--	--	--	--	--	--	2	43	55	--	--	--
GEO-9	Historic	7.5	SPT-3	33			12			33	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	10	SPT-4	10			12			10	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	12.5	SPT-5	6			12			6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	15	SPT-6	2			12			2	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	17.5	SPT-7	3			12			3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	20	SPT-8	3			12			3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	22.5	SPT-9	17			12			17	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	25	SPT-10	8			12			8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	30	SPT-11	20			12			20	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	35	SPT-12	6			12			6	CH		CH	--	56	27	29	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	40	SPT-13	97			11			106	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GEO-9	Historic	45	SPT-14	72			11			79	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H-60	Historic	1.5	SPT-1	26	34	43	6	6	6	77	SP-SM		SP-SM	4.4	--	--	--	--	--	--	--	36.5	57.7	5.8	--	--	--
H-60	Historic	5	SPT-2	44	50	60	6	6	6	110	SM		SM	2.4	--	--	--	--	--	--	--	7	85.2	7.8	--	--	--
H-60	Historic	10	SPT-3	26	24	23	6	6	6	47	SM		SM	7.6	--	--	--	--	--	--	--	8.7	66.1	25.2	--	--	--
H-60	Historic	15	SPT-4	11	18	15	6	6	6	33	SM		SM	9.2	--	--	--	--	--	--	--	9.5	59.6	30.9	--	--	--
H-60	Historic	20	SPT-5	55	38	60	6	6	6	98	SM		SM	11.4	--	--	--	--	--	--	--	0	72.6	27.4	--	--	--
H-60	Historic	25	SPT-6	7	8	11	6	6	6	19	SM		SM	15.6	--	--	--	--	--	--	--	15.7	60.7	23.6	--	--	--
H-60	Historic	30	SPT-7	19	36	31	6	6	6	67	SM		SM	8.5	--	--	--	--	--	--	--	12.1	63	24.9	--	--	--
H-61	Historic	2.5	SPT-1	4	6	11	6	6	6	17	SP-SM		SP-SM	9.9	--	--	--	--	--	--	--	14	76.7	9.3	--	--	--
H-61	Historic	5	SPT-2	10	21	37	6	6	6	58	SW-SM		SW-SM	0.4	--	--	--	--	--	--	--	11.3	81.3	7.4	--	--	--
H-61	Historic	10	SPT-3	63	51	64	6	6	6	115	SP-SM		SP-SM	0.7	--	--	--	--	--	--	--	44.1	49.2	6.7	--	--	--
H-61	Historic	15	SPT-4	76	59	93	6	6	6	152	SM		SM	9.7	--	--	--	--	--	--	--	3.1	72.1	24.8	--	--	--
H-61	Historic	20	SPT-5	22	26	26	6	6	6	52	SM		SM	7.0	--	--	--	--	--	--	--	11.4	68.7	19.9	--	--	--
H-62	Historic	1	SPT-1	32	36	40	6	6	6	76	SP-SM		SP-SM	2.9	--	--	--	--	--	--	--	41.6	53.1	5.3	--	--	--
H-62	Historic	5	SPT-2	14	21	16	6	6	6	37	SP-SM		SP-SM	6.2	--	--	--	--	--	--	--	10	81.5	8.5	--	--	--
H-62	Historic	10	SPT-3	11	16	25	6	6	6	41	SM		SM	8.0	--	--	--	--	--	--	--	10.9	66.2	22.9	--	--	--
H-62	Historic	15	SPT-4	24	34	33	6	6	6	67	SM		SM	5.0	--	--	--	--	--	--	--	10.7	60.8	28.5	--	--	--
H-62	Historic	20	SPT-5	23	36	50	6	6	6	86	SM		SM	5.4	--	--	--	--	--	--	--	12.6	76.2	11.2	--	--	--
H-62	Historic	25	SPT-6	7	14	13	6	6	6	27	SM		SM	10.2	--	--	--	--	--	--	--	6.3	64.9	28.8	--	--	--
H-62	Historic	30	SPT-7	24	15	19	6	6	6	34	SM		SM	9.3	--	--	--	--	--	--	--	10.7	70.3	19	--	--	--
H-62	Historic	35	SPT-8	17	22	46	6	6	6	68	ML		ML	8.8	--	--	--	--	--	--	--	0.6	48.2	51.2	--	--	--
H-62	Historic	40	SPT-9	13	14	15	6	6	6	29	SM		SM	3.4	--	--	--	--	--	--	--	16.1	66.3	17.6	--	--	--
H-63	Historic	2.5	SPT-1	3	6	9	6	6	6	15	SP-SM		SP-SM	5.8	--	--	--	--	--	--	--	9.9	80.5	9.6	--	--	--
H-63	Historic	5	SPT-2	31	40	50	6	6	6	90	SM		SM	2.9	--	--	--	--	--	--	--	20.1	67.8	12.1	--	--	--
H-63	Historic	7.5	SPT-3	100			6			200	SW-SM		SW-SM	0.6	--	--	--	--	--	--	--	35.8	55.2	9	--	--	--
H-63	Historic	10	SPT-4	25	26	20	6	6	6	46	SW-SM		SW-SM	6.6	--	--	--	--	--	--	--	5.2	84.5	10.3	--	--	--
H-63	Historic	15	SPT-5	18	29	24	6	6	6	53	SM		SM	10.2	--	--	--	--	--	--	--	3.5	78.7	17.8	--	--	--
H-63	Historic	20	SPT-6	50	28	25	6	6	6	53	SM		SM	2.7	--	--	--	--	--	--	--	28	60.5	11.5	--	--	--
H-63	Historic	25	SPT-7	24	15	30	6	6	6	45	SM		SM	9.6	--	--	--	--	--	--	--	20.1	64.5	15.4	--	--	--
H-63	Historic	30	SPT-8	34	42	34	6	6	6	76	SM		SM	6.4	--	--	--	--	--	--	--	17.1	69.6	13.3	--	--	--
H-63	Historic	35	SPT-9	39	36	24	6	6	6	60	SM		SM	5.9	--	--	--	--	--	--	--	12	50.9	37.1	--	--	--
H-63	Historic	40	SPT-10	100			2			600	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H-63	Historic	45	SPT-11	82	49	39	6	6	6	88	SM		SM	8.3	--	--	--	--	--	--	--	4.6	91.5	3.9	--	--	--

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
H-64	Historic	1.5	SPT-1	24	52	50	6	6	6	102	SW-SM		SW-SM	1.3	--	--	--	--	--	--	--	38.5	55.5	6	--	--	--
H-64	Historic	5	SPT-2	14	23	36	6	6	6	59	SP-SM		SP-SM	7.4	--	--	--	--	--	--	--	5.4	86.4	8.2	--	--	--
H-64	Historic	10	SPT-3	25	38	61	6	6	6	99	SW-SM		SW-SM	5.3	--	--	--	--	--	--	--	17.1	76.4	6.5	--	--	--
H-64	Historic	15	SPT-4	15	20	18	6	6	6	38	SM		SM	9.0	--	--	--	--	--	--	--	2.7	60	37.3	--	--	--
H-64	Historic	20	SPT-5	27	52	66	6	6	6	118	SM		SM	5.2	--	--	--	--	--	--	--	2.9	57.1	40	--	--	--
H-64	Historic	25	SPT-6	31	58	88	6	6	6	146	SM		SM	7.7	--	--	--	--	--	--	--	22.2	64.2	13.6	--	--	--
H-64	Historic	30	SPT-7	42	69	52	6	6	6	121	SM		SM	9.3	--	--	--	--	--	--	--	13.4	63.9	22.7	--	--	--
H-64	Historic	35	SPT-8	100			6			200	SM		SM	10.1	--	--	--	--	--	--	--	13.1	78.2	8.7	--	--	--
H-64	Historic	40	SPT-9	9	16	22	6	6	6	38	SM		SM	13.6	--	--	--	--	--	--	--	25	61.6	13.4	--	--	--
H-64	Historic	45	SPT-10	5	18	23	6	6	6	41	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H-65	Historic	2.5	SPT-1	3	10	16	6	6	6	26	SP-SM		SP-SM	3.4	--	--	--	--	--	--	--	22.4	68.2	9.4	--	--	--
H-65	Historic	5	SPT-2	14	11	24	6	6	6	35	SP-SM		SP-SM	5.1	--	--	--	--	--	--	--	16.1	72.1	11.8	--	--	--
H-65	Historic	10	SPT-3	25	68	77	6	6	6	145	SW-SM		SW-SM	6.4	--	--	--	--	--	--	--	29.2	59.4	11.4	--	--	--
H-65	Historic	15	SPT-4	16	11	15	6	6	6	26	SP-SM		SP-SM	5.9	--	--	--	--	--	--	--	24.5	64.2	11.3	--	--	--
H-65	Historic	20	SPT-5	24	16	19	6	6	6	35	SM		SM	9.0	--	--	--	--	--	--	--	16.6	61.7	21.7	--	--	--
H-65	Historic	25	SPT-6	12	13	16	6	6	6	29	SM		SM	9.1	--	--	--	--	--	--	--	15.3	59.1	25.6	--	--	--
H-65	Historic	30	SPT-7	26	12	12	6	6	6	24	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H-65	Historic	35	SPT-8	16	10	6	6	6	6	16	SM		SM	9.3	--	--	--	--	--	--	--	11.6	71.1	17.3	--	--	--
H-65	Historic	40	SPT-9	74	43	31	6	6	6	74	SM		SM	2.6	--	--	--	--	--	--	--	32.9	53.1	14	--	--	--
S-36	Historic	2.5	SPT-1	7	11	16	6	6	6	27	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	5	SPT-2	8	11	11	6	6	6	22	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	7.5	SPT-3	12	17	21	6	6	6	38	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	10	SPT-4	37	28	46	6	6	6	74	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	12.5	SPT-5	53	50		6	3		200	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	17.5	SPT-6	25	50		6	3		200	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	22.5	SPT-7	50			3			200	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	27.5	SPT-8	34	50		6	3		200	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	32.5	SPT-9	55	50		6	2		300	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	37.5	SPT-10	66	75		6	6		150	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	42.5	SPT-11	50			4			150	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	47.5	SPT-12	50			1			600	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-36	Historic	53	SPT-13	50			3			200	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	5	SPT-1	4	9	14	6	6	6	23	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	10	SPT-2	6	19	24	6	6	6	43	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	12.5	SPT-3	6	11	20	6	6	6	31	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	15	SPT-4	19	30	50	6	6	6	80	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	17.5	SPT-5	27	31	45	6	6	6	76	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	20	SPT-6	20	40		6	6		80	SW		SW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	22.5	SPT-7	25	57		6	6		114	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	25	SPT-8	46	50		6	6		100	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	27.5	SPT-9	36	42	50	6	6	3	123	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	30	SPT-10	75			3			300	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	32.5	SPT-11	75			3			300	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	35	SPT-12	75			3			300	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	37.5	SPT-13	75			4			225	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	40	SPT-14	75			4			225	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	42.5	SPT-15	75			4			225	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	45	SPT-16	75			5			180	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	47.5	SPT-17	75			3			300	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	50	SPT-18	75			4			225	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	52.5	SPT-19	75			4			225	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-37	Historic	55	SPT-20	75			3			300	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
S-38	Historic	2.5	SPT-1	8	7	7	6	6	6	14	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	5	SPT-2	2	15		6	6	6	30	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	10	SPT-3	0	0	1	6	6	6	1	MH		MH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	15	SPT-4	0	0	1	6	6	6	1	MH		MH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	20	SPT-5	13	28	32	6	6	6	60	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	22.5	SPT-6	13	43	50	6	6	6	93	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	25	SPT-7	3	14	39	6	6	6	53	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	27.5	SPT-8	8	60		6	4		180	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	30	SPT-9	60			6			120	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	32.5	SPT-10	16	60		6	6		120	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	35	SPT-11	60			5			144	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	37.5	SPT-12	60			5			144	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	42.5	SPT-13	60			4			180	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	47.5	SPT-14	60			4			180	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	52.5	SPT-15	33	60		6	5		144	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	57.5	SPT-16	30	60		6	5		144	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-38	Historic	62.5	SPT-17	11	14	22	6	6	6	36	CH		CH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	2.5	SPT-1	1	1	1	6	6	6	2	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	5	SPT-2	1	1	2	6	6	6	3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	7.5	SPT-3	2	3	3	6	6	6	6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	12.5	SPT-4	2	1	3	6	6	6	4	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	15	SPT-5	8	32	38	6	6	6	70	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	17.5	SPT-6	21	33	35	6	6	6	68	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	22.5	SPT-7	25	50		6	3		200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	27.5	SPT-8	25	50		6	3		200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	32.5	SPT-9	50			5			120	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	37.5	SPT-10	50			3			200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	42.5	SPT-11	50			3			200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	47.5	SPT-12	50			3			200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	52.5	SPT-13	50			4			150	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	57.5	SPT-14	50			3			200	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-39	Historic	60	SPT-15	20	50		6	6		100	SW-SM		SW-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1. Blank cells in the Blow Counts and Length columns signify that eiter no SPT was performed, that refusal was encountered, or that only an overall "blows per foot" N value was recorded.

-- = not tested

STANDARD PENETRATION TEST DATA [1]

PointID	PointID (Historic, WSDOT R2B, WOOD)	Sample Top Depth (ft)	Sample Number	Field SPT	Sampler Type (spt = standard penetrometer w/ 1.375-inch I.D., m = Modified California)	Samplers Have Space for Liners But didn't Use?	Borehole Diameter (in)	C_R, Rod Length Correction Factor	C_S, Sampling Method Correction Factor	C_S, Correction for Sampler without Liners	Hammer efficiency (%)	C_E, Energy Ratio Correction	C_B, Boring Dia Correction	N_{60}, Blowcount Corrected for All Factors except Overburden	Groundwater Depth (ft)	Avg Unit Wt of Sample (pcf) [or corrleation based on Coduto and USCS info or GDM for Peats]	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N, Over-burden Correction (Eq 41, Idriss & Boulanger, 2008[2]) = (pa/σvo')^0.5	$(N_1)_{60}$, Corrected Blowcount for All Factors	Limit $(N_1)_{60}$ to 46	C_N, Over-burden Correction (Eq 39, Idriss & Boulanger, 2008[2]) = $f(N_1)_{60}$	$(N_1)_{60}$, Corrected Blowcount for All Factors refined for relative density	Estimated USCS Classification	Assign ESU
				N	Sampler Type	(y/n)		C_R	C_s	C_S	ER(%)	C_E	C_B	N_{60}	gwt (ft)	γ (pcf)	σ (psf)	σ' (psf)	C_N	$(N_1)_{60}$	Limit $(N_1)_{60}$ to 46	C_N refined	$(N_1)_{60}$ refined	USCS	
W-171-20	WOOD	2.5	SPT-1	42	SPT	n	8	0.75	1	1.0	86	1.43	1.15	52	0	128	320.0	164.0	1.7	88	46	1.7	88	SP	1B
W-171-20	WOOD	5.0	SPT-2	30	SPT	n	8	0.8	1	1.0	86	1.43	1.15	40	0	125	632.5	320.5	1.7	67	46	1.6	65	SM	1B
W-171-20	WOOD	7.5	SPT-3	12	SPT	n	8	0.8	1	1.0	86	1.43	1.15	16	0	125	945.0	477.0	1.7	27	27	1.7	27	SM	1B
W-171-20	WOOD	10.0	SPT-4	21	SPT	n	8	0.85	1	1.0	86	1.43	1.15	29	0	125	1257.5	633.5	1.7	50	46	1.4	40	SM	1B
W-171-20	WOOD	15.0	SPT-5	40	SPT	n	8	0.95	1	1.0	86	1.43	1.15	63	0	125	1882.5	946.5	1.5	94	46	1.2	77	SM	1B
ALTCH-B6-06	Historic	5.0	SPT-1	28	SPT	n	4	0.8	1	1.0	80	1.33	1.00	30	31.5	93	465.0	465.0	1.7	51	46	1.5	45	ML	1B
ALTCH-B6-06	Historic	7.0	SPT-2	15	SPT	n	4	0.8	1	1.0	80	1.33	1.00	16	31.5	93	651.0	651.0	1.7	27	27	1.6	25	ML	1B
ALTCH-B6-06	Historic	10.0	SPT-3	33	SPT	n	4	0.85	1	1.0	80	1.33	1.00	37	31.5	93	930.0	930.0	1.5	56	46	1.2	46	ML	1B
ALTCH-B6-06	Historic	12.0	SPT-4	32	SPT	n	4	0.85	1	1.0	80	1.33	1.00	36	31.5	93	1116.0	1116.0	1.4	50	46	1.2	43	ML	1B
ALTCH-B6-06	Historic	15.0	SPT-5	34	SPT	n	4	0.95	1	1.0	80	1.33	1.00	43	31.5	93	1395.0	1395.0	1.2	53	46	1.1	48	ML	1B
ALTCH-B6-06	Historic	17.0	SPT-6	38	SPT	n	4	0.95	1	1.0	80	1.33	1.00	48	31.5	93	1581.0	1581.0	1.2	56	46	1.1	52	ML	1B
ALTCH-B6-06	Historic	20.0	SPT-7	20	SPT	n	4	0.95	1	1.0	80	1.33	1.00	25	31.5	93	1860.0	1860.0	1.1	27	27	1.1	27	ML	1B
ALTCH-B6-06	Historic	25.0	SPT-8	71	SPT	n	4	0.95	1	1.0	80	1.33	1.00	90	31.5	93	2325.0	2325.0	1.0	86	46	1.0	88	ML	4C
ALTCH-B6-06	Historic	30.0	SPT-9	23	SPT	n	4	1	1	1.0	80	1.33	1.00	31	31.5	112	2885.0	2885.0	0.9	26	26	0.9	27	SW-SM	4C
ALTCH-B6-06	Historic	35.0	SPT-10	63	SPT	n	4	1	1	1.0	80	1.33	1.00	84	31.5	125	3510.0	3291.6	0.8	67	46	0.9	75	SM	4C
ALTCH-B6-06	Historic	40.0	SPT-11	120	SPT	n	4	1	1	1.0	80	1.33	1.00	160	31.5	125	4135.0	3604.6	0.8	123	46	0.9	139	SM	4C
ALTCH-B6-06	Historic	45.0	SPT-12	120	SPT	n	4	1	1	1.0	80	1.33	1.00	160	31.5	105	4660.0	3817.6	0.7	119	46	0.9	137	ML	4E
ALTCH-B6-06	Historic	50.0	SPT-13	200	SPT	n	4	1	1	1.0	80	1.33	1.00	267	31.5	105	5185.0	4030.6	0.7	193	46	0.8	225	ML	4E
ALTCH-B6-06	Historic	55.0	SPT-14	200	SPT	n	4	1	1	1.0	80	1.33	1.00	267	31.5	105	5710.0	4243.6	0.7	188	46	0.8	222	ML	4E
ALTCH-B6-06	Historic	60.0	SPT-15	200	SPT	n	4	1	1	1.0	80	1.33	1.00	267	31.5	105	6235.0	4456.6	0.7	184	46	0.8	219	ML	4E
CH-B3-06	Historic	4.0	SPT-1	34	SPT	n	6	0.75	1	1.0	80	1.33	1.05	36	35	108	432.0	432.0	1.7	61	46	1.5	54	SM	1B
CH-B3-06	Historic	6.5	SPT-2	39	SPT	n	6	0.8	1	1.0	80	1.33	1.05	44	35	108	702.0	702.0	1.7	74	46	1.3	58	SM	1B
CH-B3-06	Historic	9.0	SPT-3	34	SPT	n	6	0.85	1	1.0	80	1.33	1.05	41	35	108	972.0	972.0	1.5	60	46	1.2	50	SM	1B
CH-B3-06	Historic	11.5	SPT-4	39	SPT	n	6	0.85	1	1.0	80	1.33	1.05	46	35	108	1242.0	1242.0	1.3	61	46	1.2	53	SM	1B
CH-B3-06	Historic	14.0	SPT-5	68	SPT	n	6	0.85	1	1.0	80	1.33	1.05	81	35	108	1512.0	1512.0	1.2	96	46	1.1	88	SM	1B
CH-B3-06	Historic	16.5	SPT-6	42	SPT	n	6	0.95	1	1.0	80	1.33	1.05	56	35	108	1782.0	1782.0	1.1	61	46	1.0	58	SM	1B
CH-B3-06	Historic	19.0	SPT-7	67	SPT	n	6	0.95	1	1.0	80	1.33	1.05	89	35	108	2052.0	2052.0	1.0	90	46	1.0	90	SM	1B
CH-B3-06	Historic	24.0	SPT-8	19	SPT	n	6	0.95	1	1.0	80	1.33	1.05	25	35	108	2592.0	2592.0	0.9	23	23	0.9	23	SM	4C
CH-B3-06	Historic	29.0	SPT-9	52	SPT	n	6	1	1	1.0	80	1.33	1.05	73	35	108	3132.0	3132.0	0.8	60	46	0.9	66	SM	4C
CH-B3-06	Historic	34.0	SPT-10	49	SPT	n	6	1	1	1.0	80	1.33	1.05	69	35	108	3672.0	3672.0	0.8	52	46	0.9	59	SM	4C
CH-B3-06	Historic	39.0	SPT-11	100	SPT	n	6	1	1	1.0	80	1.33	1.05	140	35	125	4297.0	4047.4	0.7	101	46	0.8	118	SM	4C
CH-B3-06	Historic	44.0	SPT-12	150	SPT	n	6	1	1	1.0	80	1.33	1.05	210	35	125	4922.0	4360.4	0.7	146	46	0.8	174	SM	4C
CH-B3-06	Historic	49.0	SPT-13	100	SPT	n	6	1	1	1.0	80	1.33	1.05	140	35	125	5547.0	4673.4	0.7	94	46	0.8	114	SM	4C
CH-B3-06	Historic	54.0	SPT-14	150	SPT	n	6	1	1	1.0	80	1.33	1.05	210	35	125	6172.0	4986.4	0.7	137	46	0.8	168	SM	4C
CH-B3-06	Historic	59.0	SPT-15	120	SPT	n	6	1	1	1.0	80	1.33	1.05	168	35	125	6797.0	5299.4	0.6	106	46	0.8	132	SM	4C
CH-B3-06	Historic	64.0	SPT-16	100	SPT	n	6	1	1	1.0	80	1.33	1.05	140	35	105	7322.0	5512.4	0.6	87	46	0.8	109	ML	4C
CH-B3-06	Historic	69.0	SPT-17	100	SPT	n	6	1	1	1.0	80	1.33	1.05	140	35	105	7847.0	5725.4	0.6	85	46	0.8	108	ML	4C
CH-B3-06	Historic	74.0	SPT-18	150	SPT	n	6	1	1	1.0	80	1.33	1.05	210	35	125	8472.0	6038.4	0.6	124	46	0.8	159	SM	4C
CH-B3-06	Historic	79.0	SPT-19	73	SPT	n	6	1	1	1.0	80	1.33	1.05	102	35	105	8997.0	6251.4	0.6	59	46	0.8	77	ML	4C
CH-B3-06	Historic	84.0	SPT-20	120	SPT	n	6	1	1	1.0	80	1.33	1.05	168	35	125	9622.0	6564.4	0.6	95	46	0.7	125	SM	4C
CH-B3-06	Historic	89.0	SPT-21	100	SPT	n	6	1	1	1.0	80	1.33	1.05	140	35	125	10247.0	6877.4	0.6	78	46	0.7	103	SM	4C
F-4	Historic	4.5	SPT-1	2	SPT	n	6	0.75	1	1.0	60	1.00	1.05	2	1	98	441.0	222.6	1.7	3	3	1.7	3	CH	2C
F-4	Historic	9.5	SPT-2	78	SPT	n	6	0.85	1	1.0	60	1.00	1.05	70	1	125	1066.0	535.6	1.7	118	46	1.4	100	SM	4C
F-4	Historic	12.5	SPT-3	59	SPT	n	6	0.85	1	1.0	60	1.00	1.05	53	1	125	1441.0	723.4	1.7	90	46	1.3	70	SM	4C
F-4	Historic	17.5	SPT-4	64	SPT	n	6	0.95	1	1.0	60	1.00	1.05	64	1	125	2066.0	1036.4	1.4	91	46	1.2	77	SM	4C
F-4	Historic	22.5	SPT-5	52	SPT	n	6	0.95	1	1.0	60	1.00	1.05	52	1	125	2691.0	1349.4	1.3	65	46	1.1	58	SM	4C
F-4	Historic	27.5	SPT-6	120	SPT	n	6	0.95	1	1.0	60	1.00	1.05	120	1	125	3316.0	1662.4	1.1	135	46	1.1	128	SM	4C

PointID	PointID (Historic, WSDOT R2B, WOOD)	Sample Top Depth (ft)	Sample Number	Field SPT	Sampler Type (spt = standard penetrometer w/ 1.375-inch I.D., m = Modified California)	Samplers Have Space for Liners But didn't Use?	Borehole Diameter (in)	C_R, Rod Length Correction Factor	C_s, Sampling Method Correction Factor	C_S, Correction for Sampler without Liners	Hammer efficiency (%)	C_E, Energy Ratio Correction	C_B, Boring Dia Correction	N_{60}, Blowcount Corrected for All Factors except Overburden	Groundwater Depth (ft)	Avg Unit Wt of Sample (pcf) [or corrleation based on Coduto and USCS info or GDM for Peats]	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N, Over-burden Correction (Eq 41, Idriss & Boulanger, 2008[2]) = (pa/σvo')^0.5	$(N_1)_{60}$, Corrected Blowcount for All Factors	Limit $(N_1)_{60}$ to 46	C_N, Over-burden Correction (Eq 39, Idriss & Boulanger, 2008[2]) = $f(N_1)_{60}$	$(N_1)_{60}$, Corrected Blowcount for All Factors refined for relative density	Estimated USCS Classification	Assign ESU
				N	Sampler Type	(y/n)		C_R	C_s	C_S	ER(%)	C_E	C_B	N_{60}	gwt (ft)	γ (pcf)	σ (psf)	σ' (psf)	C_N	$(N_1)_{60}$	Limit $(N_1)_{60}$ to 46	C_N refined	$(N_1)_{60}$ refined	USCS	
F-6	Historic	4.5	SPT-1	4	SPT	n	6	0.75	1	1.0	60	1.00	1.05	3	0	98	441.0	160.2	1.7	5	5	1.7	5	CH	2C
F-6	Historic	8.2	SPT-2	77	SPT	n	6	0.85	1	1.0	60	1.00	1.05	69	0	125	903.5	391.8	1.7	117	46	1.6	107	SM	4C
F-6	Historic	12.5	SPT-3	51	SPT	n	6	0.85	1	1.0	60	1.00	1.05	46	0	125	1441.0	661.0	1.7	77	46	1.4	62	SM	4C
F-6	Historic	17.5	SPT-4	200	SPT	n	6	0.95	1	1.0	60	1.00	1.05	200	0	125	2066.0	974.0	1.5	294	46	1.2	245	SM	4C
F-7	Historic	5.0	SPT-1	13	SPT	n	6	0.8	1	1.0	60	1.00	1.05	11	0	98	490.0	178.0	1.7	19	19	1.7	19	CH	2C
F-7	Historic	10.0	SPT-2	7	SPT	n	6	0.85	1	1.0	60	1.00	1.05	6	0	98	980.0	356.0	1.7	11	11	1.7	11	CH	2C
F-7	Historic	12.5	SPT-3	79	SPT	n	6	0.85	1	1.0	60	1.00	1.05	71	0	125	1292.5	512.5	1.7	120	46	1.5	102	SM	4C
F-7	Historic	17.5	SPT-4	85	SPT	n	6	0.95	1	1.0	60	1.00	1.05	85	0	125	1917.5	825.5	1.6	136	46	1.3	109	SM	4C
F-8	Historic	2.5	SPT-1	3	SPT	n	6	0.75	1	1.0	60	1.00	1.05	2	12	108	270.0	270.0	1.7	4	4	1.7	4	SM	2C
F-8	Historic	7.5	SPT-2	55	SPT	n	6	0.8	1	1.0	60	1.00	1.05	46	12	108	810.0	810.0	1.6	75	46	1.3	59	SM	4C
F-8	Historic	12.5	SPT-3	104	SPT	n	6	0.85	1	1.0	60	1.00	1.05	93	12	125	1435.0	1403.8	1.2	114	46	1.1	103	SM	4C
F-8	Historic	17.5	SPT-4	120	SPT	n	6	0.95	1	1.0	60	1.00	1.05	120	12	125	2060.0	1716.8	1.1	133	46	1.1	126	SM	4C
GEO-9	Historic	2.5	SPT-1	16	SPT	n	6	0.75	1	1.0	80	1.33	1.05	17	33	93	232.5	232.5	1.7	29	29	1.7	29	ML	1B
GEO-9	Historic	5.0	SPT-2	12	SPT	n	6	0.8	1	1.0	80	1.33	1.05	13	33	93	465.0	465.0	1.7	23	23	1.7	23	ML	1B
GEO-9	Historic	7.5	SPT-3	33	SPT	n	6	0.8	1	1.0	80	1.33	1.05	37	33	108	735.0	735.0	1.7	63	46	1.3	49	SM	1B
GEO-9	Historic	10.0	SPT-4	10	SPT	n	6	0.85	1	1.0	80	1.33	1.05	12	33	108	1005.0	1005.0	1.5	17	17	1.4	17	SM	1A
GEO-9	Historic	12.5	SPT-5	6	SPT	n	6	0.85	1	1.0	80	1.33	1.05	7	33	108	1275.0	1275.0	1.3	9	9	1.3	9	SM	1A
GEO-9	Historic	15.0	SPT-6	2	SPT	n	6	0.95	1	1.0	80	1.33	1.05	3	33	108	1545.0	1545.0	1.2	3	3	1.2	3	SM	1A
GEO-9	Historic	17.5	SPT-7	3	SPT	n	6	0.95	1	1.0	80	1.33	1.05	4	33	108	1815.0	1815.0	1.1	4	4	1.1	4	SM	1A
GEO-9	Historic	20.0	SPT-8	3	SPT	n	6	0.95	1	1.0	80	1.33	1.05	4	33	108	2085.0	2085.0	1.0	4	4	1.0	4	SM	1A
GEO-9	Historic	22.5	SPT-9	17	SPT	n	6	0.95	1	1.0	80	1.33	1.05	23	33	108	2355.0	2355.0	0.9	21	21	1.0	22	SM	1A
GEO-9	Historic	25.0	SPT-10	8	SPT	n	6	0.95	1	1.0	80	1.33	1.05	11	33	108	2625.0	2625.0	0.9	10	10	0.9	9	SM	1A
GEO-9	Historic	30.0	SPT-11	20	SPT	n	6	1	1	1.0	80	1.33	1.05	28	33	109	3170.0	3170.0	0.8	23	23	0.8	24	SP-SM	1A
GEO-9	Historic	35.0	SPT-12	6	SPT	n	6	1	1	1.0	80	1.33	1.05	8	33	98	3660.0	3535.2	0.8	6	6	0.7	6	CH	2C
GEO-9	Historic	40.0	SPT-13	106	SPT	n	6	1	1	1.0	80	1.33	1.05	148	33	125	4285.0	3848.2	0.7	110	46	0.9	127	SM	4A
GEO-9	Historic	45.0	SPT-14	79	SPT	n	6	1	1	1.0	80	1.33	1.05	111	33	127	4920.0	4171.2	0.7	79	46	0.8	93	SP-SM	4A
H-60	Historic	1.5	SPT-1	77	SPT	n	3	0.75	1	1.0	60	1.00	1.00	58	0	127	190.5	96.9	1.7	98	46	1.7	98	SP-SM	1B
H-60	Historic	5.0	SPT-2	110	SPT	n	3	0.8	1	1.0	60	1.00	1.00	88	0	125	628.0	316.0	1.7	150	46	1.6	145	SM	1B
H-60	Historic	10.0	SPT-3	47	SPT	n	3	0.85	1	1.0	60	1.00	1.00	40	0	125	1253.0	629.0	1.7	68	46	1.4	55	SM	1B
H-60	Historic	15.0	SPT-4	33	SPT	n	3	0.95	1	1.0	60	1.00	1.00	31	0	125	1878.0	942.0	1.5	47	46	1.2	39	SM	1B
H-60	Historic	20.0	SPT-5	98	SPT	n	3	0.95	1	1.0	60	1.00	1.00	93	0	125	2503.0	1255.0	1.3	121	46	1.1	107	SM	1B
H-60	Historic	25.0	SPT-6	19	SPT	n	3	0.95	1	1.0	60	1.00	1.00	18	0	125	3128.0	1568.0	1.2	21	21	1.1	21	SM	1B
H-60	Historic	30.0	SPT-7	67	SPT	n	3	1	1	1.0	60	1.00	1.00	67	0	125	3753.0	1881.0	1.1	71	46	1.0	69	SM	1B
H-61	Historic	2.5	SPT-1	17	SPT	n	3	0.75	1	1.0	60	1.00	1.00	13		109	272.5	272.5	1.7	22	22	1.7	22	SP-SM	1B
H-61	Historic	5.0	SPT-2	58	SPT	n	3	0.8	1	1.0	60	1.00	1.00	46		112	552.5	552.5	1.7	79	46	1.4	66	SW-SM	1B
H-61	Historic	10.0	SPT-3	115	SPT	n	3	0.85	1	1.0	60	1.00	1.00	98		109	1097.5	1097.5	1.4	136	46	1.2	116	SP-SM	1B
H-61	Historic	15.0	SPT-4	152	SPT	n	3	0.95	1	1.0	60	1.00	1.00	144		108	1637.5	1637.5	1.1	164	46	1.1	154	SM	1B
H-61	Historic	20.0	SPT-5	52	SPT	n	3	0.95	1	1.0	60	1.00	1.00	49		108	2177.5	2177.5	1.0	49	46	1.0	49	SM	1B
H-62	Historic	1.0	SPT-1	76	SPT	n	3	0.75	1	1.0	60	1.00	1.00	57	0	127	127.0	64.6	1.7	97	46	1.7	97	SP-SM	1B
H-62	Historic	5.0	SPT-2	37	SPT	n	3	0.8	1	1.0	60	1.00	1.00	30	0	127	635.0	323.0	1.7	50	46	1.6	49	SP-SM	1B
H-62	Historic	10.0	SPT-3	41	SPT	n	3	0.85	1	1.0	60	1.00	1.00	35	0	125	1260.0	636.0	1.7	59	46	1.4	48	SM	1B
H-62	Historic	15.0	SPT-4	67	SPT	n	3	0.95	1	1.0	60	1.00	1.00	64	0	125	1885.0	949.0	1.5	95	46	1.2	79	SM	1B
H-62	Historic	20.0	SPT-5	86	SPT	n	3	0.95	1	1.0	60	1.00	1.00	82	0	125	2510.0	1262.0	1.3	106	46	1.1	94	SM	1B
H-62	Historic	25.0	SPT-6	27	SPT	n	3	0.95	1	1.0	60	1.00	1.00	26	0	125	3135.0	1575.0	1.2	30	30	1.1	29	SM	1B
H-62	Historic	30.0	SPT-7	34	SPT	n	3	1	1	1.0	60	1.00	1.00	34	0	125	3760.0	1888.0	1.1	36	36	1.0	35	SM	1B
H-62	Historic	35.0	SPT-8	68	SPT	n	3	1	1	1.0	60	1.00	1.00	68	0	105	4285.0	2101.0	1.0	68	46	1.0	68	ML	1B
H-62	Historic	40.0	SPT-9	29	SPT	n	3	1	1	1.0	60	1.00	1.00	29	0	125	4910.0	2414.0	0.9	27	27	1.0	28	SM	1B

PointID	PointID (Historic, WSDOT R2B, WOOD)	Sample Top Depth (ft)	Sample Number	Field SPT	Sampler Type (spt = standard penetrometer w/ 1.375-inch I.D., m = Modified California)	Samplers Have Space for Liners But didn't Use?	Borehole Diameter (in)	C_R, Rod Length Correction Factor	C_s, Sampling Method Correction Factor	C_S, Correction for Sampler without Liners	Hammer efficiency (%)	C_E, Energy Ratio Correction	C_B, Boring Dia Correction	N_{60}, Blowcount Corrected for All Factors except Overburden	Groundwater Depth (ft)	Avg Unit Wt of Sample (pcf) [or corrleation based on Coduto and USCS info or GDM for Peats]	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N, Over-burden Correction (Eq 41, Idriss & Boulanger, 2008^2) = (pa/σvo')^0.5	$(N_1)_{60}$, Corrected Blowcount for All Factors	Limit $(N_1)_{60}$ to 46	C_N, Over-burden Correction (Eq 39, Idriss & Boulanger, 2008^2) = $f(N_1)_{60}$	$(N_1)_{60}$, Corrected Blowcount for All Factors refined for relative density	Estimated USCS Classification	Assign ESU
				N	Sampler Type	(y/n)		C_R	C_s	C_S	ER(%)	C_E	C_B	N_{60}	gwt (ft)	γ (pcf)	σ (psf)	σ' (psf)	C_N	$(N_1)_{60}$	Limit $(N_1)_{60}$ to 46	C_N refined	$(N_1)_{60}$ refined	USCS	
H-63	Historic	2.5	SPT-1	15	SPT	n	3	0.75	1	1.0	60	1.00	1.00	11		109	272.5	272.5	1.7	19	19	1.7	19	SP-SM	1B
H-63	Historic	5.0	SPT-2	90	SPT	n	3	0.8	1	1.0	60	1.00	1.00	72		108	542.5	542.5	1.7	122	46	1.4	103	SM	1B
H-63	Historic	7.5	SPT-3	200	SPT	n	3	0.8	1	1.0	60	1.00	1.00	160		112	822.5	822.5	1.6	257	46	1.3	205	SW-SM	1B
H-63	Historic	10.0	SPT-4	46	SPT	n	3	0.85	1	1.0	60	1.00	1.00	39		112	1102.5	1102.5	1.4	54	46	1.2	46	SW-SM	1B
H-63	Historic	15.0	SPT-5	53	SPT	n	3	0.95	1	1.0	60	1.00	1.00	50		108	1642.5	1642.5	1.1	57	46	1.1	54	SM	1B
H-63	Historic	20.0	SPT-6	53	SPT	n	3	0.95	1	1.0	60	1.00	1.00	50		108	2182.5	2182.5	1.0	50	46	1.0	50	SM	1B
H-63	Historic	25.0	SPT-7	45	SPT	n	3	0.95	1	1.0	60	1.00	1.00	43		108	2722.5	2722.5	0.9	38	38	0.9	40	SM	1B
H-63	Historic	30.0	SPT-8	76	SPT	n	3	1	1	1.0	60	1.00	1.00	76		108	3262.5	3262.5	0.8	61	46	0.9	68	SM	1B
H-63	Historic	35.0	SPT-9	60	SPT	n	3	1	1	1.0	60	1.00	1.00	60		108	3802.5	3802.5	0.7	45	45	0.9	51	SM	4C
H-63	Historic	40.0	SPT-10	600	SPT	n	3	1	1	1.0	60	1.00	1.00	600		108	4342.5	4342.5	0.7	419	46	0.8	497	SM	4C
H-63	Historic	45.0	SPT-11	88	SPT	n	3	1	1	1.0	60	1.00	1.00	88		108	4882.5	4882.5	0.7	58	46	0.8	71	SM	4C
H-64	Historic	1.5	SPT-1	102	SPT	n	3	0.75	1	1.0	60	1.00	1.00	77	0	129	193.5	99.9	1.7	130	46	1.7	130	SW-SM	1B
H-64	Historic	5.0	SPT-2	59	SPT	n	3	0.8	1	1.0	60	1.00	1.00	47	0	127	638.0	326.0	1.7	80	46	1.6	77	SP-SM	1B
H-64	Historic	10.0	SPT-3	99	SPT	n	3	0.85	1	1.0	60	1.00	1.00	84	0	129	1283.0	659.0	1.7	143	46	1.4	114	SW-SM	1B
H-64	Historic	15.0	SPT-4	38	SPT	n	3	0.95	1	1.0	60	1.00	1.00	36	0	125	1908.0	972.0	1.5	53	46	1.2	44	SM	1B
H-64	Historic	20.0	SPT-5	118	SPT	n	3	0.95	1	1.0	60	1.00	1.00	112	0	125	2533.0	1285.0	1.3	144	46	1.1	128	SM	1B
H-64	Historic	25.0	SPT-6	146	SPT	n	3	0.95	1	1.0	60	1.00	1.00	139	0	125	3158.0	1598.0	1.2	160	46	1.1	149	SM	1B
H-64	Historic	30.0	SPT-7	121	SPT	n	3	1	1	1.0	60	1.00	1.00	121	0	125	3783.0	1911.0	1.1	127	46	1.0	124	SM	1B
H-64	Historic	35.0	SPT-8	200	SPT	n	3	1	1	1.0	60	1.00	1.00	200	0	125	4408.0	2224.0	1.0	195	46	1.0	197	SM	1B
H-64	Historic	40.0	SPT-9	38	SPT	n	3	1	1	1.0	60	1.00	1.00	38	0	125	5033.0	2537.0	0.9	35	35	0.9	36	SM	1B
H-64	Historic	45.0	SPT-10	41	SPT	n	3	1	1	1.0	60	1.00	1.00	41	0	125	5658.0	2850.0	0.9	35	35	0.9	37	SM	1B
H-65	Historic	2.5	SPT-1	26	SPT	n	3	0.75	1	1.0	60	1.00	1.00	20		109	272.5	272.5	1.7	33	33	1.7	33	SP-SM	1B
H-65	Historic	5.0	SPT-2	35	SPT	n	3	0.8	1	1.0	60	1.00	1.00	28		109	545.0	545.0	1.7	48	46	1.4	40	SP-SM	1B
H-65	Historic	10.0	SPT-3	145	SPT	n	3	0.85	1	1.0	60	1.00	1.00	123		112	1105.0	1105.0	1.4	171	46	1.2	146	SW-SM	1B
H-65	Historic	15.0	SPT-4	26	SPT	n	3	0.95	1	1.0	60	1.00	1.00	25		109	1650.0	1650.0	1.1	28	28	1.1	27	SP-SM	1B
H-65	Historic	20.0	SPT-5	35	SPT	n	3	0.95	1	1.0	60	1.00	1.00	33		108	2190.0	2190.0	1.0	33	33	1.0	33	SM	1B
H-65	Historic	25.0	SPT-6	29	SPT	n	3	0.95	1	1.0	60	1.00	1.00	28		108	2730.0	2730.0	0.9	24	24	0.9	25	SM	1B
H-65	Historic	30.0	SPT-7	24	SPT	n	3	1	1	1.0	60	1.00	1.00	24		108	3270.0	3270.0	0.8	19	19	0.8	20	SM	1B
H-65	Historic	35.0	SPT-8	16	SPT	n	3	1	1	1.0	60	1.00	1.00	16		108	3810.0	3810.0	0.7	12	12	0.7	12	SM	1B
H-65	Historic	40.0	SPT-9	74	SPT	n	3	1	1	1.0	60	1.00	1.00	74		108	4350.0	4350.0	0.7	52	46	0.8	61	SM	4C
S-36	Historic	2.5	SPT-1	27	SPT	n	8	0.75	1	1.0	60	1.00	1.15	23	3	108	270.0	270.0	1.7	40	40	1.7	40	SM	4C
S-36	Historic	5.0	SPT-2	22	SPT	n	8	0.8	1	1.0	60	1.00	1.15	20	3	125	582.5	457.7	1.7	34	34	1.7	34	SM	4C
S-36	Historic	7.5	SPT-3	38	SPT	n	8	0.8	1	1.0	60	1.00	1.15	35	3	125	895.0	614.2	1.7	60	46	1.4	48	SM	4C
S-36	Historic	10.0	SPT-4	74	SPT	n	8	0.85	1	1.0	60	1.00	1.15	72	3	133	1227.5	790.7	1.6	118	46	1.3	94	GM	4C
S-36	Historic	12.5	SPT-5	200	SPT	n	8	0.85	1	1.0	60	1.00	1.15	196	3	133	1560.0	967.2	1.5	289	46	1.2	240	GM	4C
S-36	Historic	17.5	SPT-6	200	SPT	n	8	0.95	1	1.0	60	1.00	1.15	219	3	133	2225.0	1320.2	1.3	277	46	1.1	247	SW	4C
S-36	Historic	22.5	SPT-7	200	SPT	n	8	0.95	1	1.0	60	1.00	1.15	219	3	133	2890.0	1673.2	1.1	246	46	1.1	232	SW	4C
S-36	Historic	27.5	SPT-8	200	SPT	n	8	0.95	1	1.0	60	1.00	1.15	219	3	133	3555.0	2026.2	1.0	223	46	1.0	221	SW	4C
S-36	Historic	32.5	SPT-9	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	133	4220.0	2379.2	0.9	325	46	1.0	335	SW	4C
S-36	Historic	37.5	SPT-10	150	SPT	n	8	1	1	1.0	60	1.00	1.15	173	3	133	4885.0	2732.2	0.9	152	46	0.9	161	SW	4C
S-36	Historic	42.5	SPT-11	150	SPT	n	8	1	1	1.0	60	1.00	1.15	173	3	105	5410.0	2945.2	0.8	146	46	0.9	158	ML	4C
S-36	Historic	47.5	SPT-12	600	SPT	n	8	1	1	1.0	60	1.00	1.15	690	3	105	5935.0	3158.2	0.8	565	46	0.9	621	ML	4C
S-36	Historic	53.0	SPT-13	200	SPT	n	8	1	1	1.0	60	1.00	1.15	230	3	105	6512.5	3392.5	0.8	182	46	0.9	203	ML	4C

PointID	PointID (Historic, WSDOT R2B, WOOD)	Sample Top Depth (ft)	Sample Number	Field SPT	Sampler Type (spt = standard penetrometer w/ 1.375-inch I.D., m = Modified California)	Samplers Have Space for Liners But didn't Use?	Borehole Diameter (in)	C_R, Rod Length Correction Factor	C_s, Sampling Method Correction Factor	C_S, Correction for Sampler without Liners	Hammer efficiency (%)	C_E, Energy Ratio Correction	C_B, Boring Dia Correction	N_{60}, Blowcount Corrected for All Factors except Overburden	Groundwater Depth (ft)	Avg Unit Wt of Sample (pcf) [or corrleation based on Coduto and USCS info or GDM for Peats]	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N, Over-burden Correction (Eq 41, Idriss & Boulanger, 2008^2) = (pa/σvo')^0.5	$(N_1)_{60}$, Corrected Blowcount for All Factors	Limit $(N_1)_{60}$ to 46	C_N, Over-burden Correction (Eq 39, Idriss & Boulanger, 2008^2) = $f(N_1)_{60}$	$(N_1)_{60}$, Corrected Blowcount for All Factors refined for relative density	Estimated USCS Classification	Assign ESU
				N	Sampler Type	(y/n)		C_R	C_s	C_S	ER(%)	C_E	C_B	N_{60}	gwt (ft)	γ (pcf)	σ (psf)	σ' (psf)	C_N	$(N_1)_{60}$	Limit $(N_1)_{60}$ to 46	C_N refined	$(N_1)_{60}$ refined	USCS	
S-37	Historic	5.0	SPT-1	23	SPT	n	8	0.8	1	1.0	60	1.00	1.15	21	3	133	665.0	540.2	1.7	36	36	1.6	33	SW	4C
S-37	Historic	10.0	SPT-2	43	SPT	n	8	0.85	1	1.0	60	1.00	1.15	42	3	133	1330.0	893.2	1.5	65	46	1.3	53	SW	4C
S-37	Historic	12.5	SPT-3	31	SPT	n	8	0.85	1	1.0	60	1.00	1.15	30	3	133	1662.5	1069.7	1.4	43	43	1.2	37	SW	4C
S-37	Historic	15.0	SPT-4	80	SPT	n	8	0.95	1	1.0	60	1.00	1.15	87	3	133	1995.0	1246.2	1.3	114	46	1.1	100	SW	4C
S-37	Historic	17.5	SPT-5	76	SPT	n	8	0.95	1	1.0	60	1.00	1.15	83	3	133	2327.5	1422.7	1.2	101	46	1.1	92	SW	4C
S-37	Historic	20.0	SPT-6	80	SPT	n	8	0.95	1	1.0	60	1.00	1.15	87	3	133	2660.0	1599.2	1.2	101	46	1.1	94	SW	4C
S-37	Historic	22.5	SPT-7	114	SPT	n	8	0.95	1	1.0	60	1.00	1.15	125	3	133	2992.5	1775.7	1.1	136	46	1.0	130	GM	4C
S-37	Historic	25.0	SPT-8	100	SPT	n	8	0.95	1	1.0	60	1.00	1.15	109	3	133	3325.0	1952.2	1.0	114	46	1.0	112	GM	4C
S-37	Historic	27.5	SPT-9	123	SPT	n	8	0.95	1	1.0	60	1.00	1.15	134	3	133	3657.5	2128.7	1.0	134	46	1.0	134	GM	4C
S-37	Historic	30.0	SPT-10	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	105	3920.0	2235.2	1.0	336	46	1.0	340	ML	4E
S-37	Historic	32.5	SPT-11	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	105	4182.5	2341.7	1.0	328	46	1.0	336	ML	4E
S-37	Historic	35.0	SPT-12	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	105	4445.0	2448.2	0.9	321	46	1.0	332	ML	4E
S-37	Historic	37.5	SPT-13	225	SPT	n	8	1	1	1.0	60	1.00	1.15	259	3	105	4707.5	2554.7	0.9	236	46	1.0	246	ML	4E
S-37	Historic	40.0	SPT-14	225	SPT	n	8	1	1	1.0	60	1.00	1.15	259	3	105	4970.0	2661.2	0.9	231	46	0.9	244	ML	4E
S-37	Historic	42.5	SPT-15	225	SPT	n	8	1	1	1.0	60	1.00	1.15	259	3	105	5232.5	2767.7	0.9	226	46	0.9	241	ML	4E
S-37	Historic	45.0	SPT-16	180	SPT	n	8	1	1	1.0	60	1.00	1.15	207	3	105	5495.0	2874.2	0.9	178	46	0.9	191	ML	4E
S-37	Historic	47.5	SPT-17	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	105	5757.5	2980.7	0.8	291	46	0.9	315	ML	4E
S-37	Historic	50.0	SPT-18	225	SPT	n	8	1	1	1.0	60	1.00	1.15	259	3	105	6020.0	3087.2	0.8	214	46	0.9	234	ML	4E
S-37	Historic	52.5	SPT-19	225	SPT	n	8	1	1	1.0	60	1.00	1.15	259	3	105	6282.5	3193.7	0.8	211	46	0.9	232	ML	4E
S-37	Historic	55.0	SPT-20	300	SPT	n	8	1	1	1.0	60	1.00	1.15	345	3	105	6545.0	3300.2	0.8	276	46	0.9	307	ML	4E
S-38	Historic	2.5	SPT-1	14	SPT	n	8	0.75	1	1.0	60	1.00	1.15	12	4	108	270.0	270.0	1.7	21	21	1.7	21	SM	1B
S-38	Historic	5.0	SPT-2	30	SPT	n	8	0.8	1	1.0	60	1.00	1.15	28	4	125	582.5	520.1	1.7	47	46	1.4	40	SM	1B
S-38	Historic	10.0	SPT-3	1	SPT	n	8	0.85	1	1.0	60	1.00	1.15	1	4	103	1097.5	723.1	1.7	2	2	1.7	2	MH	2C
S-38	Historic	15.0	SPT-4	1	SPT	n	8	0.95	1	1.0	60	1.00	1.15	1	4	103	1612.5	926.1	1.5	2	2	1.7	2	MH	2C
S-38	Historic	20.0	SPT-5	60	SPT	n	8	0.95	1	1.0	60	1.00	1.15	66	4	125	2237.5	1239.1	1.3	86	46	1.2	76	SM	4C
S-38	Historic	22.5	SPT-6	93	SPT	n	8	0.95	1	1.0	60	1.00	1.15	102	4	125	2550.0	1395.6	1.2	125	46	1.1	113	SM	4C
S-38	Historic	25.0	SPT-7	53	SPT	n	8	0.95	1	1.0	60	1.00	1.15	58	4	125	2862.5	1552.1	1.2	68	46	1.1	63	SM	4C
S-38	Historic	27.5	SPT-8	180	SPT	n	8	0.95	1	1.0	60	1.00	1.15	197	4	125	3175.0	1708.6	1.1	219	46	1.1	208	SM	4C
S-38	Historic	30.0	SPT-9	120	SPT	n	8	1	1	1.0	60	1.00	1.15	138	4	133	3507.5	1885.1	1.1	146	46	1.0	142	GM	4C
S-38	Historic	32.5	SPT-10	120	SPT	n	8	1	1	1.0	60	1.00	1.15	138	4	105	3770.0	1991.6	1.0	142	46	1.0	140	ML	4C
S-38	Historic	35.0	SPT-11	144	SPT	n	8	1	1	1.0	60	1.00	1.15	166	4	125	4082.5	2148.1	1.0	164	46	1.0	165	SM	4C
S-38	Historic	37.5	SPT-12	144	SPT	n	8	1	1	1.0	60	1.00	1.15	166	4	125	4395.0	2304.6	1.0	159	46	1.0	162	SM	4C
S-38	Historic	42.5	SPT-13	180	SPT	n	8	1	1	1.0	60	1.00	1.15	207	4	125	5020.0	2617.6	0.9	186	46	0.9	196	SM	4C
S-38	Historic	47.5	SPT-14	180	SPT	n	8	1	1	1.0	60	1.00	1.15	207	4	125	5645.0	2930.6	0.8	176	46	0.9	190	SM	4C
S-38	Historic	52.5	SPT-15	144	SPT	n	8	1	1	1.0	60	1.00	1.15	166	4	125	6270.0	3243.6	0.8	134	46	0.9	148	SM	4C
S-38	Historic	57.5	SPT-16	144	SPT	n	8	1	1	1.0	60	1.00	1.15	166	4	105	6795.0	3456.6	0.8	130	46	0.9	146	ML	4E
S-38	Historic	62.5	SPT-17	36	SPT	n	8	1	1	1.0	60	1.00	1.15	41	4	98	7285.0	3634.6	0.8	32	32	0.8	34	CH	4E

PointID	PointID (Historic, WSDOT R2B, WOOD)	Sample Top Depth (ft)	Sample Number	Field SPT	Sampler Type (spt = standard penetrometer w/ 1.375-inch I.D., m = Modified California)	Samplers Have Space for Liners But didn't Use?	Borehole Diameter (in)	C_R, Rod Length Correction Factor	C_s, Sampling Method Correction Factor	C_S, Correction for Sampler without Liners	Hammer efficiency (%)	C_E, Energy Ratio Correction	C_B, Boring Dia Correction	N_{60}, Blowcount Corrected for All Factors except Overburden	Groundwater Depth (ft)	Avg Unit Wt of Sample (pcf) [or corrleation based on Coduto and USCS info or GDM for Peats]	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N, Over-burden Correction (Eq 41, Idriss & Boulanger, 2008[2]) = (pa/σvo')^0.5	$(N_1)_{60}$, Corrected Blowcount for All Factors	Limit $(N_1)_{60}$ to 46	C_N, Over-burden Correction (Eq 39, Idriss & Boulanger, 2008[2]) = $f(N_1)_{60}$	$(N_1)_{60}$, Corrected Blowcount for All Factors refined for relative density	Estimated USCS Classification	Assign ESU
				N	Sampler Type	(y/n)		C_R	C_s	C_S	ER(%)	C_E	C_B	N_{60}	gwt (ft)	γ (pcf)	σ (psf)	σ' (psf)	C_N	$(N_1)_{60}$	Limit $(N_1)_{60}$ to 46	C_N refined	$(N_1)_{60}$ refined	USCS	
S-39	Historic	2.5	SPT-1	2	SPT	n	8	0.75	1	1.0	60	1.00	1.15	2	7.5	108	270.0	270.0	1.7	3	3	1.7	3	SM	1A
S-39	Historic	5.0	SPT-2	3	SPT	n	8	0.8	1	1.0	60	1.00	1.15	3	7.5	108	540.0	540.0	1.7	5	5	1.7	5	SM	1A
S-39	Historic	7.5	SPT-3	6	SPT	n	8	0.8	1	1.0	60	1.00	1.15	6	7.5	125	852.5	852.5	1.6	9	9	1.7	9	SM	1A
S-39	Historic	12.5	SPT-4	4	SPT	n	8	0.85	1	1.0	60	1.00	1.15	4	7.5	103	1367.5	1055.5	1.4	6	6	1.5	6	CL	2C
S-39	Historic	15.0	SPT-5	70	SPT	n	8	0.95	1	1.0	60	1.00	1.15	77	7.5	125	1680.0	1212.0	1.3	101	46	1.2	89	SM	4C
S-39	Historic	17.5	SPT-6	68	SPT	n	8	0.95	1	1.0	60	1.00	1.15	74	7.5	125	1992.5	1368.5	1.2	92	46	1.1	83	SM	4C
S-39	Historic	22.5	SPT-7	200	SPT	n	8	0.95	1	1.0	60	1.00	1.15	219	7.5	129	2637.5	1701.5	1.1	244	46	1.1	231	SW-SM	4C
S-39	Historic	27.5	SPT-8	200	SPT	n	8	0.95	1	1.0	60	1.00	1.15	219	7.5	129	3282.5	2034.5	1.0	223	46	1.0	221	SW-SM	4C
S-39	Historic	32.5	SPT-9	120	SPT	n	8	1	1	1.0	60	1.00	1.15	138	7.5	129	3927.5	2367.5	0.9	130	46	1.0	134	SW-SM	4C
S-39	Historic	37.5	SPT-10	200	SPT	n	8	1	1	1.0	60	1.00	1.15	230	7.5	129	4572.5	2700.5	0.9	204	46	0.9	216	SW-SM	4C
S-39	Historic	42.5	SPT-11	200	SPT	n	8	1	1	1.0	60	1.00	1.15	230	7.5	129	5217.5	3033.5	0.8	192	46	0.9	209	SW-SM	4C
S-39	Historic	47.5	SPT-12	200	SPT	n	8	1	1	1.0	60	1.00	1.15	230	7.5	129	5862.5	3366.5	0.8	182	46	0.9	204	SW-SM	4C
S-39	Historic	52.5	SPT-13	150	SPT	n	8	1	1	1.0	60	1.00	1.15	173	7.5	129	6507.5	3699.5	0.8	130	46	0.9	149	SW-SM	4C
S-39	Historic	57.5	SPT-14	200	SPT	n	8	1	1	1.0	60	1.00	1.15	230	7.5	129	7152.5	4032.5	0.7	167	46	0.8	194	SW-SM	4C
S-39	Historic	60.0	SPT-15	100	SPT	n	8	1	1	1.0	60	1.00	1.15	115	7.5	129	7475.0	4199.0	0.7	82	46	0.8	96	SW-SM	4C

Notes:

1. Yellow highlighting indicates fields where input data was required.
2. Source: Idriss, I.M. and R.W. Boulanger. 2008. *Soil Liquefaction During Earthquakes.* Earthquake Engineering Research Institute.

ASSIGNED ESUs

Point ID	PointID (HISTORIC, WSDOT R2B, WOOD)	Sample ID	Sample Top Depth (ft)	Field N	N_{60}	$(N_1)_{60}$	Estimated USCS Classification	ESU	LL	PI	% Fines (Lab)
W-171-20	WOOD	SPT-1	2.5	42	52	88	SP	1B	--	--	--
W-171-20	WOOD	SPT-2	5.0	30	40	67	SM	1B	--	--	30.6
W-171-20	WOOD	SPT-3	7.5	12	16	27	SM	1B	--	--	--
W-171-20	WOOD	SPT-4	10.0	21	29	50	SM	1B	--	--	--
W-171-20	WOOD	SPT-5	15.0	40	63	94	SM	1B	--	--	--
ALTCH-B6-06	Historic	SPT-1	5.0	28	30	51	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-2	7.0	15	16	27	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-3	10.0	33	37	56	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-4	12.0	32	36	50	ML	1B	15	--	26.6
ALTCH-B6-06	Historic	SPT-5	15.0	34	43	53	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-6	17.0	38	48	56	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-7	20.0	20	25	27	ML	1B	--	--	--
ALTCH-B6-06	Historic	SPT-8	25.0	71	90	86	ML	4C	--	--	--
ALTCH-B6-06	Historic	SPT-9	30.0	23	31	26	SW-SM	4C	--	--	8.7
ALTCH-B6-06	Historic	SPT-10	35.0	63	84	67	SM	4C	--	--	--
ALTCH-B6-06	Historic	SPT-11	40.0	120	160	123	SM	4C	--	--	--
ALTCH-B6-06	Historic	SPT-12	45.0	120	160	119	ML	4E	--	--	50.4
ALTCH-B6-06	Historic	SPT-13	50.0	200	267	193	ML	4E	--	--	81.9
ALTCH-B6-06	Historic	SPT-14	55.0	200	267	188	ML	4E	--	--	--
ALTCH-B6-06	Historic	SPT-15	60.0	200	267	184	ML	4E	--	--	--
CH-B3-06	Historic	SPT-1	4.0	34	36	61	SM	1B	--	--	--
CH-B3-06	Historic	SPT-2	6.5	39	44	74	SM	1B	--	--	--
CH-B3-06	Historic	SPT-3	9.0	34	41	60	SM	1B	--	--	--
CH-B3-06	Historic	SPT-4	11.5	39	46	61	SM	1B	--	--	31.2
CH-B3-06	Historic	SPT-5	14.0	68	81	96	SM	1B	--	--	--
CH-B3-06	Historic	SPT-6	16.5	42	56	61	SM	1B	--	--	--
CH-B3-06	Historic	SPT-7	19.0	67	89	90	SM	1B	--	--	--
CH-B3-06	Historic	SPT-8	24.0	19	25	23	SM	4C	--	--	15.5
CH-B3-06	Historic	SPT-9	29.0	52	73	60	SM	4C	--	--	--
CH-B3-06	Historic	SPT-10	34.0	49	69	52	SM	4C	--	--	--
CH-B3-06	Historic	SPT-11	39.0	100	140	101	SM	4C	--	--	--
CH-B3-06	Historic	SPT-12	44.0	150	210	146	SM	4C	--	--	--
CH-B3-06	Historic	SPT-13	49.0	100	140	94	SM	4C	--	--	31.7
CH-B3-06	Historic	SPT-14	54.0	150	210	137	SM	4C	--	--	--
CH-B3-06	Historic	SPT-15	59.0	120	168	106	SM	4C	--	--	38.1
CH-B3-06	Historic	SPT-16	64.0	100	140	87	ML	4C	--	--	--
CH-B3-06	Historic	SPT-17	69.0	100	140	85	ML	4C	--	--	96.3
CH-B3-06	Historic	SPT-18	74.0	150	210	124	SM	4C	--	--	--
CH-B3-06	Historic	SPT-19	79.0	73	102	59	ML	4C	--	--	--
CH-B3-06	Historic	SPT-20	84.0	120	168	95	SM	4C	--	--	--
CH-B3-06	Historic	SPT-21	89.0	100	140	78	SM	4C	--	--	--
F-4	Historic	SPT-1	4.5	2	2	3	CH	2C	--	--	--
F-4	Historic	SPT-2	9.5	78	70	118	SM	4C	--	--	--
F-4	Historic	SPT-3	12.5	59	53	90	SM	4C	--	--	--
F-4	Historic	SPT-4	17.5	64	64	91	SM	4C	--	--	--
F-4	Historic	SPT-5	22.5	52	52	65	SM	4C	--	--	--
F-4	Historic	SPT-6	27.5	120	120	135	SM	4C	--	--	--
F-6	Historic	SPT-1	4.5	4	3	5	CH	2C	--	--	--
F-6	Historic	SPT-2	8.2	77	69	117	SM	4C	--	--	--
F-6	Historic	SPT-3	12.5	51	46	77	SM	4C	--	--	--
F-6	Historic	SPT-4	17.5	200	200	294	SM	4C	--	--	--
F-7	Historic	SPT-1	5.0	13	11	19	CH	2C	--	--	--
F-7	Historic	SPT-2	10.0	7	6	11	CH	2C	--	--	--
F-7	Historic	SPT-3	12.5	79	71	120	SM	4C	--	--	--
F-7	Historic	SPT-4	17.5	85	85	136	SM	4C	--	--	--
F-8	Historic	SPT-1	2.5	3	2	4	SM	2C	--	--	--
F-8	Historic	SPT-2	7.5	55	46	75	SM	4C	--	--	--
F-8	Historic	SPT-3	12.5	104	93	114	SM	4C	--	--	--
F-8	Historic	SPT-4	17.5	120	120	133	SM	4C	--	--	--

Point ID	PointID (HISTORIC, WSDOT R2B, WOOD)	Sample ID	Sample Top Depth (ft)	Field N	N_{60}	$(N_1)_{60}$	Estimated USCS Classification	ESU	LL	PI	% Fines (Lab)
GEO-9	Historic	SPT-1	2.5	16	17	29	ML	1B	--	--	--
GEO-9	Historic	SPT-2	5.0	12	13	23	ML	1B	--	--	55.0
GEO-9	Historic	SPT-3	7.5	33	37	63	SM	1B	--	--	--
GEO-9	Historic	SPT-4	10.0	10	12	17	SM	1A	--	--	--
GEO-9	Historic	SPT-5	12.5	6	7	9	SM	1A	--	--	--
GEO-9	Historic	SPT-6	15.0	2	3	3	SM	1A	--	--	--
GEO-9	Historic	SPT-7	17.5	3	4	4	SM	1A	--	--	--
GEO-9	Historic	SPT-8	20.0	3	4	4	SM	1A	--	--	--
GEO-9	Historic	SPT-9	22.5	17	23	21	SM	1A	--	--	--
GEO-9	Historic	SPT-10	25.0	8	11	10	SM	1A	--	--	--
GEO-9	Historic	SPT-11	30.0	20	28	23	SP-SM	1A	--	--	--
GEO-9	Historic	SPT-12	35.0	6	8	6	CH	2C	56	29	--
GEO-9	Historic	SPT-13	40.0	106	148	110	SM	4A	--	--	--
GEO-9	Historic	SPT-14	45.0	79	111	79	SP-SM	4A	--	--	--
H-60	Historic	SPT-1	1.5	77	58	98	SP-SM	1B	--	--	5.8
H-60	Historic	SPT-2	5.0	110	88	150	SM	1B	--	--	7.8
H-60	Historic	SPT-3	10.0	47	40	68	SM	1B	--	--	25.2
H-60	Historic	SPT-4	15.0	33	31	47	SM	1B	--	--	30.9
H-60	Historic	SPT-5	20.0	98	93	121	SM	1B	--	--	27.4
H-60	Historic	SPT-6	25.0	19	18	21	SM	1B	--	--	23.6
H-60	Historic	SPT-7	30.0	67	67	71	SM	1B	--	--	24.9
H-61	Historic	SPT-1	2.5	17	13	22	SP-SM	1B	--	--	9.3
H-61	Historic	SPT-2	5.0	58	46	79	SW-SM	1B	--	--	7.4
H-61	Historic	SPT-3	10.0	115	98	136	SP-SM	1B	--	--	6.7
H-61	Historic	SPT-4	15.0	152	144	164	SM	1B	--	--	24.8
H-61	Historic	SPT-5	20.0	52	49	49	SM	1B	--	--	19.9
H-62	Historic	SPT-1	1.0	76	57	97	SP-SM	1B	--	--	5.3
H-62	Historic	SPT-2	5.0	37	30	50	SP-SM	1B	--	--	8.5
H-62	Historic	SPT-3	10.0	41	35	59	SM	1B	--	--	22.9
H-62	Historic	SPT-4	15.0	67	64	95	SM	1B	--	--	28.5
H-62	Historic	SPT-5	20.0	86	82	106	SM	1B	--	--	11.2
H-62	Historic	SPT-6	25.0	27	26	30	SM	1B	--	--	28.8
H-62	Historic	SPT-7	30.0	34	34	36	SM	1B	--	--	19.0
H-62	Historic	SPT-8	35.0	68	68	68	ML	1B	--	--	51.2
H-62	Historic	SPT-9	40.0	29	29	27	SM	1B	--	--	17.6
H-63	Historic	SPT-1	2.5	15	11	19	SP-SM	1B	--	--	9.6
H-63	Historic	SPT-2	5.0	90	72	122	SM	1B	--	--	12.1
H-63	Historic	SPT-3	7.5	200	160	257	SW-SM	1B	--	--	9.0
H-63	Historic	SPT-4	10.0	46	39	54	SW-SM	1B	--	--	10.3
H-63	Historic	SPT-5	15.0	53	50	57	SM	1B	--	--	17.8
H-63	Historic	SPT-6	20.0	53	50	50	SM	1B	--	--	11.5
H-63	Historic	SPT-7	25.0	45	43	38	SM	1B	--	--	15.4
H-63	Historic	SPT-8	30.0	76	76	61	SM	1B	--	--	13.3
H-63	Historic	SPT-9	35.0	60	60	45	SM	4C	--	--	37.1
H-63	Historic	SPT-10	40.0	600	600	419	SM	4C	--	--	--
H-63	Historic	SPT-11	45.0	88	88	58	SM	4C	--	--	3.9
H-64	Historic	SPT-1	1.5	102	77	130	SW-SM	1B	--	--	6.0
H-64	Historic	SPT-2	5.0	59	47	80	SP-SM	1B	--	--	8.2
H-64	Historic	SPT-3	10.0	99	84	143	SW-SM	1B	--	--	6.5
H-64	Historic	SPT-4	15.0	38	36	53	SM	1B	--	--	37.3
H-64	Historic	SPT-5	20.0	118	112	144	SM	1B	--	--	40.0
H-64	Historic	SPT-6	25.0	146	139	160	SM	1B	--	--	13.6
H-64	Historic	SPT-7	30.0	121	121	127	SM	1B	--	--	22.7
H-64	Historic	SPT-8	35.0	200	200	195	SM	1B	--	--	8.7
H-64	Historic	SPT-9	40.0	38	38	35	SM	1B	--	--	13.4
H-64	Historic	SPT-10	45.0	41	41	35	SM	1B	--	--	--
H-65	Historic	SPT-1	2.5	26	20	33	SP-SM	1B	--	--	9.4
H-65	Historic	SPT-2	5.0	35	28	48	SP-SM	1B	--	--	11.8
H-65	Historic	SPT-3	10.0	145	123	171	SW-SM	1B	--	--	11.4
H-65	Historic	SPT-4	15.0	26	25	28	SP-SM	1B	--	--	11.3
H-65	Historic	SPT-5	20.0	35	33	33	SM	1B	--	--	21.7
H-65	Historic	SPT-6	25.0	29	28	24	SM	1B	--	--	25.6
H-65	Historic	SPT-7	30.0	24	24	19	SM	1B	--	--	--
H-65	Historic	SPT-8	35.0	16	16	12	SM	1B	--	--	17.3
H-65	Historic	SPT-9	40.0	74	74	52	SM	4C	--	--	14.0

Point ID	PointID (HISTORIC, WSDOT R2B, WOOD)	Sample ID	Sample Top Depth (ft)	Field N	N_{60}	$(N_1)_{60}$	Estimated USCS Classification	ESU	LL	PI	% Fines (Lab)
S-36	Historic	SPT-1	2.5	27	23	40	SM	4C	--	--	--
S-36	Historic	SPT-2	5.0	22	20	34	SM	4C	--	--	--
S-36	Historic	SPT-3	7.5	38	35	60	SM	4C	--	--	--
S-36	Historic	SPT-4	10.0	74	72	118	GM	4C	--	--	--
S-36	Historic	SPT-5	12.5	200	196	289	GM	4C	--	--	--
S-36	Historic	SPT-6	17.5	200	219	277	SW	4C	--	--	--
S-36	Historic	SPT-7	22.5	200	219	246	SW	4C	--	--	--
S-36	Historic	SPT-8	27.5	200	219	223	SW	4C	--	--	--
S-36	Historic	SPT-9	32.5	300	345	325	SW	4C	--	--	--
S-36	Historic	SPT-10	37.5	150	173	152	SW	4C	--	--	--
S-36	Historic	SPT-11	42.5	150	173	146	ML	4C	--	--	--
S-36	Historic	SPT-12	47.5	600	690	565	ML	4C	--	--	--
S-36	Historic	SPT-13	53.0	200	230	182	ML	4C	--	--	--
S-37	Historic	SPT-1	5.0	23	21	36	SW	4C	--	--	--
S-37	Historic	SPT-2	10.0	43	42	65	SW	4C	--	--	--
S-37	Historic	SPT-3	12.5	31	30	43	SW	4C	--	--	--
S-37	Historic	SPT-4	15.0	80	87	114	SW	4C	--	--	--
S-37	Historic	SPT-5	17.5	76	83	101	SW	4C	--	--	--
S-37	Historic	SPT-6	20.0	80	87	101	SW	4C	--	--	--
S-37	Historic	SPT-7	22.5	114	125	136	GM	4C	--	--	--
S-37	Historic	SPT-8	25.0	100	109	114	GM	4C	--	--	--
S-37	Historic	SPT-9	27.5	123	134	134	GM	4C	--	--	--
S-37	Historic	SPT-10	30.0	300	345	336	ML	4E	--	--	--
S-37	Historic	SPT-11	32.5	300	345	328	ML	4E	--	--	--
S-37	Historic	SPT-12	35.0	300	345	321	ML	4E	--	--	--
S-37	Historic	SPT-13	37.5	225	259	236	ML	4E	--	--	--
S-37	Historic	SPT-14	40.0	225	259	231	ML	4E	--	--	--
S-37	Historic	SPT-15	42.5	225	259	226	ML	4E	--	--	--
S-37	Historic	SPT-16	45.0	180	207	178	ML	4E	--	--	--
S-37	Historic	SPT-17	47.5	300	345	291	ML	4E	--	--	--
S-37	Historic	SPT-18	50.0	225	259	214	ML	4E	--	--	--
S-37	Historic	SPT-19	52.5	225	259	211	ML	4E	--	--	--
S-37	Historic	SPT-20	55.0	300	345	276	ML	4E	--	--	--
S-38	Historic	SPT-1	2.5	14	12	21	SM	1B	--	--	--
S-38	Historic	SPT-2	5.0	30	28	47	SM	1B	--	--	--
S-38	Historic	SPT-3	10.0	1	1	2	MH	2C	--	--	--
S-38	Historic	SPT-4	15.0	1	1	2	MH	2C	--	--	--
S-38	Historic	SPT-5	20.0	60	66	86	SM	4C	--	--	--
S-38	Historic	SPT-6	22.5	93	102	125	SM	4C	--	--	--
S-38	Historic	SPT-7	25.0	53	58	68	SM	4C	--	--	--
S-38	Historic	SPT-8	27.5	180	197	219	SM	4C	--	--	--
S-38	Historic	SPT-9	30.0	120	138	146	GM	4C	--	--	--
S-38	Historic	SPT-10	32.5	120	138	142	ML	4C	--	--	--
S-38	Historic	SPT-11	35.0	144	166	164	SM	4C	--	--	--
S-38	Historic	SPT-12	37.5	144	166	159	SM	4C	--	--	--
S-38	Historic	SPT-13	42.5	180	207	186	SM	4C	--	--	--
S-38	Historic	SPT-14	47.5	180	207	176	SM	4C	--	--	--
S-38	Historic	SPT-15	52.5	144	166	134	SM	4C	--	--	--
S-38	Historic	SPT-16	57.5	144	166	130	ML	4E	--	--	--
S-38	Historic	SPT-17	62.5	36	41	32	CH	4E	--	--	--
S-39	Historic	SPT-1	2.5	2	2	3	SM	1A	--	--	--
S-39	Historic	SPT-2	5.0	3	3	5	SM	1A	--	--	--
S-39	Historic	SPT-3	7.5	6	6	9	SM	1A	--	--	--
S-39	Historic	SPT-4	12.5	4	4	6	CL	2C	--	--	--
S-39	Historic	SPT-5	15.0	70	77	101	SM	4C	--	--	--
S-39	Historic	SPT-6	17.5	68	74	92	SM	4C	--	--	--
S-39	Historic	SPT-7	22.5	200	219	244	SW-SM	4C	--	--	--
S-39	Historic	SPT-8	27.5	200	219	223	SW-SM	4C	--	--	--
S-39	Historic	SPT-9	32.5	120	138	130	SW-SM	4C	--	--	--
S-39	Historic	SPT-10	37.5	200	230	204	SW-SM	4C	--	--	--
S-39	Historic	SPT-11	42.5	200	230	192	SW-SM	4C	--	--	--
S-39	Historic	SPT-12	47.5	200	230	182	SW-SM	4C	--	--	--
S-39	Historic	SPT-13	52.5	150	173	130	SW-SM	4C	--	--	--
S-39	Historic	SPT-14	57.5	200	230	167	SW-SM	4C	--	--	--
S-39	Historic	SPT-15	60.0	100	115	82	SW-SM	4C	--	--	--

UNIT WEIGHT

$(N_1)_{60}$	SM	SC	GM	ML	MH	SP	GP	GW	GW	SP-SM	GP-GM	GW-GM	GW-GC	CL	CH
0	70	70	70	70	70	85	85	100	100	77.5	77.5	85	85	100	100
1	80	80	80	80	80	95	95	105	105	87.5	87.5	92.5	91.5	105	105
2	80	80	80	80	80	95	95	105	105	87.5	87.5	92.5	92.5	110	110
3	90	90	90	90	90	105	105	115	115	97.5	97.5	102.5	101.5	115	115
4	90	90	90	90	90	105	105	115	115	97.5	97.5	102.5	102.5	115	115
5	95	95	95	95	95	105	105	115	115	100	100	105	105	115	115
6	100	100	100	100	100	110	110	120	120	105	105	110	110	120	120
7	110	110	110	110	110	120	120	125	125	115	115	117.5	116.5	120	120
8	110	110	110	110	110	120	120	125	125	115	115	117.5	117.5	120	120
9	110	110	110	110	110	120	120	130	130	115	115	120	120	120	120
10	110	110	110	110	110	120	120	130	130	115	115	120	120	125	125
11	110	110	110	110	110	120	120	130	130	115	115	120	120	125	125
12	110	110	110	110	110	120	120	130	130	115	115	120	120	125	125
13	110	110	110	110	110	125	125	130	130	117.5	117.5	120	120	130	130
14	110	110	110	110	110	125	125	130	130	117.5	117.5	120	120	130	130
15	110	110	110	110	110	125	125	135	135	117.5	117.5	122.5	122.5	130	130
16	110	110	110	110	110	125	125	135	135	117.5	117.5	122.5	122.5	130	130
17	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
18	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
19	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
20	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
21	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
22	115	115	115	115	115	125	125	135	135	120	120	125	125	130	130
23	115	115	115	115	115	130	130	135	135	122.5	122.5	125	125	130	130
24	115	115	115	115	115	130	130	135	135	122.5	122.5	125	125	130	130
25	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
26	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
27	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
28	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
29	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
30	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
32	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
34	120	120	120	120	120	130	130	140	140	125	125	130	130	130	130
36	120	120	120	120	120	135	135	145	145	127.5	127.5	132.5	132.5	130	130
38	125	125	125	125	125	135	135	145	145	130	130	135	135	130	130
40	125	125	125	125	125	135	135	145	145	130	130	135	135	130	130
42	125	125	125	125	125	135	135	145	145	130	130	135	135	130	130
44	125	125	125	125	125	135	135	145	145	130	130	135	135	130	130
46	130	130	130	130	130	140	140	150	150	135	135	140	140	130	130
48	130	130	130	130	130	140	140	150	150	135	135	140	140	130	130
50	130	130	130	130	130	140	140	150	150	135	135	140	140	130	130

Note: CALTRANS

Coduto Table		
	Above GW	Below GW
GP	120	133
GW	125	137
GW-GM	120	135
GW-GC	118	135
GM	115	133
GP-GM	118	133
GC	115	133
SP	110	128
SP-SM	109	127
SP-SC	112	125
SW	115	133
SW-SM	112	129
SW-SC	114	128
SM	108	125
SC	113	123
ML	93	105
MH	93	103
CL	95	103
CH	95	98
OL	80	80
PT	80	80
CL-ML	94	104
SM-ML	101	115
SC-SM	110	126

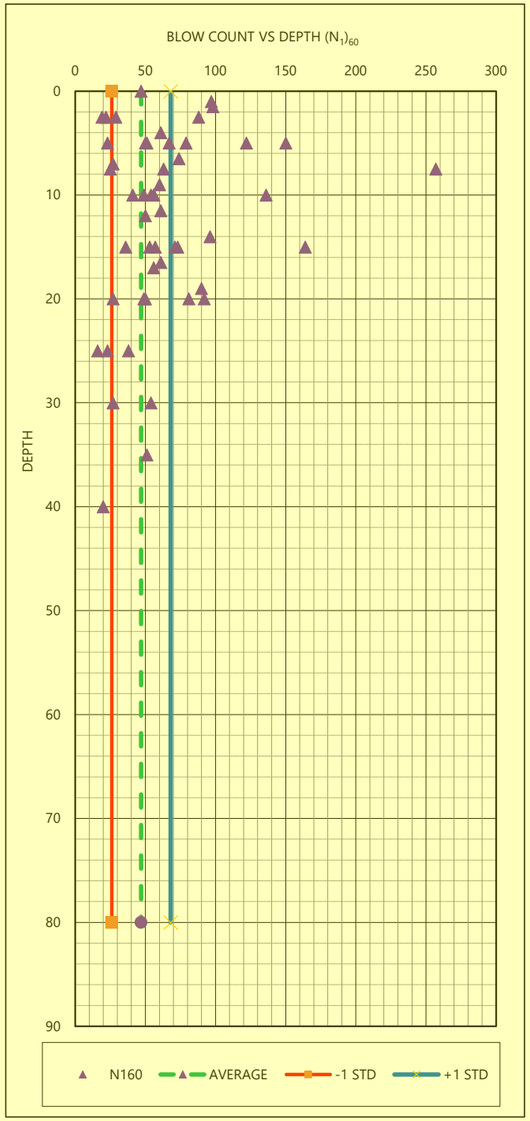
TABLE 3.2 TYPICAL UNIT WEIGHTS

Soil Type and Unified Soil Classification (See Figure 3.3)	Typical Unit Weight, γ			
	Above Groundwater Table		Below Groundwater Table	
	(lb/ft^3)	(kN/m^3)	(lb/ft^3)	(kN/m^3)
GP—Poorly-graded gravel	110–130	17.5–20.5	125–140	19.5–22.0
GW—Well-graded gravel	110–140	17.5–22.0	125–150	19.5–23.5
GM—Silty gravel	100–130	16.0–20.5	125–140	19.5–22.0
GC—Clayey gravel	100–130	16.0–20.5	125–140	19.5–22.0
SP—Poorly-graded sand	95–125	15.0–19.5	120–135	19.0–21.0
SW—Well-graded sand	95–135	15.0–21.0	120–145	19.0–23.0
SM—Silty sand	80–135	12.5–21.0	110–140	17.5–22.0
SC—Clayey sand	85–130	13.5–20.5	110–135	17.5–21.0
ML—Low plasticity silt	75–110	11.5–17.5	80–130	12.5–20.5
MH—High plasticity silt	75–110	11.5–17.5	75–130	11.5–20.5
CL—Low plasticity clay	80–110	12.5–17.5	75–130	11.5–20.5
CH—High plasticity clay	80–110	12.5–17.5	70–125	11.0–19.5

ESU #1B Fill (Medium dense to dense SAND/GRAVEL)

1 REVIEW $(N_1)_{60}$ PARAMETERS AND CHECK FOR OUTLIERS

Point ID	Depth	$(N_1)_{60}$	PI	%Fine	USCS	Check $(N_1)_{60}$ data for outliers	
						deleted	why
W-171-20	2.5	88			SP		
W-171-20	5	67		30.6	SM		
W-171-20	7.5	25			SM		
W-171-20	10	41			SM		
W-171-20	15	71			SM		
ALTCH-B6-06	5	51			ML		
ALTCH-B6-06	7	27			ML		
ALTCH-B6-06	10	56			ML		
ALTCH-B6-06	12	50		26.6	ML		
ALTCH-B6-06	15	53			ML		
ALTCH-B6-06	17	56			ML		
ALTCH-B6-06	20	27			ML		
CH-B3-06	4	61			SM		
CH-B3-06	9	60			SM		
CH-B3-06	14				SM	96	Note 1
CH-B3-06	19	90			SM		
CH-B3-06	6.5	74			SM		
CH-B3-06	11.5	61		31.2	SM		
CH-B3-06	16.5	61			SM		
GEO-9	2.5	29			ML		
GEO-9	5	23		55.0	ML		
GEO-9	7.5	63			SM		
H-60	5			7.8	SM	150	Note 1
H-60	10	56		25.2	SM		
H-60	15	36		30.9	SM		
H-60	20	92		27.4	SM		
H-60	25	16		23.6	SM		
H-60	30	54		24.9	SM		
H-60	1.5			5.8	SP-SM	98	Note 1
H-61	2.5	22		9.3	SP-SM		
H-61	5	79		7.4	SW-SM		
H-61	10			6.7	SP-SM	136	Note 1
H-61	15			24.8	SM	164	Note 1
H-61	20	49		19.9	SM		
H-62	5	50		8.5	SP-SM		
H-62	10	49		22.9	SM		
H-62	15	73		28.5	SM		
H-62	20	81		11.2	SM		
H-62	25	23		28.8	SM		
H-62	30	27		19.0	SM		
H-62	35	51		51.2	ML		
H-62	40	20		17.6	SM		
H-62	1			5.3	SP-SM	97	Note 1
H-63	2.5	19		9.6	SP-SM		
H-63	5			12.1	SM	122	Note 1
H-63	7.5			9.0	SW-SM	257	Note 1
H-63	10	54		10.3	SW-SM		
H-63	15	57		17.8	SM		
H-63	20	50		11.5	SM		
H-63	25	38		15.4	SM		



Depth (ft)	A	B	C
0	47.0	68.0	26.0
80	47.0	68.0	26.0

A = Average $(N_1)_{60}$

B = Average $[(N_1)_{60}$ + (STD Dev $(N_1)_{60})]$

C = Average $[(N_1)_{60}$ - (STD Dev $(N_1)_{60})]$

H-63	30	61		13.3	SM		
H-64	5	80		8.2	SP-SM		
H-64	10			6.5	SW-SM	116	Note 1
H-64	15	41		37.3	SM		
H-64	20			40.0	SM	110	Note 1
H-64	25			13.6	SM	122	Note 1
H-64	30			22.7	SM	97	Note 1
H-64	35			8.7	SM	149	Note 1
H-64	40	27		13.4	SM		
H-64	45	27			SM		
H-64	1.5			6.0	SW-SM	130	Note 1
H-65	2.5	33		9.4	SP-SM		
H-65	5	48		11.8	SP-SM		
H-65	10			11.4	SW-SM	171	Note 1
H-65	15	28		11.3	SP-SM		
H-65	20	33		21.7	SM		
H-65	25	24		25.6	SM		
H-65	30	19			SM		
H-65	35	12		17.3	SM		
S-38	2.5	21			SM		
S-38	5	47			SM		
	AVERAGE	**47.0**		**18.7**			
	STD DEV	**21.0**					
	GEOMEAN	**42.0**					

Outlier Notes:

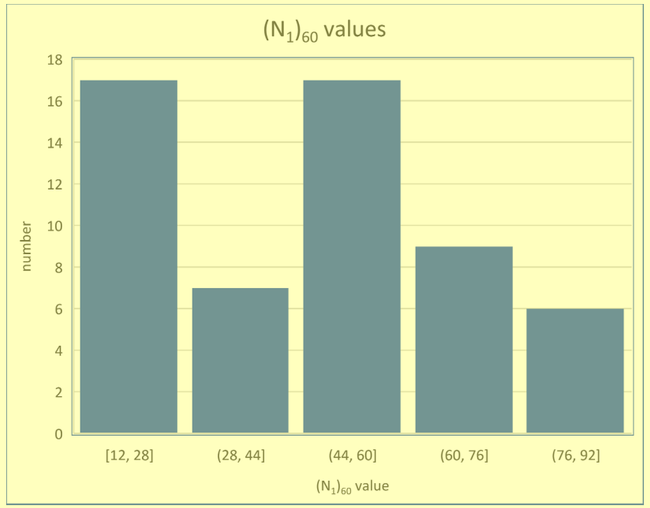
1. Maximum values removed to reduce the standard deviation, which is a conservative practice for design values.

2	**CHECK COV IS BETWEEN 15 AND 45%**

(consider revising ESU limits if outside range)

Coefficient of Variation (V) = standard deviation/average	45%
(V_{low}) from Table 52 in GEC 5 Sabatini (2002)	15%
(V_{high}) from Table 52 in GEC 5 Sabatini (2002)	45%

3	PLOT HISTOGRAM AND COMPARE TO GEOMEAN VALUE

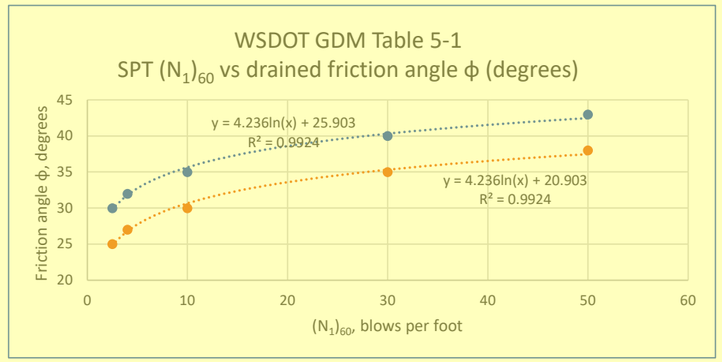


GEOMEAN	42

4	ESTIMATE PEAK FRICTION ANGLE (deg)

Using WSDOT correlation

$(N_1)_{60}$ (blows per foot)	Friction angle ϕ (degrees)
2.5	25
2.5	30
4	27
4	32
10	30
10	35
30	35
30	40
50	38
50	43



	$(N_1)_{60}$	ϕ (high)	ϕ (low)	ϕ (avg)
Geomean	42.0	42	37	39
Average	47.0	42	37	40
Average minus one standard deviation	26.0	40	35	37

ESTIMATE PEAK FRICTION ANGLE (deg)	38	Selected value from lower end of the range plus 1 based on average fines content of 19%

5	**USCS**	**SM**	USE PREDOMINANT USCS CLASSIFICATION
6	**Unit Weight (pcf)**	**130**	USE CALTRANS, verify with CODUTO (2001) or GDM for PEAT/ ORGANICS if no measurements.
7	**Apparent Cohesion (psf)**	**100**	Based on Table 11-2 of Kavazanjian et al (2011) for backfill soils with 15% to 25% fines

Notes:

= selected soil design properties

REFERENCES:

California Department of Transportation (Caltrans). 2014. *Geotechnical Manual.*

Coduto, D.P. 2001. *Foundation Design Principles and Practices.* 2nd Edition. Prentice-Hall, Inc., New Jersey.

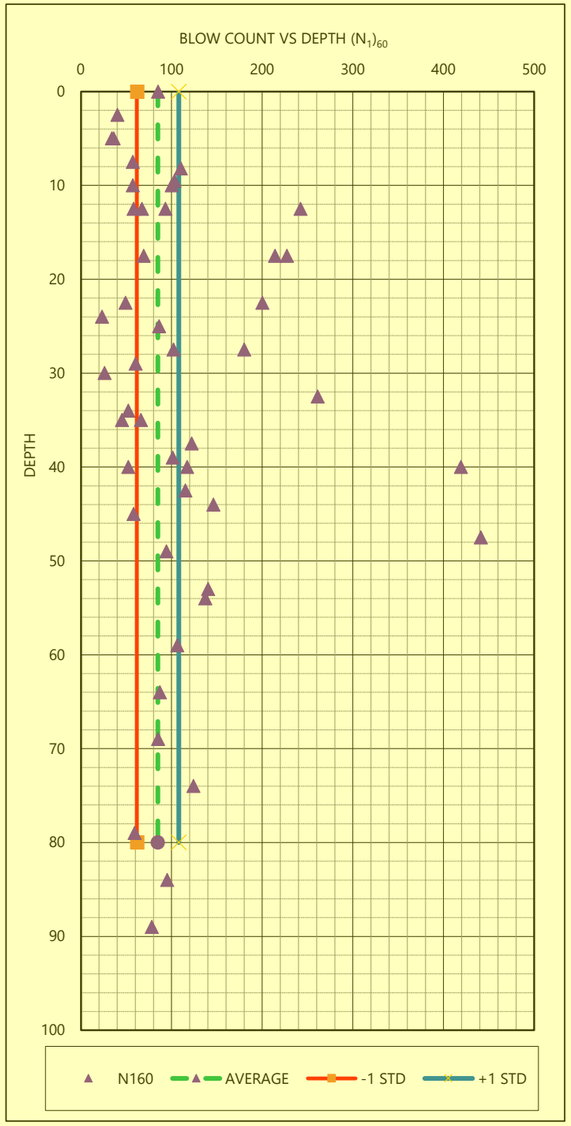
Sabatini, P.J., R.C. Bachus, P.W. Mayne, T.E. Schneider, and T. E. Zettler. 2002. *Geotechnical Engineering Circular No. 5: Evaluation of Soil and Rock Properties.* FHWA-IF-02-034.

Kavazanjian, E.J., Wang, JN.J., Martin, G.R., Shamsabadi, A., Lam, I., Dicenson, S.E., and Hung., C.J. 2011. *LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations*. FHWA-NHO-11-032.

ESU #4C Glacial Till (Dense to very dense Silty SAND)

1 REVIEW $(N_1)_{60}$ PARAMETERS AND CHECK FOR OUTLIERS

Point ID	Depth	$(N_1)_{60}$	PI	%Fine	USCS	Check $(N_1)_{60}$ data for outliers	
						deleted	why
ALTCH-B6-06	25	86			ML		
ALTCH-B6-06	30	26		9	SW-SM		
ALTCH-B6-06	35	66			SM		
ALTCH-B6-06	40	100			SM	117	Capped to 100
CH-B3-06	24	23		16	SM		
CH-B3-06	29	60			SM		
CH-B3-06	34	52			SM		
CH-B3-06	39	101			SM		
CH-B3-06	44	100			SM	146	Capped to 100
CH-B3-06	49	94		32	SM		
CH-B3-06	54	100			SM	137	Capped to 100
CH-B3-06	59	106		38	SM		
CH-B3-06	64	87			ML		
CH-B3-06	69	85		96	ML		
CH-B3-06	74	100			SM	124	Capped to 100
CH-B3-06	79	59			ML		
CH-B3-06	84	95			SM		
CH-B3-06	89	78					
F-4	12.5	67					
F-4	22.5	49					
F-4	17.5	69					
F-4	27.5	100			SM	102	Capped to 100
F-4	9.5	100			SM	103	Capped to 100
F-6	12.5	58			SM		
F-6	17.5	100			SM	214	Capped to 100
F-6	8.2	100			SM	110	Capped to 100
F-7	12.5	100			SM		
H-63	35	45		37	SM		
H-63	40	100			SM	419	Capped to 100
H-63	45	58		4	SM		
H-65	40	52		14	SM		
S-36	2.5	40			SM		
S-36	5	34			SM		
S-36	7.5	57			SM		
S-36	10	100			GM		
S-36	12.5	100			GM	242	Capped to 100
S-36	22.5	100			SW	200	Capped to 100
S-36	17.5	100			SW	227	Capped to 100
S-36	27.5	100			SW	180	Capped to 100
S-36	32.5	100			SW	261	Capped to 100
S-36	37.5	100			SW	122	Capped to 100
S-36	42.5	100			ML	115	Capped to 100
S-36	47.5	100			ML	441	Capped to 100
S-36	53	100			ML	140	Capped to 100
S-37	5	36			SW		
S-37	10	57			SW		



Depth (ft)	A	B	C
0	84.8	107.9	61.7
80	84.8	107.9	61.7

A = Average $(N_1)_{60}$

B = Average $[(N_1)_{60}$ + (STD Dev $(N_1)_{60})]$

C = Average $[(N_1)_{60}$ - (STD Dev $(N_1)_{60})]$

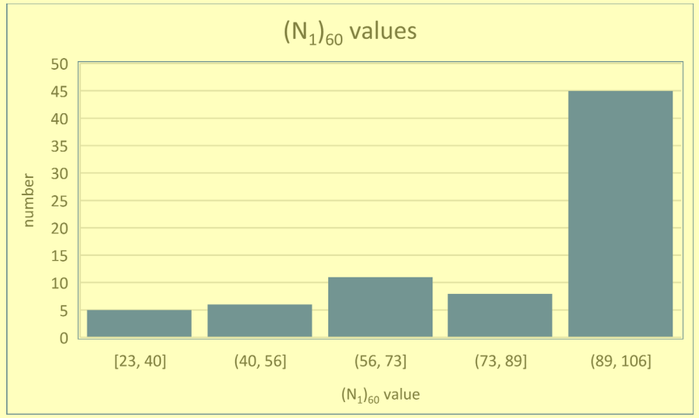
S-37	12.5	37			SW		
S-37	15	97			SW		
S-37	20	84			SW		
S-37	22.5	100			GM	113	Capped to 100
S-37	25	94			GM		
S-37	17.5	85			SW		
S-37	27.5	100			GM	110	Capped to 100
S-38	20	67			SM		
S-38	22.5	98			SM		
S-38	25	53			SM		
S-38	30	100			GM	114	Capped to 100
S-38	35	100			SM	127	Capped to 100
S-38	27.5	100			SM	170	Capped to 100
S-38	32.5	100			ML	110	Capped to 100
S-38	37.5	100			SM	122	Capped to 100
S-38	42.5	100			SM	143	Capped to 100
S-38	47.5	100			SM	135	Capped to 100
S-38	52.5	100			SM	103	Capped to 100
S-39	15	89			SM		
S-39	22.5	100			SW-SM	206	Capped to 100
S-39	17.5	80			SM		
S-39	27.5	100			SW-SM	185	Capped to 100
S-39	32.5	100			SW-SM	107	Capped to 100
S-39	37.5	100			SW-SM	166	Capped to 100
S-39	42.5	100			SW-SM	156	Capped to 100
S-39	47.5	100			SW-SM	147	Capped to 100
S-39	52.5	100			SW-SM	105	Capped to 100
S-39	57.5	100			SW-SM	133	Capped to 100
S-39	60	65			SW-SM		
	AVERAGE	**84.8**		**30.7**			
	STD DEV	**23.1**					
	GEOMEAN	**77.1**					

2	**CHECK COV IS BETWEEN 15 AND 45%**

(consider revising ESU limits if outside range)

Coefficient of Variation (V) = standard deviation/average	27%
(V_{low}) from Table 52 in GEC 5 Sabatini (2002)	15%
(V_{high}) from Table 52 in GEC 5 Sabatini (2002)	45%

3 **PLOT HISTOGRAM AND COMPARE TO GEOMEAN VALUE**

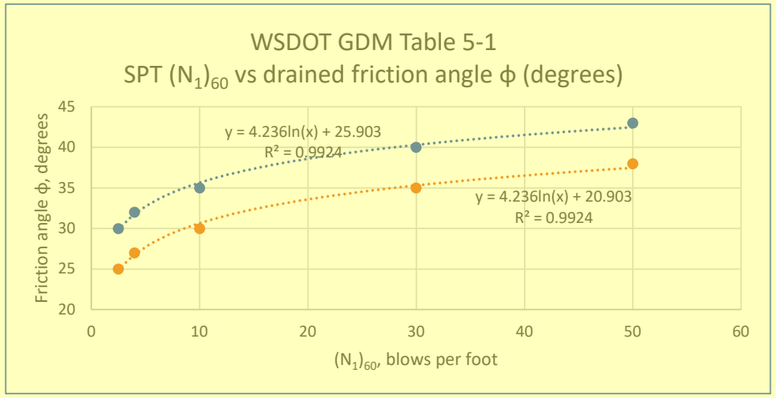


GEOMEAN	77

4 **ESTIMATE PEAK FRICTION ANGLE (deg)**

Using WSDOT correlation

$(N_1)_{60}$ (blows per foot)	Friction angle ϕ (degrees)
2.5	25
2.5	30
4	27
4	32
10	30
10	35
30	35
30	40
50	38
50	43



	$(N_1)_{60}$	ϕ (high)	ϕ (low)	ϕ (avg)
Geomean	77.1	44	39	42
Average	84.8	45	40	42
Average minus one standard deviation	61.7	43	38	41

PEAK FRICTION ANGLE (deg) **39** Selected value of low end of the range plus 1 based on average fines content of 29%; using geomean value due to non-strandard distribution of data points

5	**USCS**	SM	USE PREDOMINANT USCS CLASSIFICATION
6	**Unit Weight (pcf)**	130	USE CALTRANS, verify with CODUTO (2001) or GDM for PEAT/ ORGANICS if no measurements.

Notes:

= selected soil design properties

REFERENCES:

California Department of Transportation (Caltrans). 2014. *Geotechnical Manual.*

Coduto, D.P. 2001. *Foundation Design Principles and Practices.* 2nd Edition. Prentice-Hall, Inc., New Jersey.

Sabatini, P.J., R.C. Bachus, P.W. Mayne, T.E. Schneider, and T. E. Zettler. 2002. *Geotechnical Engineering Circular No. 5: Evaluation of Soil and Rock Properties.* FHWA-IF-02-034.

Project: **I-405 Renton to Bellevue Widening and Express Toll Lanes Project**

EMB - MP 10.84–10.99

Cross section B–B' at Station 5882+50

Elevation (feet)		Depth (feet)		Layer Depth (feet)	ESU	USCS	$(N_1)_{60}$	Ymoist (pcf)	Effective Peak ϕ' (deg)	Apparent c' (psf)	Su (psf)
from	to	from	to								
See Cross section					ESU 1B	SM	47	130	38	100	-
					ESU 4C	SM	85	130	39	-	-

Groundwater Elevation: Dry

EMB - MP 10.84–10.99

Cross section A–A' at Station 5882+00

Elevation (feet)		Depth (feet)		Layer Depth (feet)	ESU	USCS	$(N_1)_{60}$	Ymoist (pcf)	Effective Peak ϕ' (deg)	Apparent c' (psf)	Su (psf)
from	to	from	to								
See Cross section					ESU 1B	SM	47	130	38	100	-
					ESU 4C	SM	85	130	39	-	-

Groundwater Elevation: Dry

In Association with

Appendix E
Calculation Packages

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

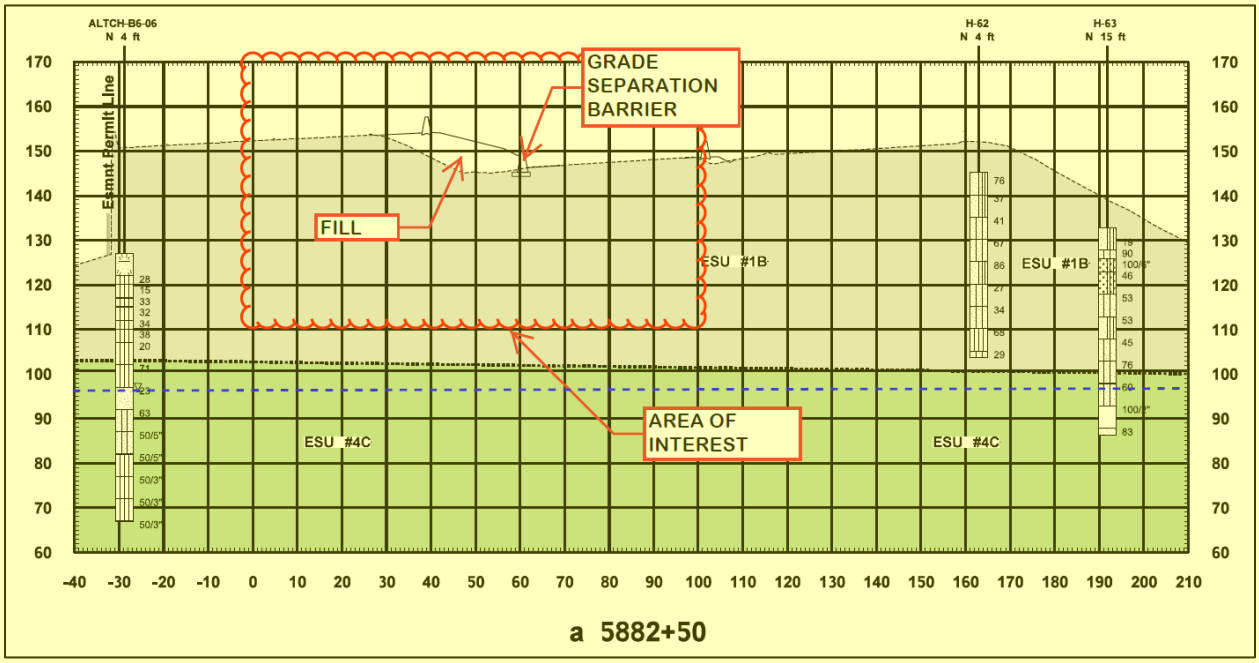
DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

1.0 GEOMETRY AND SOIL CONDITIONS

- Grade behind southbound barrier is 4 feet higher than grade in front of barrier. Behind barrier is 4:1 slope (for cross section A–A only – for all other sections there is a 2H:1V slope and short bench). In front of barrier is roadway with ~ 1% slope (assume 0). Sides of all barriers are sloped at 4H:21V (10.8 degrees).
- Cross section A–A' at Station 5882+00 for Grade Separation Barrier and embankment slope stability analysis



wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

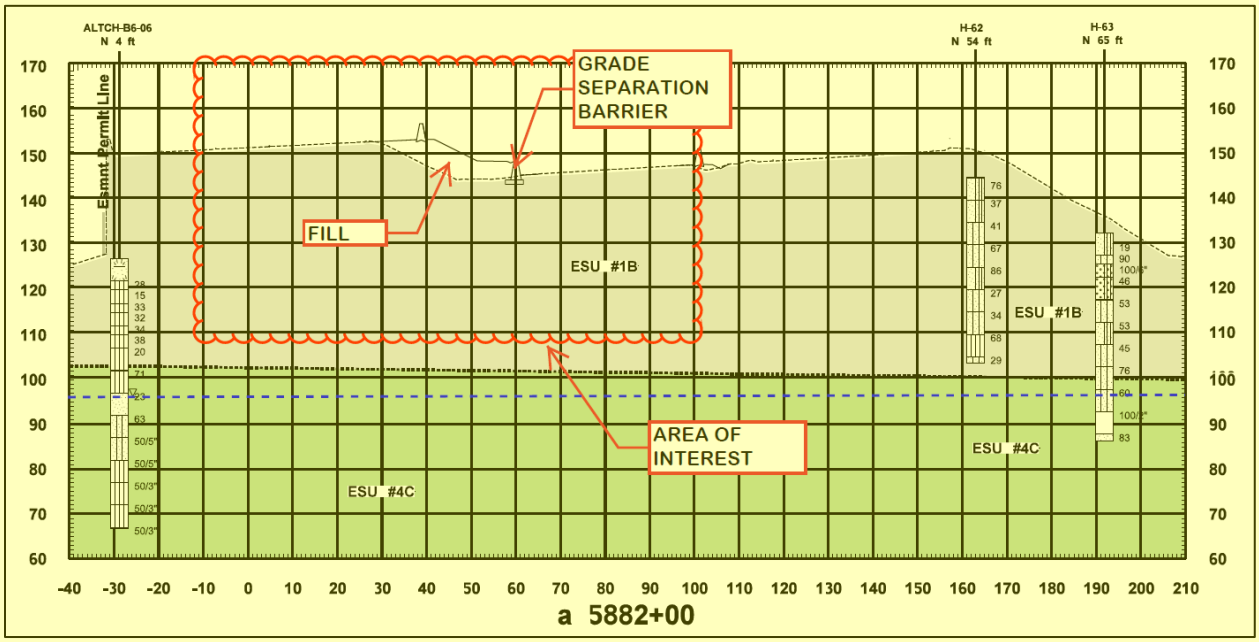
PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

- Cross section B–B' at Station 5882+50 for Grade Separation Barrier and embankment settlement analysis



- Design Parameter Table

Project:											
I-405 Renton to Bellevue Widening and Express Toll Lanes Project											
EMB - MP 10.84–10.99											
Cross section B–B' at Station 5882+50											
Elevation (feet)		Depth (feet)		Layer Depth (feet)	ESU	USCS	$(N_1)_{60}$	Ymoist (pcf)	Effective Peak ϕ' (deg)	Apparent c' (psf)	Su (psf)
from	to	from	to								
See Cross section					ESU 1B	SM	47	130	38	100	-
					ESU 4C	SM	85	130	39	-	-
Groundwater Elevation: Dry											
EMB - MP 10.84–10.99											
Cross section A–A' at Station 5882+00											
Elevation (feet)		Depth (feet)		Layer Depth (feet)	ESU	USCS	$(N_1)_{60}$	Ymoist (pcf)	Effective Peak ϕ' (deg)	Apparent c' (psf)	Su (psf)
from	to	from	to								
See Cross section					ESU 1B	SM	47	130	38	100	-
					ESU 4C	SM	85	130	39	-	-
Groundwater Elevation: Dry											

- Groundwater Elevation at Barrier assumed to be dry based on WL measured in borings (below El. 95 feet)

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

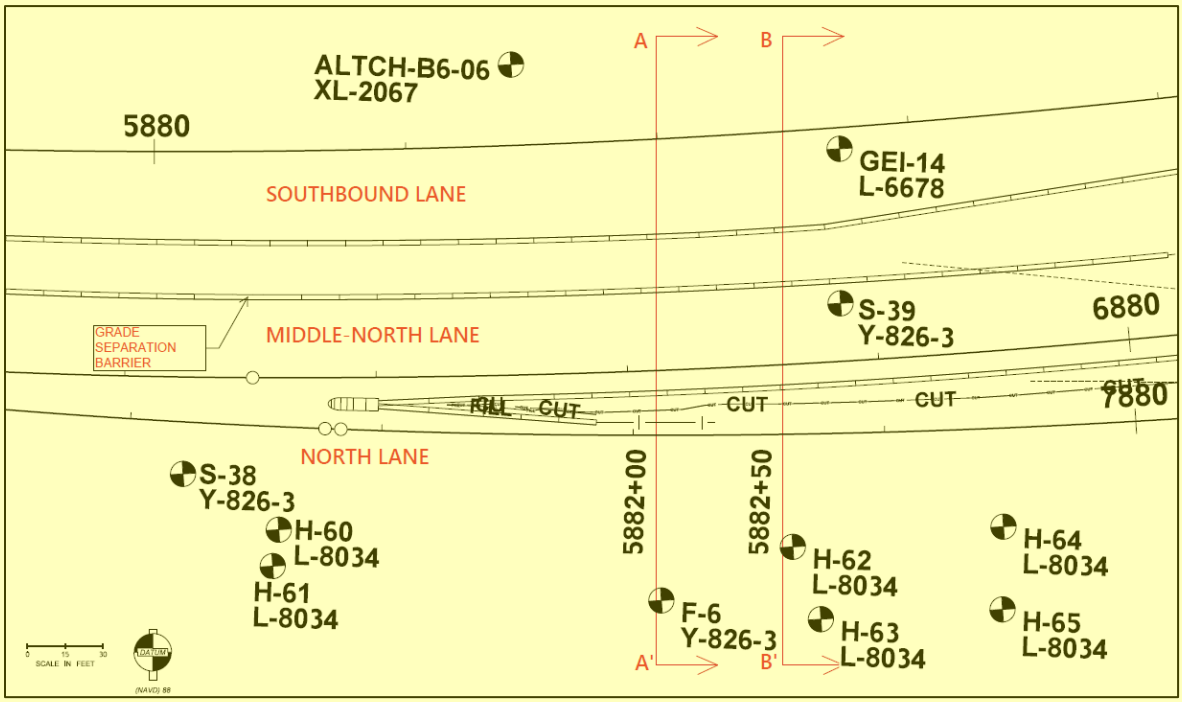
PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

- Plan/Profile – 2 of 2



2.0 BEARING RESISTANCE

The grade separation barrier will be founded either directly on the ESU 1B or on a few feet of Common Fill over these soils. The bearing resistance values below are based on the barrier being founded directly on the ESU 1B material. We have assumed that the bottom of the barrier will be 1 foot below the adjacent grade on the northbound side and 3.5 feet below the adjacent grade on the southbound side. The special barriers will consist of a 4.5' high cast-in-place concrete barrier.

Soil parameters for soil bearing are as follows:

Bearing Material	Common Fill (or better)
Friction Angle ϕf:	38 degrees
Footing Embedment Depth D_{f1} (min):	1 foot
Footing Embedment Depth D_{f2} (max):	5 feet
Footing Width B:	2 to 7 feet
Depth to GWL below Ground Surface Dw:	>10 feet
Soil Unit Weight (above footing level), γ:	130 pcf
Cohesion, c	0 psf

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

2.1 Nominal Bearing Resistance

Per the *LRFD Bridge Design Specifications* (AASHTO 2017), nominal bearing resistance (neglecting shape factors) is:

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma}$$

in which:

$$N_{cm} = N_c \cancel{s_c i_c}$$

$$N_{qm} = N_q \cancel{s_q d_q i_q}$$

$$N_\gamma m = N_\gamma \cancel{s_\gamma i_\gamma}$$

Correction factors (from AASHTO 2017 Table 10.6.3.1.2a-1 and 10.6.3.1.2a-2):

Factor	Value
N_c	61.4
N_q	48.9
N_γ	78.0
C_{wq}*	1.0
$C_{w\gamma}$*	1.0

* groundwater depth assumed to be greater than 1.5B + Df

Using the above, the nominal bearing resistance for various width of base, B, and D_f is:

q =	$C*N_c$	+	$\gamma * D_f * N_q * C_{wq}$	+	$0.5*\gamma *$	B	$*N_\gamma*C_{w\gamma}$	=	Nominal Bearing Resistance (psf)
D_f = 1 foot									
	0	+	130*1*48.9*1.0	+	0.5*130*	2	*78.0*1.0	=	16,497
	0	+	130*1*48.9*1.0	+	0.5*130*	3	*78.0*1.0	=	21,567
	0	+	130*1*48.9*1.0	+	0.5*130*	4	*78.0*1.0	=	26,637
	0	+	130*1*48.9*1.0	+	0.5*130*	5	*78.0*1.0	=	31,707
	0	+	130*1*48.9*1.0	+	0.5*130*	6	*78.0*1.0	=	36,777
	0	+	130*1*48.9*1.0	+	0.5*130*	7	*78.0*1.0	=	41,847
D_f = 3.5 feet									
	0	+	130*5*48.9*1.0	+	0.5*130*	2	*78.0*1.0	=	41,925
	0	+	130*5*48.9*1.0	+	0.5*130*	3	*78.0*1.0	=	46,995
	0	+	130*5*48.9*1.0	+	0.5*130*	4	*78.0*1.0	=	52,065
	0	+	130*5*48.9*1.0	+	0.5*130*	5	*78.0*1.0	=	57,135
	0	+	130*5*48.9*1.0	+	0.5*130*	6	*78.0*1.0	=	62,205
	0	+	130*5*48.9*1.0	+	0.5*130*	7	*78.0*1.0	=	67,275

2.2 SERVICE BEARING RESISTANCE FOR 1 INCH OF SETTLEMENT PER MODIFIED HOUGH METHOD

See summaries for cross section A–A' (SB Sta. 5882+50) from spreadsheet. Note that cross section A–A has been used because this section has the highest fill thickness and height difference from upper lane to lower lane.

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

For B = 7':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

wood.

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Shallow Wall Footing	
	Bottom of Footing/Embankment Subrade Elevation	144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	2900	psf
	Width of Footing	7	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		2900	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1691.7	0.68	0.68
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	922.7	0.21	0.90
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	634.4	0.10	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches
2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/20/2021
Reviewed by: JSD Date: 12/21/2021

For B = 6':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

wood.

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Shallow Wall Footing	
	Bottom of Footing/Embankment Subrade Elevation	144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	3150	psf
	Width of Footing	6	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		3150	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1718.2	0.69	0.69
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	900.0	0.21	0.90
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	609.7	0.10	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches
2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/20/2021
Reviewed by: JSD Date: 12/21/2021

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

For B = 5':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction		Type = Shallow Wall Footing	
Bottom of Footing/Embankment Subrade Elevation		144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	3550	psf
	Width of Footing	5	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		3550	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1775.0	0.70	0.70
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	887.5	0.21	0.91
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	591.7	0.09	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:

1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches

2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/15/2021

Reviewed by: JSD Date: 12/21/2021

For B = 4':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction		Type = Shallow Wall Footing	
Bottom of Footing/Embankment Subrade Elevation		144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	4050	psf
	Width of Footing	4	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		4050	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1800.0	0.71	0.71
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	852.6	0.20	0.91
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	558.6	0.09	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8				-									

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:

1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches

2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/15/2021

Reviewed by: JSD Date: 12/21/2021

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

For B = 3':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Shallow Wall Footing	
Bottom of Footing/Embankment Subrade Elevation		144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	4950	psf
	Width of Footing	3	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		4950	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1856.3	0.72	0.72
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	825.0	0.19	0.92
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	530.4	0.08	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches

2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/15/2021

Reviewed by: JSD Date: 12/21/2021

For B = 2':

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A')

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	144.7	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	84	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Shallow Wall Footing	
Bottom of Footing/Embankment Subrade Elevation		144	feet
Foundation	Net Bearing Pressure on Bottom of Footing	6700	psf
	Width of Footing	2	ft
Embankment	Proposed Finished Grade Elevation		Not Applicable
	Distributed Embankment Pressure (Dp)	-17364	Not Applicable
		6700	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	144	10	130	130	1384	734	38	91	1914.3	0.73	0.73
2	ESU # 1B	SM	134	10	130	130	2684	2034	38	91	788.2	0.19	0.92
3	ESU # 1B	SM	124	10	130	130	3984	3334	38	91	496.3	0.08	1.00
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 1.0 inches

2/3 Correction = = 0.7 inches

Prepared by: LDN Date: 12/15/2021

Reviewed by: JSD Date: 12/21/2021

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

Recommendations:

Width of Foundation (feet)	Service Bearing Resistance for 1 inch of Settlement (psf)	Unfactored Bearing Resistance (psf)	
		1 foot	5 feet
2	**6,700**	**16,500**	**41,900**
3	**4,950**	**21,550**	**47,000**
4	**4,050**	**26,650**	**52,050**
5	**3,550**	**31,700**	**57,150**
6	**3,150**	**36,800**	**62,200**
7	**2,900**	**41,850**	**67,250**

3.0 SETTLEMENT OF THE EMBANKMENT

Using modified Hough method (as soils are non-cohesive), calculate settlement at cross section B–B', where the height of fill is the greatest.

Existing ground elevation = 145.1 ft
Proposed finish grade elevation = 152.7 ft
Elevation difference = 7.6 ft

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A') - at location of maximum fill

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	145.1	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	0.00012	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Embankment Fill	
Bottom of Footing/Embankment Subrade Elevation		145.1	feet
Foundation	Net Bearing Pressure on Bottom of Footing		Not Applicable
	Width of Footing		Not Applicable
Embankment	Proposed Finished Grade Elevation	152.7	ft
	Distributed Embankment Pressure (Dp)	912	psf
		912	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	145.1	9.999999	130	130	1300	650	38	91	912.0	0.50	0.50
2	ESU # 1B	SM	135.1	10	130	130	2600	1950	38	91	912.0	0.22	0.72
3	ESU # 1B	SM	125.1	10	130	130	3900	3250	38	91	912.0	0.14	0.86
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 0.9 inches
2/3 Correction = = 0.6 inches

Prepared by: LDN Date: 12/20/2021
Reviewed by: JSD Date: 12/21/2021

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

Estimate settlement at the edge of the southbound lane (cross section B–B')

Existing ground elevation = 147.5 ft
Proposed finish grade elevation = 154.1 ft
Elevation difference = 6.6 ft

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99

Notes: SB Station 5882+50 (Cross Section A-A') - at edge of SB lane

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	147.5	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	1.2E-06	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction		Type = Embankment Fill	
Bottom of Footing/Embankment Subrade Elevation		147.5	feet
Foundation	Net Bearing Pressure on Bottom of Footing		Not Applicable
	Width of Footing		Not Applicable
Embankment	Proposed Finished Grade Elevation	154.1	ft
	Distributed Embankment Pressure (Dp)	792	psf
		792	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	147.5	10	130	130	1300	650	38	91	792.0	0.46	0.46
2	ESU # 1B	SM	137.5	10	130	130	2600	1950	38	91	792.0	0.20	0.65
3	ESU # 1B	SM	127.5	10	130	130	3900	3250	38	91	792.0	0.12	0.78
4				-		-	-	-		-	-	-	-
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 0.8 inches
2/3 Correction = = 0.5 inches

Prepared by: LDN Date: 12/20/2021
Reviewed by: JSD Date: 12/21/2021

wood.

JOB NO. PS19203160

COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

DATE December 15, 2021

SUBJECT Geotechnical Parameters

CHECKED BY J Dransfield DATE 01/05/2021

Estimate settlement over Utilities between SB STA 5878 & 5879 (using cross section B–B' ESU)

Existing ground elevation = 140.8 ft
Proposed finish grade elevation = 145.4 ft
Elevation difference = 4.6 ft

Settlement Calculation for Shallow Footing or Embankment (Modified Hough Method)

Project/Task Name: I405: Renton to Bellevue Widening and Express Toll Lanes Project / I-405 SB MP 10.84 to 10.99
Notes: SB Station 5882+50 (Cross Section A-A') - utilities between SB STA. 5878 and 5879

wood.

Existing Subsurface Condition		
Existing Ground Surface Elevation	140.8	feet
Groundwater Elevation	100	feet
Total Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf
Existing Surchage pressure above BOF EL.	0.00012	psf
Weighted Effective Unit Weight of Soil from Ex. GSE to BOF EL.)	120	pcf

Proposed Construction	Type =	Embankment Fill	
	Bottom of Footing/Embankment Subrade Elevation	140.8	feet
Foundation	Net Bearing Pressure on Bottom of Footing		Not Applicable
	Width of Footing		Not Applicable
Embankment	Proposed Finished Grade Elevation	145.4	ft
	Distributed Embankment Pressure (Dp)	552	psf
		552	psf

Accept Inputs in yellow-marked Cells ONLY

Layer No.	Material	Code**	Layer Top Elevation	Layer Thickness H (feet)	Saturated Unit Weight γ (pcf)	Effective Unit Weight γ' (pcf)	Existing effective overburden Pressure Bot. of Layer psf)	Existing effective overburden Pressure Mid. of Layer Po (psf)	$N1_{60}$	Bearing Capacity Index C'	Distributed Additional Pressure Δp (Notes 1&2) (psf)	Settlement of Subdivided Layer ΔH (in.)	Cumulative Settlement ΣΔH (in.)
1	ESU # 1B	SM	140.8	5.799999	130	130	754	377	38	91	552.0	0.30	0.30
2	ESU # 1B	SM	135	5	130	130	1404	1079	38	91	552.0	0.12	0.42
3	ESU # 1B	SM	130	10	130	130	2704	2054	38	91	552.0	0.14	0.55
4	ESU # 1B	SM	120	10	130	130	4004	3354	38	91	552.0	0.09	0.64
5				-		-	-	-		-	-	-	-
6				-		-	-	-		-	-	-	-
7				-		-	-	-		-	-	-	-
8													

Code**	Model
ML	INORGANIC SILT
SM	f/m silty SAND
SW	Well graded fine to coarse SAND
GM	Well graded silty SAND & Gravel
SP	Clean uniform medium SAND

Notes:
1. For Shallow Footings, a 1H:2V stress increase ditribution is considerted; one-way for wall footing and 2-way for square footing.
2. For Embankment Fill, assume no reduction of the aerial surcharge load vs.depths.

Estimated Settlement = 0.6 inches
2/3 Correction = = 0.4 inches

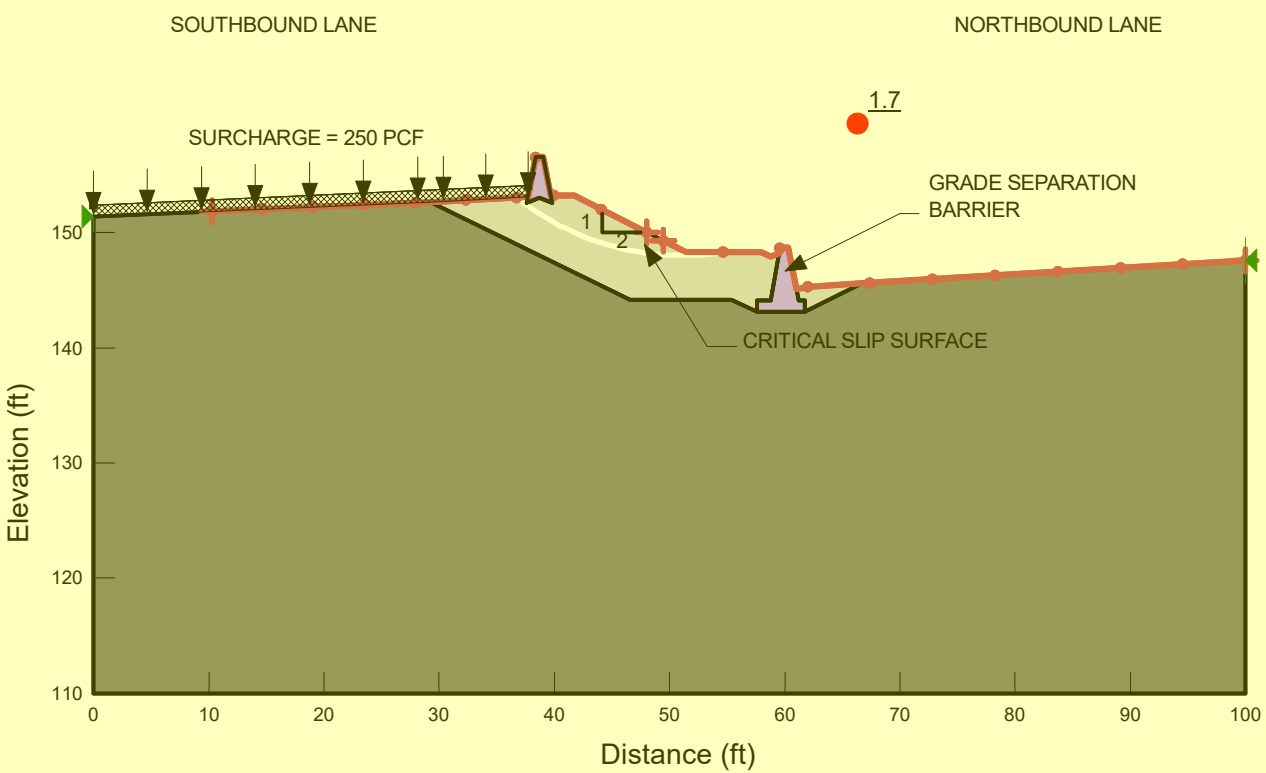
Prepared by: LDN Date: 12/20/2021
Reviewed by: JSD Date: 12/21/2021

4.0 GLOBAL STABILITY

- Evaluate the static stability of cross section A–A' (SB Sta. 5882+00) and cross section B–B' (SB Sta. 5882+50)
- The Slope/W software by GeoStudio 2016 (commerically available programs) was used. The overall stability of the special barrier slope was estimated using both Bishop and Morgenstern-Price (M-P) methods, which satisfy both force and moment equilibriums.
- A minimum factor of safety of 1.3 is required for the stability under Strength (static) conditions and 1.1 for Seismic (pseudo-static) conditions.
    - As discussed in Wood 2021a, for walls not greater than 4 feet in height, slope stability evaluation under seismic conditions is not required.
- A surcharge load in the southbound driving lane of 250 psf was used (AASHTO 3.6.1.6). It is understood that a surcharge of 250 psf should be used for design of the median where service traffic may travel, however, this results in a higher factor of safety for the embankment, and as such was neglected to be conservative.
- Groundwater level was assumed to be dry as below elevation 95 ft.
- Backfill adjacent to the special barrier was assumed to be Common Fill.
- The input and output files for the Slope/ W analyses are presented in Appendix E. A tabular summary of the stability results for the different conditions is presented below:

Section	Station	Limit State FS	Static FS	
			(M&P)	(Spencer)
A–A'	5882+00	1.3 (Static)	1.7	1.7
B–B'	5882+50		2.5	2.5

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Common Borrow	Mohr-Coulomb	120	0	32
	ESU 1B	Mohr-Coulomb	130	100	38
	Special Barrier	High Strength	130		



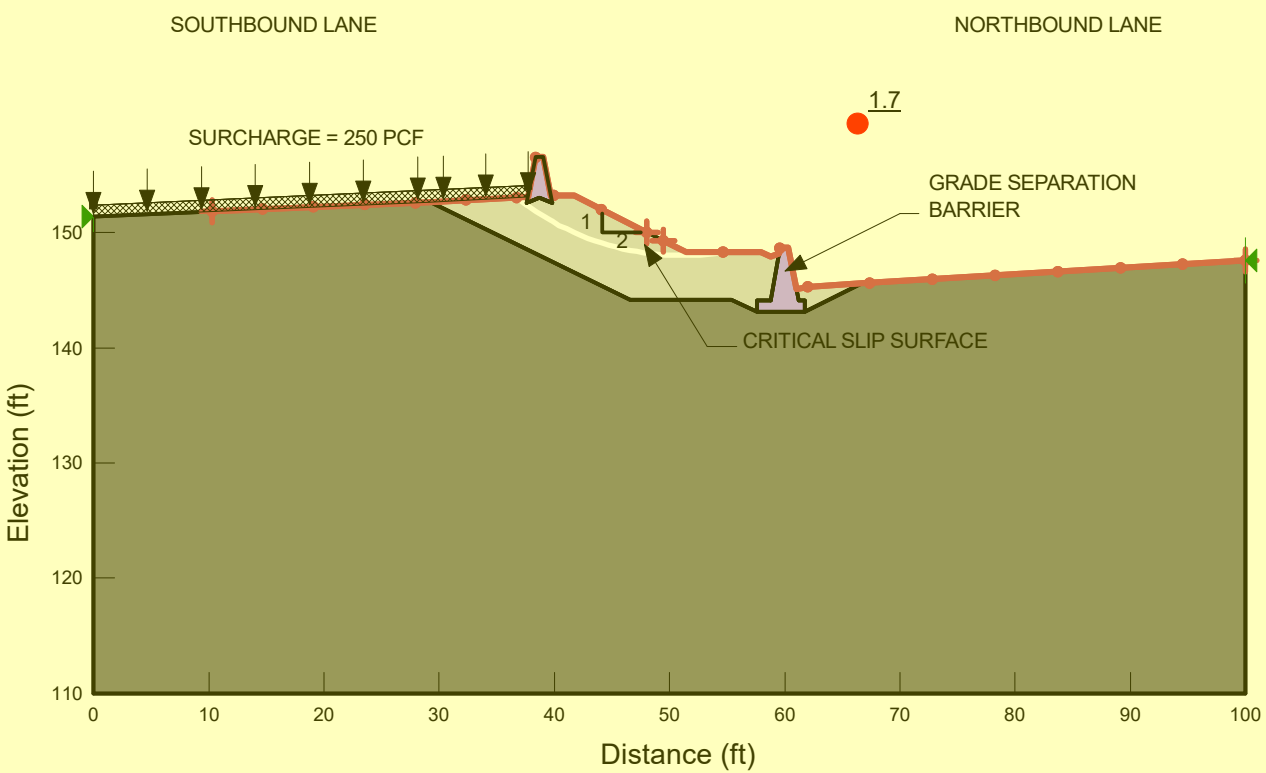
SURCHARGE (UNIT WEIGHT): 250 PCF
GROUNDWATER LEVEL: DRY

SLOPE/W Slope Stability (M-P)

EMB MP 10.84-10.99 Cross Section A-A' (SB Sta. 5882+00)

1/7/2022 1:200

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Common Borrow	Mohr-Coulomb	120	0	32
	ESU 1B	Mohr-Coulomb	130	100	38
	Special Barrier	High Strength	130		



SURCHARGE (UNIT WEIGHT): 250 PCF
GROUNDWATER LEVEL: DRY

SLOPE/W Slope Stability (Spencer)

EMB MP 10.84-10.99 Cross Section A-A' (SB Sta. 5882+00)

1/7/2022 1:200

Slope Stability (Spencer)

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File Information

File Version: 8.16
Title: EMB MP 10.84-10.99 Cross Section A-A' (SB Sta. 5882+00)
Created By: Nehring, Lisa
Last Edited By: Nehring, Lisa
Revision Number: 463
Date: 1/7/2022
Time: 4:09:35 PM
Tool Version: 8.16.5.15361
File Name: EMB 10.84 to 10.99 Cross Section 5882+00_RevA.gsz
Directory: C:\Users\lisa.nehring\OneDrive - Wood PLC\Documents\Projects\I405\SB MP 10.81 to 10.99\IRCR_RA\
Last Solved Date: 1/7/2022
Last Solved Time: 4:09:40 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Slope Stability (Spencer)

Kind: SLOPE/W
Method: Spencer
Settings
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: No
    Tension Crack
        Tension Crack Option: (none)
F of S Distribution
    F of S Calculation Option: Constant
Advanced
    Number of Slices: 30

F of S Tolerance: 0.001
Minimum Slip Surface Depth: 3 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Common Borrow

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °

ESU 1B

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 100 psf
Phi': 38 °
Phi-B: 0 °

Special Barrier

Model: High Strength
Unit Weight: 130 pcf

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (10.27166, 151.8413) ft
Left-Zone Right Coordinate: (48.00003, 150.0175) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (49.44794, 149.2861) ft
Right-Zone Right Coordinate: (100, 147.6) ft
Right-Zone Increment: 10
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 151.4) ft
Right Coordinate: (100, 147.6) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 250 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	0	152.4
	37.7	154.1

Points

	X (ft)	Y (ft)
Point 1	0	151.4
Point 2	41.7	153.2
Point 3	51.4	148.3
Point 4	57.9	148.3
Point 5	100	147.6
Point 6	100	110
Point 7	0	110
Point 8	55.4	144.2
Point 9	46.6	144.2
Point 10	29.24012	152.6561
Point 11	58.8	147.9
Point 12	39.68	153.2
Point 13	37.7	153.1
Point 14	38.4	156.6
Point 15	39	156.6
Point 16	37.6	152.6
Point 17	38.7	153
Point 18	39.8	152.6
Point 19	62.1	145.3
Point 20	100	120
Point 21	0	120
Point 22	57.6	143.1
Point 23	57.6	144.1
Point 24	61.7	143.1
Point 25	61.7	144.1
Point 26	58.8	144.1
Point 27	61.2	144.1
Point 28	59.6	148.7
Point 29	60.3	148.7
Point 30	59.51	148.2
Point 31	60.985	145.1
Point 32	0	152.4
Point 33	66.7	145.6

Regions

	Material	Points	Area (ft^2)
Region 1	Common Borrow	26,30,11,4,3,2,12,18,17,16,13,10,9,8,22,23	131.58
Region 2	Special Barrier	15,14,13,16,17,18,12	5.16
Region 3	ESU 1B	9,10,1,21,7,6,20,5,33,24,22,8	3,797.2

Region 4	Special Barrier	26,23,22,24,25,27,31,29,28,30	11.192
Region 5	Common Borrow	19,31,27,25,24,33	6.079

Current Slip Surface

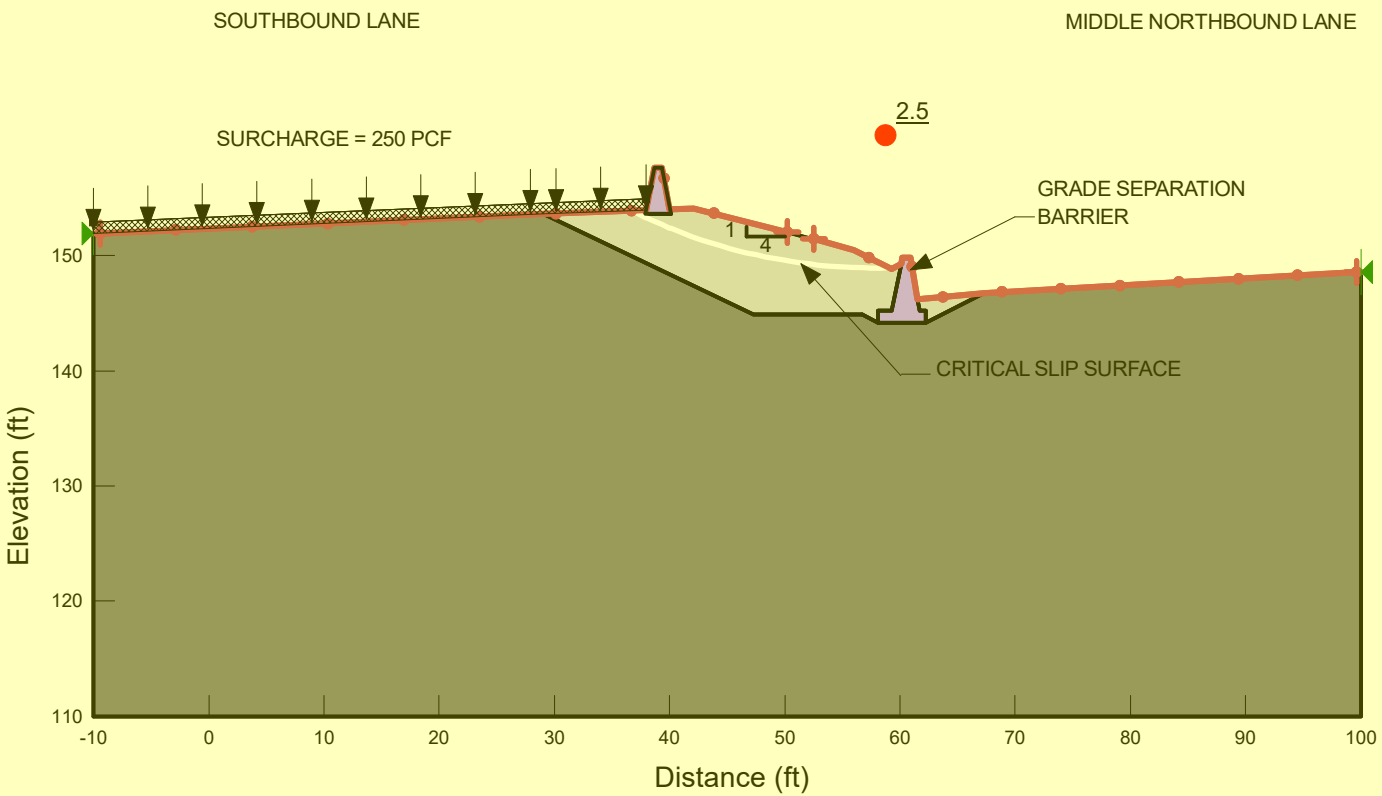
Slip Surface: 606
F of S: 1.7
Volume: 34.124219 ft³
Weight: 4,146.5062 lbs
Resisting Moment: 59,703.567 lbs-ft
Activating Moment: 35,844.976 lbs-ft
Resisting Force: 2,402.3157 lbs
Activating Force: 1,442.3631 lbs
F of S Rank (Analysis): 1 of 1,089 slip surfaces
F of S Rank (Query): 1 of 1,089 slip surfaces
Exit: (54.654794, 148.3) ft
Entry: (36.747252, 153.05001) ft
Radius: 22.872418 ft
Center: (51.062714, 170.88859) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	37.173626	152.72399	0	205.79529	128.59517	0
Slice 2	37.65	152.36178	0	244.5102	152.78693	0
Slice 3	38.05	152.08339	0	257.51857	160.91546	0
Slice 4	38.55	151.74316	0	461.37021	288.2961	0
Slice 5	38.85	151.5504	0	484.3507	302.65591	0
Slice 6	39.34	151.25269	0	352.66785	220.37133	0
Slice 7	39.74	151.01552	0	206.67953	129.1477	0
Slice 8	40.116667	150.80871	0	227.02997	141.86407	0
Slice 9	40.75	150.47611	0	264.66308	165.37985	0
Slice 10	41.383333	150.16819	0	301.31356	188.28161	0
Slice 11	42.003125	149.88949	0	320.6705	200.37717	0
Slice 12	42.609375	149.63813	0	321.73562	201.04273	0
Slice 13	43.215625	149.40682	0	320.49236	200.26585	0
Slice 14	43.821875	149.19491	0	316.89375	198.01719	0
Slice 15	44.428125	149.00185	0	310.88547	194.2628	0
Slice 16	45.034375	148.82713	0	302.40515	188.96371	0
Slice 17	45.640625	148.67033	0	291.38159	182.07542	0
Slice 18	46.246875	148.53106	0	277.73383	173.54736	0
Slice 19	46.853125	148.40901	0	261.37011	163.32217	0

Slice 20	47.459375	148.30388	0	242.18665	151.33501	0
Slice 21	48.065625	148.21545	0	220.06621	137.51263	0
Slice 22	48.671875	148.14352	0	194.87646	121.77233	0
Slice 23	49.278125	148.08793	0	166.46805	104.02078	0
Slice 24	49.884375	148.04856	0	134.67232	84.152603	0
Slice 25	50.490625	148.02534	0	99.298617	62.048662	0
Slice 26	51.096875	148.01821	0	60.131151	37.574113	0
Slice 27	51.725479	148.0281	0	38.47071	24.039168	0
Slice 28	52.376438	148.05626	0	35.340638	22.083282	0
Slice 29	53.027397	148.10305	0	29.283556	18.298397	0
Slice 30	53.678356	148.16859	0	20.052286	12.530059	0
Slice 31	54.329315	148.25303	0	7.3617583	4.6001371	0

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Common Borrow	Mohr-Coulomb	125	0	32
	ESU 1B	Mohr-Coulomb	130	100	38
	Special Barrier	High Strength	130		



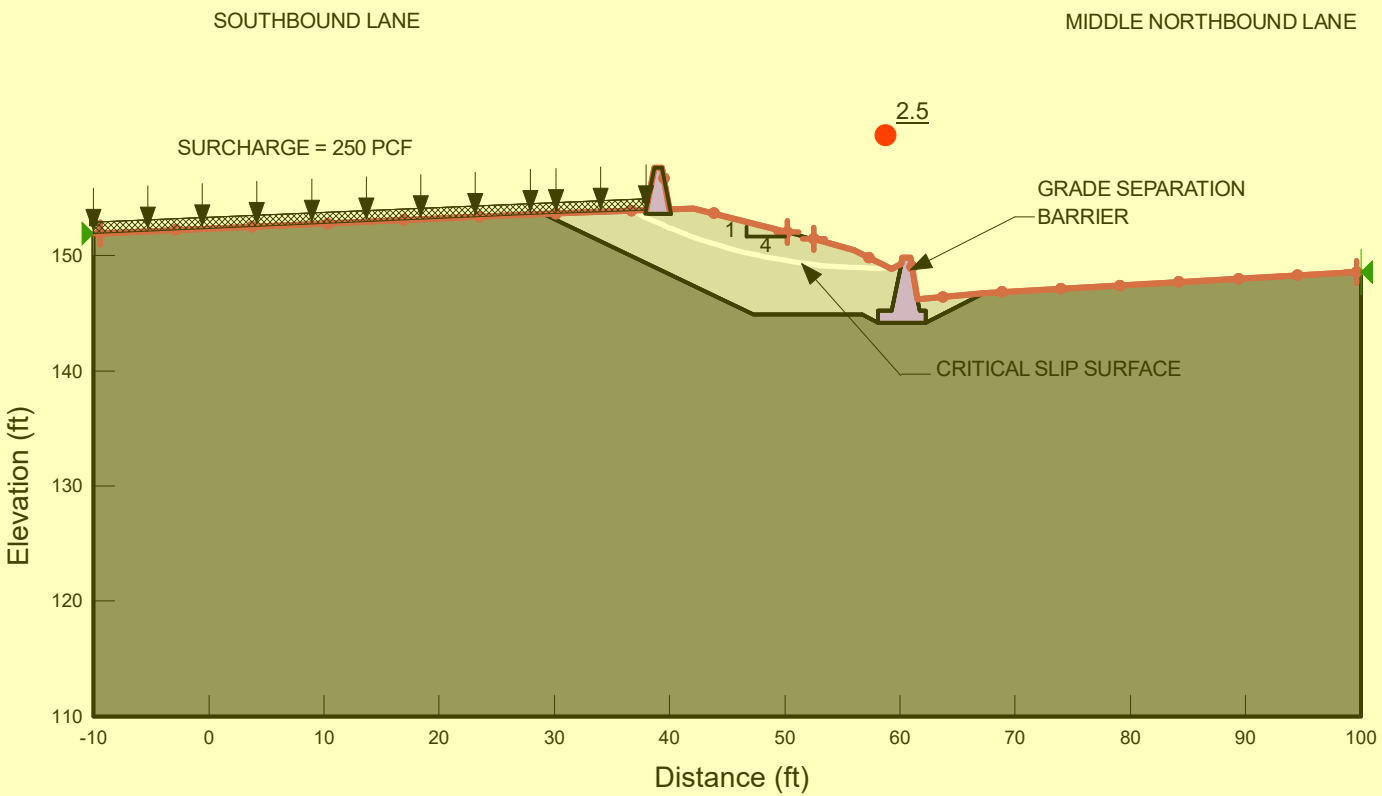
SURCHARGE (UNIT WEIGHT): 250 PCF
GROUNDWATER LEVEL: DRY

SLOPE/W Slope Stability (M-P)

EMB MP 10.82-10.99 Cross Section B-B' (STA 5882+50)

12/13/2021 1:200

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Common Borrow	Mohr-Coulomb	125	0	32
	ESU 1B	Mohr-Coulomb	130	100	38
	Special Barrier	High Strength	130		



SURCHARGE (UNIT WEIGHT): 250 PCF
GROUNDWATER LEVEL: DRY

SLOPE/W Slope Stability (Spencer)

EMB MP 10.82-10.99 Cross Section B-B' (STA 5882+50)

12/13/2021 1:200

Slope Stability (Spencer)

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File Information

File Version: 8.16
Title: EMB MP 10.82-10.99 Cross Section B-B' (STA 5882+50)
Created By: Nehring, Lisa
Last Edited By: Nehring, Lisa
Revision Number: 462
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Time: 12:26:33 PM
Tool Version: 8.16.5.15361
File Name: EMB 10.84 to 10.99 Cross Section 5882+50_RevA.gsz
Directory: C:\Users\lisa.nehring\OneDrive - Wood PLC\Documents\Projects\I405\SB MP 10.81 to 10.99\IRCR_RA\
Last Solved Date: 12/13/2021
Last Solved Time: 12:26:36 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Slope Stability (Spencer)

Kind: SLOPE/W
Method: Spencer
Settings
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: No
    Tension Crack
        Tension Crack Option: (none)
F of S Distribution
    F of S Calculation Option: Constant
Advanced
    Number of Slices: 30

F of S Tolerance: 0.001
Minimum Slip Surface Depth: 3 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Common Borrow

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °

ESU 1B

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 100 psf
Phi': 38 °
Phi-B: 0 °

Special Barrier

Model: High Strength
Unit Weight: 130 pcf

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-9.4384, 151.9245) ft
Left-Zone Right Coordinate: (50.23665, 152.032) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (52.4949, 151.4317) ft
Right-Zone Right Coordinate: (99.61659, 148.5783) ft
Right-Zone Increment: 10
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (-10, 151.9) ft
Right Coordinate: (100, 148.6) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 250 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-10	152.9
	37.97	154.93

Points

	X (ft)	Y (ft)
Point 1	42.1	154.1
Point 2	60.2	149.8
Point 3	60.9	149.8
Point 4	100	148.6
Point 5	100	110
Point 6	-20	110
Point 7	-10	110
Point 8	-10	151.9
Point 9	47.3	144.9
Point 10	40.09	153.6
Point 11	39.35	157.6
Point 12	38.65	157.6
Point 13	37.91	153.6
Point 14	37.97	153.93
Point 15	40.01307	154.0159
Point 16	29	153.6
Point 17	49.8789	152.1271
Point 18	58.1	144.2
Point 19	62.2	144.2
Point 20	58.1	145.2
Point 21	62.2	145.2
Point 22	59.3	145.2
Point 23	61.7	145.2
Point 24	56	150.5
Point 25	60.1	149.3
Point 26	67.3	146.75
Point 27	61.5	146.2
Point 28	56.7	144.9
Point 29	59.3	148.8

Regions

	Material	Points	Area (ft^2)
Region 1	Special Barrier	3,2,25,22,20,18,19,21,23,27	11.175
Region 2	Special Barrier	11,12,14,13,10,15	5.7621
Region 3	ESU 1B	18,28,9,16,8,7,5,4,26,19	4,315.1
Region 4	Common Borrow	27,23,21,19,26	5.8925
Region 5	Common Borrow	28,18,20,22,25,29,24,17,1,15,10,13,14,16,9	157.17

Current Slip Surface

Slip Surface: 713
F of S: 2.5
Volume: 47.660096 ft³
Weight: 5,986.3226 lbs
Resisting Moment: 182,040.61 lbs-ft
Activating Moment: 72,586.748 lbs-ft
Resisting Force: 3,704.075 lbs
Activating Force: 1,476.7375 lbs
F of S Rank (Analysis): 1 of 1,089 slip surfaces
F of S Rank (Query): 1 of 1,089 slip surfaces
Exit: (59.024949, 148.94169) ft
Entry: (36.728508, 153.88433) ft
Radius: 47.303756 ft
Center: (57.81165, 196.22989) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	37.023881	153.73982	0	227.02576	141.86144	0
Slice 2	37.614627	153.45584	0	261.94768	163.68308	0
Slice 3	37.94	153.30249	0	281.76207	176.06448	0
Slice 4	38.31	153.13474	0	292.05764	182.49787	0
Slice 5	39	152.82918	0	534.39768	333.92873	0
Slice 6	39.681535	152.53989	0	366.6682	229.11972	0
Slice 7	40.051535	152.38674	0	179.82644	112.36803	0
Slice 8	40.425	152.23875	0	197.64763	123.50395	0
Slice 9	41.095	151.97979	0	230.91621	144.29246	0
Slice 10	41.765	151.73243	0	263.36781	164.57047	0
Slice 11	42.488945	151.47845	0	284.556	177.81032	0
Slice 12	43.266835	151.21959	0	294.03065	183.73074	0
Slice 13	44.044725	150.97558	0	301.92302	188.66244	0
Slice 14	44.822615	150.74619	0	308.21961	192.59699	0
Slice 15	45.600505	150.53119	0	312.90568	195.52517	0
Slice 16	46.378395	150.33037	0	315.9651	197.43691	0
Slice 17	47.156285	150.14356	0	317.38035	198.32125	0
Slice 18	47.934175	149.97059	0	317.13236	198.16629	0
Slice 19	48.712065	149.81129	0	315.20051	196.95914	0
Slice 20	49.489955	149.66554	0	311.56246	194.68583	0
Slice 21	50.261469	149.53417	0	305.67934	191.00965	0

Slice 22	51.026606	149.41686	0	297.54089	185.92418	0
Slice 23	51.791744	149.31233	0	287.65778	179.74853	0
Slice 24	52.556881	149.22048	0	276.00109	172.46462	0
Slice 25	53.322019	149.14124	0	262.53972	164.05302	0
Slice 26	54.087156	149.07455	0	247.24026	154.49286	0
Slice 27	54.852294	149.02035	0	230.06685	143.76172	0
Slice 28	55.617431	148.9786	0	210.98098	131.83555	0
Slice 29	56.378119	148.94937	0	177.71672	111.04973	0
Slice 30	57.134356	148.93249	0	129.94488	81.198574	0
Slice 31	57.890593	148.92771	0	79.753168	49.835311	0
Slice 32	58.64683	148.93502	0	27.081557	16.922435	0

wood.

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COMPUTED BY Lisa Nehring

PROJECT I-405 – Grade Separation Barrier MP 10.84 to 10.99

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SUBJECT Geotechnical Parameters

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5.0 LATERAL EARTH PRESSURE PARAMETERS

5.1 Active Earth Pressure Coefficients

Active earth pressure coefficients from AASHTO 3.11.5.3:

$$k_a = \frac{\sin^2(\theta+\phi'_f)}{\Gamma[\sin^2\theta\sin(\theta-\delta)]} \qquad (3.11.5.3\text{-}1)$$

in which:

$$\Gamma = \left[1+\sqrt{\frac{\sin(\phi'_f+\delta)\sin(\phi'_f-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right]^2 \qquad (3.11.5.3\text{-}2)$$

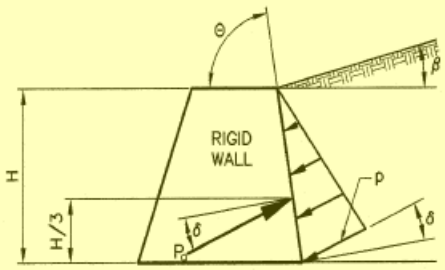

Figure 3.11.5.3-1—Notation for Coulomb Active Earth Pressure

The backfill behind the barrier could consist of the existing fill (ESU #1B), or WSDOT Common Borrow, Select Borrow or Gravel Borrow.

For the grade separation barrier, the wall backslope will be 4H:21V, or θ = 79.2°. The retained fill will either consist of a level bench (β = 0°) (cross section A–A') or a 4H:1V slope (β = 14°) adjacent to the ITS cabinet (cross section B–B'). The friction angle between the fill and the wall (per AASHTO C3.11.5.3) is $\delta = 2/3 * \phi'_f$, where ϕ'_f is the effective angle of internal friction of the soil (degrees).

Therefore, for the potential backfill soils at the site, the input parameters and the active earth pressure coefficient from equation 3.11.5.3-1 are as follows:

Backfill Type	Effective angle of Internal Friction ϕ'_f (degrees)	Interface Friction Angle, δ (degrees)	Level Slope Active Earth Pressure Coefficient, K_a	4H:1V Slope Active Earth Pressure Coefficient, K_a
ESU #1B	38	25.33	0.30	0.36
Common Borrow	32	21.33	0.36	0.45
Select Borrow	36	24.00	0.32	0.39
Gravel Borrow	38	25.33	0.30	0.36

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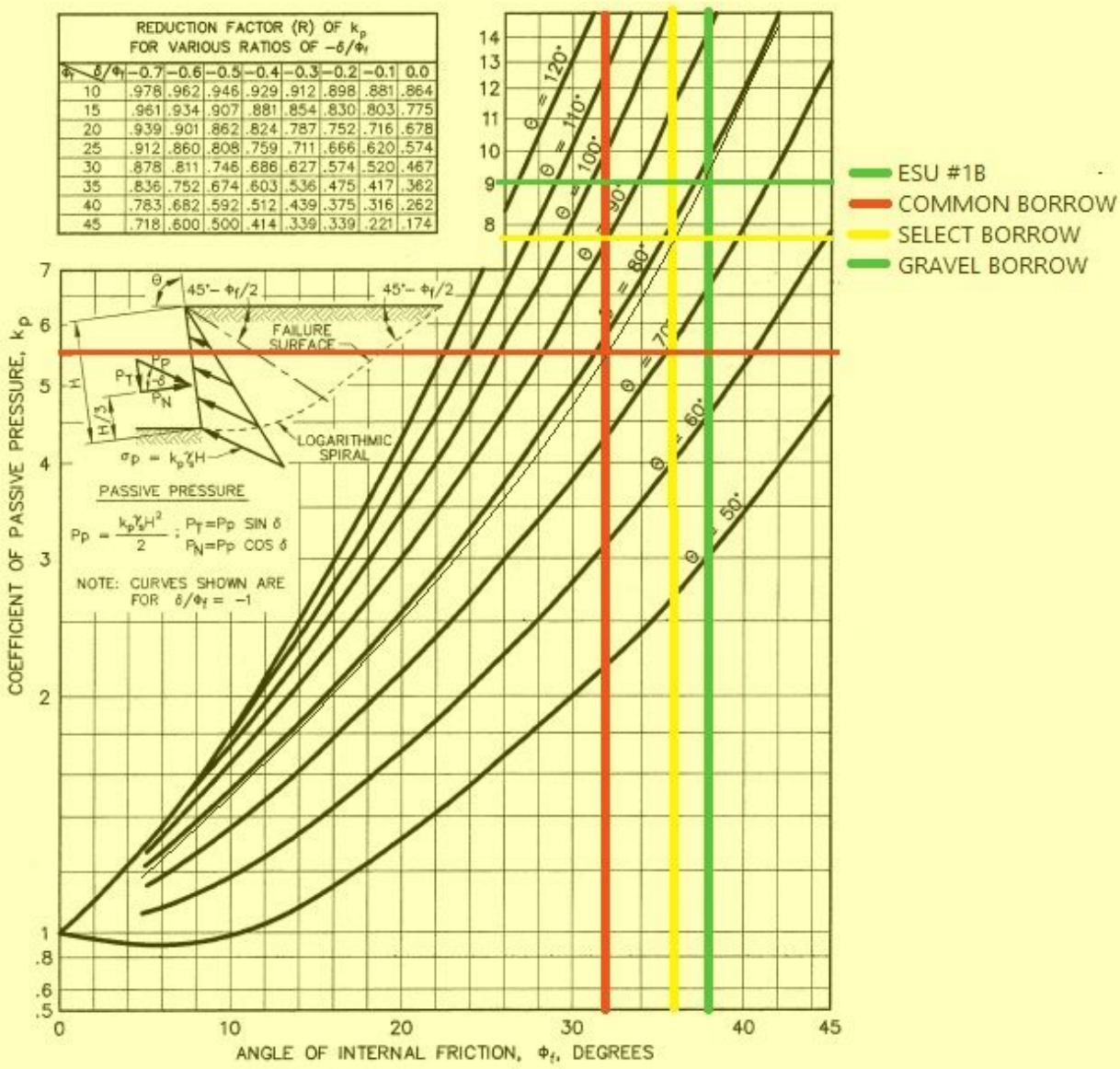
5.2 Passive Earth Coefficients

The passive earth pressure coefficient for the backfill materials on the side and below the grade separation barriers are based on Figure 3.11.5.4-1 in the *LRFD Bridge Design Specifications* (AASHTO 2017), as shown below:



REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\Phi_f$

Φ_f \ δ/Φ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574
30	.878	.811	.746	.686	.627	.574	.520	.467
35	.836	.752	.674	.603	.536	.475	.417	.362
40	.783	.682	.592	.512	.439	.375	.316	.262
45	.718	.600	.500	.414	.339	.339	.221	.174

Figure 3.11.5.4-1—Computational Procedures for Passive Earth Pressures for Vertical and Sloping Walls with Horizontal Backfill (U.S. Department of the Navy, 1982a)

wood.

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REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\phi_f$

ϕ_f \ δ/ϕ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574
30	.878	.811	.746	.686	.627	.574	.520	.467
35	.836	.752	.674	.603	.536	.475	.417	.362
40	.783	.682	.592	.512	.439	.375	.316	.262
45	.718	.600	.500	.414	.339	.339	.221	.174

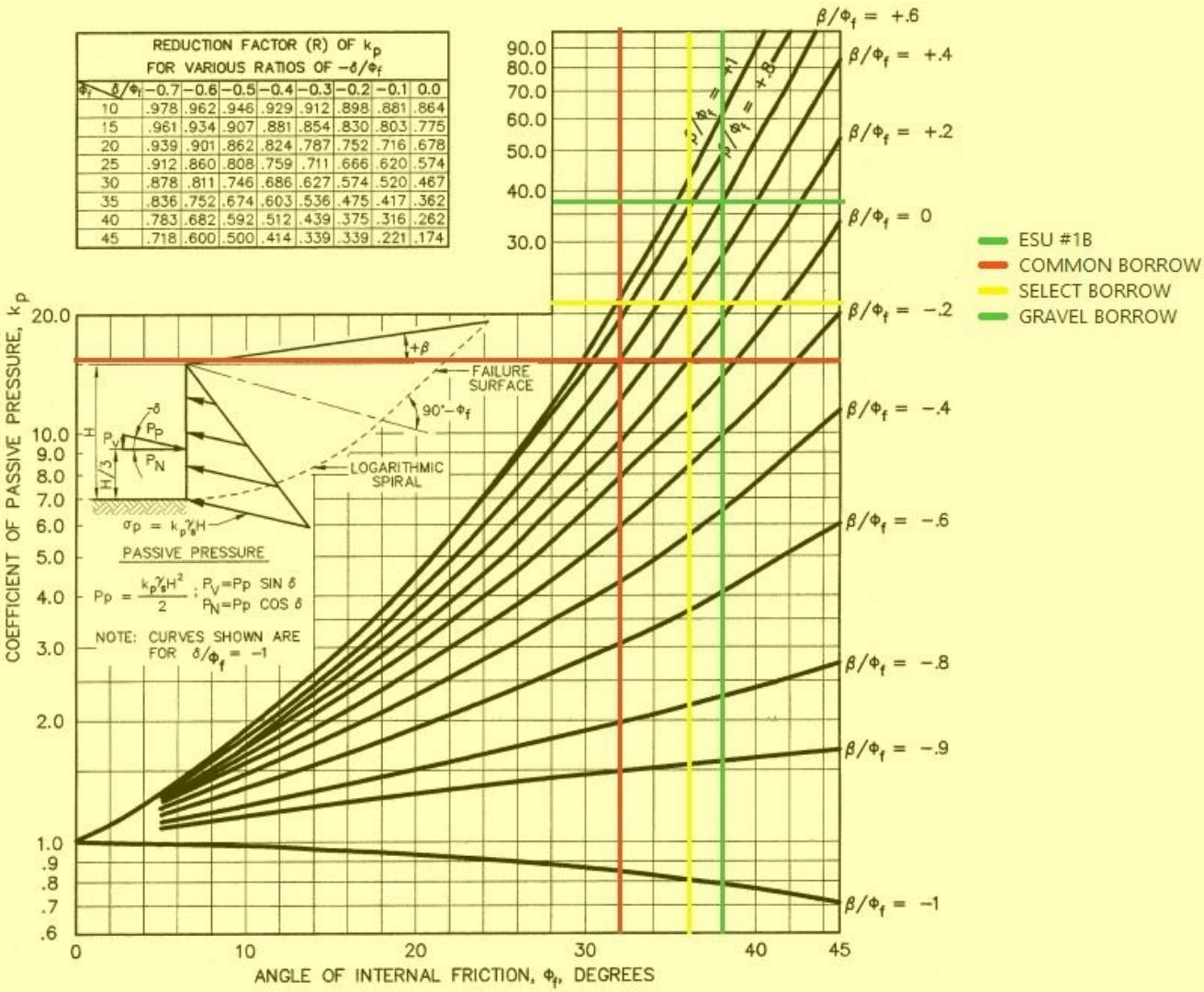

Figure 3.11.5.4-2—Computational Procedures for Passive Earth Pressures for Vertical Wall with Sloping Backfill (U.S. Department of the Navy, 1982a)

Calculate β/ϕ_f:

β/ϕ_f: = 14/38 = 0.37, β/ϕ_f = 14/36 = 0.39, β/ϕ_f = 14/32 = 0.44

For all cases, <u>assume β/ϕ_f: = + 0.4</u>

Calculate δ/ϕ_f:

δ/ϕ_f: = δ/ϕ_f = 25.33/38 = 0.67, δ/ϕ_f = 24/36 = 0.67, δ/ϕ_f = 21.33/32 = 0.67

For all cases, <u>assume δ/ϕ_f: = - 0.7</u>

Interpolate for Reduction Factor, R based on Figure 3.11.5.4-1:

For ϕ_f = 32° and δ/ϕ_f = 0.7:

$$\frac{(35-32)}{(0.836-R1)} = \frac{(35-30)}{(0.836-0.878)}$$

$R1 = 0.836 - \frac{(35-32)(0.836-0.878)}{(35-30)}$ = 0.861

For ϕ_f = 36° and δ/ϕ_f = 0.7:

$$\frac{(40-36)}{(0.783-R2)} = \frac{(40-36)}{(0.783-0.836)}$$

$R1 = 0.783 - \frac{(40-36)(0.783-0.836)}{(40-35)}$ = 0.825

For ϕ_f = 38° and δ/ϕ_f = 0.7:

$$\frac{(40-38)}{(0.783-R)} = \frac{(40-35)}{(0.783-0.836)}$$

$R = 0.783 - \frac{(40-38)(0.783-0.836)}{(40-35)}$ = 0.804

For θ = 0° (CROSS SECTION A–A')

Backfill Type	Effective angle of Internal Friction ϕ'_f (degrees)	Passive Earth Pressure Coefficient from graph, K_p	Reduction Factor (δ/ϕ_f = 0.7)	**Passive Earth Pressure Coefficient**
ESU #1B	38	9.0	0.8	**8.2**
Common Borrow	32	5.5	0.9	**4.6**
Select Borrow	36	7.8	0.8	**7.0**
Gravel Borrow	38	9.0	0.8	**8.2**

For $\theta = 14^{\circ}$ (CROSS SECTION B–B')

Backfill Type	Effective angle of Internal Friction ϕ'_f (degrees)	Passive Earth Pressure Coefficient from graph, K_p	Reduction Factor ($\delta/\phi_f = 0.7$)	**Passive Earth Pressure Coefficient**
ESU #1B	38	38	0.8	**37.2**
Common Borrow	32	15	0.9	**14.1**
Select Borrow	36	21	0.8	**20.2**
Gravel Borrow	38	38	0.8	**37.2**

6.0 SLIDING COEFFICIENTS

Per AASHTO C10.6.3.4 the coefficient of sliding resistance between soil and foundations on cohesionless soil can be taken as $\tan(\phi'_f)$ for cast in place concrete and 0.8* $\tan(\phi_f)$ for precast concrete.

Therefore, sliding coefficients can be taken as:

Foundation Soil	ϕ'_f (degrees)	Cast-in-place	Precast
ESU #1B	38	0.78	0.63
Common Borrow	32	0.62	0.50
Select Borrow	36	0.73	0.58
Gravel Borrow	38	0.78	0.63

7.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO). 2017. *LRFD Bridge Design Specifications*. Eighth Edition. Washington, D.C., USA.

Wood Environment & Infrastructure Solutions, Inc. (Wood). 2021a. *WSDOT I-405 Design Requirements and Geotechnical Assessment of Retaining Walls.* Released for Construction letter. In association with Flatiron-Lane Joint Venture. January 26.

Wood. 2021b. *WSDOT I-405 Seismic Hazard*. In association with Flatiron-Lane Joint Venture. March 31.