EXHIBIT H

MAUL
FOSTER
ALONGI

MEMORANDUM

To: North Suttle Road Property Owners
Date: August 16, 2017
From: Jacob Faust, PE
Project: 0106.24.01

REGISTERED PROFESSIONAL ENGINEER
83172PE
OREGON
JUNE 7, 2012
JACOB M. FAUST
EXPIRES: 12/31/2017
This digital seal certifies the signatory and document content.

RE: North Suttle Road Engineering Study

Maul Foster and Alongi, Inc. (MFA) has prepared this engineering study on behalf of the property owners located along North Suttle Road in Portland, Oregon. The study is in response to the City of Portland's (City's) proposal to form a Local Improvement District (LID) to reconstruct North Suttle Road to modern roadway standards, at a City-estimated cost of $9.6 million. A significant portion of that cost would be funded through an assessment against the respective properties based upon the total number of square feet of land in each parcel on a *pro rata* basis. The owners of many of the properties identified for inclusion within the LID are of the opinion that proposed *pro rata* assessment costs, over the LID's 20-year repayment period, are unsustainable and may cause many of these small businesses to close. Further, the LID assessments become liens against these properties, which may significantly diminish their fair market value during the repayment period. The purpose of this study is to identify options for the roadway's replacement that reduce the overall project's cost relative to the City's current proposal.

The City's current proposal calls for a 32-foot wide asphalt roadway with curbs and a detached sidewalk. The proposed roadway section design requires nine inches of asphalt pavement over eight inches of compacted base gravel. Stormwater would be collected and conveyed to a to-be-constructed stormwater infrastructure that drains to the North Portland Harbor. Per discussion with the City, this is a typical design for freight districts in the City, except for the reduced pavement width, which is typically 36 feet (curb to curb). The preliminary City design is considered to be conservative, and data collected for this study shows that the design parameters can be reduced and still meet design requirements for the road's usage. Conclusions and recommendations for the design are described at the end of this document.

MFA has coordinated with the property owners, their representatives, and the City to identify feasible cost saving measures to potentially incorporate into the final roadway design. This engineering study utilizes results of a traffic study, geotechnical engineering study, and stormwater study, as well as input from the property owners and City to develop concepts for inclusion within the LID. This study does not include a final engineering design.

EXISTING CONDITIONS

North Suttle Road extends approximately 3,000 feet west from North Portland Road to where it dead ends at the BNSF railroad track right of way. The roadway cross section currently consists of an approximately 20 feet wide asphalt section with gravel shoulders. There are currently no pedestrian facilities along the road, and no formal stormwater management system. A railroad spur runs along the road alignment, approximately 20 feet south of the pavement edge; three side spurs also cross North Suttle Road serving properties to the north of the study area. Utilities in the road consist of water and sanitary sewer only. An overhead utility line also runs along the south edge of the road, approximately six feet from the edge of pavement.

The City Transportation System Plan (TSP) classifies North Suttle Road as a *local service traffic street,* which serves 12 properties predominately comprised of industrial businesses. Based upon roadway usage, of the seven roadway types set forth in the TSP for North Portland, a *local service traffic street* is the least used street; whereas North Marine Drive and North Portland Road are classified as *major city traffic streets.* According to the landowners, the North Suttle Road was originally constructed as a Multnomah County road, which was later annexed into the City. Maintenance of the road has historically been completed by the landowners, with some support from the City.

The roadway and surrounding properties are located entirely within the Federal Emergency Management Agency's (FEMA) 100-year flood plain. Construction work within the 100-year flood plain is subject to the City of Portland development code, which requires cut and fill balance (i.e., no net fill). Special consideration should be given to this factor as all material imported to the site to construct the new roadway will require and equal amount of offsite disposal of existing materials, unless the City grants a variance from this regulation.

The landowners concur with the City's position that portions of the road are in poor condition and in need of replacement, particularly the eastern third of the roadway. Due to lack of maintenance, stormwater drainage has become increasingly problematic due to decreased infiltration; standing stormwater following rain events has caused significant degradation of the road (e.g., potholes and pavement cracking). Minor repair efforts have been completed periodically; however, major modifications are required to ensure continued long-term accessibility to the properties along this industrial corridor.

TRAFFIC STUDY

Kittelson and Associates, Inc. (KAI) performed a traffic study to define current uses and conditions of North Suttle Road. The traffic analysis included a site visit to inventory existing conditions (land configurations, signage, markings, sight distances, pedestrian facilities, traffic characteristics); review of available recent traffic studies or other background information; review of the TSP, Comprehensive Plan, and other applicable planning/policy documents for the study corridor; conducting a 24-hour tube count to collect data on daily traffic volumes, speeds, and vehicle classification; and review of historical crash data.

The TSP classifies North Suttle Road as a *local service access street*. Of the seven street usage classifications set forth in the Portland TSP, in the North District, a *local service traffic street* has the least usage, see Map 6.35.1. In contrast to N Portland Road and N. Marine Drive which are classified as *major city traffic streets*, with the third most usage. Suttle Road is located in an industrial zoned area (IH), and is also located in the City's aircraft landing overlay zone. Traffic volumes were measured at 1,890 trips per day, with 44% of the traffic consisting of heavy trucks. There were no geometric or safety concerns identified in the traffic study. The traffic study is included as Attachment 1.

GEOTECHNICAL ENGINEERING STUDY

Hart Crowser, Inc. (Hart Crowser) performed a geotechnical engineering study of North Suttle Road to evaluate pavement design, infiltration characteristics of site soils, and general geotechnical construction and design considerations. The study included review of available subsurface soil and groundwater information; a subsurface exploration to characterize pavement, base aggregate, and soil subgrade conditions; in-situ infiltration testing; laboratory testing of soil samples for physical characteristics; and recommendations regarding pavement design and earthwork practices.

The site explorations revealed variable pavement and base rock sections throughout the study area. The existing asphalt pavement thickness was generally around 6 inches, but ranged from 4.5 inches to as much as 8 inches. Base rock thickness was also variable, ranging from non-existent to 17 inches. Two borings on the west end of the study area revealed a 6-inch thick concrete slab, which was paved over with 5.5 inches of asphalt. Subsurface soils consist of silty-sand dredge spoils.

Test results indicated infiltration rates typically ranging from 12 to 50 inches per hour. The subsurface soils are generally well suited for infiltration. There was one exception, with an infiltration rate of 0.1 inches per hour, which was determined to be an anomaly as the soil characteristics immediately adjacent to the test location were consistent with soils at the other boring location. The test location may have been performed over an isolated deposit of clay, which is not uncommon in dredge spoil fill material. The geotechnical engineering study is included as Attachment 2.

STORMWATER STUDY

MFA conducted a stormwater study to identify options for stormwater collection and disposal. Results of infiltration testing performed through the geotechnical engineering study were used to size conceptual stormwater infiltration facilities to dispose of roadway runoff. The stormwater model divided the street into two basins to calculate stormwater runoff for the 100-year, 24-hour design storm. The runoff volumes were then modeled with a City stormwater planter design to determine the size of conceptual facilities necessary to infiltrate all runoff. The study indicates that stormwater infiltration is feasible and is included as Attachment 3.

RESULTS AND RECOMMENDATIONS

MFA used the results of the three engineering studies to develop a conceptual typical cross section and to provide additional recommendations for further consideration during final road design. The results of the engineering study are described below.

Stormwater Infiltration

Infiltration testing and runoff calculations showed that infiltration is a viable option for stormwater disposal. The geotechnical analysis determined that site soils generally consist of sandy to silty dredge spoils with measured infiltration rates ranging from 12 to 50 inches per hour. Calculations prepared by MFA show that a two-foot wide infiltration facility would be required along 1,100 feet (approximately one-third) of the road frontage to dispose of all stormwater runoff under the 100-year design storm scenario. The facilities could be modified dimensionally to reduce cost (i.e., utilize side slopes rather than vertical walls), as well as a wider facility to reduce overall length of facility required. Eliminating the need for catchments, subsurface piping, and connection to the City's stormwater conveyance system or constructing a new outfall to the Columbia River, will create efficiencies in construction and reduce the overall cost of the roadway replacement.

Additional information may be required to design infiltration facilities, including: chemical site characterization of the soils in the area of the proposed facilities; additional infiltration testing; and, if needed, characterization of groundwater elevations and flow direction.

Reduced Pavement Thickness

The geotechnical engineering report recommends a pavement section of 7.5 inches of minor warm mix asphalt concrete (MWMAC) pavement over 8 inches of compacted base gravel. This section reduces the amount of asphalt by 1.5 inches, and provides adequate structural stability for the heavy truck traffic on North Suttle Road. A reduced pavement thickness will provide a direct cost savings by a reduction in materials, as well as reducing the amount of material requiring offsite disposal to comply with flood plain cut/fill balance condition.

MFA understands that the City desires to incorporate Perpetual Pavement Design[1] standards to the roadway design. If this design standard is used, the pavement section as summarized in the geotechnical engineering report would be 9 inches of MWMAC over 8 inches of base aggregate, which is consistent with the City's original preliminary design section.

Additionally, the City has proposed an option to construct a Portland cement concrete (PCC) roadway surfacing in place of the asphalt section. According to calculations summarized in the geotechnical engineering report (and utilizing a 50-year design life), the design section for a PCC roadway would be 9.1 inches of PCC over 6 inches of base aggregate. This option, according to the MFA cost opinion (attached) could potentially present a cost savings of approximately $122,000. The City cost opinion shows a significant increase in cost compared to MWMAC surfacing; therefore, MFA recommends additional cost analysis be performed by the City to select the most cost effective roadway surfacing for the project.

Reduced Driveway Widths/Shared Driveways

The conceptual City design assumes a standard 30-foot wide driveway width to replace all property access points in the study area. This width is assumed to accommodate large truck movements which may not be necessary for all access points. Additionally, some properties may have the opportunity to combine access points; therefore, reducing the total number of driveways to be constructed. Further discussion with the property owners, additional traffic data collection, and analysis of vehicle turning movement analysis is recommended to determine appropriate driveway widths for each access point. MFA anticipates that several of the access widths may be reduced, which would present additional cost savings to the project.

Reduced Pavement Width

A pavement width of 36 feet was proposed in the City's August 8, 2016 preliminary design drawings. MFA understands that the City has since reduced the pavement width to 32 feet to reduce the overall cost on the project. The TSP identifies North Suttle Road as a *local access traffic street* (map 6.35.1). Table 6.12 of the TSP defines the minimum pavement width for a *local access traffic street* as 28 feet, when the street is not in a pedestrian district and no additional bicycle lanes are required—North Suttle Road meets both of these exemptive criteria. Reduction of the roadway width to the minimum 28-foot requirement will reduce construction costs, as well as the impervious area, which in turn also reduces stormwater runoff and the associated stormwater management facilities. Therefore, a reduced pavement width will reduce costs not only for the road surface construction, but also for stormwater facility construction. A pavement width of 28 feet is recommended.

It is understood that reducing the pavement width may require increase of driveway widths to accommodate large truck turning movements. MFA recommends value engineering the pavement

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[1] Perpetual Pavement design standard is defined as "an asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement" (American Pavement Alliance (APA). 2002. Perpetual Pavements: A Synthesis. APA 101, Lanham, Maryland.)

width and driveway dimensions to define a geometrically efficient but cost effective final design. Additionally, although the majority of the properties have adequate on-site parking for their site uses, certain properties currently rely on the right of way for employee parking. Each property should be addressed accordingly during the final design to ensure no loss of parking necessary for operation.

Utilize Grind and Inlay for Pavement Sections

Some portions of the project may only require asphalt grind and inlay rather than full depth replacement. The average pavement thickness in the study area is approximately 6 inches, while as much as 8 inches of asphalt is present in certain areas. Additional study of the roadway surface should be completed to identify suitable locations for grind and inlay. These areas should then be compared to the vertical and horizontal geometry of the proposed roadway surface to determine if a reconstruction cost savings is achievable.

Remove Separated Pedestrian Connection Between North Suttle Road and Marine Drive

The preliminary City plan includes a north/south pedestrian connection between North Suttle Road and Marine Drive. The TSP does not identify North Suttle Road as being located within a pedestrian district; therefore, the pedestrian connection does not appear to be warranted. Installing a sidewalk along the north side of the road should adequately address pedestrian needs.

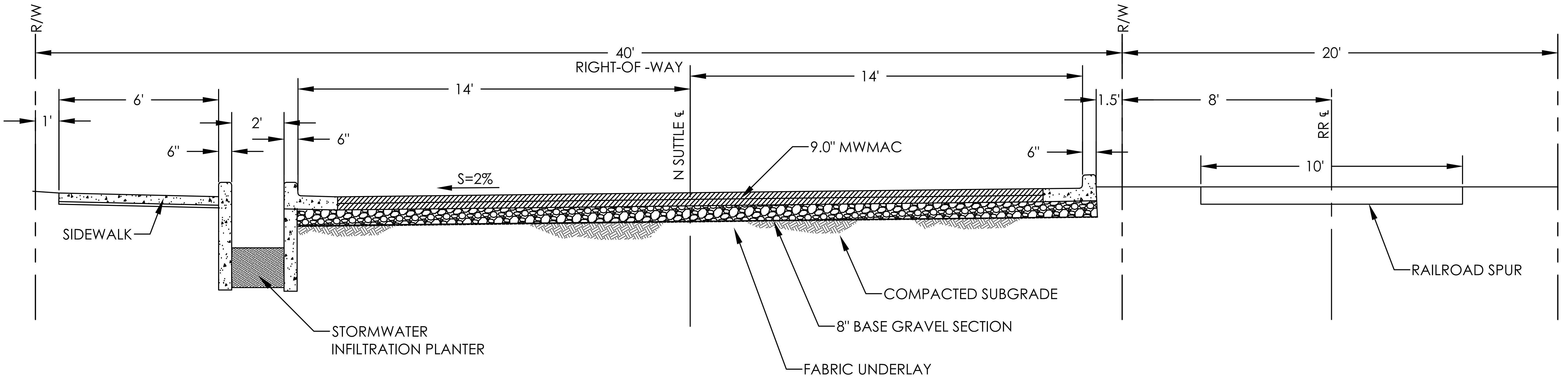
MFA understands that if stormwater infiltration is incorporated into the street design, the need for a stormwater outfall will be eliminated, thus the right of way would not be acquired that was also planned for the pedestrian connection. If the right of way is still deemed necessary as part of the project (for stormwater conveyance), MFA recommends alternate surfacing (e.g., gravel) be used to reduce project cost but still provide desired access to the right of way.

CONCLUSIONS

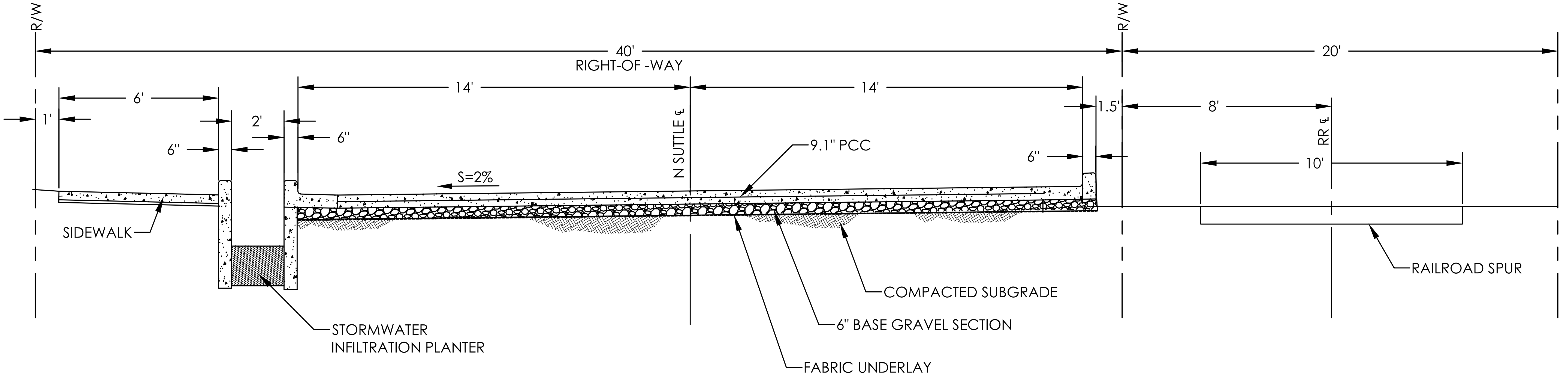
The recommendations in this study were developed using a limited, but suitable set of data pertaining to the existing conditions in the study area. Additional information is required to better assess project applicability; however, if the recommendations in this document are implemented, a significant cost savings could be achieved for this project while maintaining the functionality of the roadway facility. A conceptual cross section utilizing the recommendations described above is shown in the attached figure. Based upon the information considered in this report and the *local service street* nature of North Suttle Road, MFA's **Engineer's Preliminary Opinion of Probable Cos**t found that an acceptable roadway can be rebuilt for $4,006,115. The PCC roadway surfacing option could be constructed at a cost of $3,883,382, presenting an overall cost savings of approximately 3% compared to MWMAC. Both cost opinions include a 30% contingency and are attached.

MFA appreciates the positive input received to-date from both the landowners and the City, and looks forward to working toward a successful outcome.

FIGURE



MINOR WARM MIX ASPHALT CONCRETE OPTION



PORTLAND CEMENT CONCRETE OPTION

MAUL FOSTER ALONGI
971.544.2139 (phone) | www.maulfoster.com

NOT TO SCALE

Figure
Typical Street Sections
N. Suttle Road Engineering Study
Portland, Oregon

Filepath: G:\00_MFA Civil 3D\00_PROJECTS\0106.24 James C. Brown & Associates P.C\EXHIBIT\Figure-Typical Section.dwg
Printed by:Jacob Faust
Date:8/15/2017 3:35:00 PM

ENGINEER'S PRELIMINARY OPINION OF PROBABLE COST

ENGINEER'S PRELIMINARY OPINION OF PROBABLE COST

Title:	**N Suttle Road Replacement (MWMAC Option)**	
Project:	N. Suttle Road Engineering Study	
Client:	Jim Brown & Associates	
Project #/Task:	0106.24.01	Initial
Prepared By:	J. Faust	
Checked By:	J. Clary	
Date:	8/15/2017	
Revision #.:	1	

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Cost Estimate Summary - Feasibility Level

Schedule 'A' - General	$	619,495
Schedule 'B' - Street Construction	$	1,549,809
Schedule 'C' - Stormwater Construction	$	140,175
Schedule 'D' - Soft Costs	$	1,696,636
Total:	**$**	**4,006,115**

Assumptions:

1. Roadway surfacing is Minor Warm Mix Asphalt Concrete (MWMAC) pavement, meeting the City's desired Perpetual Pavement Design standard.
2. Unit costs based on local public bid tabs, construction contracts, and internal records.
3. Opinion excludes property acquisition for additional right of way.
4. Quantities are based on field measurements and assumed street section.
5. Street lighting and traffic signal lighting (at N Portland Rd. intersection) is excluded.

ENGINEER'S PRELIMINARY OPINION OF PROBABLE COST

Schedule 'A' - General					
Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
A.1	Temporary Traffic Control	18	WK	$ 6,500.00	$ 117,000.00
A.2	Temporary Erosion Control	1	LS	$ 30,000.00	$ 30,000.00
A.3	Clearing and Grubbing	2	AC	$ 8,000.00	$ 16,800.00
A.4	Demo and Remove Existing AC Pavement	1,333	Ton	$ 35.00	$ 46,666.67
A.5	Excavate Excess Soil and Dispose Offsite (assumes clean soil)	3,454	CY	$ 75.00	$ 259,027.78
A.6	Miscellaneous Demolition	1	LS	$ 150,000.00	$ 150,000.00
				Subtotal Schedule 'A':	**$ 619,495**

Schedule 'B' - Street Construction					
Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
B.1	General Grading	5,556	CY	$ 30.00	$ 166,666.67
B.2	Subgrade Preparation	99,000	SF	$ 0.50	$ 49,500.00
B.3	Subgrade Geotextile	99,000	SF	$ 0.20	$ 19,800.00
B.4	Aggregate Base, 8 inches thick	2,148	CY	$ 45.00	$ 96,666.67
B.5	Process and Reuse Existing Base Material (Structural Fill)	1,800	CY	$ 30.00	$ 54,000.00
B.6	Level 3, 1/2 Inch Dense MWMAC, 9 inches thick	4,568	Ton	$ 90.00	$ 411,075.00
B.7	Concrete Curb and Gutter	6,000	LF	$ 25.00	$ 150,000.00
B.8	Concrete Sidewalk	18,000	SF	$ 6.70	$ 120,600.00
B.9	Reinforced Concrete Driveways	5,400	SF	$ 10.00	$ 54,000.00
B.10	Reinforced Concrete Driveways (w/RR Grade)	4,200	SF	$ 15.00	$ 63,000.00
B.11	Thermoplastic Pavement Striping	6,000	LF	$ 1.50	$ 9,000.00
B.12	Street Signage	1	LS	$ 8,000.00	$ 8,000.00
B.13	Concrete Railroad Crossing Panels	2,400	SF	$ 75.00	$ 180,000.00
B.14	Miscellaneous Utility Relocation	1	LS	$ 150,000.00	$ 150,000.00
B.15	Street Trees	50	EA	$ 350.00	$ 17,500.00
				Subtotal Schedule 'B':	**$ 1,549,809**

Schedule 'C' - Stormwater Construction					
Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
C.1	Stormwater Planting Medium	135	CY	$ 65.00	$ 8,775.00
C.2	Concrete Planter Wall	2,430	LF	$ 35.00	$ 85,050.00
C.3	Stormwater Facility Planting	270	SY	$ 55.00	$ 14,850.00
C.4	Culvert Piping Under Driveways	100	LF	$ 35.00	$ 3,500.00
C.5	Conveyance Ditches	1,000	LF	$ 8.00	$ 8,000.00
C.6	Misc. Planter Components	1	LS	$ 20,000.00	$ 20,000.00
				Subtotal Schedule 'C':	**$ 140,175**

Schedule 'D' - Soft Cost					
Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
D.1	Mobilization	1	PCT	15%	$ 346,421.85
D.2	Contingency	1	PCT	30%	$ 692,843.70
D.3	Phase 2 Site Characterization	1	LS	$ 80,000	$ 80,000.00
D.4	Design, Permitting, Contracting, Admin.	1	LS	25%	$ 577,369.75
				Subtotal Schedule 'F':	**$ 1,696,636**

ENGINEER'S PRELIMINARY OPINION OF PROBABLE COST

Title:	**N Suttle Road Replacement (PCC Option)**	
Project:	N. Suttle Road Engineering Study	
Client:	Jim Brown & Associates	
Project #/Task:	0106.24.01	Initial
Prepared By:	J. Faust	
Checked By:	J. Clary	
Date:	8/15/2017	
Revision #.:	0	

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Cost Estimate Summary - Feasibility Level

Schedule 'A' - General	$	581,231
Schedule 'B' - Street Construction	$	1,515,877
Schedule 'C' - Stormwater Construction	$	140,175
Schedule 'D' - Soft Costs	$	1,646,099
Total:	**$**	**3,883,382**

Assumptions:

1. Roadway surfacing is Portland Cement Concrete (PCC) pavement, meeting a 50-year design life.
2. Unit costs based on local public bid tabs, construction contracts, and internal records.
3. Opinion excludes property acquisition for additional right of way.
4. Quantities are based on field measurements and assumed street section.
5. Street Lighting and traffic signal lighting (at N. Portland Rd. Intersection) is excluded.

ENGINEER'S PRELIMINARY OPINION OF PROBABLE COST

Maul, Foster Alongi, Inc.

Schedule 'A' - General

Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
A.1	Temporary Traffic Control	18	WK	$ 6,500.00	$ 117,000.00
A.2	Temporary Erosion Control	1	LS	$ 30,000.00	$ 30,000.00
A.3	Clearing and Grubbing	2	AC	$ 8,000.00	$ 16,800.00
A.4	Demo and Remove Existing AC Pavement	1,333	Ton	$ 35.00	$ 46,666.67
A.5	Excavate Excess Soil and Dispose Offsite (assumes clean soil)	2,944	CY	$ 75.00	$ 220,763.89
A.6	Miscellaneous Demolition	1	LS	$ 150,000.00	$ 150,000.00
				Subtotal Schedule 'A':	**$ 581,231**

Schedule 'B' - Street Construction

Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
B.1	General Grading	5,556	CY	$ 30.00	$ 166,666.67
B.2	Subgrade Preparation	99,000	SF	$ 0.50	$ 49,500.00
B.3	Subgrade Geotextile	99,000	SF	$ 0.20	$ 19,800.00
B.4	Aggregate Base, 8 inches thick	1,611	CY	$ 45.00	$ 72,500.00
B.5	Process and Reuse Existing Base Material (Structural Fill)	1,800	CY	$ 30.00	$ 54,000.00
B.6	Portland Cement Concrete Surfacing, 9.1 inches thick	2,359	CY	$ 170.10	$ 401,310.00
B.7	Concrete Curb and Gutter	6,000	LF	$ 25.00	$ 150,000.00
B.8	Concrete Sidewalk	18,000	SF	$ 6.70	$ 120,600.00
B.9	Reinforced Concrete Driveways	5,400	SF	$ 10.00	$ 54,000.00
B.10	Reinforced Concrete Driveways (w/RR Grade)	4,200	SF	$ 15.00	$ 63,000.00
B.11	Thermoplastic Pavement Striping	6,000	LF	$ 1.50	$ 9,000.00
B.12	Street Signage	1	LS	$ 8,000.00	$ 8,000.00
B.13	Concrete Railroad Crossing Panels	2,400	SF	$ 75.00	$ 180,000.00
B.14	Miscellaneous Utility Relocation	1	LS	$ 150,000.00	$ 150,000.00
B.15	Street Trees	50	EA	$ 350.00	$ 17,500.00
				Subtotal Schedule 'B':	**$ 1,515,877**

Schedule 'C' - Stormwater Construction

Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
C.1	Stormwater Planting Medium	135	CY	$ 65.00	$ 8,775.00
C.2	Concrete Planter Wall	2,430	LF	$ 35.00	$ 85,050.00
C.3	Stormwater Facility Planting	270	SY	$ 55.00	$ 14,850.00
C.4	Culvert Piping Under Driveways	100	LF	$ 35.00	$ 3,500.00
C.5	Conveyance Ditches	1,000	LF	$ 8.00	$ 8,000.00
C.6	Misc. Planter Components	1	LS	$ 20,000.00	$ 20,000.00
				Subtotal Schedule 'C':	**$ 140,175**

Schedule 'D' - Soft Cost

Description		*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
D.1	Mobilization	1	PCT	15%	$ 335,592.45
D.2	Contingency	1	PCT	30%	$ 671,184.90
D.3	Phase 2 Site Characterization	1	LS	$ 80,000	$ 80,000.00
D.4	Design, Permitting, Contracting, Admin.	1	LS	25%	$ 559,320.75
				Subtotal Schedule 'F':	**$ 1,646,099**

ATTACHMENT 1

TRAFFIC STUDY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
610 SW Alder Street, Suite 700, Portland, OR 97205 P 503.228.5230 F 503.273.8169

TECHNICAL MEMORANDUM

N Suttle Road Local Improvement

Portland, Oregon

Traffic Data Summary

Date: August 16, 2017 Project #:21564

To: Jacob Faust, P.E., Maul Foster Alongi

From: Wade Scarbrough, P.E., and Caitlin Mildner

Kittelson & Associates (KAI) collected and reviewed traffic data to support the development of a roadway improvement design for N Suttle Road in the City of Portland. This technical memorandum summarizes the traffic volumes, crash history, and design considerations for the project corridor.

PROJECT BACKGROUND

Property owners on N Suttle Road are proposing to pave and improve N Suttle Road to City of Portland standards from N Portland Road to the western end of N Suttle Road. The project will also include new curb and sidewalk, in addition to other utility and drainage improvements, as needed.

EXISTING CONDITIONS

The existing conditions analysis identifies field conditions and the current operational, traffic control, and geometric characteristics of roadways and other transportation facilities within the study area. KAI visited the project area and inventoried the existing transportation system to identify lane configurations, traffic control devices, bicycle and pedestrian facilities, transit stops, geometric features, sight distances, and adjacent land uses. Traffic flow during the peak hours was observed to identify existing operational issues.

Site Conditions and Adjacent Land Uses

The study corridor is approximately 0.6 miles in length. N Suttle Road is located in an area occupied predominately by industrial uses. The land use around the study area is zoned Heavy Industrial (IH) per City of Portland zoning designation. Given the corridor's proximity to Portland International Airport, N Suttle Road is within Portland's Aircraft Landing overlay zone, which limits the height of structures and vegetation.

Roadway Facilities

The City of Portland's *Transportation System Plan* (Reference 1) identifies seven different functional classifications for roadways ranging from *Local Service Streets* to *Regional Trafficways*. These roadway classifications have varying roles with respect to their level of access and mobility. N Suttle Road is classified by the City as a Local Service Street and provides local access between N Portland Road and the surrounding industrial developments.

The existing roadway cross-section for N Suttle Road consists of a two-lane section with no curbs or sidewalks. N Suttle Road begins at N Portland Road and continues 0.6 miles to a dead end. The intersection of N Suttle Road and N Portland Road is stop-controlled on the eastbound (N Suttle Road) approach. The paved roadway surface widens at the intersection to accommodate turning heavy vehicle movements.

Table 1 summarizes the existing roadway characteristics.

Table 1: Existing Transportation Roadway Facilities and Roadway Designations

Roadway	Classification[1]	Cross-Section	Posted Speed	Sidewalks?	Bicycle Lanes?	On-Street Parking?
N Suttle Road	Local	2 Lanes	30 mph	No	No	No
N Portland Road	Major City Traffic Street	2 Lanes	45 mph	Partial	Multi-Use Path	No

[1] Classifications are based on the City of Portland's *Transportation System Plan*

Pedestrian and Bicycle Facilities

No sidewalks or bike lanes currently exist along N Suttle Road. The Peninsula Crossing Trail is an existing multi-use path that is situated separate from, and roughly parallel to, the east side of N Portland Road. The trail is a regional facility extending as far north as the north side of N Marine Drive, south to the Columbia Slough and to points east.

Existing Traffic Volumes

In June 2017, KAI commissioned a 24-hour bi-directional roadway tube count on N Suttle Road at a point approximately 150 feet west of N Portland Road. The count recorded traffic volumes and vehicle classifications along the roadway at hourly intervals by direction. Table 2 summarizes the existing conditions traffic data. *Appendix "A" and "B" contain the tube count data for volumes and vehicle classifications, respectively.*

Table 2: Existing Traffic Characteristics

Location	150 feet West of N Portland Road
Average Daily Traffic Volume	1,890 vehicles
AM Peak Hour Volumes (8-9 AM)	130 vehicles
Midday Peak Hour Volumes (1-2 PM)	150 vehicles
PM Peak Hour (3-4 PM)	130 vehicles
Truck Percentage (%) – Daily	44%

As shown in Table 2, the roadway currently carries approximately 1,890 vehicles per day with the peak hour of traffic occurring from 1:00 to 2:00 p.m. Heavy vehicles comprise approximately 44% of the overall daily volume of traffic. A more detailed breakdown of vehicle classifications is provided in the appendix.

Crash History Review

The reported crash histories along the study corridor were reviewed in an effort to identify potential segment and/or intersection safety issues. Crash records were obtained from the Oregon Department of Transportation (ODOT) for the five-year period from January 1, 2011 through December 31, 2015. *Appendix "C" includes the crash data worksheets.*

Intersection Crash Observations

Both intersection and segment crash were reviewed along the N Suttle Road corridor from N Portland Road to the end of N Suttle Road. Per the ODOT database, there were no reported crashes along the N Suttle Road corridor from January 1, 2011 through December 31, 2015.

A summary of the reported intersection crashes is provided in Table 3 including the severity and types of crashes over the five-year analysis period at the study intersections.

Table 3: Summary of Reported Crashes at Study Intersections (2011-2015)

Intersection	Number of Crashes	Crash Type				Crash Severity	
		Rear-End	Turning	Angle	Other	PDO	Injury
N Suttle Road/N Portland Road	2	1	1	-	-	2	-
N Suttle Road Corridor	0	-	-	-	-	-	-

As shown in the table, there were two reported crashes at the intersection of N Suttle Road and N Portland Road. A rear end crash involved four vehicles heading south on N Portland Road and reportedly resulted from one vehicle following too closely and rear-ending a stopped queue of three vehicles. The other reported crash involved two vehicles turning right from N Suttle Road onto N Portland Road, heading south. The vehicles were heading in the same direction and the crash was attributed to improper overtaking. Neither crash resulted in injuries.

No apparent crash patterns were identified through review of the crash data.

Intersection Sight Distance

The available intersection sight distances were evaluated at the intersection of N Suttle Road and N Portland Road and found to be adequate. Based on the 2011 AASHTO publication *A Policy on Geometric Design of Highways and Streets* (Reference 2)*,* the desirable intersection sight distance is 500 feet for the design speed of 45 mph on N Portland Road. In accordance with the AASHTO methodology, KAI reviewed intersection sight distances from a point 14.5 feet back from the major street traffic lane and found that the available sight distance is sufficient in both directions.

Intersection Design Considerations

Given the heavy vehicle traffic at the intersection of N Suttle Road and N Portland Road, we recommend that the intersection be designed to accommodate full-size highway semi-trailers (AASHTO WB-67 vehicles) as well as dual-trailer fuel delivery trucks making all turning movements at the intersection. During preliminary design, the designers should evaluate truck turning needs and develop appropriate intersection geometry (including curb radii and channelization) accordingly.

REFERENCES

1. City of Portland. *2007 Transportation System Plan*.
2. Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets, 6th Edition*. 2011.

APPENDICES

A. Tube Count Data – Volumes

B. Tube Count Data – Vehicle Classification

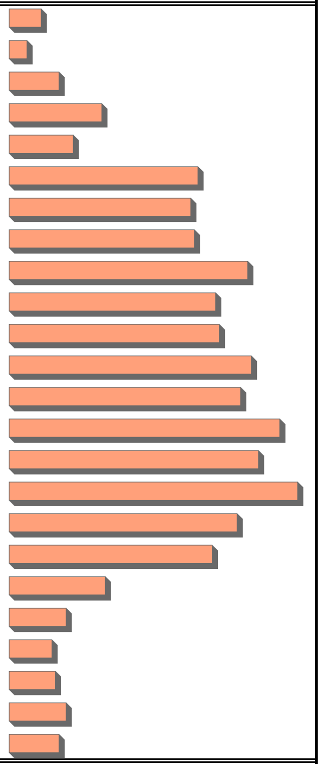
C. Crash Data

Appendix A Tube Count Data - Volumes

Type of report: Tube Count - Volume Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: EB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Mon	Tue	Wed 21-Jun-17	Thu	Fri	Average Weekday Hourly Traffic	Sat	Sun	Average Week Hourly Traffic	Average Week Profile
12:00 AM			9			9			9	
1:00 AM			5			5			5	
2:00 AM			14			14			14	
3:00 AM			26			26			26	
4:00 AM			18			18			18	
5:00 AM			53			53			53	
6:00 AM			51			51			51	
7:00 AM			52			52			52	
8:00 AM			67			67			67	
9:00 AM			58			58			58	
10:00 AM			59			59			59	
11:00 AM			**68**			**68**			**68**	
12:00 PM			65			65			65	
1:00 PM			76			76			76	
2:00 PM			70			70			70	
3:00 PM			**81**			**81**			**81**	
4:00 PM			64			64			64	
5:00 PM			57			57			57	
6:00 PM			27			27			27	
7:00 PM			16			16			16	
8:00 PM			12			12			12	
9:00 PM			13			13			13	
10:00 PM			16			16			16	
11:00 PM			14			14			14	
Day Total			991			991			991	
% Weekday Average			100.0%							
% Week Average			100.0%			100.0%				
AM Peak Volume			11:00 AM 68			11:00 AM 68			11:00 AM 68	
PM Peak Volume			3:00 PM 81			3:00 PM 81			3:00 PM 81	

Comments:

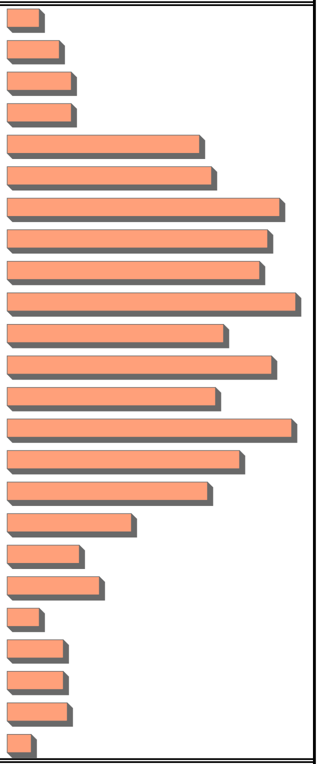
Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of report: Tube Count - Volume Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: WB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Mon	Tue	Wed 21-Jun-17	Thu	Fri	Average Weekday Hourly Traffic	Sat	Sun	Average Week Hourly Traffic	Average Week Profile
12:00 AM			8			8			8	
1:00 AM			13			13			13	
2:00 AM			16			16			16	
3:00 AM			16			16			16	
4:00 AM			48			48			48	
5:00 AM			51			51			51	
6:00 AM			68			68			68	
7:00 AM			65			65			65	
8:00 AM			63			63			63	
9:00 AM			**72**			**72**			**72**	
10:00 AM			54			54			54	
11:00 AM			66			66			66	
12:00 PM			52			52			52	
1:00 PM			**71**			**71**			**71**	
2:00 PM			58			58			58	
3:00 PM			50			50			50	
4:00 PM			31			31			31	
5:00 PM			18			18			18	
6:00 PM			23			23			23	
7:00 PM			8			8			8	
8:00 PM			14			14			14	
9:00 PM			14			14			14	
10:00 PM			15			15			15	
11:00 PM			6			6			6	
Day Total			900			900			900	
% Weekday Average			100.0%							
% Week Average			100.0%			100.0%				
AM Peak Volume			9:00 AM 72			9:00 AM 72			9:00 AM 72	
PM Peak Volume			1:00 PM 71			1:00 PM 71			1:00 PM 71	

Comments:

Report generated on 6/27/2017 4:40 PM

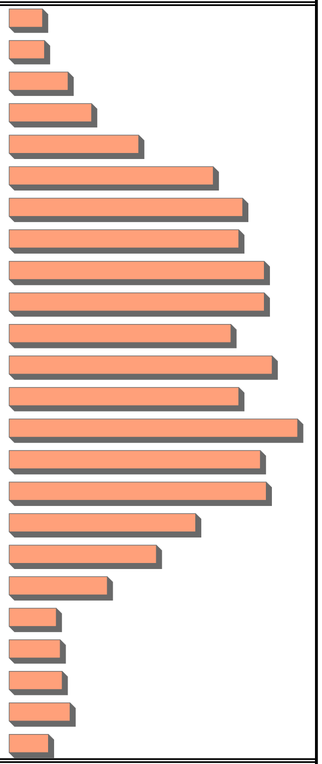
SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of report: Tube Count - Volume Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: EB/WB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Mon	Tue	Wed 21-Jun-17	Thu	Fri	Average Weekday Hourly Traffic	Sat	Sun	Average Week Hourly Traffic	Average Week Profile
12:00 AM			17			17			17	
1:00 AM			18			18			18	
2:00 AM			30			30			30	
3:00 AM			42			42			42	
4:00 AM			66			66			66	
5:00 AM			104			104			104	
6:00 AM			119			119			119	
7:00 AM			117			117			117	
8:00 AM			130			130			130	
9:00 AM			130			130			130	
10:00 AM			113			113			113	
11:00 AM			**134**			**134**			**134**	
12:00 PM			117			117			117	
1:00 PM			**147**			**147**			**147**	
2:00 PM			128			128			128	
3:00 PM			131			131			131	
4:00 PM			95			95			95	
5:00 PM			75			75			75	
6:00 PM			50			50			50	
7:00 PM			24			24			24	
8:00 PM			26			26			26	
9:00 PM			27			27			27	
10:00 PM			31			31			31	
11:00 PM			20			20			20	
Day Total			1891			1891			1891	
% Weekday Average			100.0%							
% Week Average			100.0%			100.0%				
AM Peak Volume			11:00 AM 134			11:00 AM 134			11:00 AM 134	
PM Peak Volume			1:00 PM 147			1:00 PM 147			1:00 PM 147	



Comments:

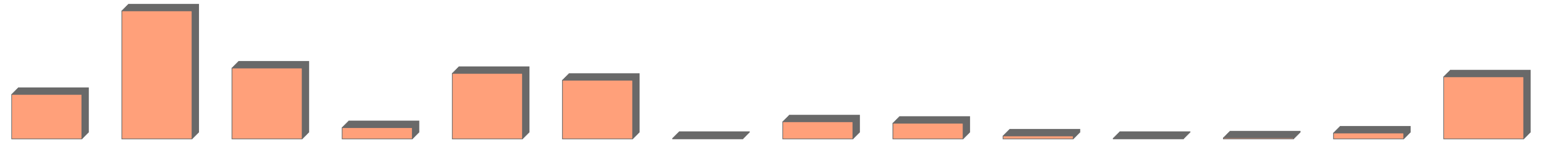
Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Appendix B Tube Count Data – Vehicle Classifications

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: EB
DATE: Jun 21 2017

Start Time	Motor-cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
12:00 AM	3	2	1	0	0	3	0	0	0	0	0	0	0	0	9
1:00 AM	0	2	2	0	0	0	0	0	1	0	0	0	0	0	5
2:00 AM	1	3	2	0	1	1	0	2	0	0	**1**	0	2	1	14
3:00 AM	0	4	2	0	7	4	0	1	0	0	0	0	1	7	26
4:00 AM	3	0	3	0	3	5	0	1	2	0	0	0	0	1	18
5:00 AM	4	11	0	0	2	8	0	2	**4**	1	0	**1**	1	**19**	53
6:00 AM	**11**	3	3	1	5	**15**	0	**3**	2	0	0	0	0	8	51
7:00 AM	7	9	5	4	8	4	0	3	4	0	0	0	1	7	52
8:00 AM	11	**12**	9	2	11	12	0	0	4	1	0	0	0	5	67
9:00 AM	8	5	7	1	**13**	5	0	2	1	1	0	0	1	14	58
10:00 AM	5	7	12	**5**	3	11	0	3	4	**2**	0	0	**4**	3	59
11:00 AM	7	12	**14**	2	11	7	0	0	1	0	0	0	1	13	**68**
12:00 PM	4	14	**14**	0	**15**	7	0	4	1	0	0	0	0	6	65
1:00 PM	4	21	11	2	11	8	**1**	**6**	**2**	0	0	0	0	10	76
2:00 PM	**5**	19	14	2	9	**10**	0	5	1	**1**	0	0	0	4	70
3:00 PM	4	**33**	13	**3**	11	2	0	1	1	0	0	0	0	**13**	**81**
4:00 PM	4	31	8	1	9	2	0	1	1	0	0	0	0	7	64
5:00 PM	3	30	11	0	3	4	0	0	1	0	0	**1**	**1**	3	57
6:00 PM	2	9	6	0	2	5	0	0	1	0	0	0	0	2	27
7:00 PM	2	7	0	0	3	1	0	1	0	0	0	0	0	2	16
8:00 PM	1	6	1	0	1	2	0	0	0	0	0	0	0	1	12
9:00 PM	1	5	3	0	2	1	0	0	1	0	0	0	0	0	13
10:00 PM	1	10	1	0	2	2	0	0	0	0	0	0	0	0	16
11:00 PM	0	7	3	0	2	1	0	0	0	0	0	0	0	1	14
Day Total **Percent**	91 9.2%	262 26.4%	145 14.6%	23 2.3%	134 13.5%	120 12.1%	1 0.1%	35 3.5%	32 3.2%	6 0.6%	1 0.1%	2 0.2%	12 1.2%	127 12.8%	991
ADT **991**															
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PM Peak Volume	2:00 PM 5	3:00 PM 33	12:00 PM 14	3:00 PM 3	12:00 PM 15	2:00 PM 10	1:00 PM 1	1:00 PM 6	1:00 PM 2	2:00 PM 1		5:00 PM 1	5:00 PM 1	3:00 PM 13	3:00 PM 81

Comments:

Report generated on 6/27/2017 4:40 PM

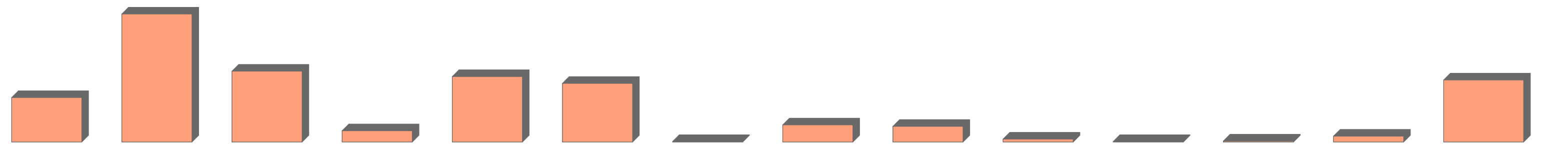
SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

SUMMARY - Tube Count - Vehicle Classification Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR
QC JOB #: 14451001
DIRECTION: EB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Motor-cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
Grand Total	91	262	145	23	134	120	1	35	32	6	1	2	12	127	991
Percent	9.2%	26.4%	14.6%	2.3%	13.5%	12.1%	0.1%	3.5%	3.2%	0.6%	0.1%	0.2%	1.2%	12.8%	

ADT
991



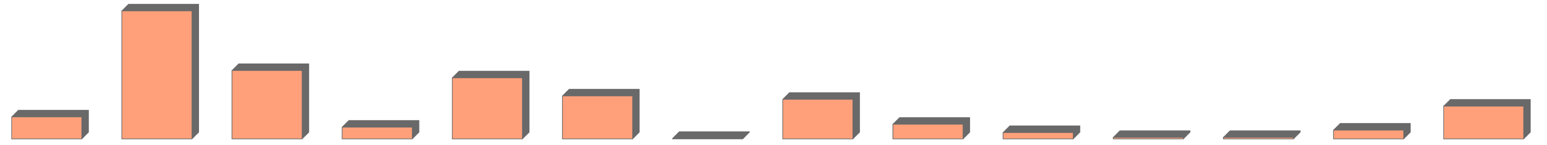
Comments:

Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: WB
DATE: Jun 21 2017

Start Time	Motor-cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
12:00 AM	2	0	0	0	2	2	0	0	1	0	0	0	0	1	8
1:00 AM	0	1	2	0	3	1	0	1	1	0	0	0	2	2	13
2:00 AM	1	2	2	0	5	3	0	1	0	0	0	0	1	1	16
3:00 AM	0	7	1	0	3	0	0	2	0	0	**1**	0	2	0	16
4:00 AM	0	22	**15**	0	5	0	0	2	1	0	0	**1**	2	0	48
5:00 AM	1	29	4	0	4	5	0	1	0	1	0	0	1	5	51
6:00 AM	3	**35**	12	1	4	5	0	3	0	0	0	1	0	4	68
7:00 AM	**7**	27	9	2	8	2	**1**	4	1	1	0	0	2	1	65
8:00 AM	5	19	11	1	11	4	0	2	2	1	0	0	0	7	63
9:00 AM	4	16	12	1	9	**7**	0	**11**	1	**2**	0	0	**4**	5	**72**
10:00 AM	3	8	9	**4**	7	5	0	5	**4**	1	0	0	0	**8**	54
11:00 AM	3	11	12	4	**13**	6	0	5	4	1	0	0	1	6	66
12:00 PM	1	13	**10**	3	5	6	0	6	**3**	1	0	0	**1**	3	52
1:00 PM	**3**	**23**	10	3	7	**7**	0	**9**	1	2	0	**1**	0	5	**71**
2:00 PM	2	10	7	**4**	**13**	6	0	5	3	**3**	0	0	0	5	58
3:00 PM	3	6	5	1	12	5	0	7	3	0	0	0	1	**7**	50
4:00 PM	1	7	5	0	4	3	0	3	2	0	**2**	0	0	4	31
5:00 PM	1	5	2	0	2	2	0	3	1	0	0	0	1	1	18
6:00 PM	0	4	4	0	4	6	0	4	0	0	0	0	0	1	23
7:00 PM	1	2	3	0	1	1	0	0	0	0	0	0	0	0	8
8:00 PM	0	4	1	0	1	4	0	3	1	0	0	0	0	0	14
9:00 PM	0	6	1	0	2	4	0	1	0	0	0	0	0	0	14
10:00 PM	2	5	1	0	0	3	0	3	1	0	0	0	0	0	15
11:00 PM	2	0	2	0	0	1	0	0	0	0	0	0	0	1	6
Day Total **Percent**	45 5.0%	262 29.1%	140 15.6%	24 2.7%	125 13.9%	88 9.8%	1 0.1%	81 9.0%	30 3.3%	13 1.4%	3 0.3%	3 0.3%	18 2.0%	67 7.4%	900
ADT **900**															
AM Peak Volume	7:00 AM 7	6:00 AM 35	4:00 AM 15	10:00 AM 4	11:00 AM 13	9:00 AM 7	7:00 AM 1	9:00 AM 11	10:00 AM 4	9:00 AM 2	3:00 AM 1	4:00 AM 1	9:00 AM 4	10:00 AM 8	9:00 AM 72
PM Peak Volume	1:00 PM 3	1:00 PM 23	12:00 PM 10	2:00 PM 4	2:00 PM 13	1:00 PM 7		1:00 PM 9	12:00 PM 3	2:00 PM 3	4:00 PM 2	1:00 PM 1	12:00 PM 1	3:00 PM 7	1:00 PM 71

Comments:

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

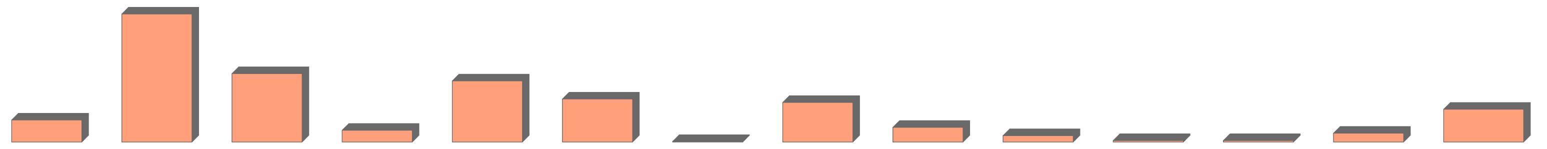
SUMMARY - Tube Count - Vehicle Classification Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: WB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Motor-cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
Grand Total	45	262	140	24	125	88	1	81	30	13	3	3	18	67	900
Percent	5.0%	29.1%	15.6%	2.7%	13.9%	9.8%	0.1%	9.0%	3.3%	1.4%	0.3%	0.3%	2.0%	7.4%	

ADT
900



Comments:

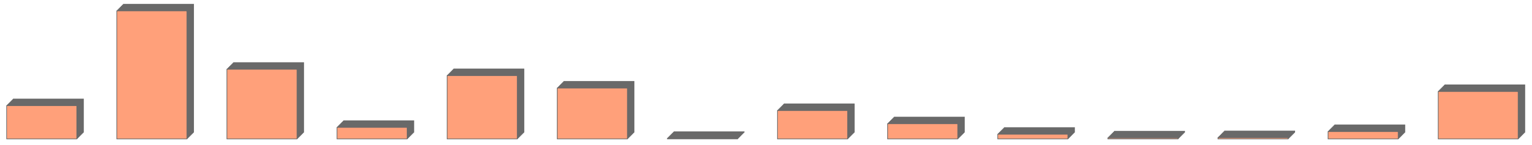
Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of report: Tube Count - Vehicle Classification Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: EB/WB
DATE: Jun 21 2017

Start Time	Motor- cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
12:00 AM	5	2	1	0	2	5	0	0	1	0	0	0	0	1	17
1:00 AM	0	3	4	0	3	1	0	1	2	0	0	0	2	2	18
2:00 AM	2	5	4	0	6	4	0	3	0	0	**1**	0	3	2	30
3:00 AM	0	11	3	0	10	4	0	3	0	0	1	0	3	7	42
4:00 AM	3	22	18	0	8	5	0	3	3	0	0	**1**	2	1	66
5:00 AM	5	**40**	4	0	6	13	0	3	4	2	0	1	2	**24**	104
6:00 AM	14	38	15	2	9	**20**	0	6	2	0	0	1	0	12	119
7:00 AM	14	36	14	6	16	6	**1**	7	5	1	0	0	3	8	117
8:00 AM	**16**	31	20	3	22	16	0	2	6	2	0	0	0	12	130
9:00 AM	12	21	19	2	22	12	0	**13**	2	**3**	0	0	**5**	19	130
10:00 AM	8	15	21	**9**	10	16	0	8	**8**	3	0	0	4	11	113
11:00 AM	10	23	**26**	6	**24**	13	0	5	5	1	0	0	2	19	**134**
12:00 PM	5	27	**24**	3	20	13	0	10	**4**	1	0	0	1	9	117
1:00 PM	**7**	**44**	21	5	18	15	**1**	**15**	3	2	0	**1**	0	15	**147**
2:00 PM	7	29	21	**6**	22	**16**	0	10	4	**4**	0	0	0	9	128
3:00 PM	7	39	18	4	**23**	7	0	8	4	0	0	0	1	**20**	131
4:00 PM	5	38	13	1	13	5	0	4	3	0	**2**	0	0	11	95
5:00 PM	4	35	13	0	5	6	0	3	2	0	0	1	**2**	4	75
6:00 PM	2	13	10	0	6	11	0	4	1	0	0	0	0	3	50
7:00 PM	3	9	3	0	4	2	0	1	0	0	0	0	0	2	24
8:00 PM	1	10	2	0	2	6	0	3	1	0	0	0	0	1	26
9:00 PM	1	11	4	0	4	5	0	1	1	0	0	0	0	0	27
10:00 PM	3	15	2	0	2	5	0	3	1	0	0	0	0	0	31
11:00 PM	2	7	5	0	2	2	0	0	0	0	0	0	0	2	20
Day Total **Percent**	136 7.2%	524 27.7%	285 15.1%	47 2.5%	259 13.7%	208 11.0%	2 0.1%	116 6.1%	62 3.3%	19 1.0%	4 0.2%	5 0.3%	30 1.6%	194 10.3%	1891
ADT **1891**															
AM Peak Volume	8:00 AM 16	5:00 AM 40	11:00 AM 26	10:00 AM 9	11:00 AM 24	6:00 AM 20	7:00 AM 1	9:00 AM 13	10:00 AM 8	9:00 AM 3	2:00 AM 1	4:00 AM 1	9:00 AM 5	5:00 AM 24	11:00 AM 134
PM Peak Volume	1:00 PM 7	1:00 PM 44	12:00 PM 24	2:00 PM 6	3:00 PM 23	2:00 PM 16	1:00 PM 1	1:00 PM 15	12:00 PM 4	2:00 PM 4	4:00 PM 2	1:00 PM 1	5:00 PM 2	3:00 PM 20	1:00 PM 147

Comments:

Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

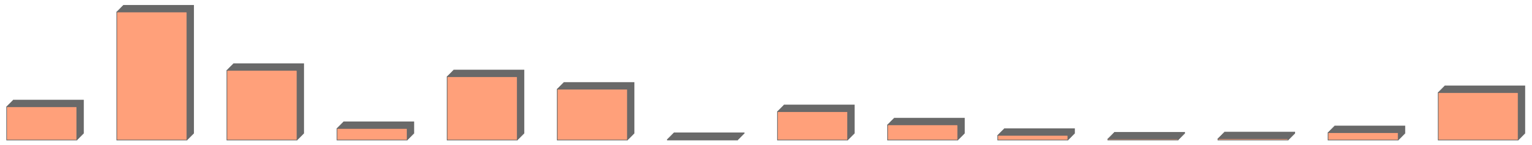
SUMMARY - Tube Count - Vehicle Classification Data

LOCATION: N Suttle Rd 150' west of Portland Rd
SPECIFIC LOCATION: N Suttle Rd 150' west of Portland Rd
CITY/STATE: Portland, OR

QC JOB #: 14451001
DIRECTION: EB/WB
DATE: Jun 21 2017 - Jun 21 2017

Start Time	Motor-cycles	Cars & Trailer	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi	Not Classified	Total
Grand Total	136	524	285	47	259	208	2	116	62	19	4	5	30	194	1891
Percent	7.2%	27.7%	15.1%	2.5%	13.7%	11.0%	0.1%	6.1%	3.3%	1.0%	0.2%	0.3%	1.6%	10.3%	

ADT
1891



Comments:

Report generated on 6/27/2017 4:40 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Appendix C Crash Data

OREGON DEPARTMENT OF TRANSPORTATION - TRANSPORTATION DEVELOPMENT DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
CRASH SUMMARIES BY YEAR BY COLLISION TYPE

N Suttle Rd & N Portland Rd
January 1, 2011 through December 31, 2015

COLLISION TYPE	FATAL CRASHES	NON-FATAL CRASHES	PROPERTY DAMAGE ONLY	TOTAL CRASHES	PEOPLE KILLED	PEOPLE INJURED	TRUCKS	DRY SURF	WET SURF	DAY	DARK	INTER-SECTION	INTER-SECTION RELATED	OFF-ROAD
YEAR: 2013														
REAR-END	0	0	1	1	0	0	0	0	1	0	1	1	0	0
TURNING MOVEMENTS	0	0	1	1	0	0	0	1	0	1	0	1	0	0
2013 TOTAL	0	0	2	2	0	0	0	1	1	1	1	2	0	0
FINAL TOTAL	0	0	2	2	0	0	0	1	1	1	1	2	0	0

Disclaimer: A higher number of crashes may be reported as of 2011 compared to prior years. This does not reflect an increase in annual crashes. The higher numbers result from a change to an internal departmental process that allows the Crash Analysis and Reporting Unit to add previously unavailable, non-fatal crash reports to the annual data file. Please be aware of this change when comparing pre-2011 crash statistics.

OREGON DEPARTMENT OF TRANSPORTATION - TRANSPORTATION DEVELOPMENT DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
CRASH SUMMARIES BY YEAR BY COLLISION TYPE

N Suttle Rd to the Northwest of N Portland Rd (intersection excluded)
January 1, 2011 through December 31, 2015

COLLISION TYPE	FATAL CRASHES	NON-FATAL CRASHES	PROPERTY DAMAGE ONLY	TOTAL CRASHES	PEOPLE KILLED	PEOPLE INJURED	TRUCKS	DRY SURF	WET SURF	DAY	DARK	INTER-SECTION	INTER-SECTION RELATED	OFF-ROAD
YEAR:														
TOTAL														
FINAL TOTAL														

Disclaimer: A higher number of crashes may be reported as of 2011 compared to prior years. This does not reflect an increase in annual crashes. The higher numbers result from a change to an internal departmental process that allows the Crash Analysis and Reporting Unit to add previously unavailable, non-fatal crash reports to the annual data file. Please be aware of this change when comparing pre-2011 crash statistics.

```
CITY OF PORTLAND N,  MULTNOMAH COUNTY                                                             N Suttle Rd & N Portland Rd
                                                                                            January 1, 2011 through December 31, 2015

        S   D
        P   R S W                       CITY STREET                           INT-TYP                                        SPCL USE
SER#    E A U C O   DATE                FIRST STREET               RD CHAR    (MEDIAN) INT-REL OFF-RD  WTHR  CRASH TYP       TRLR QTY   MOVE                    A  S
INVEST  E L G H R   DAY/TIME    FC      SECOND STREET              DIRECT       LEGS   TRAF-   RNDBT   SURF  COLL TYP        OWNER      FROM       PRTC  INJ    G  E LICNS  PED
UNLOC?  D C S L K   LAT/LONG    DISTNC INTERSECTION SEQ #          LOCTN      (#LANES) CONTL   DRVWY   LIGHT SVRTY        V# VEH TYPE   TO      P# TYPE  SVRTY  E  X RES    LOC  ERROR       ACTN EVENT         CAUSE

11672   N N N       10/31/2013  16      N PORTLAND RD              INTER       CROSS   N            N  RAIN  S-1STOP      01 NONE    0  STRGHT                                                    013           07
NO RPT              Thu    6A    0      N SUTTLE RD                NE                  TRF SIGNAL   N  WET   REAR            PRVTE      NE  SW                                                000               00
No     45 36 44.53   -122 42 18.00       1                         06             0                 N  DLIT  PDO            PSNGR CAR           01 DRVR  NONE  54  M OTH-Y       026          000               07
                                                                                                                                                                     N-RES

                                                                                                                          02 NONE    0  STOP
                                                                                                                             PRVTE      NE  SW                                                011 013           00
                                                                                                                            PSNGR CAR           01 DRVR  NONE  45  F OTH-Y       000          000               00
                                                                                                                                                                     N-RES

                                                                                                                          03 NONE    0  STOP
                                                                                                                             PRVTE      NE  SW                                                022 013           00
                                                                                                                            PSNGR CAR           01 DRVR  NONE  40  M OTH-Y       000          000               00
                                                                                                                                                                     N-RES

                                                                                                                          04 NONE    0  STOP
                                                                                                                             PRVTE      NE  SW                                                011               00
                                                                                                                            PSNGR CAR           01 DRVR  NONE  56  F OTH-Y       000          000               00
                                                                                                                                                                     N-RES

06482   N N N       06/28/2013  16      N PORTLAND RD              INTER       3-LEG   N            N  CLR   S-OTHER      01 NONE    1  TURN-R                                                                  06
NO RPT              Fri    3P    0      N SUTTLE RD                CN                  STOP SIGN    N  DRY   TURN            PRVTE      NW  SW                                                000               00
No     45 36 44.53   -122 42 18.00       1                         03             0                 N  DAY   PDO            PSNGR CAR           01 DRVR  NONE  38  M OR-Y        000          000               00
                                                                                                                                                                     OR>25

                                                                                                                          02 NONE    0  TURN-R
                                                                                                                             PRVTE      NW  SW                                                031               00
                                                                                                                            PSNGR CAR           01 DRVR  NONE  60  F OR-Y        031          000               06
                                                                                                                                                                     OR>25
```

ACTION CODE TRANSLATION LIST

ACTION CODE	SHORT DESCRIPTION	LONG DESCRIPTION
000	NONE	NO ACTION OR NON-WARRANTED
001	SKIDDED	SKIDDED
002	ON/OFF V	GETTING ON OR OFF STOPPED OR PARKED VEHICLE
003	LOAD OVR	OVERHANGING LOAD STRUCK ANOTHER VEHICLE, ETC.
006	SLOW DN	SLOWED DOWN
007	AVOIDING	AVOIDING MANEUVER
008	PAR PARK	PARALLEL PARKING
009	ANG PARK	ANGLE PARKING
010	INTERFERE	PASSENGER INTERFERING WITH DRIVER
011	STOPPED	STOPPED IN TRAFFIC NOT WAITING TO MAKE A LEFT TURN
012	STP/L TRN	STOPPED BECAUSE OF LEFT TURN SIGNAL OR WAITING, ETC.
013	STP TURN	STOPPED WHILE EXECUTING A TURN
014	EMR V PKD	EMERGENCY VEHICLE LEGALLY PARKED IN THE ROADWAY
015	GO A/STOP	PROCEED AFTER STOPPING FOR A STOP SIGN/FLASHING RED.
016	TRN A/RED	TURNED ON RED AFTER STOPPING
017	LOSTCTRL	LOST CONTROL OF VEHICLE
018	EXIT DWY	ENTERING STREET OR HIGHWAY FROM ALLEY OR DRIVEWAY
019	ENTR DWY	ENTERING ALLEY OR DRIVEWAY FROM STREET OR HIGHWAY
020	STR ENTR	BEFORE ENTERING ROADWAY, STRUCK PEDESTRIAN, ETC. ON SIDEWALK OR SHOULDER
021	NO DRVR	CAR RAN AWAY - NO DRIVER
022	PREV COL	STRUCK, OR WAS STRUCK BY, VEHICLE OR PEDESTRIAN IN PRIOR COLLISION BEFORE ACC. STABILIZED
023	STALLED	VEHICLE STALLED OR DISABLED
024	DRVR DEAD	DEAD BY UNASSOCIATED CAUSE
025	FATIGUE	FATIGUED, SLEEPY, ASLEEP
026	SUN	DRIVER BLINDED BY SUN
027	HDLGHTS	DRIVER BLINDED BY HEADLIGHTS
028	ILLNESS	PHYSICALLY ILL
029	THRU MED	VEHICLE CROSSED, PLUNGED OVER, OR THROUGH MEDIAN BARRIER
030	PURSUIT	PURSUING OR ATTEMPTING TO STOP A VEHICLE
031	PASSING	PASSING SITUATION
032	PRKOFFRD	VEHICLE PARKED BEYOND CURB OR SHOULDER
033	CROS MED	VEHICLE CROSSED EARTH OR GRASS MEDIAN
034	X N/SGNL	CROSSING AT INTERSECTION - NO TRAFFIC SIGNAL PRESENT
035	X W/ SGNL	CROSSING AT INTERSECTION - TRAFFIC SIGNAL PRESENT
036	DIAGONAL	CROSSING AT INTERSECTION - DIAGONALLY
037	BTWN INT	CROSSING BETWEEN INTERSECTIONS
038	DISTRACT	DRIVER'S ATTENTION DISTRACTED
039	W/TRAF-S	WALKING, RUNNING, RIDING, ETC., ON SHOULDER WITH TRAFFIC
040	A/TRAF-S	WALKING, RUNNING, RIDING, ETC., ON SHOULDER FACING TRAFFIC
041	W/TRAF-P	WALKING, RUNNING, RIDING, ETC., ON PAVEMENT WITH TRAFFIC
042	A/TRAF-P	WALKING, RUNNING, RIDING, ETC., ON PAVEMENT FACING TRAFFIC
043	PLAYINRD	PLAYING IN STREET OR ROAD
044	PUSH MV	PUSHING OR WORKING ON VEHICLE IN ROAD OR ON SHOULDER
045	WORK ON	WORKING IN ROADWAY OR ALONG SHOULDER
046	W/ TRAFIC	NON-MOTORIST WALKING, RUNNING, RIDING, ETC. WITH TRAFFIC
047	A/ TRAFIC	NON-MOTORIST WALKING, RUNNING, RIDING, ETC. FACING TRAFFIC
050	LAY ON RD	STANDING OR LYING IN ROADWAY
051	ENT OFFRD	ENTERING / STARTING IN TRAFFIC LANE FROM OFF ROAD
052	MERGING	MERGING
055	SPRAY	BLINDED BY WATER SPRAY

ACTION CODE TRANSLATION LIST

ACTION CODE	SHORT DESCRIPTION	LONG DESCRIPTION
088	OTHER	OTHER ACTION
099	UNK	UNKNOWN ACTION

CAUSE CODE TRANSLATION LIST

CAUSE CODE	SHORT DESCRIPTION	LONG DESCRIPTION
00	NO CODE	NO CAUSE ASSOCIATED AT THIS LEVEL
01	TOO-FAST	TOO FAST FOR CONDITIONS (NOT EXCEED POSTED SPEED
02	NO-YIELD	DID NOT YIELD RIGHT-OF-WAY
03	PAS-STOP	PASSED STOP SIGN OR RED FLASHER
04	DIS SIG	DISREGARDED TRAFFIC SIGNAL
05	LEFT-CTR	DROVE LEFT OF CENTER ON TWO-WAY ROAD; STRADDLING
06	IMP-OVER	IMPROPER OVERTAKING
07	TOO-CLOS	FOLLOWED TOO CLOSELY
08	IMP-TURN	MADE IMPROPER TURN
09	DRINKING	ALCOHOL OR DRUG INVOLVED
10	OTHR-IMP	OTHER IMPROPER DRIVING
11	MECH-DEF	MECHANICAL DEFECT
12	OTHER	OTHER (NOT IMPROPER DRIVING)
13	IMP LN C	IMPROPER CHANGE OF TRAFFIC LANES
14	DIS TCD	DISREGARDED OTHER TRAFFIC CONTROL DEVICE
15	WRNG WAY	WRONG WAY ON ONE-WAY ROAD; WRONG SIDE DIVIDED RO
16	FATIGUE	DRIVER DROWSY/FATIGUED/SLEEPY
17	ILLNESS	PHYSICAL ILLNESS
18	IN RDWY	NON-MOTORIST ILLEGALLY IN ROADWAY
19	NT VISBL	NON-MOTORIST NOT VISIBLE; NON-REFLECTIVE CLOTHIN
20	IMP PKNG	VEHICLE IMPROPERLY PARKED
21	DEF STER	DEFECTIVE STEERING MECHANISM
22	DEF BRKE	INADEQUATE OR NO BRAKES
24	LOADSHFT	VEHICLE LOST LOAD OR LOAD SHIFTED
25	TIREFAIL	TIRE FAILURE
26	PHANTOM	PHANTOM / NON-CONTACT VEHICLE
27	INATTENT	INATTENTION
28	NM INATT	NON-MOTORIST INATTENTION
29	F AVOID	FAILED TO AVOID VEHICLE AHEAD
30	SPEED	DRIVING IN EXCESS OF POSTED SPEED
31	RACING	SPEED RACING (PER PAR)
32	CARELESS	CARELESS DRIVING (PER PAR)
33	RECKLESS	RECKLESS DRIVING (PER PAR)
34	AGGRESV	AGGRESSIVE DRIVING (PER PAR)
35	RD RAGE	ROAD RAGE (PER PAR)
40	VIEW OBS	VIEW OBSCURED
50	USED MDN	IMPROPER USE OF MEDIAN OR SHOULDER
51	FAIL LN	FAILED TO MAINTAIN LANE
52	OFF RD	RAN OFF ROAD

COLLISION TYPE CODE TRANSLATION LIST

COLL CODE	SHORT DESCRIPTION	LONG DESCRIPTION
&	OTH	MISCELLANEOUS
-	BACK	BACKING
0	PED	PEDESTRIAN
1	ANGL	ANGLE
2	HEAD	HEAD-ON
3	REAR	REAR-END
4	SS-M	SIDESWIPE - MEETING
5	SS-O	SIDESWIPE - OVERTAKING
6	TURN	TURNING MOVEMENT
7	PARK	PARKING MANEUVER
8	NCOL	NON-COLLISION
9	FIX	FIXED OBJECT OR OTHER OBJECT

CRASH TYPE CODE TRANSLATION LIST

CRASH TYPE	SHORT DESCRIPTION	LONG DESCRIPTION
&	OVERTURN	OVERTURNED
0	NON-COLL	OTHER NON-COLLISION
1	OTH RDWY	MOTOR VEHICLE ON OTHER ROADWAY
2	PRKD MV	PARKED MOTOR VEHICLE
3	PED	PEDESTRIAN
4	TRAIN	RAILWAY TRAIN
6	BIKE	PEDALCYCLIST
7	ANIMAL	ANIMAL
8	FIX OBJ	FIXED OBJECT
9	OTH OBJ	OTHER OBJECT
A	ANGL-STP	ENTERING AT ANGLE - ONE VEHICLE STOPPED
B	ANGL-OTH	ENTERING AT ANGLE - ALL OTHERS
C	S-STRGHT	FROM SAME DIRECTION - BOTH GOING STRAIGHT
D	S-1TURN	FROM SAME DIRECTION - ONE TURN, ONE STRAIGHT
E	S-1STOP	FROM SAME DIRECTION - ONE STOPPED
F	S-OTHER	FROM SAME DIRECTION-ALL OTHERS, INCLUDING PARKING
G	O-STRGHT	FROM OPPOSITE DIRECTION - BOTH GOING STRAIGHT
H	O-1 L-TURN	FROM OPPOSITE DIRECTION-ONE LEFT TURN,ONE STRAIGHT
I	O-1STOP	FROM OPPOSITE DIRECTION - ONE STOPPED
J	O-OTHER	FROM OPPOSITE DIRECTION-ALL OTHERS INCL. PARKING

DRIVER LICENSE CODE TRANSLATION LIST

LIC CODE	SHORT DESC	LONG DESCRIPTION
0	NONE	NOT LICENSED (HAD NEVER BEEN LICENSED)
1	OR-Y	VALID OREGON LICENSE
2	OTH-Y	VALID LICENSE, OTHER STATE OR COUNTRY
3	SUSP	SUSPENDED/REVOKED

DRIVER RESIDENCE CODE TRANSLATION LIST

RES CODE	SHORT DESC	LONG DESCRIPTION
1	OR<25	OREGON RESIDENT WITHIN 25 MILE OF HOME
2	OR>25	OREGON RESIDENT 25 OR MORE MILES FROM HOME
3	OR-?	OREGON RESIDENT - UNKNOWN DISTANCE FROM HOME
4	N-RES	NON-RESIDENT
9	UNK	UNKNOWN IF OREGON RESIDENT

ERROR CODE TRANSLATION LIST

ERROR CODE	SHORT DESCRIPTION	FULL DESCRIPTION
000	NONE	NO ERROR
001	WIDE TRN	WIDE TURN
002	CUT CORN	CUT CORNER ON TURN
003	FAIL TRN	FAILED TO OBEY MANDATORY TRAFFIC TURN SIGNAL, SIGN OR LANE MARKINGS
004	L IN TRF	LEFT TURN IN FRONT OF ONCOMING TRAFFIC
005	L PROHIB	LEFT TURN WHERE PROHIBITED
006	FRM WRNG	TURNED FROM WRONG LANE
007	TO WRONG	TURNED INTO WRONG LANE
008	ILLEG U	U-TURNED ILLEGALLY
009	IMP STOP	IMPROPERLY STOPPED IN TRAFFIC LANE
010	IMP SIG	IMPROPER SIGNAL OR FAILURE TO SIGNAL
011	IMP BACK	BACKING IMPROPERLY (NOT PARKING)
012	IMP PARK	IMPROPERLY PARKED
013	UNPARK	IMPROPER START LEAVING PARKED POSITION
014	IMP STRT	IMPROPER START FROM STOPPED POSITION
015	IMP LGHT	IMPROPER OR NO LIGHTS (VEHICLE IN TRAFFIC)
016	INATTENT	INATTENTION (FAILURE TO DIM LIGHTS PRIOR TO 4/1/97)
017	UNSF VEH	DRIVING UNSAFE VEHICLE (NO OTHER ERROR APPARENT)
018	OTH PARK	ENTERING/EXITING PARKED POSITION W/ INSUFFICIENT CLEARANCE; OTHER IMPROPER PARKING MANEUVER
019	DIS DRIV	DISREGARDED OTHER DRIVER'S SIGNAL
020	DIS SGNL	DISREGARDED TRAFFIC SIGNAL
021	RAN STOP	DISREGARDED STOP SIGN OR FLASHING RED
022	DIS SIGN	DISREGARDED WARNING SIGN, FLARES OR FLASHING AMBER
023	DIS OFCR	DISREGARDED POLICE OFFICER OR FLAGMAN
024	DIS EMER	DISREGARDED SIREN OR WARNING OF EMERGENCY VEHICLE
025	DIS RR	DISREGARDED RR SIGNAL, RR SIGN, OR RR FLAGMAN
026	REAR-END	FAILED TO AVOID STOPPED OR PARKED VEHICLE AHEAD OTHER THAN SCHOOL BUS
027	BIKE ROW	DID NOT HAVE RIGHT-OF-WAY OVER PEDALCYCLIST
028	NO ROW	DID NOT HAVE RIGHT-OF-WAY
029	PED ROW	FAILED TO YIELD RIGHT-OF-WAY TO PEDESTRIAN
030	PAS CURV	PASSING ON A CURVE
031	PAS WRNG	PASSING ON THE WRONG SIDE
032	PAS TANG	PASSING ON STRAIGHT ROAD UNDER UNSAFE CONDITIONS
033	PAS X-WK	PASSED VEHICLE STOPPED AT CROSSWALK FOR PEDESTRIAN
034	PAS INTR	PASSING AT INTERSECTION
035	PAS HILL	PASSING ON CREST OF HILL
036	N/PAS ZN	PASSING IN "NO PASSING" ZONE
037	PAS TRAF	PASSING IN FRONT OF ONCOMING TRAFFIC
038	CUT-IN	CUTTING IN (TWO LANES - TWO WAY ONLY)
039	WRNGSIDE	DRIVING ON WRONG SIDE OF THE ROAD (2-WAY UNDIVIDED ROADWAYS)
040	THRU MED	DRIVING THROUGH SAFETY ZONE OR OVER ISLAND
041	F/ST BUS	FAILED TO STOP FOR SCHOOL BUS

ERROR CODE TRANSLATION LIST

ERROR CODE	SHORT DESCRIPTION	FULL DESCRIPTION
042	F/SLO MV	FAILED TO DECREASE SPEED FOR SLOWER MOVING VEHICLE
043	TOO CLOSE	FOLLOWING TOO CLOSELY (MUST BE ON OFFICER'S REPORT)
044	STRDL LN	STRADDLING OR DRIVING ON WRONG LANES
045	IMP CHG	IMPROPER CHANGE OF TRAFFIC LANES
046	WRNG WAY	WRONG WAY ON ONE-WAY ROADWAY; WRONG SIDE DIVIDED ROAD
047	BASCRULE	DRIVING TOO FAST FOR CONDITIONS (NOT EXCEEDING POSTED SPEED)
048	OPN DOOR	OPENED DOOR INTO ADJACENT TRAFFIC LANE
049	IMPEDING	IMPEDING TRAFFIC
050	SPEED	DRIVING IN EXCESS OF POSTED SPEED
051	RECKLESS	RECKLESS DRIVING (PER PAR)
052	CARELESS	CARELESS DRIVING (PER PAR)
053	RACING	SPEED RACING (PER PAR)
054	X N/SGNL	CROSSING AT INTERSECTION, NO TRAFFIC SIGNAL PRESENT
055	X W/SGNL	CROSSING AT INTERSECTION, TRAFFIC SIGNAL PRESENT
056	DIAGONAL	CROSSING AT INTERSECTION - DIAGONALLY
057	BTWN INT	CROSSING BETWEEN INTERSECTIONS
059	W/TRAF-S	WALKING, RUNNING, RIDING, ETC., ON SHOULDER WITH TRAFFIC
060	A/TRAF-S	WALKING, RUNNING, RIDING, ETC., ON SHOULDER FACING TRAFFIC
061	W/TRAF-P	WALKING, RUNNING, RIDING, ETC., ON PAVEMENT WITH TRAFFIC
062	A/TRAF-P	WALKING, RUNNING, RIDING, ETC., ON PAVEMENT FACING TRAFFIC
063	PLAYINRD	PLAYING IN STREET OR ROAD
064	PUSH MV	PUSHING OR WORKING ON VEHICLE IN ROAD OR ON SHOULDER
065	WORK IN RD	WORKING IN ROADWAY OR ALONG SHOULDER
070	LAY ON RD	STANDING OR LYING IN ROADWAY
071	NM IMP USE	IMPROPER USE OF TRAFFIC LANE BY NON-MOTORIST
073	ELUDING	ELUDING / ATTEMPT TO ELUDE
079	F NEG CURV	FAILED TO NEGOTIATE A CURVE
080	FAIL LN	FAILED TO MAINTAIN LANE
081	OFF RD	RAN OFF ROAD
082	NO CLEAR	DRIVER MISJUDGED CLEARANCE
083	OVRSTEER	OVER-CORRECTING
084	NOT USED	CODE NOT IN USE
085	OVRLOAD	OVERLOADING OR IMPROPER LOADING OF VEHICLE WITH CARGO OR PASSENGERS
097	UNA DIS TC	UNABLE TO DETERMINE WHICH DRIVER DISREGARDED TRAFFIC CONTROL DEVICE

EVENT CODE TRANSLATION LIST

EVENT CODE	SHORT DESCRIPTION	LONG DESCRIPTION
001	FEL/JUMP	OCCUPANT FELL, JUMPED OR WAS EJECTED FROM MOVING VEHICLE
002	INTERFER	PASSENGER INTERFERED WITH DRIVER
003	BUG INTF	ANIMAL OR INSECT IN VEHICLE INTERFERED WITH DRIVER
004	INDRCT PED	PEDESTRIAN INDIRECTLY INVOLVED (NOT STRUCK)
005	SUB-PED	"SUB-PED": PEDESTRIAN INJURED SUBSEQUENT TO COLLISION, ETC.
006	INDRCT BIK	PEDALCYCLIST INDIRECTLY INVOLVED (NOT STRUCK)
007	HITCHIKR	HITCHHIKER (SOLICITING A RIDE)
008	PSNGR TOW	PASSENGER OR NON-MOTORIST BEING TOWED OR PUSHED ON CONVEYANCE
009	ON/OFF V	GETTING ON/OFF STOPPED/PARKED VEHICLE (OCCUPANTS ONLY; MUST HAVE PHYSICAL CONTACT W/ VEHI
010	SUB OTRN	OVERTURNED AFTER FIRST HARMFUL EVENT
011	MV PUSHD	VEHICLE BEING PUSHED
012	MV TOWED	VEHICLE TOWED OR HAD BEEN TOWING ANOTHER VEHICLE
013	FORCED	VEHICLE FORCED BY IMPACT INTO ANOTHER VEHICLE, PEDALCYCLIST OR PEDESTRIAN
014	SET MOTN	VEHICLE SET IN MOTION BY NON-DRIVER (CHILD RELEASED BRAKES, ETC.)
015	RR ROW	AT OR ON RAILROAD RIGHT-OF-WAY (NOT LIGHT RAIL)
016	LT RL ROW	AT OR ON LIGHT-RAIL RIGHT-OF-WAY
017	RR HIT V	TRAIN STRUCK VEHICLE
018	V HIT RR	VEHICLE STRUCK TRAIN
019	HIT RR CAR	VEHICLE STRUCK RAILROAD CAR ON ROADWAY
020	JACKNIFE	JACKKNIFE; TRAILER OR TOWED VEHICLE STRUCK TOWING VEHICLE
021	TRL OTRN	TRAILER OR TOWED VEHICLE OVERTURNED
022	CN BROKE	TRAILER CONNECTION BROKE
023	DETACH TRL	DETACHED TRAILING OBJECT STRUCK OTHER VEHICLE, NON-MOTORIST, OR OBJECT
024	V DOOR OPN	VEHICLE DOOR OPENED INTO ADJACENT TRAFFIC LANE
025	WHEELOFF	WHEEL CAME OFF
026	HOOD UP	HOOD FLEW UP
028	LOAD SHIFT	LOST LOAD, LOAD MOVED OR SHIFTED
029	TIREFAIL	TIRE FAILURE
030	PET	PET: CAT, DOG AND SIMILAR
031	LVSTOCK	STOCK: COW, CALF, BULL, STEER, SHEEP, ETC.
032	HORSE	HORSE, MULE, OR DONKEY
033	HRSE&RID	HORSE AND RIDER
034	GAME	WILD ANIMAL, GAME (INCLUDES BIRDS; NOT DEER OR ELK)
035	DEER ELK	DEER OR ELK, WAPITI
036	ANML VEH	ANIMAL-DRAWN VEHICLE
037	CULVERT	CULVERT, OPEN LOW OR HIGH MANHOLE
038	ATENUATN	IMPACT ATTENUATOR
039	PK METER	PARKING METER
040	CURB	CURB (ALSO NARROW SIDEWALKS ON BRIDGES)
041	JIGGLE	JIGGLE BAR OR TRAFFIC SNAKE FOR CHANNELIZATION
042	GDRL END	LEADING EDGE OF GUARDRAIL
043	GARDRAIL	GUARD RAIL (NOT METAL MEDIAN BARRIER)
044	BARRIER	MEDIAN BARRIER (RAISED OR METAL)
045	WALL	RETAINING WALL OR TUNNEL WALL
046	BR RAIL	BRIDGE RAILING OR PARAPET (ON BRIDGE OR APPROACH)
047	BR ABUTMNT	BRIDGE ABUTMENT (INCLUDED "APPROACH END" THRU 2013)
048	BR COLMN	BRIDGE PILLAR OR COLUMN
049	BR GIRDR	BRIDGE GIRDER (HORIZONTAL BRIDGE STRUCTURE OVERHEAD)
050	ISLAND	TRAFFIC RAISED ISLAND
051	GORE	GORE
052	POLE UNK	POLE – TYPE UNKNOWN
053	POLE UTL	POLE – POWER OR TELEPHONE
054	ST LIGHT	POLE – STREET LIGHT ONLY
055	TRF SGNL	POLE – TRAFFIC SIGNAL AND PED SIGNAL ONLY
056	SGN BRDG	POLE – SIGN BRIDGE
057	STOPSIGN	STOP OR YIELD SIGN
058	OTH SIGN	OTHER SIGN, INCLUDING STREET SIGNS
059	HYDRANT	HYDRANT

EVENT CODE TRANSLATION LIST

EVENT CODE	SHORT DESCRIPTION	LONG DESCRIPTION
060	MARKER	DELINEATOR OR MARKER (REFLECTOR POSTS)
061	MAILBOX	MAILBOX
062	TREE	TREE, STUMP OR SHRUBS
063	VEG OHED	TREE BRANCH OR OTHER VEGETATION OVERHEAD, ETC.
064	WIRE/CBL	WIRE OR CABLE ACROSS OR OVER THE ROAD
065	TEMP SGN	TEMPORARY SIGN OR BARRICADE IN ROAD, ETC.
066	PERM SGN	PERMANENT SIGN OR BARRICADE IN/OFF ROAD
067	SLIDE	SLIDES, FALLEN OR FALLING ROCKS
068	FRGN OBJ	FOREIGN OBSTRUCTION/DEBRIS IN ROAD (NOT GRAVEL)
069	EQP WORK	EQUIPMENT WORKING IN/OFF ROAD
070	OTH EQP	OTHER EQUIPMENT IN OR OFF ROAD (INCLUDES PARKED TRAILER, BOAT)
071	MAIN EQP	WRECKER, STREET SWEEPER, SNOW PLOW OR SANDING EQUIPMENT
072	OTHER WALL	ROCK, BRICK OR OTHER SOLID WALL
073	IRRGL PVMT	OTHER BUMP (NOT SPEED BUMP), POTHOLE OR PAVEMENT IRREGULARITY (PER PAR)
074	OVERHD OBJ	OTHER OVERHEAD OBJECT (HIGHWAY SIGN, SIGNAL HEAD, ETC.); NOT BRIDGE
075	CAVE IN	BRIDGE OR ROAD CAVE IN
076	HI WATER	HIGH WATER
077	SNO BANK	SNOW BANK
078	LO-HI EDGE	LOW OR HIGH SHOULDER AT PAVEMENT EDGE
079	DITCH	CUT SLOPE OR DITCH EMBANKMENT
080	OBJ FRM MV	STRUCK BY ROCK OR OTHER OBJECT SET IN MOTION BY OTHER VEHICLE (INCL. LOST LOADS)
081	FLY-OBJ	STRUCK BY ROCK OR OTHER MOVING OR FLYING OBJECT (NOT SET IN MOTION BY VEHICLE)
082	VEH HID	VEHICLE OBSCURED VIEW
083	VEG HID	VEGETATION OBSCURED VIEW
084	BLDG HID	VIEW OBSCURED BY FENCE, SIGN, PHONE BOOTH, ETC.
085	WIND GUST	WIND GUST
086	IMMERSED	VEHICLE IMMERSED IN BODY OF WATER
087	FIRE/EXP	FIRE OR EXPLOSION
088	FENC/BLD	FENCE OR BUILDING, ETC.
089	OTHR CRASH	CRASH RELATED TO ANOTHER SEPARATE CRASH
090	TO 1 SIDE	TWO-WAY TRAFFIC ON DIVIDED ROADWAY ALL ROUTED TO ONE SIDE
091	BUILDING	BUILDING OR OTHER STRUCTURE
092	PHANTOM	OTHER (PHANTOM) NON-CONTACT VEHICLE
093	CELL PHONE	CELL PHONE (ON PAR OR DRIVER IN USE)
094	VIOL GDL	TEENAGE DRIVER IN VIOLATION OF GRADUATED LICENSE PGM
095	GUY WIRE	GUY WIRE
096	BERM	BERM (EARTHEN OR GRAVEL MOUND)
097	GRAVEL	GRAVEL IN ROADWAY
098	ABR EDGE	ABRUPT EDGE
099	CELL WTNSD	CELL PHONE USE WITNESSED BY OTHER PARTICIPANT
100	UNK FIXD	FIXED OBJECT, UNKNOWN TYPE.
101	OTHER OBJ	NON-FIXED OBJECT, OTHER OR UNKNOWN TYPE
102	TEXTING	TEXTING
103	WZ WORKER	WORK ZONE WORKER
104	ON VEHICLE	PASSENGER RIDING ON VEHICLE EXTERIOR
105	PEDAL PSGR	PASSENGER RIDING ON PEDALCYCLE
106	MAN WHLCHR	PEDESTRIAN IN NON-MOTORIZED WHEELCHAIR
107	MTR WHLCHR	PEDESTRIAN IN MOTORIZED WHEELCHAIR
108	OFFICER	LAW ENFORCEMENT / POLICE OFFICER
109	SUB-BIKE	"SUB-BIKE": PEDALCYCLIST INJURED SUBSEQUENT TO COLLISION, ETC.
110	N-MTR	NON-MOTORIST STRUCK VEHICLE
111	S CAR VS V	STREET CAR/TROLLEY (ON RAILS OR OVERHEAD WIRE SYSTEM) STRUCK VEHICLE
112	V VS S CAR	VEHICLE STRUCK STREET CAR/TROLLEY (ON RAILS OR OVERHEAD WIRE SYSTEM)
113	S CAR ROW	AT OR ON STREET CAR OR TROLLEY RIGHT-OF-WAY
114	RR EQUIP	VEHICLE STRUCK RAILROAD EQUIPMENT (NOT TRAIN) ON TRACKS
115	DSTRCT GPS	DISTRACTED BY NAVIGATION SYSTEM OR GPS DEVICE
116	DSTRCT OTH	DISTRACTED BY OTHER ELECTRONIC DEVICE
117	RR GATE	RAIL CROSSING DROP-ARM GATE

EVENT CODE TRANSLATION LIST

EVENT CODE	SHORT DESCRIPTION	LONG DESCRIPTION
118	EXPNSN JNT	EXPANSION JOINT
119	JERSEY BAR	JERSEY BARRIER
120	WIRE BAR	WIRE OR CABLE MEDIAN BARRIER
121	FENCE	FENCE
123	OBJ IN VEH	LOOSE OBJECT IN VEHICLE STRUCK OCCUPANT
124	SLIPPERY	SLIDING OR SWERVING DUE TO WET, ICY, SLIPPERY OR LOOSE SURFACE (NOT GRAVEL)
125	SHLDR	SHOULDER GAVE WAY
126	BOULDER	ROCK(S), BOULDER (NOT GRAVEL; NOT ROCK SLIDE)
127	LAND SLIDE	ROCK SLIDE OR LAND SLIDE
128	CURVE INV	CURVE PRESENT AT CRASH LOCATION
129	HILL INV	VERTICAL GRADE / HILL PRESENT AT CRASH LOCATION
130	CURVE HID	VIEW OBSCURED BY CURVE
131	HILL HID	VIEW OBSCURED BY VERTICAL GRADE / HILL
132	WINDOW HID	VIEW OBSCURED BY VEHICLE WINDOW CONDITIONS
133	SPRAY HID	VIEW OBSCURED BY WATER SPRAY

FUNCTIONAL CLASSIFICATION TRANSLATION LIST

FUNC CLASS	DESCRIPTION
01	RURAL PRINCIPAL ARTERIAL - INTERSTATE
02	RURAL PRINCIPAL ARTERIAL - OTHER
06	RURAL MINOR ARTERIAL
07	RURAL MAJOR COLLECTOR
08	RURAL MINOR COLLECTOR
09	RURAL LOCAL
11	URBAN PRINCIPAL ARTERIAL - INTERSTATE
12	URBAN PRINCIPAL ARTERIAL - OTHER FREEWAYS AND EXP
14	URBAN PRINCIPAL ARTERIAL - OTHER
16	URBAN MINOR ARTERIAL
17	URBAN MAJOR COLLECTOR
18	URBAN MINOR COLLECTOR
19	URBAN LOCAL
78	UNKNOWN RURAL SYSTEM
79	UNKNOWN RURAL NON-SYSTEM
98	UNKNOWN URBAN SYSTEM
99	UNKNOWN URBAN NON-SYSTEM

HIGHWAY COMPONENT TRANSLATION LIST

CODE	DESCRIPTION
0	MAINLINE STATE HIGHWAY
1	COUPLET
3	FRONTAGE ROAD
6	CONNECTION
8	HIGHWAY - OTHER

INJURY SEVERITY CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
1	KILL	FATAL INJURY
2	INJA	INCAPACITATING INJURY - BLEEDING, BROKEN BONES
3	INJB	NON-INCAPACITATING INJURY
4	INJC	POSSIBLE INJURY - COMPLAINT OF PAIN
5	PRI	DIED PRIOR TO CRASH
7	NO<5	NO INJURY - 0 TO 4 YEARS OF AGE

LIGHT CONDITION CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	UNK	UNKNOWN
1	DAY	DAYLIGHT
2	DLIT	DARKNESS - WITH STREET LIGHTS
3	DARK	DARKNESS - NO STREET LIGHTS
4	DAWN	DAWN (TWILIGHT)
5	DUSK	DUSK (TWILIGHT)

MEDIAN TYPE CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	NONE	NO MEDIAN
1	RSDMD	SOLID MEDIAN BARRIER
2	DIVMD	EARTH, GRASS OR PAVED MEDIAN

MILEAGE TYPE CODE TRANSLATION LIST

CODE	LONG DESCRIPTION
0	REGULAR MILEAGE
T	TEMPORARY
Y	SPUR
Z	OVERLAPPING

MOVEMENT TYPE CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	UNK	UNKNOWN
1	STRGHT	STRAIGHT AHEAD
2	TURN-R	TURNING RIGHT
3	TURN-L	TURNING LEFT
4	U-TURN	MAKING A U-TURN
5	BACK	BACKING
6	STOP	STOPPED IN TRAFFIC
7	PRKD-P	PARKED - PROPERLY
8	PRKD-I	PARKED - IMPROPERLY

PEDESTRIAN LOCATION CODE TRANSLATION LIST

CODE	LONG DESCRIPTION
00	AT INTERSECTION - NOT IN ROADWAY
01	AT INTERSECTION - INSIDE CROSSWALK
02	AT INTERSECTION - IN ROADWAY, OUTSIDE CROSSWALK
03	AT INTERSECTION - IN ROADWAY, XWALK AVAIL UNKNWN
04	NOT AT INTERSECTION - IN ROADWAY
05	NOT AT INTERSECTION - ON SHOULDER
06	NOT AT INTERSECTION - ON MEDIAN
07	NOT AT INTERSECTION - WITHIN TRAFFIC RIGHT-OF-WAY
08	NOT AT INTERSECTION - IN BIKE PATH OR PARKING LANE
09	NOT-AT INTERSECTION - ON SIDEWALK
10	OUTSIDE TRAFFICWAY BOUNDARIES
13	AT INTERSECTION - IN BIKE LANE
14	NOT AT INTERSECTION - IN BIKE LANE
15	NOT AT INTERSECTION - INSIDE MID-BLOCK CROSSWALK
16	NOT AT INTERSECTION - IN PARKING LANE

ROAD CHARACTER CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	UNK	UNKNOWN
1	INTER	INTERSECTION
2	ALLEY	DRIVEWAY OR ALLEY
3	STRGHT	STRAIGHT ROADWAY
4	TRANS	TRANSITION
5	CURVE	CURVE (HORIZONTAL CURVE)
6	OPENAC	OPEN ACCESS OR TURNOUT
7	GRADE	GRADE (VERTICAL CURVE)
8	BRIDGE	BRIDGE STRUCTURE
9	TUNNEL	TUNNEL

PARTICIPANT TYPE CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	OCC	UNKNOWN OCCUPANT TYPE
1	DRVR	DRIVER
2	PSNG	PASSENGER
3	PED	PEDESTRIAN
4	CONV	PEDESTRIAN USING A PEDESTRIAN CONVEYA
5	PTOW	PEDESTRIAN TOWING OR TRAILERING AN OB
6	BIKE	PEDALCYCLIST
7	BTOW	PEDALCYCLIST TOWING OR TRAILERING AN
8	PRKD	OCCUPANT OF A PARKED MOTOR VEHICLE
9	UNK	UNKNOWN TYPE OF NON-MOTORIST

TRAFFIC CONTROL DEVICE CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
000	NONE	NO CONTROL
001	TRF SIGNAL	TRAFFIC SIGNALS
002	FLASHBCN-R	FLASHING BEACON - RED (STOP)
003	FLASHBCN-A	FLASHING BEACON - AMBER (SLOW)
004	STOP SIGN	STOP SIGN
005	SLOW SIGN	SLOW SIGN
006	REG-SIGN	REGULATORY SIGN
007	YIELD	YIELD SIGN
008	WARNING	WARNING SIGN
009	CURVE	CURVE SIGN
010	SCHL X-ING	SCHOOL CROSSING SIGN OR SPECIAL SIGNAL
011	OFCR/FLAG	POLICE OFFICER, FLAGMAN - SCHOOL PATROL
012	BRDG-GATE	BRIDGE GATE - BARRIER
013	TEMP-BARR	TEMPORARY BARRIER
014	NO-PASS-ZN	NO PASSING ZONE
015	ONE-WAY	ONE-WAY STREET
016	CHANNEL	CHANNELIZATION
017	MEDIAN BAR	MEDIAN BARRIER
018	PILOT CAR	PILOT CAR
019	SP PED SIG	SPECIAL PEDESTRIAN SIGNAL
020	X-BUCK	CROSSBUCK
021	THR-GN-SIG	THROUGH GREEN ARROW OR SIGNAL
022	L-GRN-SIG	LEFT TURN GREEN ARROW, LANE MARKINGS, OR SIGNAL
023	R-GRN-SIG	RIGHT TURN GREEN ARROW, LANE MARKINGS, OR SIGNAL
024	WIGWAG	WIGWAG OR FLASHING LIGHTS W/O DROP-ARM GATE
025	X-BUCK WRN	CROSSBUCK AND ADVANCE WARNING
026	WW W/ GATE	FLASHING LIGHTS WITH DROP-ARM GATES
027	OVRHD SGNL	SUPPLEMENTAL OVERHEAD SIGNAL (RR XING ONLY)
028	SP RR STOP	SPECIAL RR STOP SIGN
029	ILUM GRD X	ILLUMINATED GRADE CROSSING
037	RAMP METER	METERED RAMPS
038	RUMBLE STR	RUMBLE STRIP
090	L-TURN REF	LEFT TURN REFUGE (WHEN REFUGE IS INVOLVED)
091	R-TURN ALL	RIGHT TURN AT ALL TIMES SIGN, ETC.
092	EMR SGN/FL	EMERGENCY SIGNS OR FLARES
093	ACCEL LANE	ACCELERATION OR DECELERATION LANES
094	R-TURN PRO	RIGHT TURN PROHIBITED ON RED AFTER STOPPING

095	BUS STPSGN	BUS STOP SIGN AND RED LIGHTS
099	UNKNOWN	UNKNOWN OR NOT DEFINITE

VEHICLE TYPE CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
00	PDO	NOT COLLECTED FOR PDO CRASHES
01	PSNGR CAR	PASSENGER CAR, PICKUP, LIGHT DELIVERY, ETC.
02	BOBTAIL	TRUCK TRACTOR WITH NO TRAILERS (BOBTAIL)
03	FARM TRCTR	FARM TRACTOR OR SELF-PROPELLED FARM EQUIPMENT
04	SEMI TOW	TRUCK TRACTOR WITH TRAILER/MOBILE HOME IN TOW
05	TRUCK	TRUCK WITH NON-DETACHABLE BED, PANEL, ETC.
06	MOPED	MOPED, MINIBIKE, SEATED MOTOR SCOOTER, MOTOR BIKE
07	SCHL BUS	SCHOOL BUS (INCLUDES VAN)
08	OTH BUS	OTHER BUS
09	MTRCYCLE	MOTORCYCLE, DIRT BIKE
10	OTHER	OTHER: FORKLIFT, BACKHOE, ETC.
11	MOTRHOME	MOTORHOME
12	TROLLEY	MOTORIZED STREET CAR/TROLLEY (NO RAILS/WIRES)
13	ATV	ATV
14	MTRSCTR	MOTORIZED SCOOTER (STANDING)
15	SNOWMOBILE	SNOWMOBILE
99	UNKNOWN	UNKNOWN VEHICLE TYPE

WEATHER CONDITION CODE TRANSLATION LIST

CODE	SHORT DESC	LONG DESCRIPTION
0	UNK	UNKNOWN
1	CLR	CLEAR
2	CLD	CLOUDY
3	RAIN	RAIN
4	SLT	SLEET
5	FOG	FOG
6	SNOW	SNOW
7	DUST	DUST
8	SMOK	SMOKE
9	ASH	ASH

ATTACHMENT 2

GEOTECHNICAL ENGINEERING REPORT

Limited Geotechnical Design Study

North Suttle Road Improvements

North Suttle Road
Portland, Oregon

Prepared for
Maul Foster & Alongi, Inc.

August 15, 2017
15941-04

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Limited Geotechnical Design Study

North Suttle Road Improvements

North Suttle Road
Portland, Oregon

Prepared for

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Prepared by

Hart Crowser, Inc.

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Limited Geotechnical Design Study

North Suttle Road Improvements

North Suttle Road
Portland, Oregon

1.0 INTRODUCTION AND PROJECT DESCRIPTION

Hart Crowser, Inc. is pleased to present this report to Maul Foster & Alongi, Inc. (MFA) outlining our geotechnical engineering findings, conclusions and pavement design recommendations related to the proposed improvements to North Suttle Road. Our work was performed in general accordance with our subconsultant agreement with MFA, dated May 31, 2017.

The proposed North Suttle Road improvements include approximately 3,100 linear feet of roadway between the Union Pacific railway tracks at the northwest end and North Portland Road at the southeast end. The proposed improvements include widening and reconstruction of the existing roadway with the addition of curbs, gutters, and sidewalks. Low impact drainage improvements, such as infiltration, will likely be incorporated into the project.

The location of the site is shown on Figure 1. The existing site layout and exploration locations are shown on Figure 2.

2.0 SCOPE OF SERVICES

The purpose of our work was to evaluate existing pavement and subsurface conditions along the proposed project alignment and to provide geotechnical engineering services for the design of specific project elements. Our complete scope of work is summarized below.

- Reviewed relevant, readily available geologic maps and regional soil mapping.
- Conducted field explorations including:
    - Completing eight pavement cores to determine existing pavement section thicknesses;
    - Advancing eight Dynamic Cone Penetrometer (DCP) probes to depths ranging from approximately 0.7 to 4 feet below ground surface (bgs) at the locations of each pavement core;
    - Drilling eight hand-augered soil borings to depths ranging between approximately 1 and 4 feet bgs at the locations of each pavement core, and maintaining a log of the encountered materials and collected samples for laboratory testing; and
    - Drilling three hand-augered soil borings to depths of 8 to 9 feet bgs, and conducting *in situ* infiltration tests adjacent to three of the borings at depths ranging between approximately 2.75 and 3.5 feet bgs.
- Conducted a limited program of laboratory testing on select soil samples.

- Conducted engineering analyses to evaluate pavement design alternatives, infiltration system design, and earthwork construction guidelines.

- Prepared a draft report (dated August 2, 2017) for review by the project team.

- Prepared this final report outlining our findings and recommendations, including information related to the following:
  - Site and exploration locations,
  - Description of subsurface conditions,
  - Pavement design parameters and alternatives,
  - Infiltration design parameters,
  - Earthwork recommendations and guidelines, and
  - Other pertinent geotechnical design and construction considerations.

- Provided project management and support services, including coordinating staff and subcontractors and conducting telephone consultations and email communications with the design team.

3.0 SITE CONDITIONS

3.1 Geologic, Soils, and Groundwater Mapping

The geology of the site is mapped by Trimble (1963) as Quaternary-age alluvial deposits and by Beeson, et al (1991) as artificial fill. Our subsurface investigation suggests that the site soils consist of dredge sand fill, as mapped by Beeson, et al.

Groundwater is mapped by Snyder (2008) at a depth of approximately 8 feet bgs or approximate elevation 19 to 20 feet above mean sea level (MSL).

The U.S. Department of Agriculture (USDA) has mapped the near-surface soils in the vicinity of the project as “Pilchuck-Urban land complex, 0 to 3 percent slopes” and “Sauvie-Rafton-Urban land complex, 0 to 3 percent slopes.” The site is primarily underlain by the Pilchuck soil unit, with approximately 125 feet of the eastern end of the alignment mapped as the Sauvie-Rafton soil unit.

The Pilchuck soil unit is described as sand and extends to depths in excess of 60 inches bgs. The Sauvie-Rafton soil unit is described as silt loam from 0 to 15 inches, followed by silty clay loam down to depths of 39 inches, followed by very fine sandy loam to depths in excess of 60 inches bgs.

The USDA indicates the following index properties for the mapped soil unit.

Table 1 – USDA Index Properties

Soil Unit	Clay (percent)	Silt (percent)	Sand (percent)	Liquid Limit	Plasticity Index	Hydrologic Group	Estimated Hydraulic Conductivity (inches/hour)
Pilchuck	2.5	1.5	96.0	5	0	A	6 to 20
Sauvie-Rafton	23.4	50.7	25.9	33	8	C	0.2 to 0.6

* Estimated hydraulic conductivity as reported for the “most limiting layer to transmit water.”

3.2 Surface Conditions

The project site begins at North Portland Road and extends approximately 3,100 linear feet northwest towards the Union Pacific Railway.

North Suttle Road consists of an approximate 20-foot-wide pavement section and traverses through an industrial area comprised of warehouse, laboratory, and construction facilities. The site is generally flat with existing surface elevations varying from approximately 28 feet MSL near the Union Pacific Railway to approximately 31 feet MSL at North Portland Road. Sidewalks, curbs, and gutters are generally not present through the existing alignment.

The roadway, particularly the eastern third, has potholes and fatigue cracking (or alligator cracking), as well as weathering and raveling along the alignment. The pavement distress appears to have been caused by a combination of the progressive deterioration of the asphalt from the surface downwards; water intrusion into cracks from poor drainage; and an apparent general lack of regular maintenance of pavement distress, such as pot holes, fatigue cracking, and raveling.

The roadway itself is gently crowned to drain stormwater off the pavement to both north and south sides; however, both sides of the roadway are generally relatively flat and not well drained. We understand that water will pond adjacent to the roadway during rainy weather, particulary in the eastern portion of the alignment.

Refer to Figure 2 for the approximate extent of the project alignment.

3.3 Subsurface Conditions

3.3.1 General

Soil conditions interpreted from geologic maps and our explorations, in conjunction with soil properties inferred from field observations and laboratory tests, formed the basis for the conclusions and recommendations contained within this report. Appendix A describes our field exploration procedures and presents field data and boring logs. Appendix B describes our laboratory soil testing procedures and results. Appendix C presents photographs of the pavement cores and DCP probe data correlations.

We completed eight pavement cores to evaluate existing asphalt and base rock thicknesses, and then performed eight DCP probes below the cored sections to evaluate the strength of the pavement subgrade. We further explored subsurface soil conditions by excavating eight soil borings, designated HC-1 through HC-8, and three infiltration tests borings, designated IT-1 through IT-3. The soil borings were advanced to depths ranging from approximately 1 to 9 feet bgs. The adjacent *in situ* infiltration tests were completed to depths ranging between approximately 2.75 and 3.5 feet bgs. DCP probes were generally advanced between 0.7 and 4 feet bgs. Locations of the borings and infiltration tests are shown on Figure 2.

The project alignment is mantled by a surficial layer of asphalt concrete (AC), typically underlain by base rock; however, two of our explorations (HC-1 and HC-2) performed on the western end of the alignment encountered Portland cement concrete (PCC) pavement beneath the AC section.

The pavement sections at the site were mostly underlain by dredge fill sand deposits extending to the depths explored (1 to 9 feet bgs). In general, the dredge fill deposits consisted of poorly graded sand with varying amounts of gravel and silt; though one of our explorations encountered interbedded silty sand with variable gravel content.

Descriptions of the units discussed above are provided in detail below.

3.3.2 Pavement

Pavement sections were evaluated by completing eight pavement cores (HC-1 through HC-8), with associated DCP probes at each core location.

In general, the AC thickness varied between approximately 4.5 and 8 inches, with an average thickness of approximately 6.2 inches. Typically, the AC appeared to have been placed in one or two lifts, though in some cases we could not differentiate lifts when the AC certainly would have been placed in at least two lifts. The underlying base typically consisted of a well-graded gravel with sand containing subrounded to subangular gravel up to 2 inches in diameter. The base thickness varied from approximately 0 to 17+ inches. Additionally, in HC-1 and HC-2, the AC was underlain by approximately 6 to 6.5 inches of PCC pavement.

Table 2 below summarizes the dimensions of the pavement cores.

Table 2 – North Suttle Road Pavement Cores

Core Location	AC Thickness (inches)	PCC Thickness (inches)	Base Condition
HC-1	5.5	6.5	Not present.
HC-2	5.5	6	Not present.
HC-3	7.0	0	5+ inches of gravel fill
HC-4	8.0	0	12+ inches of gravel fill
HC-5	5.75	0	14 inches of gravel fill
HC-6	4.5	0	17+ inches of gravel fill
HC-7	6.5	0	5 inches of angular base rock
HC-8	6.0	0	12 inches of gravel fill

Pavement along the project alignment is in a generally poor to fair condition. Distress in the pavement is present throughout the roadway alignment, though is most pronounced in the eastern approximately third of the road. We estimate the pavement condition index (PCI) for the roadway to be between 60 and 75, though the eastern end has lower values. Surficial cracking and potholes are evident along most of the road. The cracking mostly consists of block and fatigue cracking. Block cracking is typically characterized by a pattern of cracks that divides the pavement into approximately square or rectangular pieces. Fatigue cracking is generally caused by fatigue failure in the AC section resulting from prolonged traffic loading. Block sizes can range from approximately 1 square foot to 30 square feet, and fatigue cracks are mostly less than 2 feet on the longest side. Large potholes are present, particularly along the unbound edges of the pavement.

The DCP testing indicates that the base and subgrade beneath the pavement typically have resilient modulus values ranging from approximately 2,000 to 25,000 pound per square inch (psi). More typical values are 6,000 to 9,000 psi.

3.3.3 Soil

We advanced eight soil borings (HC-1 through HC-8) and three infiltration test borings (IT-1 through IT-3) along the project alignment. HC-1 through HC-8 were cores within the pavement, while IT-1 through IT-3 were advanced in unpaved shoulder areas.

The three infiltration test borings encountered approximately 2 feet of gravel fill that typically contained gravel up to 3 inches in diameter and trace amounts of concrete and asphalt debris. Beneath this surficial fill and the pavement sections noted above, our explorations generally encountered dry to moist, light brown to brown, poorly graded sand with variable amounts of gravel and silt below the observed pavement sections. Occasional “nodules” of silt were found in the sand. In IT-2 a layer of silt with sand was encountered at 8 feet bgs. We judge these materials to be “dredge sand” fill.

Laboratory results on select soil samples indicated that *in-situ* moisture contents of the sandy soils encountered during our field explorations typically ranged from approximately 2 to 26 percent, with an average value closer to 9 to 10 percent. The one sample of silt had a moisture content of 32 percent. Grain size analyses determined that the fines content (percentage finer than the #200 sieve) of the sand deposits varies between approximately 1 and 13 percent, with one deeper sample from IT-3 having a fines content of 32 percent. The silt sample had a fines content of 80 percent.

3.3.4 Groundwater

Groundwater was not encountered in any of our explorations to the shallow depths explored, though moisture content increased at depths of approximately 7 to 8 feet bgs. As noted above, the mapped groundwater level is 8 feet bgs. The depth to groundwater will vary throughout the year, depending on rainfall, river levels and other factors.

4.0 INFILTRATION TESTING

We performed three falling head field infiltration tests (IT-1 through IT-3) at the locations shown on Figure 2. The field infiltration tests were conducted in general accordance with the methodologies outlined in Chapter 2, Section 2.3.6 of Portland's *Stormwater Management Manual* (SWMM) (Portland 2016) for "falling head encased borehole" tests. However, a formal "depth to groundwater study" was not completed, and the number of infiltration tests completed is not sufficient for final design; therefore, the following data should be considered preliminary in nature. The field test methods are briefly described in Appendix A of this report.

A summary of the field testing results is provided below in Table 3. The field-measured infiltration rates represent the vertical drop in the water level with time.

Table 3 – Infiltration Test Data

Infiltration Test No.	Approximate Test Depth (feet)	Measured Infiltration Rate (inches/hour)	Fines Content (%) at Test Depth
IT-1	3.5	12.5	0.5
IT-2	2.75	50	1.1
IT-3	3.5	0.1	7.1

As shown in Table 3, the infiltration rate at IT-3 in the east end of North Suttle Road was quite low; however, the fines content of the soil was not particularly high. It is possible that a thin silt layer was present within the soil "plug" at the base of the test casing. Such a layer could have impeded infiltration. Our test exploration at this location (IT-3) did not reveal such a layer, and we would expect the infiltration at this location to be similar to the other two tests (e.g., at least several inches per hour). Prior to final design of any stormwater infiltration systems, we recommend supplemental testing.

The designer should refer to *Section 7.0 – Infiltration System Design Recommendations* of this report for further discussion on the infiltration results.

5.0 CONCLUSIONS

Based on our explorations, testing, and analyses, the subsurface soil conditions are relatively uniform throughout the improvement area. The *in situ* site soils will generally provide good support for new pavement sections and are suitable for stormwater infiltration. Following is a summary of our key findings.

- The condition of the existing AC pavement in the project alignment is generally poor to fair. Much of the distress noted appears to be due to lack of maintenance, no edge of pavement confinement (e.g., no curb or gutters), and poor drainage gradients allowing ponding water.

- The *in situ* base and subgrade materials generally consist of a layer of gravelly fill underlain by sandy dredge fill. These soils are suitable for support of new pavements.

- The soils are generally sandy in nature and suitable for infiltration of stormwater. We note that our three infiltration tests resulted in unfactored infiltration rates of 12.5, 50, and 0.1 inches/hour. We believe the 0.1 inches/hour rate is not representative of general site conditions and can be ignored for preliminary design and planning. However, supplemental infiltration testing should be completed as part of final design.

- Our explorations, which extended as deep as 9 feet bgs, did not encounter groundwater, though it is mapped as being approximately 8 feet bgs. We recommend the groundwater level be monitored to verify an appropriate design elevation for the seasonal high groundwater.

The following sections present our recommendations for geotechnical aspects of roadway design and related development. Our geotechnical investigation and engineering analyses have been performed in accordance with generally accepted geotechnical practices. We have developed our conclusions and recommendations based on our current understanding of the project. If the nature of the project or the location of specific project elements are altered from those described in this report, Hart Crowser should be notified so we can confirm or modify our recommendations.

6.0 EARTHWORK RECOMMENDATIONS

Based on available information, we estimate mass grading for the proposed project will be limited, with shallow cuts and fills required for fine grading and to accommodate new aggregate base sections. All earthwork activities should be conducted in accordance with the City of Portland's *Standard Construction Specifications (*SCS) (Portland 2010), in particular section SCS 00330 – Earthwork, and the *Oregon Standard Specifications* (OSS) (ODOT 2015), including OSS 00330 – Earthwork, OSS 00400 – Drainage and Sewers, and OSS 02600 – Aggregates, depending on the application.

6.1 Site Preparation

6.1.1 General

Most of the near-surface site soils are granular and generally well drained; therefore, the soils are not significantly susceptible to moisture-related disturbance. However, we recommend working from existing pavement and base material wherever possible to reduce the potential for construction related disturbance.

6.1.2 Demolition

Demolition should include complete removal of existing site improvements within areas to receive new pavements, curbs, or sidewalks. Underground utility lines, vaults, or tanks that are to be abandoned should be completely removed or grouted full if left in place.

Voids resulting from removal of below grade structures or loose soil in utility lines should be backfilled with compacted fill, as discussed in *Section 6.2 - Structural Fill and Backfill*. The bases of such excavations should be completed to a firm subgrade before filling, and their sides sloped slightly to allow for more uniform compaction at the edges of the excavations.

Debris generated during demolition of existing improvements generally will not be suitable for reuse as fill. However, asphalt, concrete, and base material may be crushed and recycled for use as fill, provided it meets the appropriate specifications for the intended usage as outlined in OSSC, SCS and *Section 6.2 - Structural Fill and Backfill*.

6.1.3 Stripping

We anticipate limited stripping of organic materials will be required, except for in some localized landscaped areas at the edges of the roadway. Generally, visible organic material (sod, roots larger than 1/4-inch diameter, and/or other plant material), debris, and other unsuitable materials should be removed from the subgrade areas. Such material will not be suitable for use as structural fill and should be hauled off site as designated by the City.

6.1.4 Subgrade Preparation

Wherever possible, the contractor should work from existing paved surfaces and limit trafficking onto exposed soil subgrades. Following subgrade excavation, the suitability of the subgrade should be evaluated by Hart Crowser. Our explorations generally did not encounter loose or soft materials; therefore, proof rolling with a fully loaded dump truck or similar heavy rubber-tired construction equipment should be suitable for the site. If excessively loose or soft zones are identified during the evaluation, then additional subgrade excavation may be required. Otherwise, the subgrade should be compacted with a smooth-drummed vibratory roller to create a smooth, dense, unyielding surface.

6.2 Structural Fill and Backfill

Structural fill is considered to be any fill or trench backfill placed within the roadway alignment, including beneath sidewalks, curbs, gutters, and similar improvements. Stuctural fill should only be placed over a subgrade that has been prepared in accordance with *Section 6.1 - Site Preparation* of this report. A variety of soils may be used as structural fill, provided they are free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, particles exceeding 4 inches in size, and other deleterious material. Structural fill should meet the appropriate specifications provided in SCS/OSSC 00330.12 – Borrow Material, 00330.13 – Selected General Backfill, or 00330.14 – Selected Granular Backfill.

Fill and backfill material should be placed and compacted in lifts with maximum uncompacted thicknesses and relative densities as recommended in the tables that follow in *Section 6.3 – Fill Placement and Compaction.*

6.2.1 On-Site Soils

In general, the *in situ* materials that may be excavated and reused as structural fill consist of gravelly and sandy soils, which should be suitable for use as structural fill. Additionally, the asphalt and aggregate base can be reused as aggregate base or structural fill, as noted below, provided it adheres to the fill requirements provided in this report, SCS and OSSC.

6.2.2 Recycled AC, PCC, and Aggregate Base

Existing AC, PCC, and aggregate base from the site can be used in general structural fill, provided they are thoroughly and uniformly crushed with no particles greater than 3 inches. If used as trench backfill, this material should not be used within the pipe zone. The recycled materials should meet the specifications provided in SCS/OSSC 00330.13 – Selected General Backfill.

6.2.3 Aggregate Base

Imported granular material used as aggregate base beneath pavements or slabs should be clean, crushed rock or crushed gravel and sand that is fairly well graded between coarse and fine. The base aggregate should meet the specifications provided in SCS/OSSC 02630.10 – Dense-Graded Base Aggregate, depending upon application. For use beneath sidewalks we generally recommend the rock have a maximum particle size of 0.75 or 1 inch.

6.2.4 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 12 inches above utility lines (i.e., the pipe zone) should meet City and Oregon Department of Transportation (ODOT) specifications and consist of well-graded granular material with a maximum particle size of 3/4 inch and less than 10 percent by dry weight passing the U.S. Standard No. 200 Sieve, and should meet the specifications provided in SCS/OSSC 00405.13 – Pipe Zone Material.

Within roadway alignments, the remainder of the trench backfill up to the subgrade elevation should consist of well-graded granular material with a maximum particle size of 3 inches, have less than 10 percent by dry weight passing the U.S. Standard No. 200 Sieve, and meet the specifications provided in SCS/OSSC 00405.14 – Trench Backfill, Class A, B, or D.

6.2.5 Imported Select Structural Fill

Imported granular material used as structural fill during periods of wet weather should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in SCS/OSSC 00330.14 – Selected Granular Backfill, 00330.15 – Selected Stone Backfill, or 00330.16 – Selected Stone Embankment Material. The imported granular material should also be angular, relatively well graded between coarse and fine material, clean (indicating less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve), and have at least two mechanically fractured faces.

6.3 Fill Placement and Compaction

Structural fill should be placed and compacted in accordance with SCS/OSSC 00330.43 – Earthwork Compaction requirements and the following guidelines.

- Place fill and backfill on a prepared subgrade that consists of firm, inorganic native soils prepared per *Section 6.1 – Site Preparation*, or approved structural fill.

- Place fill or backfill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Table 4 provides general guidance for uncompacted lift thicknesses.

Table 4 – Guidelines for Uncompacted Lift Thickness

Compaction Equipment	Guidelines for Uncompacted Lift Thickness (inches)		
	Native Soils	Granular and Crushed Rock Maximum Particle Size ≤ 1½ inch	Crushed Rock Maximum Particle Size > 1½ inch
Plate Compactors and Jumping Jacks	4 – 8	4 – 8	Not Recommended
Rubber-Tire Equipment	6 – 8	10 – 12	6 – 8
Light Roller	8 – 10	10 – 12	8 – 10
Heavy Roller	10 – 12	12 – 18	12 – 16
Hoe Pack Equipment	12 – 16	18 – 24	12 – 16

Note: The above table is based on our experience, is intended to serve as a guideline, and should not be included in the project specifications.

- Do not place fill and backfill until the required tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.

- Limit the maximum particle size within the fill to two-thirds of the loose lift thickness.

- Control the moisture content of the fill to within 3 percent of the optimum moisture content based on laboratory Proctor tests. The optimum moisture content corresponds to the moisture content at the maximum attainable Proctor dry density.

- Perform a representative number of in-place density tests on structural fill in the field to verify adequate compaction.

During structural fill placement and compaction, a sufficient number of in-place density tests should be completed by Hart Crowser to verify that the specified degree of compaction is being achieved. For structural fill with more than 30 percent retained on the 3/4-inch sieve, proper compaction should be verified with a proof roll or other performance methods.

6.4 Excavation

6.4.1 General

Site soils within expected excavation depths generally consist of a sand and gravel with variable silt content. In our opinion, conventional earthmoving equipment in proper working condition should be capable of making necessary general excavations for utilities and other earthwork. Our explorations did not encounter cobbles or boulders within the maximum depths explored; therefore, we do not anticipate these materials to be present within excavation depths. However, some debris was present in the gravelly fill, so unknown materials could be present. The earthwork contractor should be responsible for providing equipment and following procedures as needed to excavate the site soils, as described in this report, while protecting the subgrade.

6.4.2 Temporary Cut Stability

Because of the variables involved, actual slope angles required for stability in temporary cut areas can only be estimated before construction. We recommend that stability of the temporary slopes used for construction be the responsibility of the contractor, since the contractor is in control of the construction operation and is continuously at the site to observe the nature and condition of the subsurface.

All temporary soil cuts associated with site excavations (greater than 4 feet in depth) should be adequately sloped back to prevent sloughing and collapse, in accordance with Occupational Safety and Health Administration (OSHA) guidelines. The stability and safety of cut slopes depend on a number of factors, including:

- The type and density of the soil;
- The presence and amount of any seepage;
- Depth of cut;
- Proximity and magnitude of the cut to any surcharge loads, such as stockpiled material, traffic loads, or structures;
- Duration of the open excavation; and
- Care and methods used by the contractor.

All excavations should be made in accordance with all local, state, and federal safety requirements. According to OSHA guidelines, we expect that the existing site sandy soils would be considered Type C.

If excavations deeper than approximately 7 feet are required, then groundwater may be encountered. Excavations below the groundwater table will run and slough, and will need to be shored.

It is the responsibility of the contractor to ensure that the excavation is properly sloped or braced for worker protection in accordance with OSHA guidelines. To assist with this effort, for planning purposes only, we make the following recommendations regarding temporary excavations.

- Protect excavations from erosion with plastic sheeting for the duration of the excavation to minimize surface erosion and raveling;

- Limit the maximum duration of the open excavation to the shortest time possible; and

- Place no surcharge loads (equipment, materials, etc.) within 10 feet of the top of excavations.

More restrictive requirements may apply depending on specific site conditions, which should be continuously assessed by the contractor.

If temporary sloping is not feasible, based on site spatial constraints, excavations could be supported by internally braced shoring systems, such as a trench box or other temporary shoring. There are a variety of options available. We recommend that the contractor be responsible for selecting the type of shoring system to apply. We note that box shoring is a safety feature used to protect workers and does not prevent caving. If the excavations are left open for extended periods of time, then caving of the sidewalls may occur. The presence of caved material will limit the ability to properly backfill and compact the trenches. The voids between the box shoring and the sidewalls of the trenches should be filled with sand or gravel before caving occurs.

6.5 Dewatering and Temporary Drainage

While our explorations did not encounter groundwater, it is expected to be present at approximately 8 feet bgs. Utility excavations which extend this deep will require dewatering. Refer to *Section 3.3.4 - Groundwater* for a discussion of groundwater conditions at the site. Dewatering is typically the responsibility of the contractor. We anticipate that excavations below the water table will require well point dewatering. Failure to dewater can result in issues, such as base heave, sidewall caving and sloughing, increased backfill and haul off requirements, and project delays.

During grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion of the working surface. During rough and finished grading of the roadway alignment, the contractor should keep subgrades free of water.

7.0 INFILTRATION SYSTEM DESIGN RECOMMENDATIONS

Our investigation and analysis indicates that the site soils are generally suitable for infiltration.

As discussed above, we found variable infiltration rates during our field testing. However, we believe that the 0.1 inch/hour rate found at IT-3 can reasonably be ignored for preliminary design and planning. We anticipate that the low rate was a local anomaly, possibly due to a thin silt layer within the test casing, as we found similar sandy soils adjacent to the exploration at this location.

As a reasonable basis for design of infiltration systems, we recommend the use of an unfactored infiltration rate of 12.5 inches/hour. We recommend that a factor of safety of 2 be applied to this value. Therefore, a preliminary design infiltration rate of 6.25 inches/hour may be assumed. We recommend the performance of supplemental field infiltration testing prior to construction to verify actual infiltration rates at the proposed system locations.

We also recommend groundwater levels be monitored to verify the seasonal high groundwater level.

8.0 PAVEMENT DESIGN AND CONSIDERATIONS

8.1 General

Paving for the project includes new and possibly rehabilitated pavements. We evaluated flexible hot-mixed asphaltic concrete (HMAC) and rigid Portland cement concrete (PCC) pavements. Pavements should be constructed in accordance with SCS/OSSC 00744 – Asphalt Concrete Pavement and 00756 – Plain Concrete Pavement.

8.2 Roadway Traffic

The following traffic loading criteria for the pavement design were based on guidelines found in the *ODOT Pavement Design Guide* (ODOT 2011), our engineering assumptions, and traffic data provided by Kittleson & Associates.

- Alternative design lifes of 20 and 50 years for new and rebuilt HMAC sections, and a 15-year design life for rehabilitated HMAC sections
- Alternative design lifes of 30 and 50 years for new PCC sections
- Annual traffic growth values of 0 percent and 2 percent (Both values are provided, as we are unsure of the appropriate growth rate.)
- Average daily traffic (ADT) values of 1,891 vehicles per day (two-way traffic)
- Vehicle distribution and equivalent single axle load (ESAL) annual factors, as shown in Table 5

Table 5 – Vehicle Distribution

FHWA Classification	Percentage of ADT	ODOT Annual ESAL Factor	
		HMAC	PCC
Type 1, 2, 3	50%	0	0
Type 4	2.5%	246	269
Type 5	13.7%	104	99
Type 6	11.0%	284	417
Type 7	0.1%	757	1199
Type 8	6.1%	253	277
Type 9	3.3%	466	715
Type 10	1.0%	561	912
Type 11	0.2%	603	606
Type 12	C.3%	546	663
Type 13	1.6%	1037	1660
Unclassified	10.3%	n/a	n/a

Notes: Unclassified vehicles were re-distributed on a proportional basis.

Based on the data in Table 5, we calculated the ESAL values summarized in Table 6.

Table 6 – ESAL Values

Annual Growth Rate (%)	Rehabilitated HMAC 15-year ESAL	New HMAC ESAL		New PCC ESAL	
		20-year	50-year	30-year	50-year
0	1,693,418	2,257,891	5,644,727	4,590,682	7,651,137
2	2,279,118	3,355,107	15,193,281	8,315,385	20,593,708

8.3 Design Parameters

The following pavement design parameters were based on guidelines found in ODOT (2011) and American Association of State Highway and Transportation Officials (AASHTO) *Guide for Design of Pavement Structures* (AASHTO 1993).

- Average resilient modulus of 6,000 psi for *in situ* soil and fill subgrade
- A resilient modulus of 20,000 psi for base rock
- Initial serviceability indices of 4.2 and 4.5 for HMAC and PCC, respectively
- Terminal serviceability index of 2.5 for both HMAC and PCC
- Standard deviations of 0.49 and 0.39 for HMAC and PCC, respectively
- Reliability of 75 percent based on the roadway's classification as a Local Access Road
- Structural coefficients of 0.42 and 0.10 for new HMAC and base rock layers, respectively
- Structural coefficient of 0.25 for existing HMAC layers
- Modulus of rupture of 575 psi and elastic modulus of 3,600,000 psi for PCC layers
- An effective modulus of subgrade reaction with a 6-inch aggregate base layer of 350 psi/inch.

If these assumptions are incorrect, then we should be contacted to re-evaluate our recommendations.

8.4 Pavement Sections

8.4.1 General

The following section describes options for new and rebuilt pavements. Based on the scope of the project and existing site conditions, we anticipate that either full-depth HMAC reclamation or new PCC will be the likely choice for the new roadway. However, it may be feasible to use grind-and-inlay techniques if the roadway geometries allow this approach. Per ODOT (2011), new HMAC pavement sections have a minimum 20-year design life, new PCC sections have a minimum 30-year design life, while rehabilitated (e.g., grind and overlay) HMAC pavements have a 15-year design life. Additionally, the City is also considering using a 50-year design life. We have evaluated all of these design life options below.

For grind-and-inlay sections, we have assumed the existing pavement section is 5.5 inches thick, which is slightly less than the actual average AC thickness. It should be understood that if grind-and-inlay is used over the existing pavement sections, cracks may develop where underlying joints are present at widened sections. Where existing potholes or severe distress is present in the existing pavement, those areas of distress will need to be repaired prior to grind-and-inlay activities.

Tables 7 and 8 summarize section options for new and rehabilitated HMAC pavements, respectively. For new pavement sections, we evaluated 0 and 2 percent growth rates, and also provided pavement sections that match the City's standard 8-inch aggregate base section and alternative sections that have thinner HMAC layers and thicker aggregate base layer. Additionally, 20- and 50-year design life alternatives are provided.

Table 7 – New HMAC Pavement Sections

Design Life	Annual Growth Rate	HMAC (inches)	Aggregate Base (inches)	Subgrade
20 years	0 percent	6.0	14.5	Compacted *in situ* soil.
		7.5	8.0	
	2 percent	6.5	15.0	
		8.0	8.0	
50 years	0 percent	7.0	16.0	
		9.0	8.0	
	2 percent	8.5	17.0	
		10.5	8.0	

Table 8 – Rehabilitated HMAC Pavement Sections

Design Life	Annual Growth Rate	Grind Depth (inches)	Overlay Thickness (inches)	Subgrade
15 years	0 percent	2.0	7.0	Existing HMAC and base.
	2 percent	2.0	7.5	

Table 9 summarizes section options for new PCC pavements.

Table 9 – New PCC Pavement Sections

Design Life	Annual Growth Rate	PCC (inches)	Aggregate Base (inches)	Subgrade
30 years	0 percent	8.3	6.0	Compacted *in situ* soil.
	2 percent	9.2		
50 years	0 percent	9.1		
	2 percent	10.7		

8.5 Pavement Materials and Construction

8.5.1 HMAC

The HMAC should consist of 1/2-inch dense-graded, Level 3, PG 64-22 material meeting the specifications of OSSC 00744 – Asphalt Concrete Pavement. The HMAC should be placed in lifts with minimum and maximum lift thickness of 2 and 3 inches, respectively, and be compacted to a minimum 92 percent of Rice Density of the mix, as determined in accordance with American Society for Testing and Materials (ASTM) D 2041.

8.5.2 PCC

PCC used should meet the specifications provided in SCS/OSSC 00756 – Plain Concrete Pavement. The installed concrete should be Class 4000 1-1/2-inch paving concrete per SCS/OSSC 02001 - Concrete. The PCC should be constructed with a maximum joint spacing of 15 feet. The slabs shall be interlocked at contraction joints (e.g., continuous slab with no dowels). However, dowels should be used at construction and expansion joints. Dowels should be smooth, round, 1.25-inch-diameter bars that are greased on one end. The dowels should be at least 18 inches long or twice the PCC thickness, which ever is greater. PCC joints and downs should be constructed in accordance with SCS/OSS 00756.48 – Joints and OSS 00756.43 – Placing Dowels Bars.

8.5.3 Aggregate Base

Imported granular material used as aggregate base (base rock) beneath conventional AC pavement should meet the criteria specified in *Section 6.2 - Structural Fill and Backfill*.

8.5.4 AC Grinding

Grinding of existing AC should be completed in conformance with SCS/OSSC 620 – Cold Plane Pavement Removal.

9.0 CONSTRUCTION OBSERVATIONS

Satisfactory pavement and earthwork performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during subsurface explorations. Recognition of changed conditions often requires experience; therefore, Hart Crowser or their representative should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

We recommend that Hart Crowser be retained to monitor construction at the site to confirm that subsurface conditions are consistent with the site explorations and to confirm that the intent of project plans and specifications relating to earthwork, infiltration, and paving are being met. In particular, we recommend that subgrade preparation, as well as placement and compaction of structural backfill, aggregate base, and asphalt pavement, and infiltration system installation be observed and/or tested by Hart Crowser.

10.0 LIMITATIONS

We have prepared this report for the exclusive use of MFA and their authorized agents for the proposed North Suttle Road Improvements project in Portland, Oregon in accordance with our subconsultant agreement. Our report is intended to provide our opinion of geotechnical parameters for design and construction of the proposed project based on exploration locations that are believed to be representative of site conditions. However, conditions can vary significantly between exploration locations and our conclusions should not be construed as a warranty or guarantee of subsurface conditions or future site performance.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by Hart Crowser and will serve as the official document of record.

11.0 REFERENCES

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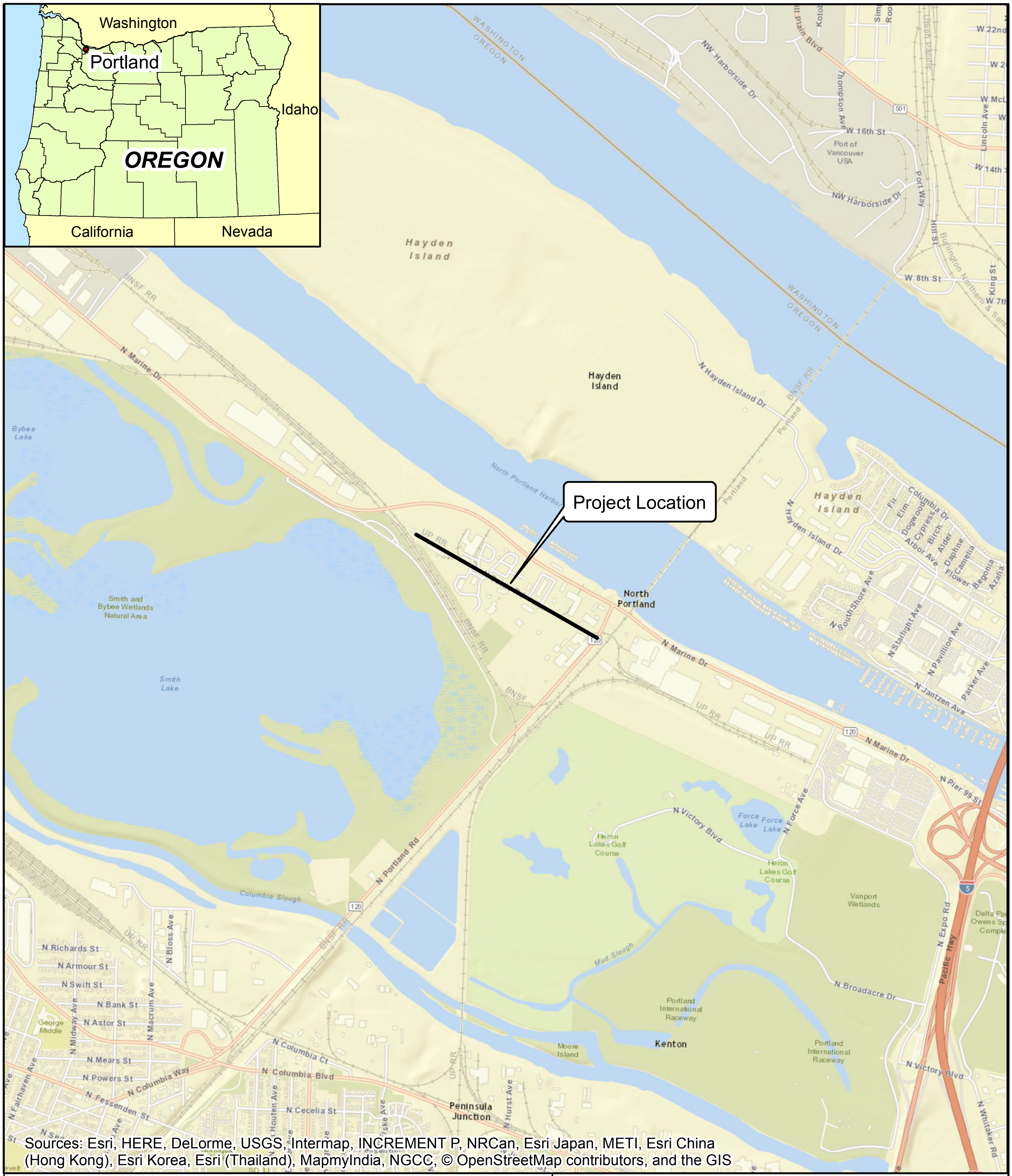

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS

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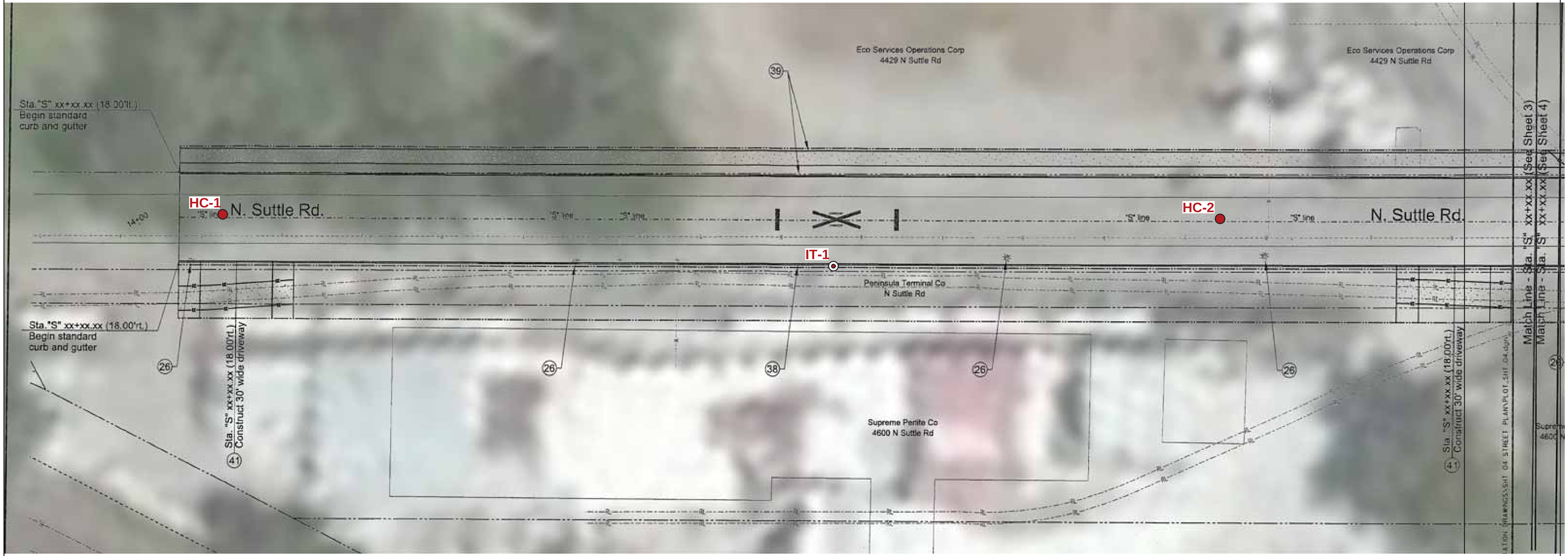
North Suttle Road Improvements
Portland, Oregon

Vicinity Map

15941-04 8/17

HARTCROWSER

Figure
1



LEGEND

HC-1 ● Proposed Pavement Core

IT-1 ◉ Proposed Infiltration Test

0 40 80

Scale in Feet

N

Note: Feature locations are approximate.

North Suttle Road Improvements
Portland, Oregon

Exploration Location Map

15941-04 8/17

HARTCROWSER

Figure
2
Sheet 1 of 5

Sources: Base map prepared from "20160919 City of PDX Engineered Drawings of Proposed Road.pdf" and Microsoft Bing aerial imagery.

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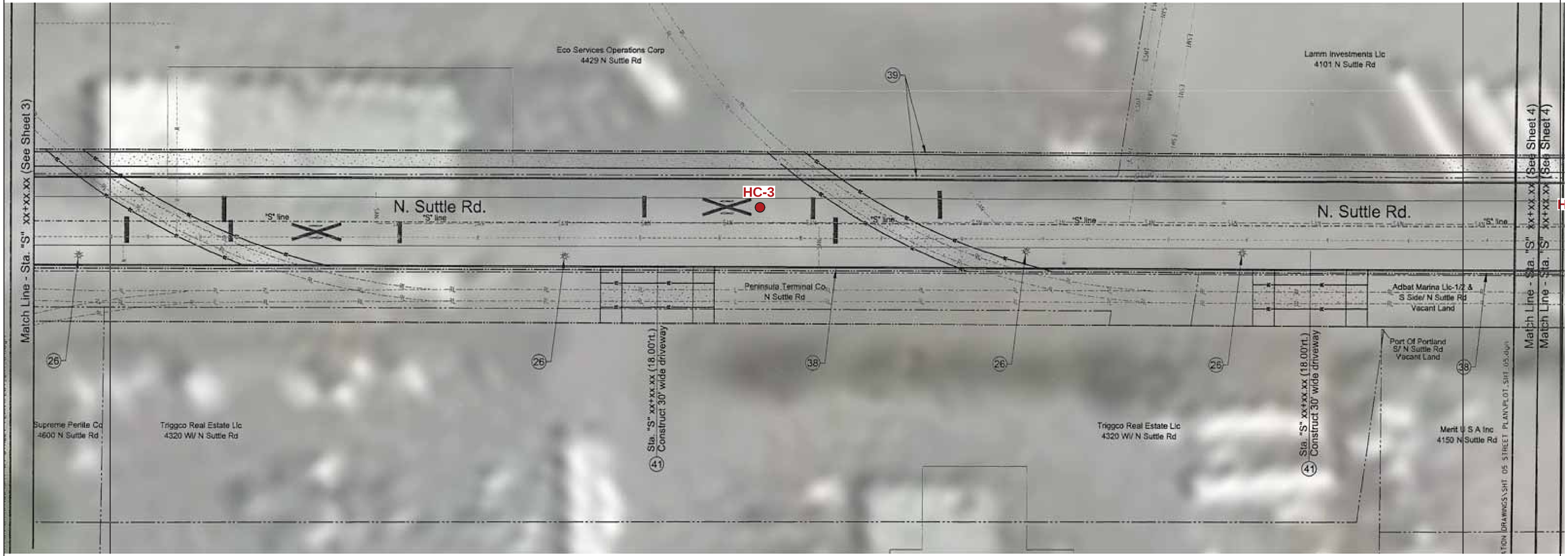

LEGEND

- **HC-1** ● Proposed Pavement Core
- **IT-1** ◉ Proposed Infiltration Test

0 40 80
Scale in Feet

N

Note: Feature locations are approximate.

North Suttle Road Improvements
Portland, Oregon

Exploration Location Map

15941-04 8/17

HARTCROWSER

Figure
2
Sheet 2 of 5

Sources: Base map prepared from "20160919 City of PDX Engineered Drawings of Proposed Road.pdf" and Microsoft Bing aerial imagery.

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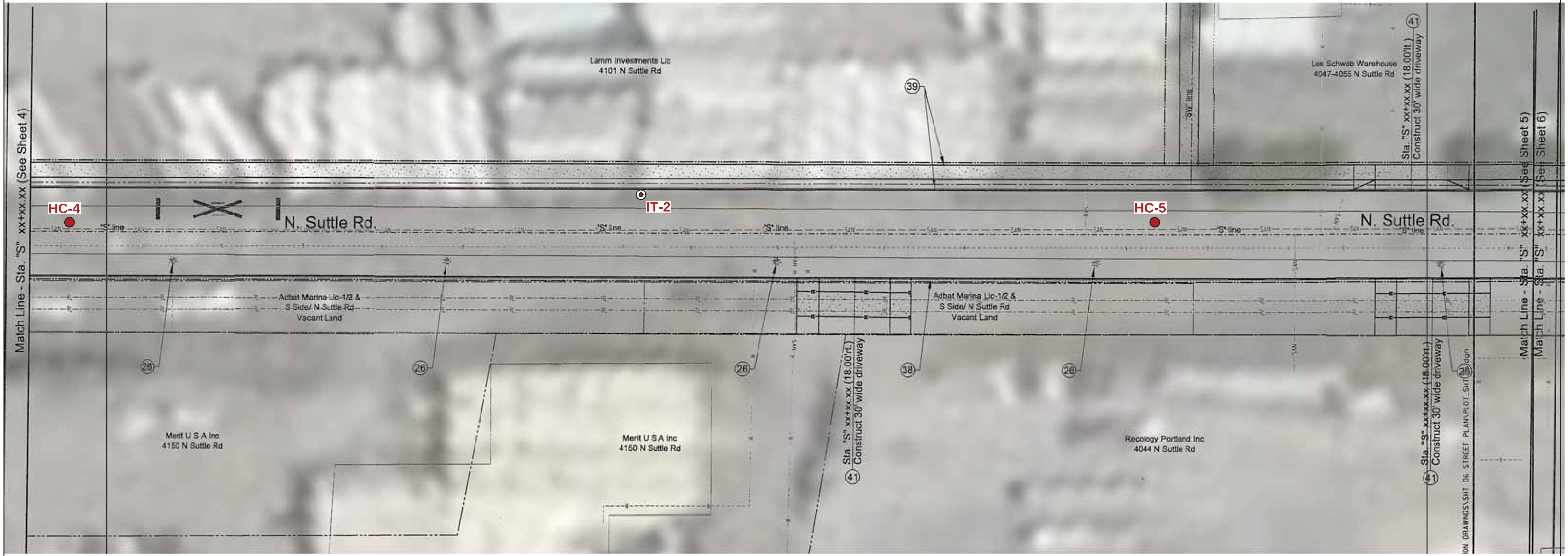

0 40 80
Scale in Feet

N

Note: Feature locations are approximate.

LEGEND

HC-1 ● Proposed Pavement Core

IT-1 ◉ Proposed Infiltration Test

North Suttle Road Improvements
Portland, Oregon

Exploration Location Map

15941-04 8/17

HARTCROWSER

Figure
2
Sheet 3 of 5

Sources: Base map prepared from "20160919 City of PDX Engineered Drawings of Proposed Road.pdf" and Microsoft Bing aerial imagery.

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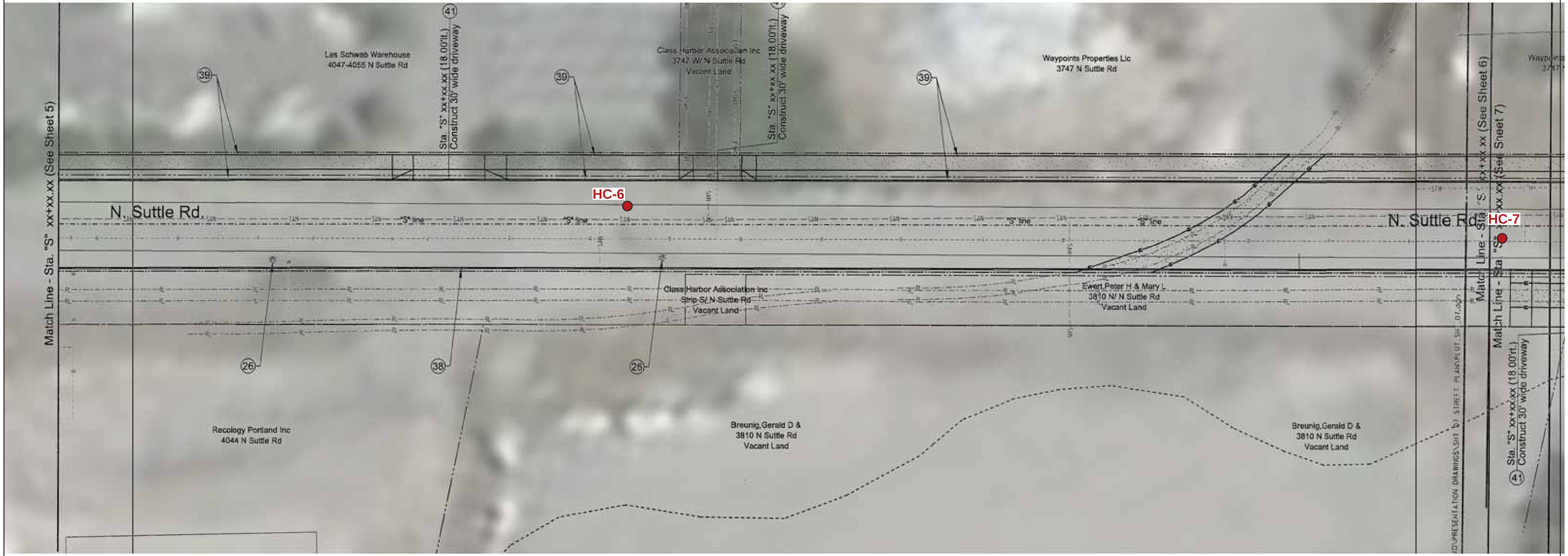

LEGEND

HC-1 ● Proposed Pavement Core

IT-1 ◉ Proposed Infiltration Test

0 40 80

Scale in Feet

N

Note: Feature locations are approximate.

North Suttle Road Improvements
Portland, Oregon

Exploration Location Map

15941-04 8/17

HARTCROWSER

Figure
2
Sheet 4 of 5

Sources: Base map prepared from "20160919 City of PDX Engineered Drawings of Proposed Road.pdf" and Microsoft Bing aerial imagery.

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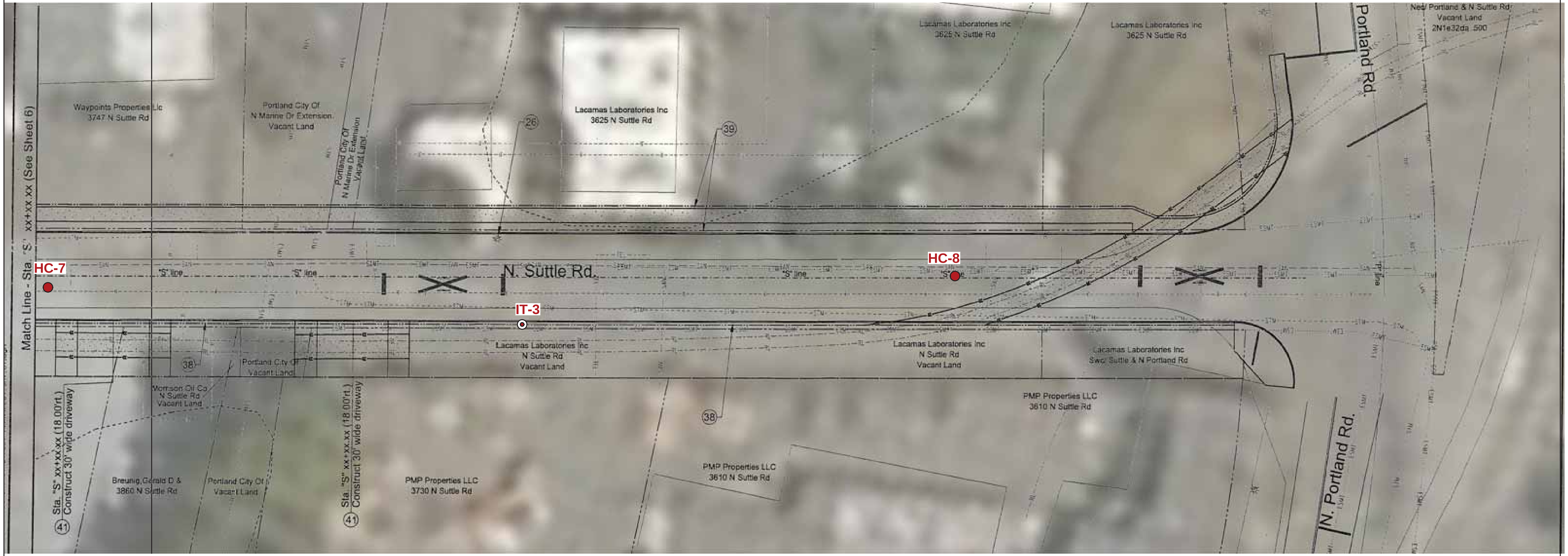

0 40 80
Scale in Feet

N

Note: Feature locations are approximate.

LEGEND

HC-1 ● Proposed Pavement Core

IT-1 ⊙ Proposed Infiltration Test

File: F:\Notebooks\1594104_N Suttle Road Improvements\CAD\1594104_SP.dwg Layout:SP-5 Date: 08-02-2017 Author: melissaschweitzer

Sources: Base map prepared from "20160919 City of PDX Engineered Drawings of Proposed Road.pdf" and Microsoft Bing aerial imagery.

North Suttle Road Improvements
Portland, Oregon

Exploration Location Map

15941-04 8/17

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Figure
2
Sheet 5 of 5

APPENDIX A
Field Explorations

APPENDIX A

Field Explorations

This appendix documents the processes Hart Crowser used to determine the nature (and quality) of the soil and groundwater underlying the project site addressed by this report. The discussion includes information on the following subjects:

- Explorations and Their Locations,
- Pavement Cores,
- Borings, and
- DCP Testing.

Explorations and Their Locations

Members of our engineering and geologic staff completed subsurface explorations for this project that included eight pavement cores, soil borings, and DCP probes, separately, and three field infiltration tests. The exploration logs in this appendix show our interpretation of the explorations, sampling, and testing data. The logs indicate the depths where the soils change. Note that soil changes may be gradual. In the field, we classified the samples taken from the explorations according to the methods presented on the *Key to Exploration Logs*. This key also provides a legend explaining the symbols and abbreviations used in the logs.

Figure 2 of the report illustrates the locations of the explorations. Exploration locations were estimated in the field based on existing landmarks.

Pavement Cores

Asphalt cores were obtained using a pavement coring machine operated by Hart Crowser field representatives. The asphalt concrete cores were collected and delivered to our laboratory. The core information is included in the main body of the report and photographs of the cores are presented in Appendix C.

Borings

The borings were manually advanced using a hand auger. The auger was approximately 3 inches in diameter and the auger was advanced by a geotechnical staff member from Hart Crowser. Disturbed samples were collected from the drill spoils at discrete depths noted on the logs. Samples from all borings were placed in watertight bags and delivered to Hart Crowser's laboratory.

DCP Testing

The DCP consists of a steel extension shaft assembly with a 60-degree hardened steel cone tip attached to one end, which is driven into the subgrade by means of a sliding dual mass hammer. Testing was conducted in accordance with ASTM D 6951/D 6951M-09. Testing provides an evaluation of in-place California Bearing Ratio and Resilient Modulus values for the subgrade. DCP testing was conducted by member of Hart Crowser’s geotechnical engineering and geologic staff.

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. ASTM D 2488 visual-manual identification methods were used as a guide. Major divisions are not necessarily an indicator of soil behavior, which is a function of fines content activity and loading rate.

Relative Density/Consistency

Soil density/consistency in borings is related primarily to the standard penetration resistance (N). Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

SAND or GRAVEL Relative Density	N (Blows/Foot)	SILT or CLAY Consistency	N (Blows/Foot)
Very loose	0 to 4	Very soft	0 to 2
Loose	4 to 10	Soft	2 to 4
Medium dense	10 to 30	Medium stiff	4 to 8
Dense	30 to 50	Stiff	8 to 15
Very dense	>50	Very stiff	15 to 30
		Hard	>30

Moisture

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

Soil Classification Chart

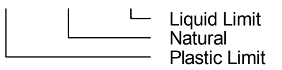
Major Divisions			Symbols		Typical Descriptions
			Graph	USCS	
Coarse Grained Soils More than 50% of Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels *(<5% fines)*		GW	Well-Graded Gravel; Well-Graded Gravel with Sand
				GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Gravels *(10% fines)*		GW-GM	Well-Graded Gravel with Silt; Well-Graded Gravel with Silt and Sand
				GW-GC	Well-Graded Gravel with Clay; Well-Graded Gravel with Clay and Sand
				GP-GM	Poorly Graded Gravel with Silt; Poorly Graded Gravel with Silt and Sand
				GP-GC	Poorly Graded Gravel with Clay; Poorly Graded Gravel with Clay and Sand
		Gravels with Fines *(>12% fines)*		GM	Silty Gravel; Silty Gravel with Sand
				GC	Clayey Gravel; Clayey Gravel with Sand
	Sand and Sandy Soils More than 50% of Coarse Fraction Passing No. 4 Sieve	Sands with few Fines *(<5% fines)*		SW	Well-Graded Sand; Well-Graded Sand with Gravel
				SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Sands *(10% fines)*		SW-SM	Well-Graded Sand with Silt Well-Graded Sand with Silt and Gravel
				SW-SC	Well-Graded Sand with Clay; Well-Graded Sand with Clay and Gravel
				SP-SM	Poorly Graded Sand with Silt; Poorly Graded Sand with Silt and Gravel
				SP-SC	Poorly Graded Sand with Clay; Poorly Graded Sand with Clay and Gravel
		Sands with Fines *(>12% fines)*		SM	Silty Sand; Silty Sand with Gravel
				SC	Clayey Sand; Clayey Sand with Gravel
Fine Grained Soils More than 50% of Material Passing No. 200 Sieve	Silts			ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
				MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
	Clays			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
				CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
	Organics			OL/OH	Organic Soil; Organic Soil with Sand or Gravel; Sandy or Gravelly Organic Soil
Highly Organic				PT	Peat - Decomposing Vegetation - Fibrous to Amorphous Texture

Minor Constituents

Minor Constituents	Estimated Percentage
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45

Soil Test Symbols

%F	Percent Passing No. 200 Sieve
AL	Atterberg Limits



CA	Chemical Analysis
CAUC	Consolidated Anisotropic Undrained Compression
CAUE	Consolidated Anisotropic Undrained Extension
CBR	California Bearing Ratio
CIDC	Consolidated Drained Isotropic Triaxial Compression
CIUC	Consolidated Isotropic Undrained Compression
CK0DC	Consolidated k0 Drained Triaxial Compression
CK0DSS	Consolidated k0 Undrained Direct Simple Shear
CK0UC	Consolidated k0 Undrained Compression
CK0UE	Consolidated k0 Undrained Extension
CRSCN	Constant Rate of Strain Consolidation
DSS	Direct Simple Shear
DT	In Situ Density
GS	Grain Size Classification
HYD	Hydrometer
ILCN	Incremental Load Consolidation
K0CN	k0 Consolidation
kc	Constant Head Permeability
kf	Falling Head Permeability
MD	Moisture Density Relationship
OC	Organic Content
OT	Tests by Others
P	Pressuremeter
PID	Photoionization Detector Reading
PP	Pocket Penetrometer
SG	Specific Gravity
TRS	Torsional Ring Shear
TV	Torvane
UC	Unconfined Compression
UUC	Unconsolidated Undrained Triaxial Compression
VS	Vane Shear
WC	Water Content

Groundwater Indicators

▽ Groundwater Level on Date or At Time of Drilling (ATD)

Groundwater Seepage (Test Pits)

Sample Symbols

☒ 1.5" I.D. Split Spoon

◪ 3.0" I.D. Split Spoon

◧ Modified California Sampler

◧ Core Run

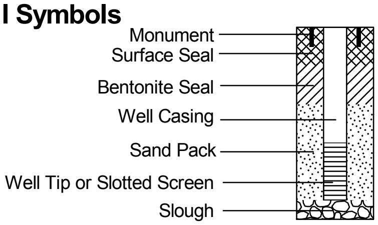
⧄ Sonic Core

◫ Thin-walled Sampler

⊠ Grab

▥ Cuttings

Well Symbols



KEY TO EXP LOGS (SOIL ONLY) - F:\GINT\HC_LIBRARY.GLB - 7/12/17 13:31 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

HARTCROWSER

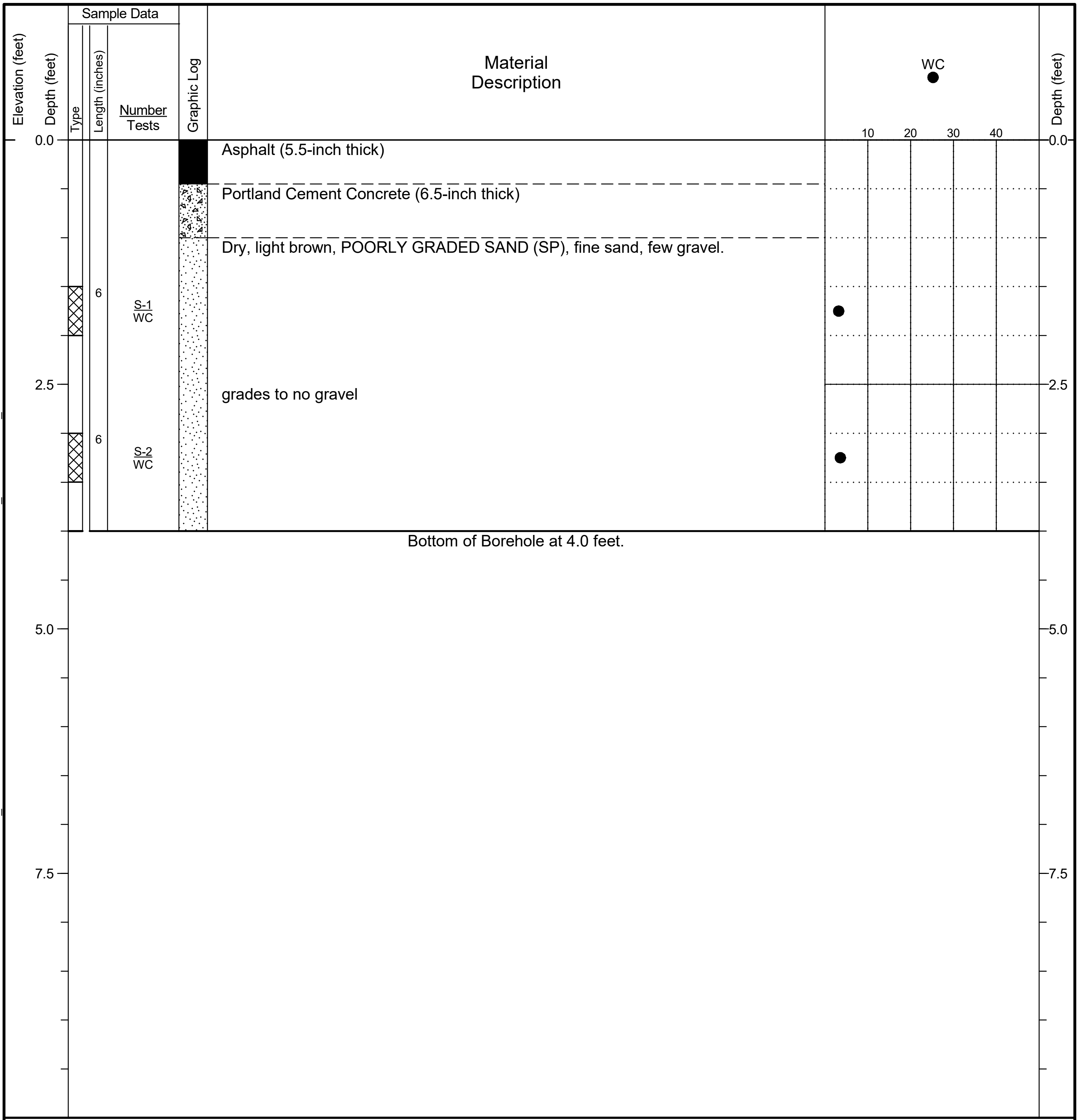
Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Key to Exploration Logs

Figure **A-1**
Sheet **1 of 1**

Date Started: 6/30/17 Date Completed: 6/30/17
Logged by: A. Chavez Checked by: J. Robinson
Location: N: 718,517.37 E: 7,635,374.41
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA Estimated: NA
Auger Diameter: 4 inches Casing Diameter: NA
Total Depth: 4 feet Depth to Ground Water: Not Identified



Asphalt (5.5-inch thick)

Portland Cement Concrete (6.5-inch thick)

Dry, light brown, POORLY GRADED SAND (SP), fine sand, few gravel.

grades to no gravel

Bottom of Borehole at 4.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

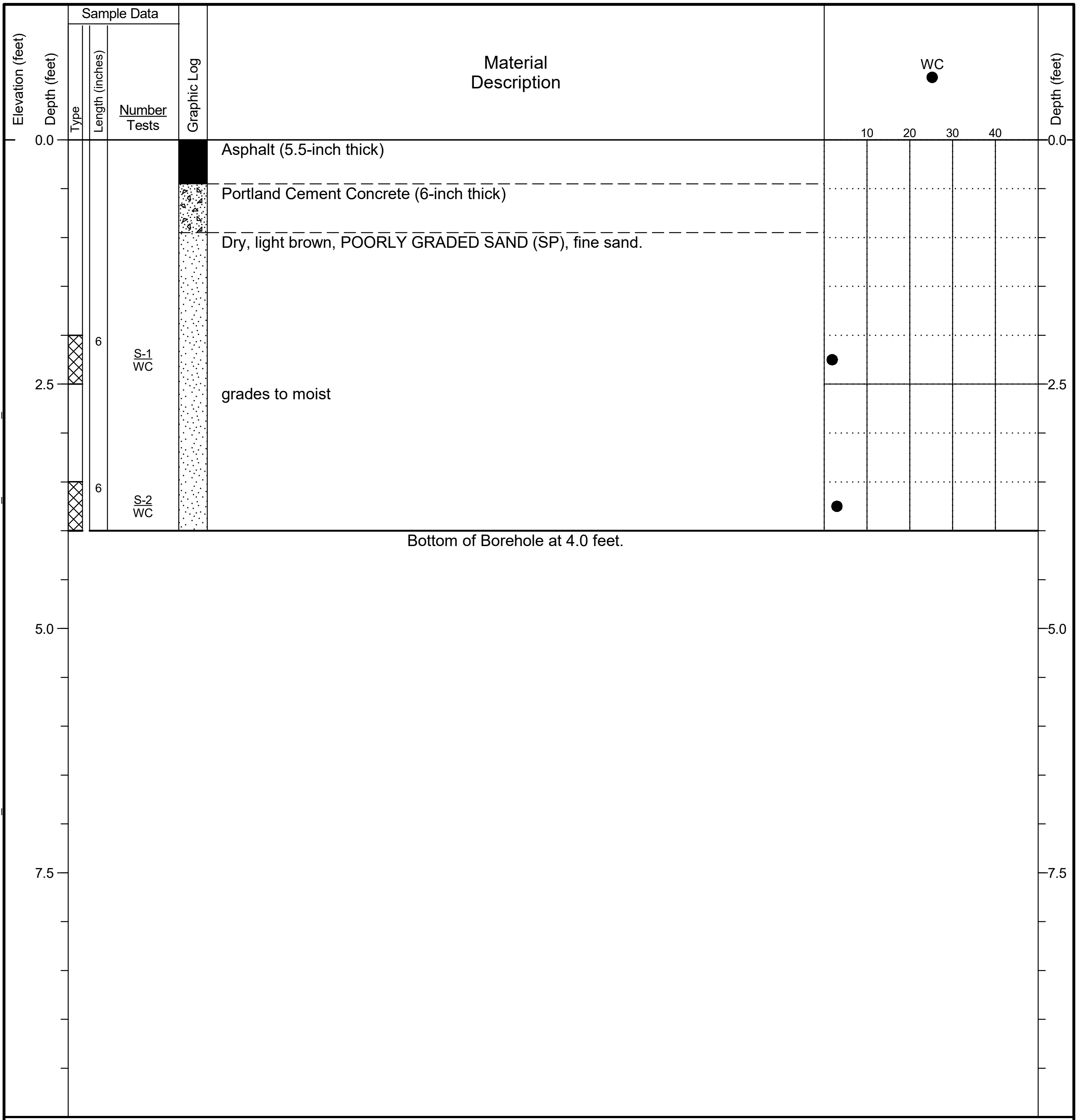
Hand-Auger Log
HC-1

Figure **A-2**
Sheet **1 of 1**

HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

Date Started: 6/30/17 Date Completed: 6/30/17
Logged by: A. Chavez Checked by: J. Robinson
Location: N: 718,312.47 E: 7,635,729.61
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA Estimated: NA
Auger Diameter: 4 inches Casing Diameter: NA
Total Depth: 4 feet Depth to Ground Water: Not Identified



Asphalt (5.5-inch thick)

Portland Cement Concrete (6-inch thick)

Dry, light brown, POORLY GRADED SAND (SP), fine sand.

grades to moist

Bottom of Borehole at 4.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

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Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
HC-2

Figure **A-3**
Sheet **1 of 1**

HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

Date Started: 6/30/17
Date Completed: 6/30/17
Logged by: A. Chavez
Checked by: J. Robinson
Location: N: 718,103.66 E: 7,636,103.81
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 1 feet
Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0.0	■	Asphalt (7-inch thick)	0.0
		●	Dry, gray and brown, WELL-GRADED GRAVEL WITH SAND (GW), subrounded to subangular gravel, up to 2-inch diameter.	
			Refusal at 1.0 feet.	
	2.5			2.5
	5.0			5.0
	7.5			7.5

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

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Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

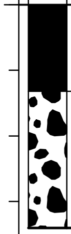
Hand-Auger Log
HC-3

Figure **A-4**
Sheet **1 of 1**

HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

Date Started: 6/30/17
Date Completed: 6/30/17
Logged by: D. Trisler
Checked by: J. Robinson
Location: N: 717,932.90 E: 7,636,393.93
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 1.7 feet
Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0.0		Asphalt (8-inch thick)	0.0
			Dry, gray and brown, WELL-GRADED GRAVEL WITH SAND (GW), angular gravel.	
			Refusal at 1.7 feet.	
	2.5			2.5
	5.0			5.0
	7.5			7.5

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

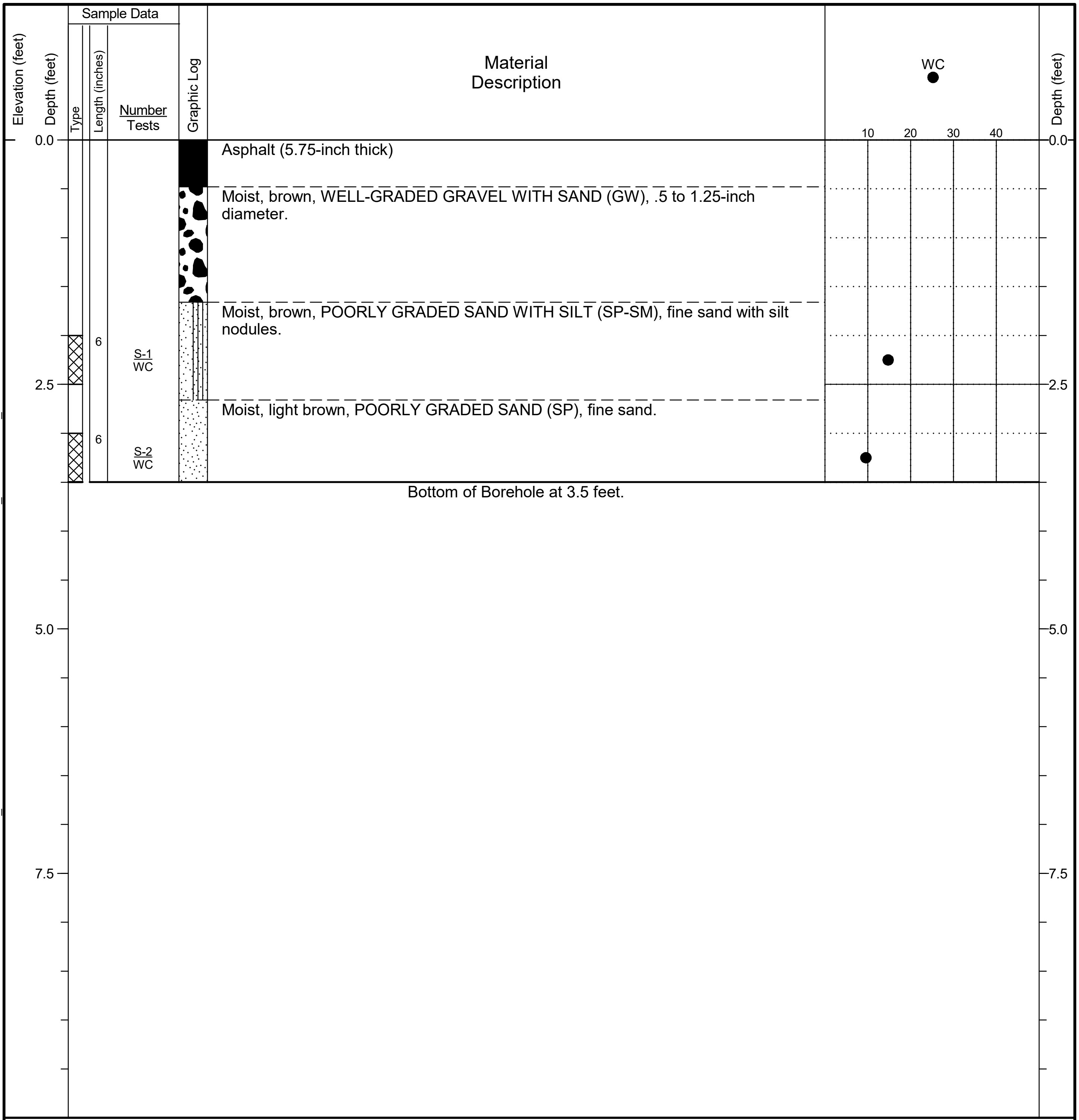
Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
HC-4

Figure **A-5**
Sheet **1 of 1**

Date Started: 7/1/17
Date Completed: 7/1/17
Logged by: D. Trisler
Checked by: J. Robinson
Location: N: 717,711.63 E: 7,636,781.45
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 3.5 feet
Depth to Ground Water: Not Identified



Depth (feet)	Length (inches)	Number / Tests	Material Description
0.0			Asphalt (5.75-inch thick)
			Moist, brown, WELL-GRADED GRAVEL WITH SAND (GW), .5 to 1.25-inch diameter.
	6	S-1 WC	Moist, brown, POORLY GRADED SAND WITH SILT (SP-SM), fine sand with silt nodules.
2.5	6	S-2 WC	Moist, light brown, POORLY GRADED SAND (SP), fine sand.

Bottom of Borehole at 3.5 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

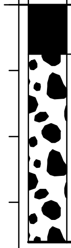
Hand-Auger Log
HC-5

Figure **A-6**
Sheet **1 of 1**

HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

Date Started: 7/1/17
Date Completed: 7/1/17
Logged by: D. Trisler
Checked by: J. Robinson
Location: N: 717,520.37 E: 7,637,120.85
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 1.8 feet
Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0.0		Asphalt (4.5-inch thick)	0.0
			Dry, brown, WELL-GRADED GRAVEL WITH SAND (GW), rounded gravel, .5-inch to 2-inch diameter gravel, few brick fragments.	
			grades to with cobbles	
			Refusal at 1.8 feet.	
	2.5			2.5
	5.0			5.0
	7.5			7.5

General Notes:
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3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
HC-6

Figure **A-7**
Sheet **1 of 1**

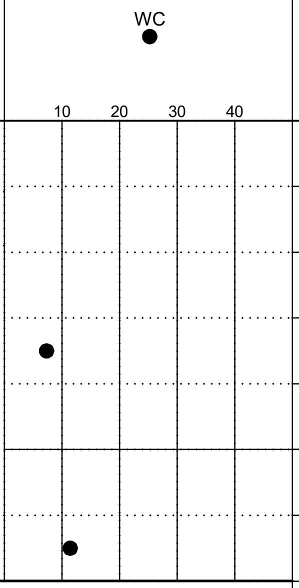
Date Started: 7/1/17
Date Completed: 7/1/17
Logged by: D. Trisler
Checked by: J. Robinson
Location: N: 717,330.55 E: 7,637,426.72
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 3.5 feet
Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Sample Data Type	Sample Data Length (inches)	Sample Data Number Tests	Graphic Log	Material Description
	0.0					Asphalt (6.5-inch thick)
						Moist, brown, WELL-GRADED GRAVEL WITH SAND (GW), 3/4-inch minus aggregate.
						Moist, brown, POORLY GRADED SAND (SP), fine sand, trace gravel.
		☒	6	S-1 WC		
	2.5					
		☒	6	S-2 WC		Moist, light brown, POORLY GRADED SAND (SP), fine sand, trace gravel, trace silt.

Bottom of Borehole at 3.5 feet.

	Depth (feet)
	5.0
	7.5



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2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

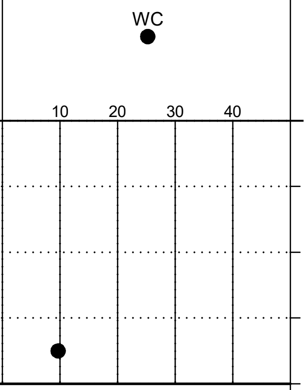
Hand-Auger Log
HC-7

Figure **A-8**
Sheet **1 of 1**

Date Started: 7/1/17
Date Completed: 7/1/17
Logged by: D. Trisler
Checked by: J. Robinson
Location: N: 717,149.67 E: 7,637,752.99
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 2 feet
Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Sample Data: Type	Sample Data: Length (inches)	Sample Data: Number Tests	Graphic Log	Material Description	Depth (feet)
	0.0					Asphalt (6-inch thick)	0.0
						Moist, brown, WELL-GRADED GRAVEL WITH SAND (GW), rounded gravel, .5-inch to 2-inch diameter gravel.	
		☒	6	S-1 WC		Moist, light brown, POORLY GRADED SAND (SP), fine sand, trace gravel, 2-inch diameter gravel. grades to with cobbles	
						Refusal at 2.0 feet.	
	2.5						2.5
	5.0						5.0
	7.5						7.5



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
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HARTCROWSER

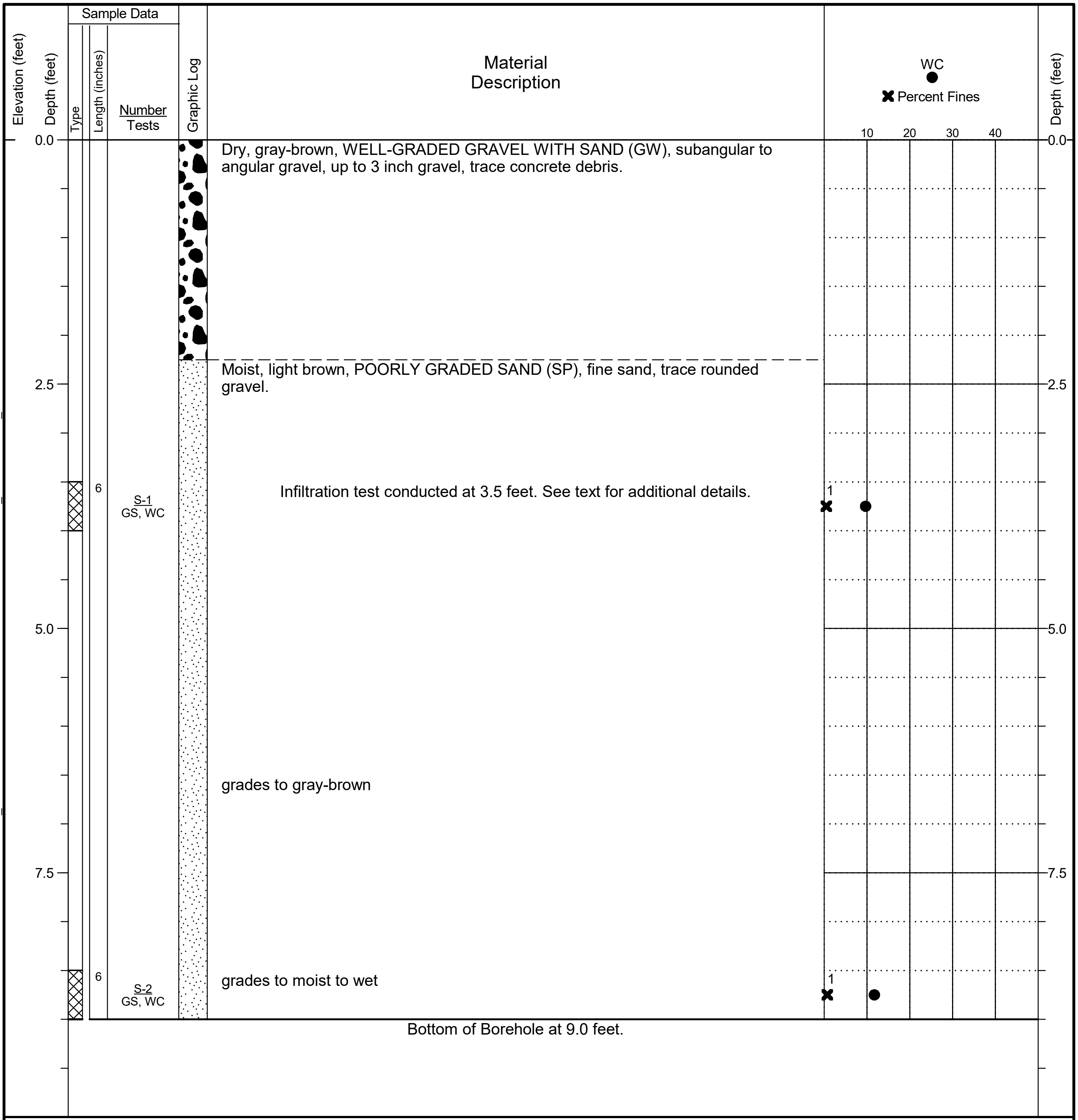
Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
HC-8

Figure **A-9**
Sheet **1 of 1**

Date Started: 6/30/17
Date Completed: 7/1/17
Logged by: A. Chavez
Checked by: J. Robinson
Location: N: 718,374.36 E: 7,635,581.88
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA
Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA
Estimated: NA
Auger Diameter: 4 inches
Casing Diameter: NA
Total Depth: 9 feet
Depth to Ground Water: Not Identified



Dry, gray-brown, WELL-GRADED GRAVEL WITH SAND (GW), subangular to angular gravel, up to 3 inch gravel, trace concrete debris.

Moist, light brown, POORLY GRADED SAND (SP), fine sand, trace rounded gravel.

Infiltration test conducted at 3.5 feet. See text for additional details.

grades to gray-brown

grades to moist to wet

Bottom of Borehole at 9.0 feet.

General Notes:

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

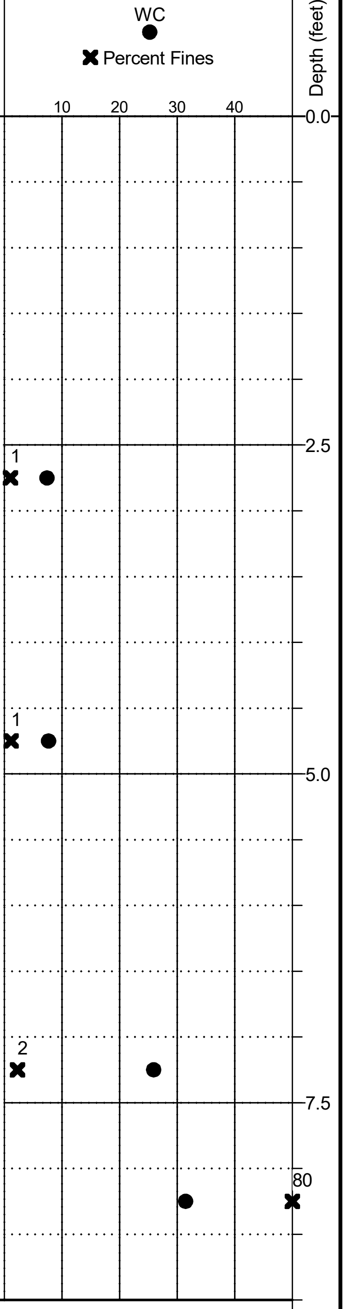
Hand-Auger Log
IT-1

Figure **A-10**
Sheet **1 of 1**

Date Started: 6/30/17 Date Completed: 7/1/17
Logged by: A. Chavez Checked by: J. Robinson
Location: N: 717,826.22 E: 7,636,603.64
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA Estimated: NA
Auger Diameter: 4 inches Casing Diameter: NA
Total Depth: 9 feet Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Sample Data: Type	Sample Data: Length (inches)	Sample Data: Number Tests	Material Description
	0.0				Dry, gray-brown, POORLY GRADED GRAVEL WITH SILT (GP-GM), subangular to angular gravel, gravel to 3 inches, trace concrete and asphalt debris.
					Dry, brown, WELL-GRADED SAND WITH GRAVEL (SW), fine sand, angular gravel.
	2.5	▨	6	S-1 GS, WC	Moist, light brown, POORLY GRADED SAND (SP), fine sand, trace red mottles. Infiltration test conducted at 2.75 feet. See text for additional details.
		▨	6	S-2 GS, WC	
	5.0				
		▨	6	S-3 GS, WC	grades to red-brown
	7.5				
		▨	6	S-4 GS, WC	Moist to wet, red-brown, SILT WITH SAND (ML), low plasticity, fine.



Bottom of Borehole at 9.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
IT-2

Figure **A-11**
Sheet **1 of 1**

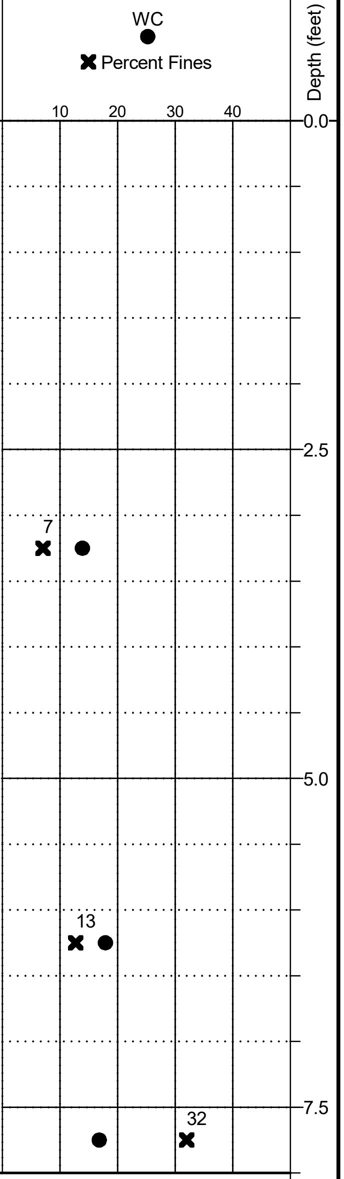
HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

Date Started: 6/30/17 Date Completed: 7/1/17
Logged by: A. Chavez Checked by: J. Robinson
Location: N: 717,220.64 E: 7,637,588.49
Ground Surface Elevation:
Horizontal Datum: OR State Plane N, NAD 83, ft.
Vertical Datum:
Comments:

Drilling Contractor/Crew: Hart Crowser
Drilling Method: Hand Auger
Rig Model/Type:
Hammer Type:
Hammer Weight (pounds): NA Hammer Drop Height (inches): NA
Hammer Efficiency (%): Measured: NA Estimated: NA
Auger Diameter: 4 inches Casing Diameter: NA
Total Depth: 8 feet Depth to Ground Water: Not Identified

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number Tests	Material Description
	0.0				Dry, light brown, SILTY GRAVEL (GM), subangular to angular gravel, up to 3-inch diameter gravel.
					Moist, red-brown, POORLY GRADED SAND WITH SILT (SP-SM), fine, low plasticity, trace subrounded to rounded gravel.
		☒	6	S-1	
	2.5				
		☒	6	S-2 GS, WC	
					Infiltration test conducted at 3.6 feet. See text for additional details.
	5.0				Moist, gray, SILTY SAND WITH GRAVEL (SM), subrounded to rounded gravel, up to 3-inch diameter gravel.
		☒	6	S-3 GS, WC	
	7.5	☒	6	S-4 GS, WC	

Bottom of Borehole at 8.0 feet.



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between material strata or geologic units. Dashed stratum lines indicate gradual or approximate change between material strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Hand-Auger Log
IT-3

Figure **A-12**
Sheet **1 of 1**

HC BORING LOG - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:45 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

APPENDIX B
Laboratory Testing

APPENDIX B

Laboratory Testing

A limited geotechnical laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. Testing was completed at our in-house laboratory in our Portland, Oregon office. The tests performed and the procedures followed are outlined below.

Soil Classification

Soil samples were visually classified in our laboratory to verify the field classifications in a relatively controlled laboratory environment. Classifications were made in general accordance with the Unified Soil Classification System (USCS) and ASTM Test Method D 2487.

Water Content Determinations

Water contents were determined for select samples recovered in the explorations in general accordance with ASTM Test Method D 2216. The test results are shown on the appropriate exploration logs included in Appendix A and shown on Figure B-1 in this appendix.

Fines Content Analyses

Fines content analyses were performed to determine the percentage of soils finer than the No. 200 sieve—the boundary between sand and silt size particles. The tests were performed in general accordance with ASTM Test Method D 1140. The test results are indicated on the appropriate exploration log included in Appendix A and on Figure B-1 in this appendix.

Sieve Analyses

Sieve analysis tests were performed on selected samples to determine the quantitative distribution of particle sizes in the original sample. The tests were performed in general accordance with ASTM Test Method D 6913-04. The test results are indicated on the exploration logs included in Appendix A and on Figure B-2 in this appendix.

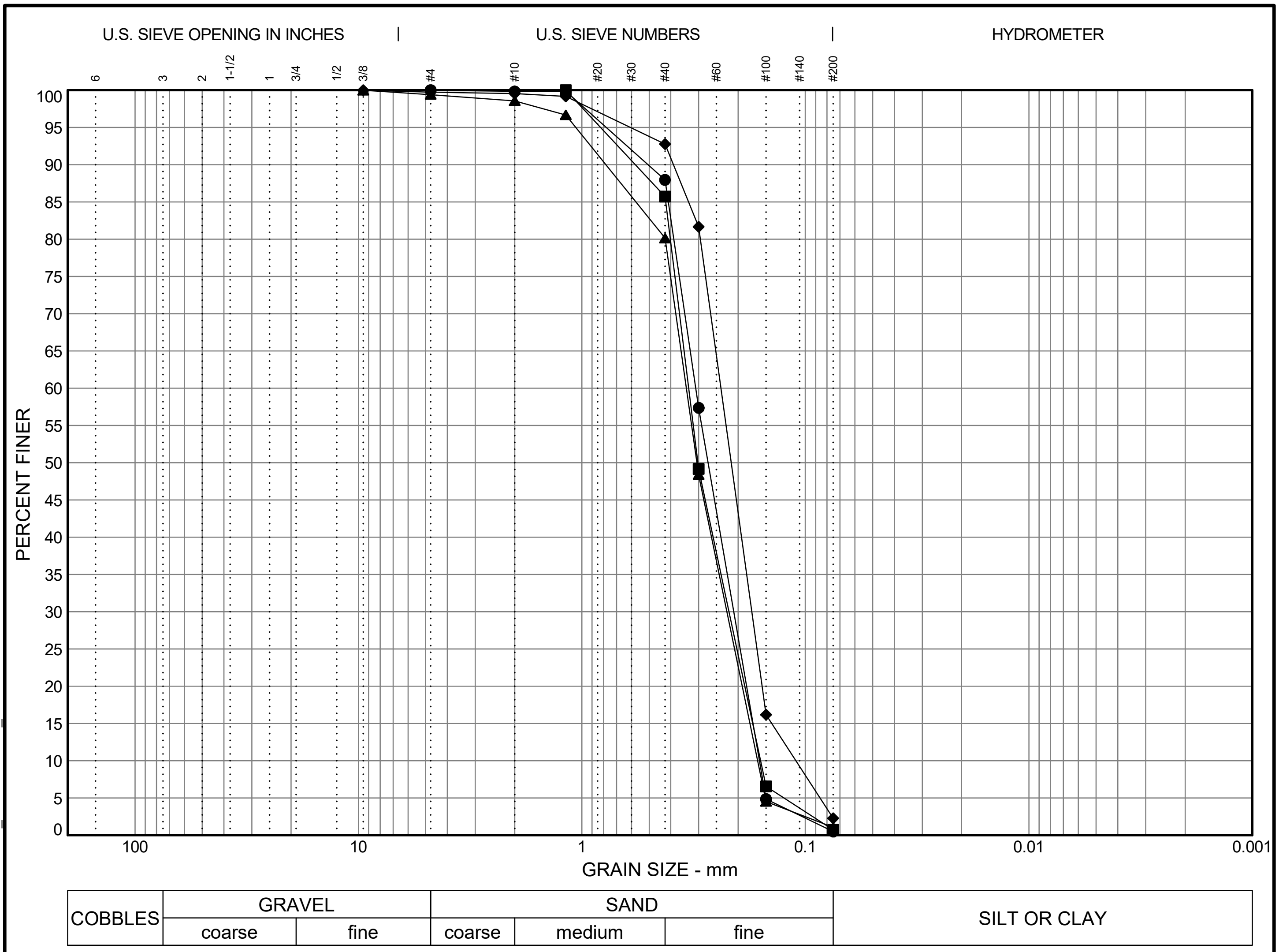
Exploration	Depth	Water Content (%)	Dry Density (pcf)	Maximum Size (mm)	%<#200 Sieve	Liquid Limit	Plastic Limit	Plasticity Index	Pocket Pen (tsf)	Torvane (tsf)
HC-1	1.5	3.2								
HC-1	3.0	3.6								
HC-2	2.0	1.9								
HC-2	3.5	3.0								
HC-5	2.0	14.7								
HC-5	3.0	9.6								
HC-7	1.5	7.3								
HC-7	3.0	11.4								
HC-8	1.5	9.7								
IT-1	3.5	9.7		4.75	1					
IT-1	9.0	11.7		1.18	1					
IT-2	2.5	7.4		9.5	1					
IT-2	4.5	7.7		0.075	1					
IT-2	7.0	25.9		9.5	2					
IT-2	8.0	31.5		0.075	80					
IT-3	3.0	13.9		25	7					
IT-3	6.0	17.9		9.5	13					
IT-3	7.5	16.8		0.075	32					

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Summary of Laboratory Results

Figure **B-1**
Sheet **1 of 1**



Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** IT-1 **Sample No.:** S-1 **Depth:** 3.5 to 4.0 POORLY GRADED SAND	0.0	0.0	99.5	0.5		10	SP
■ **Source:** IT-1 **Sample No.:** S-2 **Depth:** 8.5 to 9.0 POORLY GRADED SAND	0.0	0.0	99.3	0.7		12	SP
▲ **Source:** IT-2 **Sample No.:** S-1 **Depth:** 2.5 to 3.0 POORLY GRADED SAND	0.0	0.6	98.3	1.1		7	SP
◆ **Source:** IT-2 **Sample No.:** S-3 **Depth:** 7.0 to 7.5 POORLY GRADED SAND	0.0	0.3	97.5	2.3		26	SP

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.411	0.309	0.272	0.209	0.172	0.161	0.88	1.93
■			0.422	0.333	0.302	0.220	0.172	0.159	0.91	2.10
▲			0.574	0.341	0.305	0.224	0.177	0.164	0.90	2.08
◆			0.333	0.239	0.215	0.174	0.141	0.110	1.15	2.16

Remarks:

●
■
▲ trace low plasticity silt
◆ trace low plasticity silt

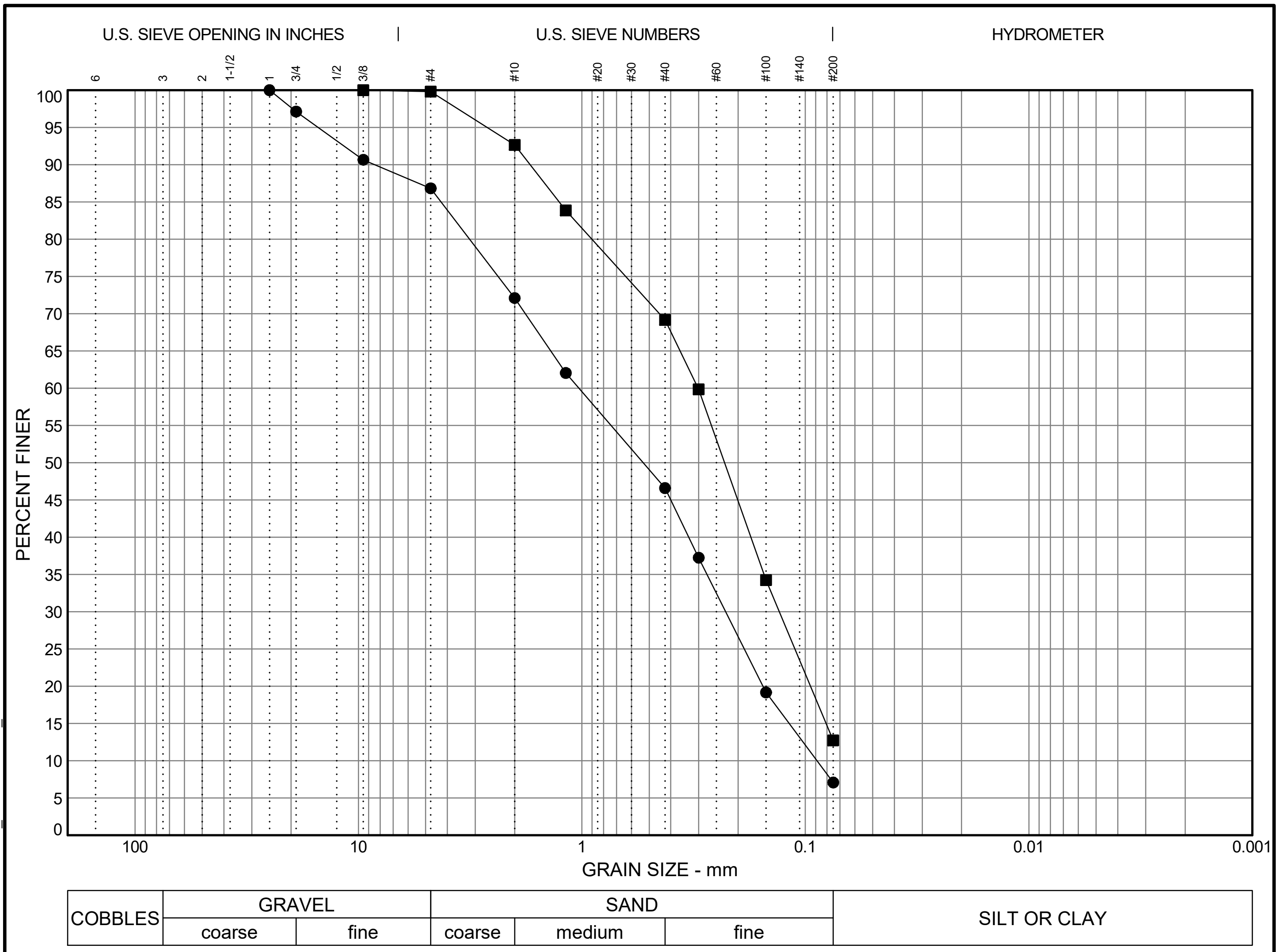
HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Particle-Size Analysis

Figure **B-2**
Sheet **1 of 2**

HC GRAIN SIZE - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:36 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ



Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** IT-3 **Sample No.:** S-2 **Depth:** 3.0 to 3.5 POORLY GRADED SAND WITH SILT	0.0	13.2	79.8	7.1		14	SP-SM
■ **Source:** IT-3 **Sample No.:** S-3 **Depth:** 6.0 to 6.5 SILTY SAND	0.0	0.2	87.1	12.7		18	SM

╳	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			4.266	1.031	0.532	0.227	0.118	0.089	0.56	11.62
■			1.263	0.302	0.230	0.131	0.081			

Remarks:

● trace angular gravel
■

HARTCROWSER

Project: North Suttle Road Improvements
Location: Portland, Oregon
Project No.: 15941-04

Particle-Size Analysis

Figure **B-2**
Sheet **2 of 2**

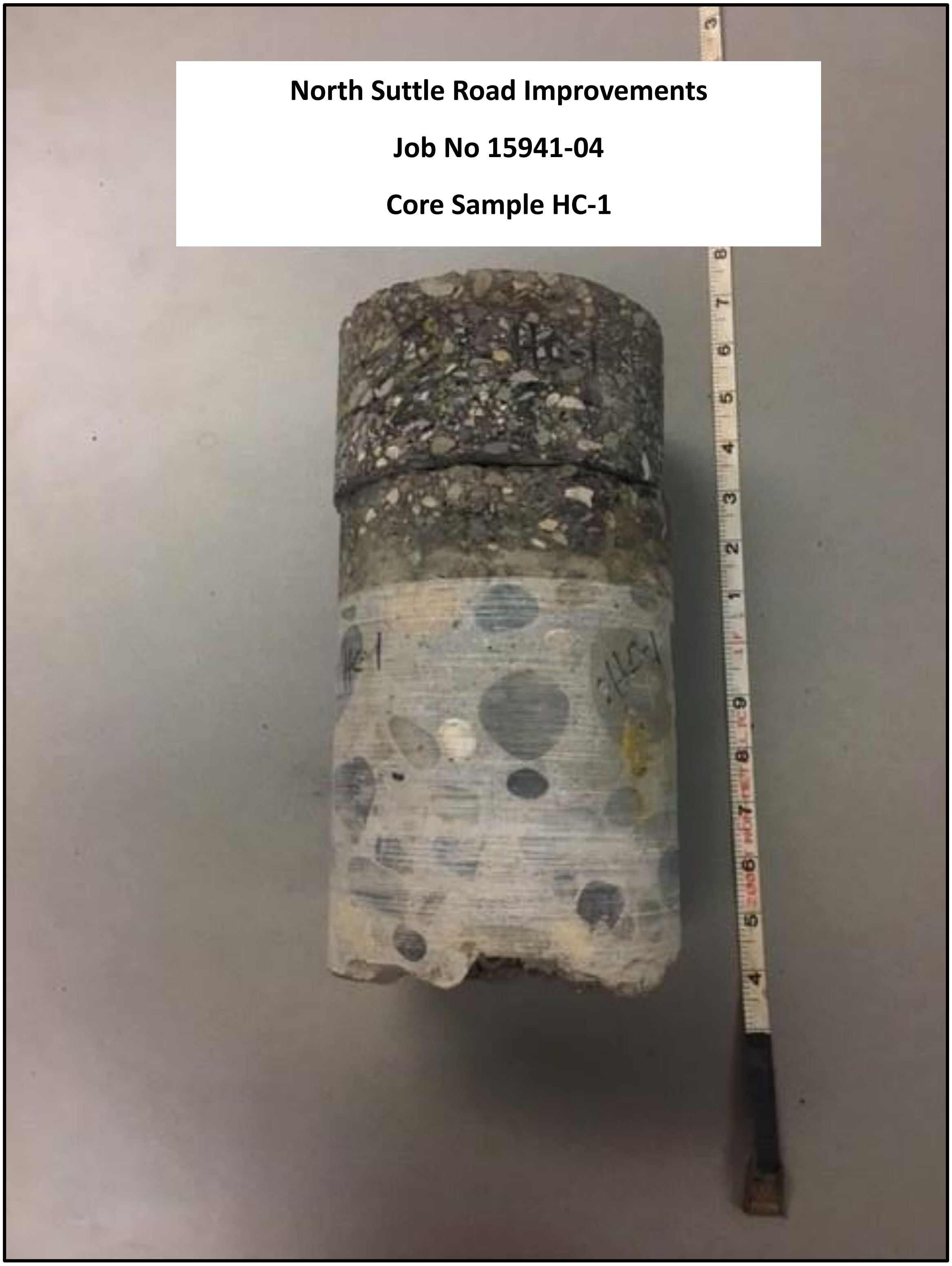
HC GRAIN SIZE - F:\GINT\HC_LIBRARY.GLB - 7/24/17 13:36 - F:\NOTEBOOKS\1594104_N SUTTLE ROAD IMPROVEMENTS\FIELD DATA\PERM_GINT\1594104_EXPLORATIONS.GPJ

APPENDIX C
Pavement Core Photographs and DCP Data Correlations

APPENDIX C

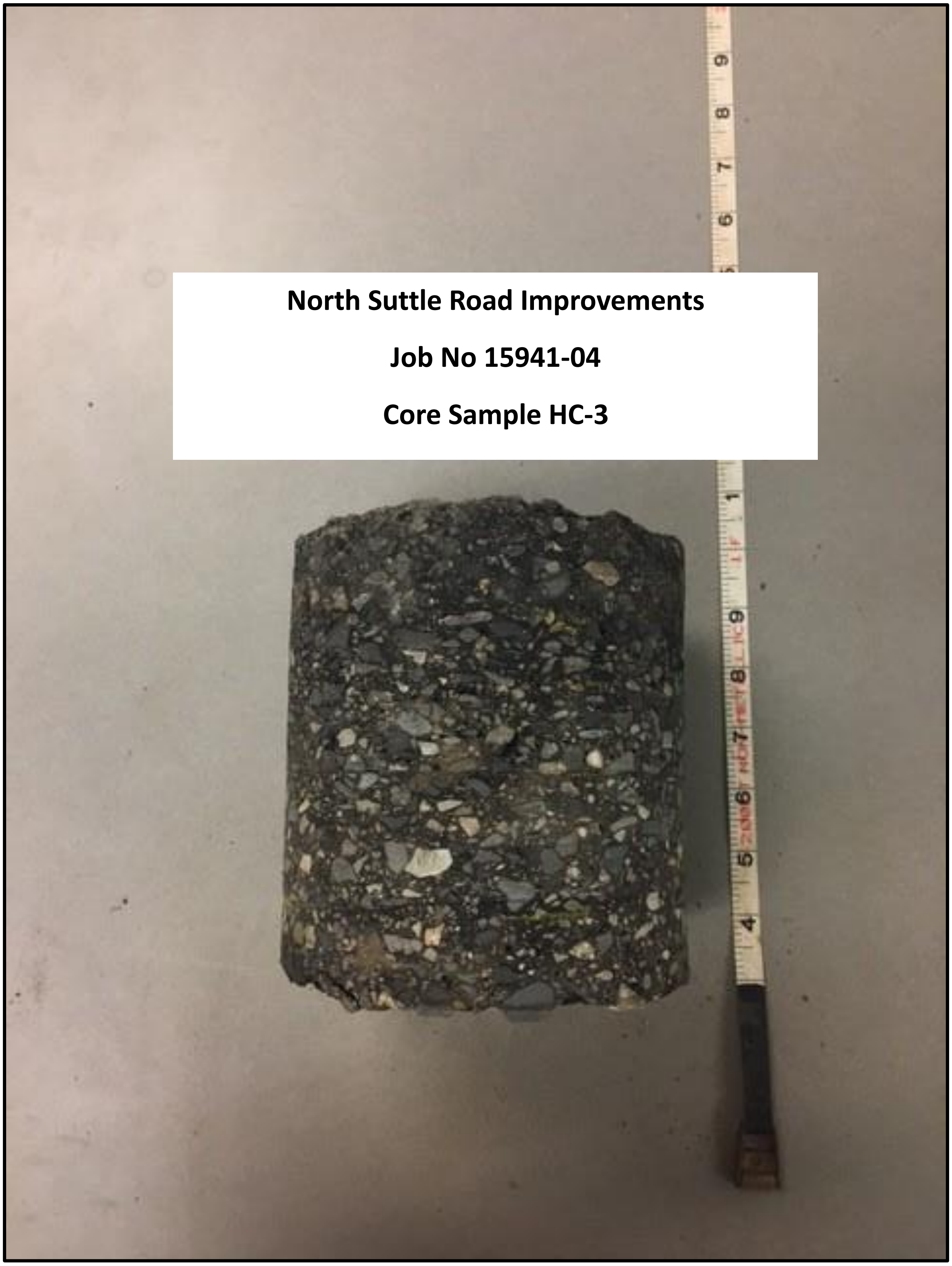
Pavement Core Photographs and DCP Data Correlations

The appendix contains photographs of the pavement cores collected at the site, as well as DCP data correlations.

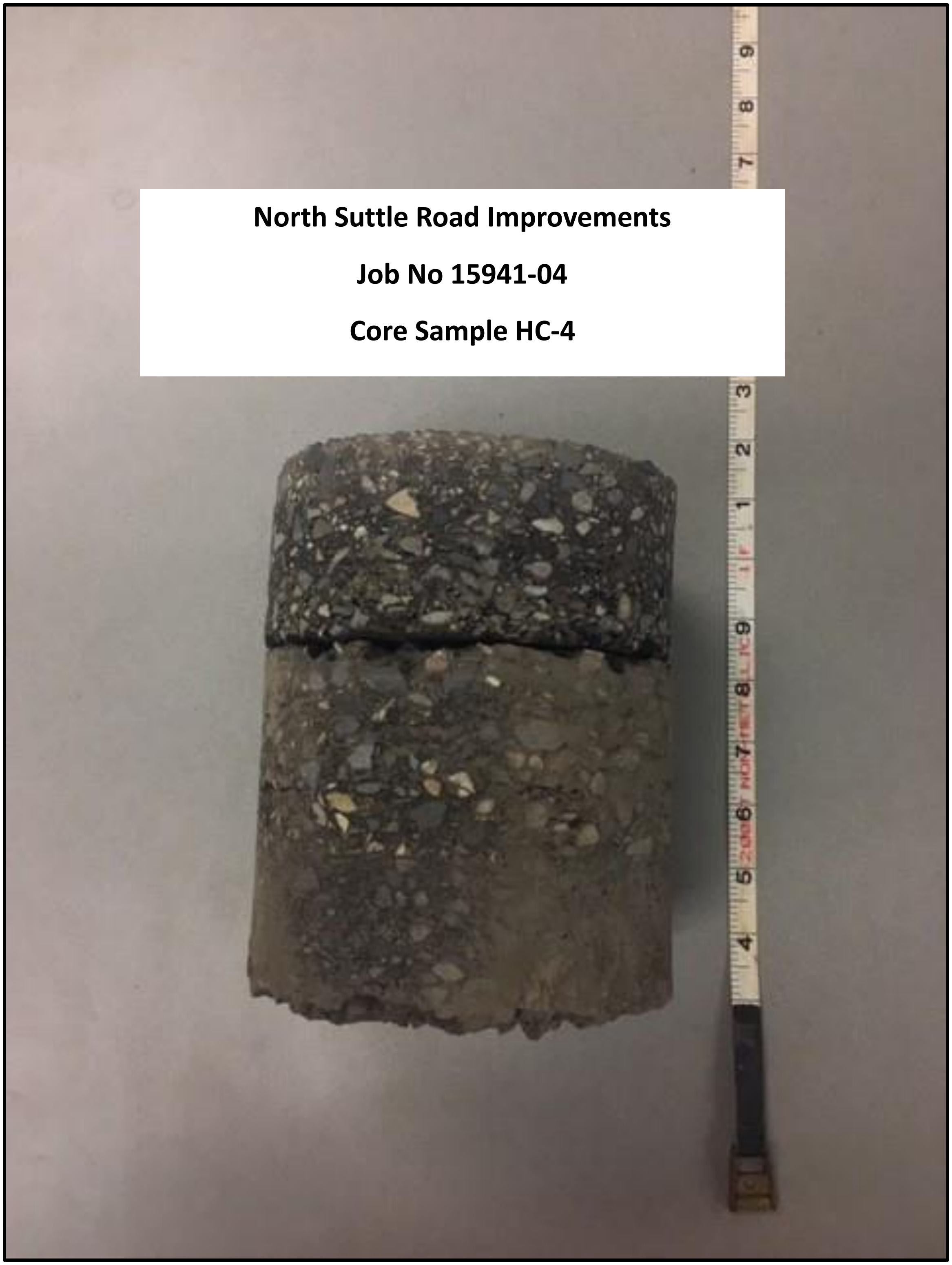


Photograph C-1: Pavement Core HC-1

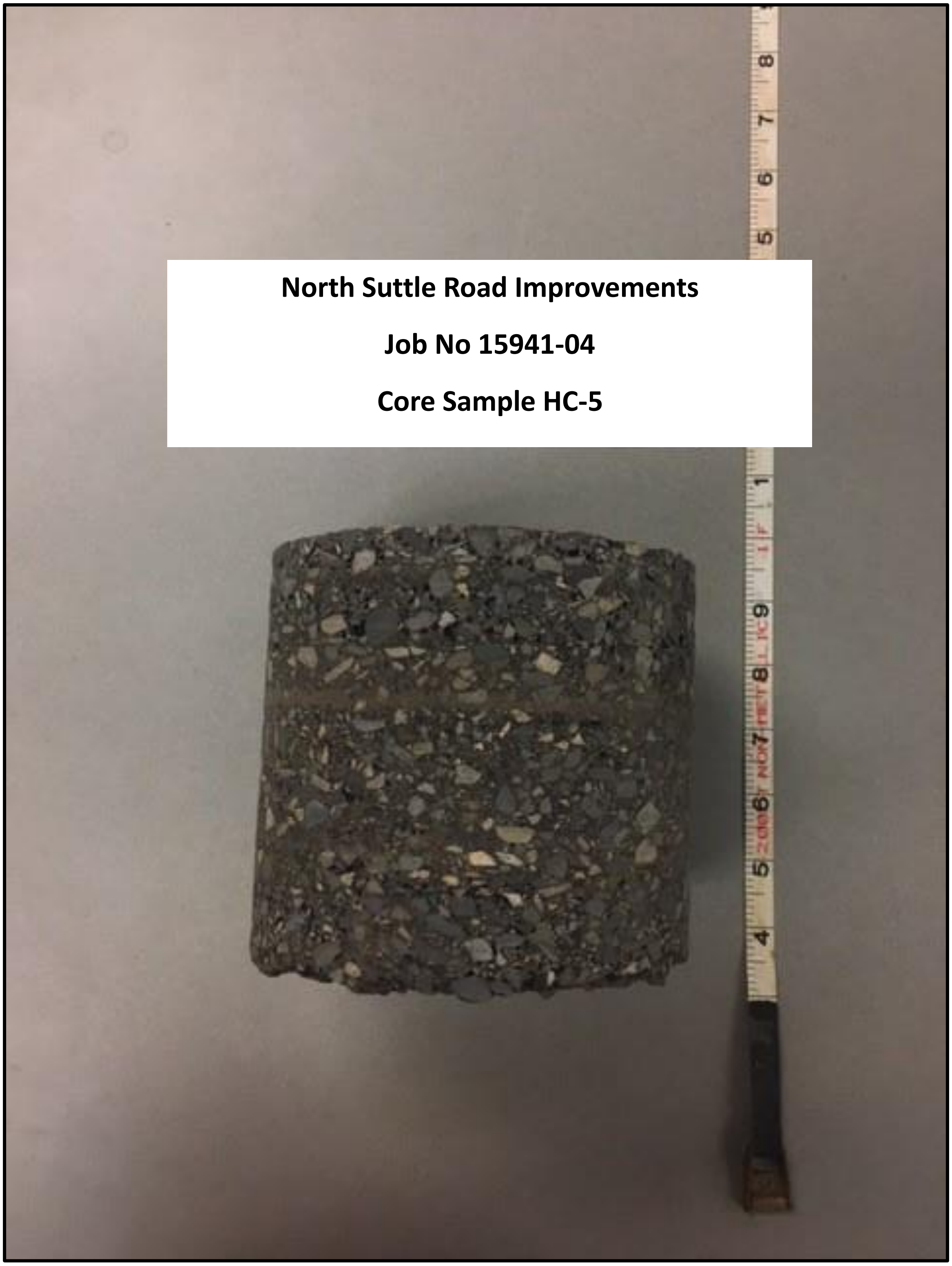
Photograph C-2: Pavement Core HC-2



Photograph C-3: Pavement Core HC-3



Photograph C-4: Pavement Core HC-4

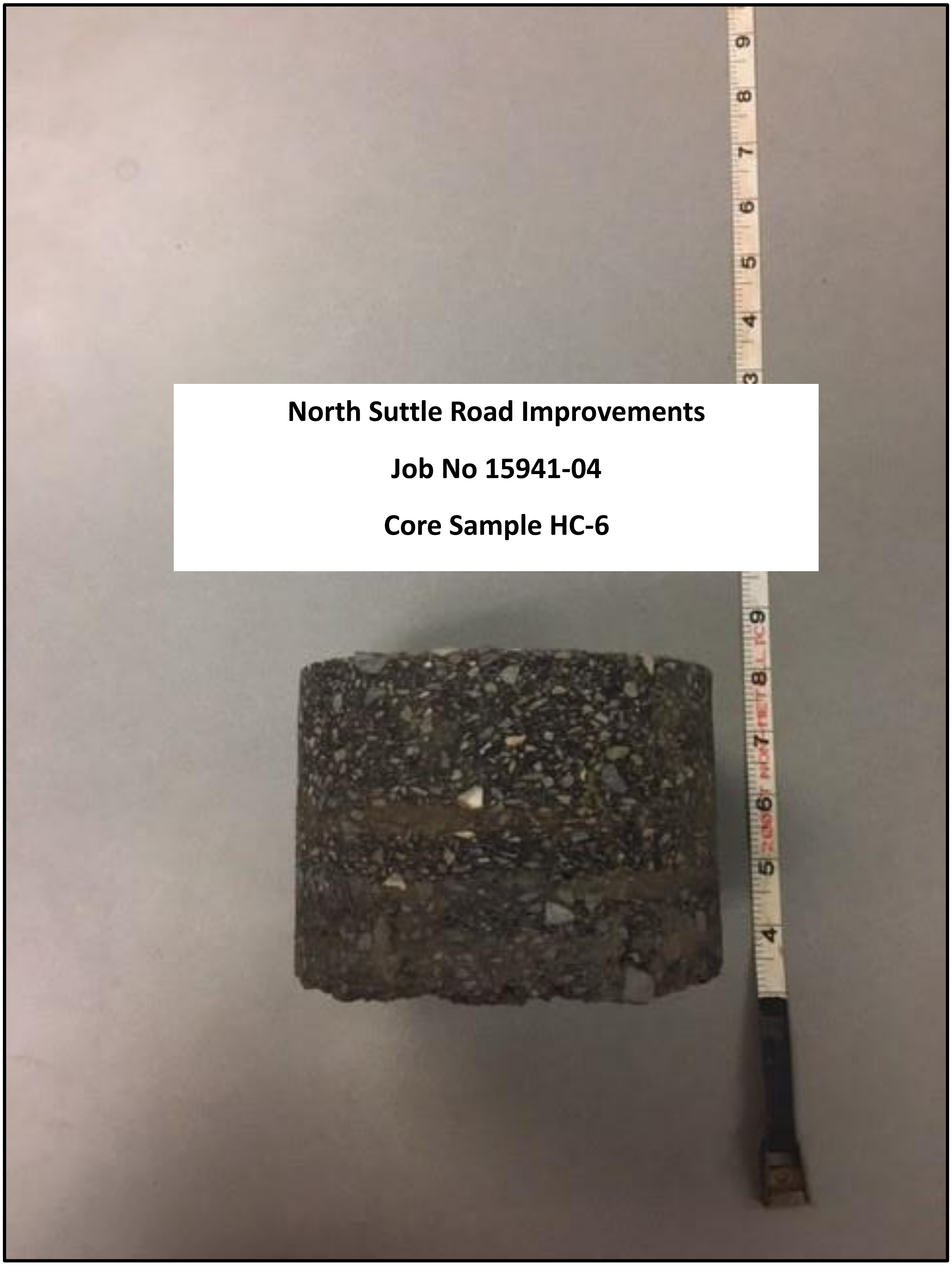


North Suttle Road Improvements

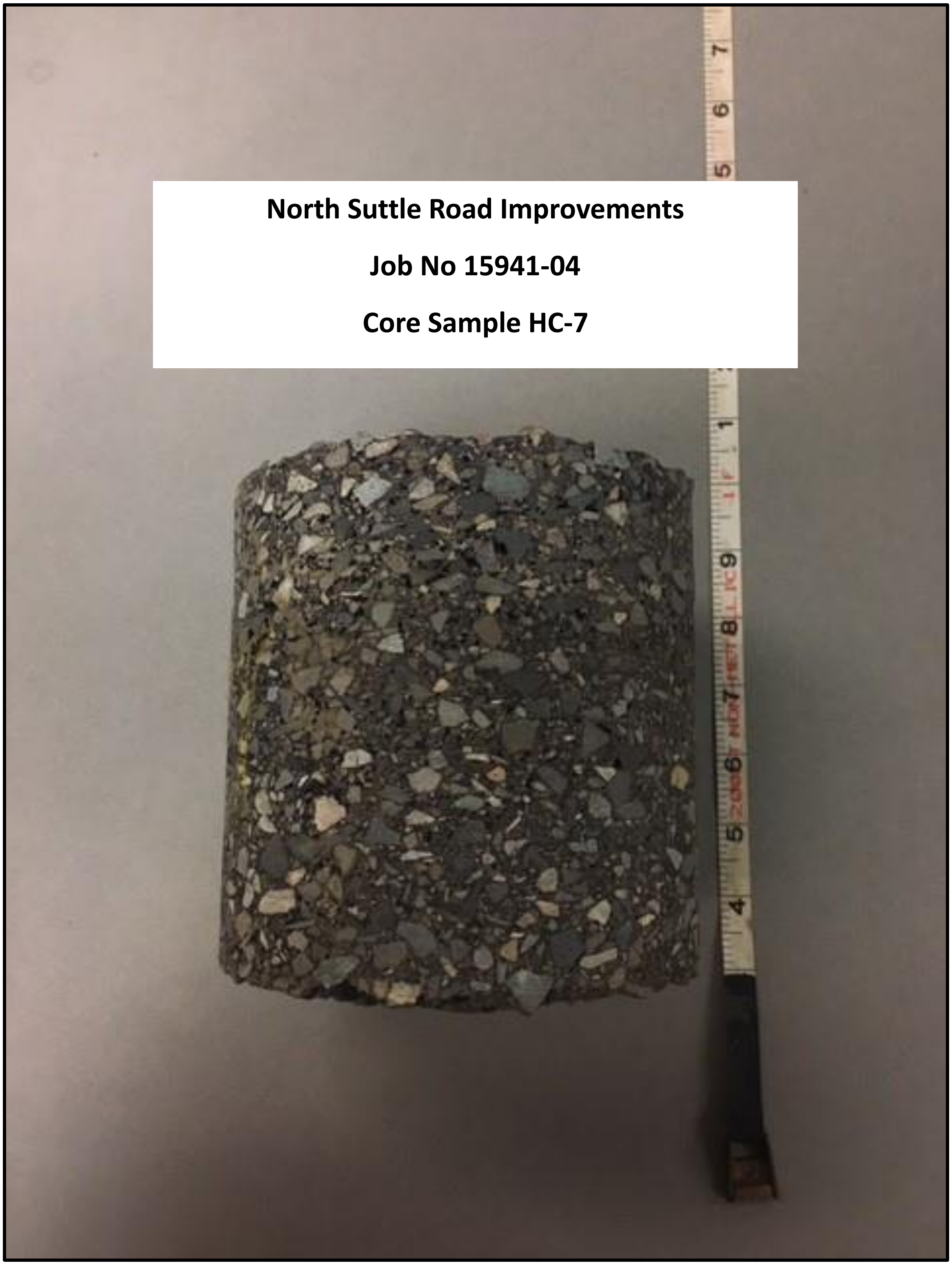
Job No 15941-04

Core Sample HC-5

Photograph C-5: Pavement Core HC-5



Photograph C-6: Pavement Core HC-6

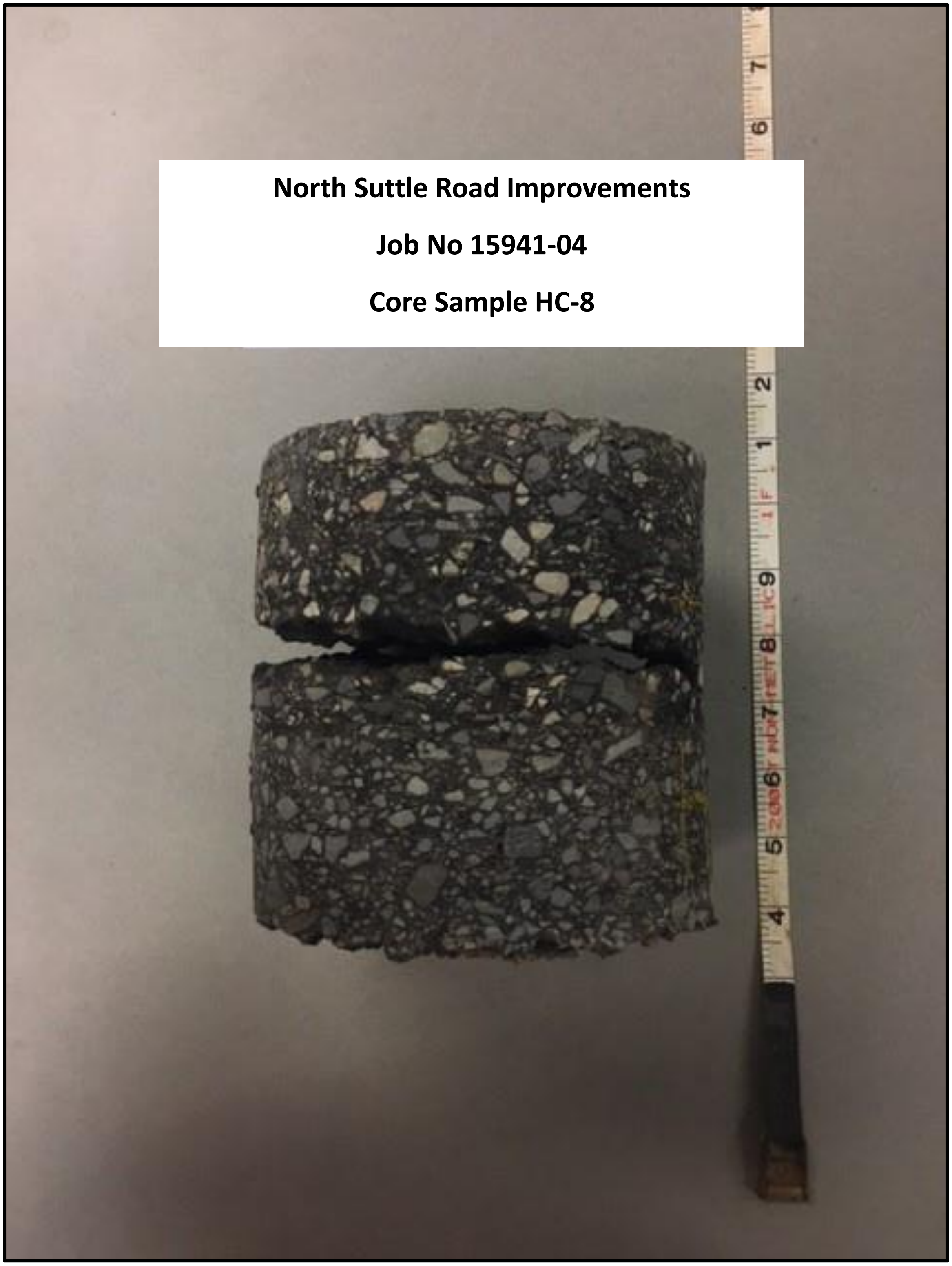


North Suttle Road Improvements

Job No 15941-04

Core Sample HC-7

Photograph C-7: Pavement Core HC-7



North Suttle Road Improvements

Job No 15941-04

Core Sample HC-8

Photograph C-8: Pavement Core HC-8

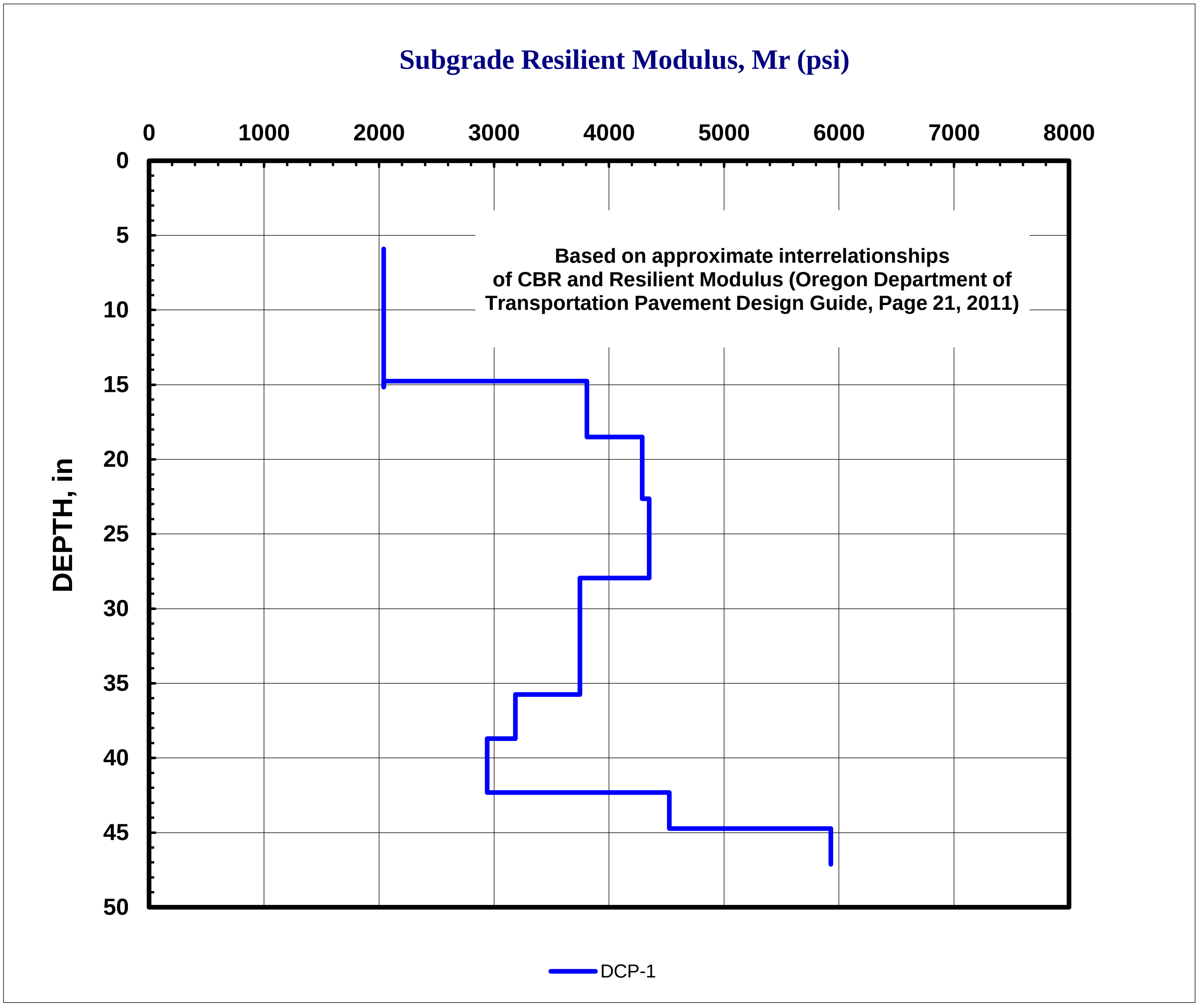


Figure C-1. HC-1 DCP Correlations

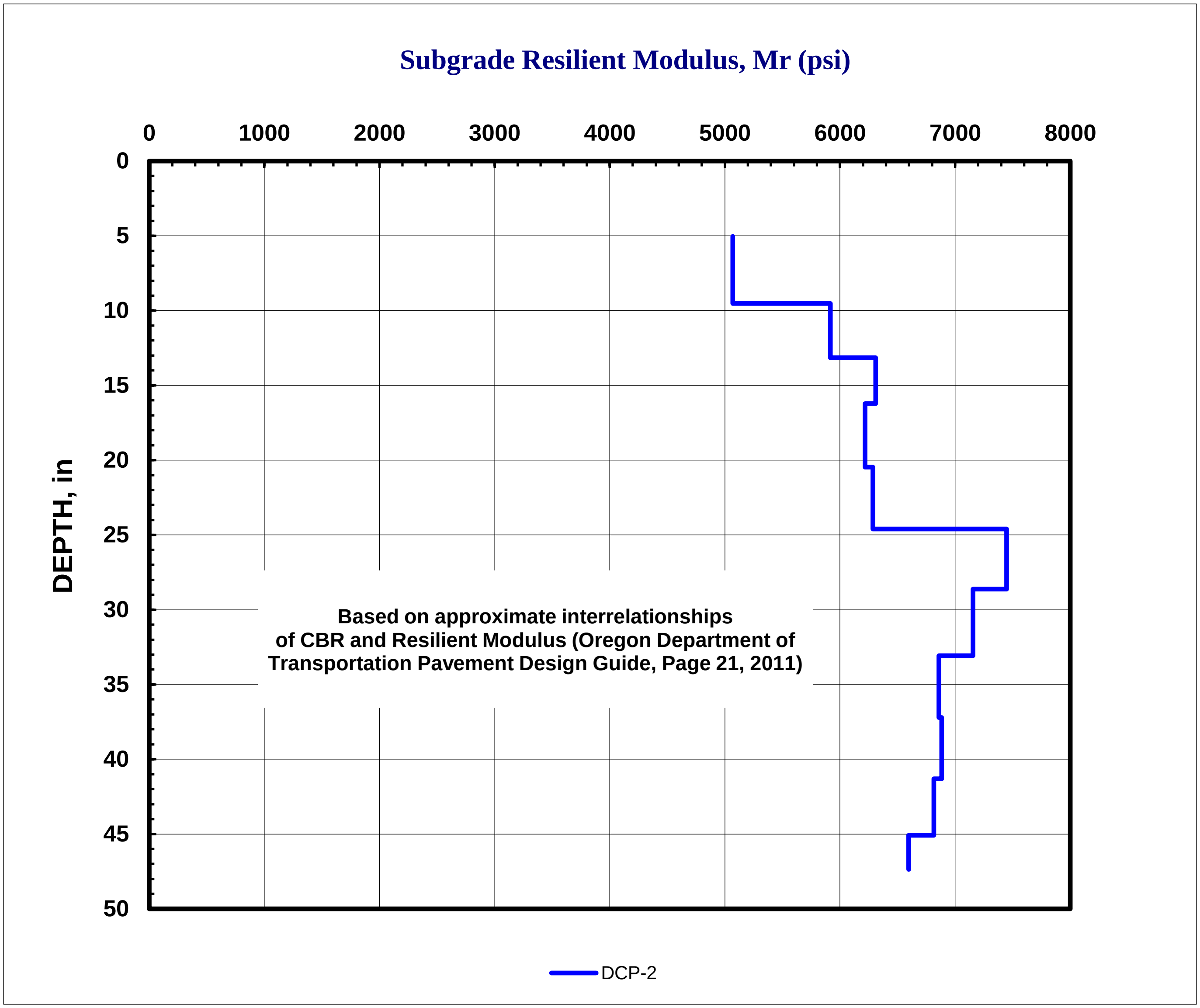


Figure C-2. HC-2 DCP Correlations

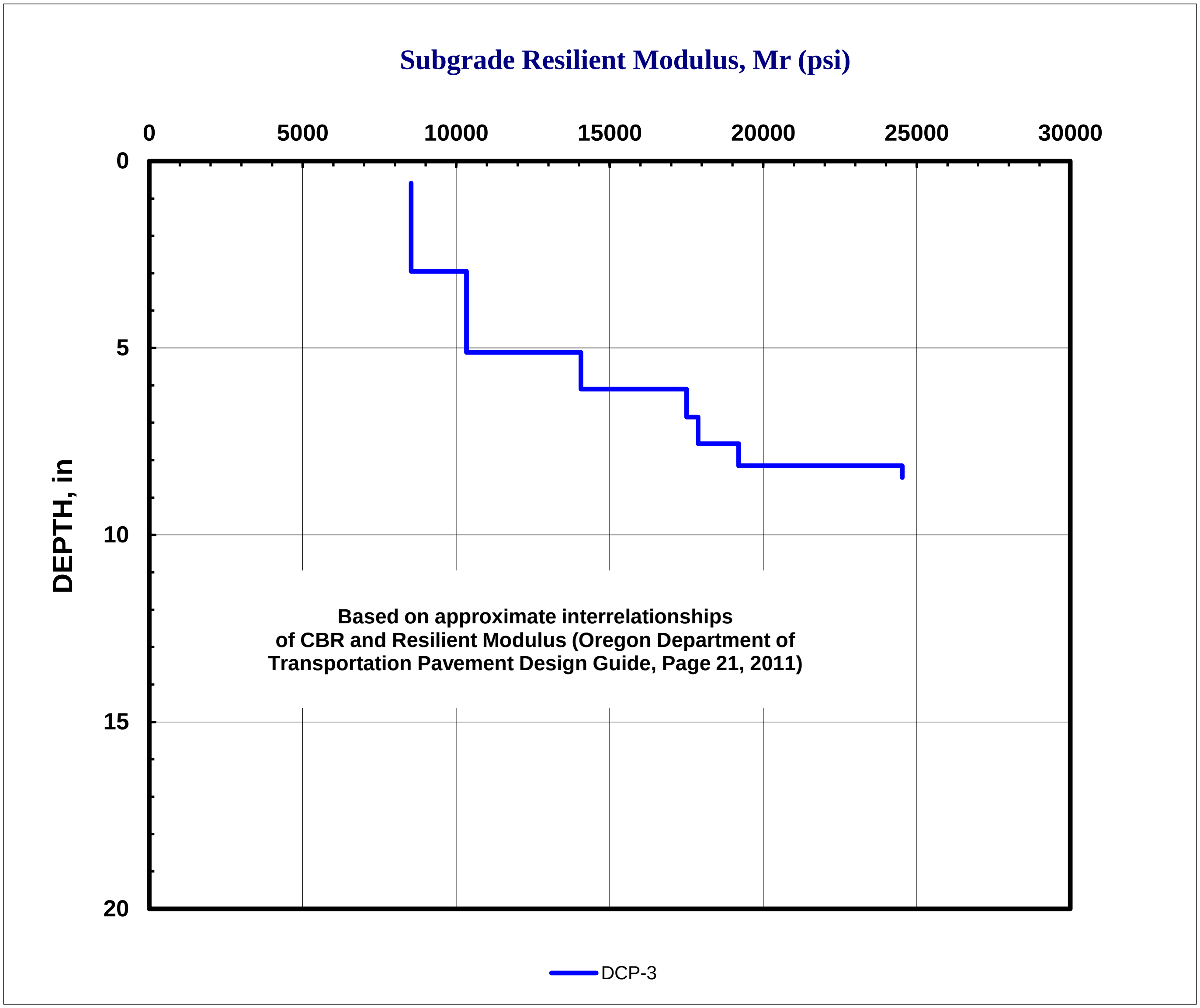


Figure C-3. HC-3 DCP Correlations

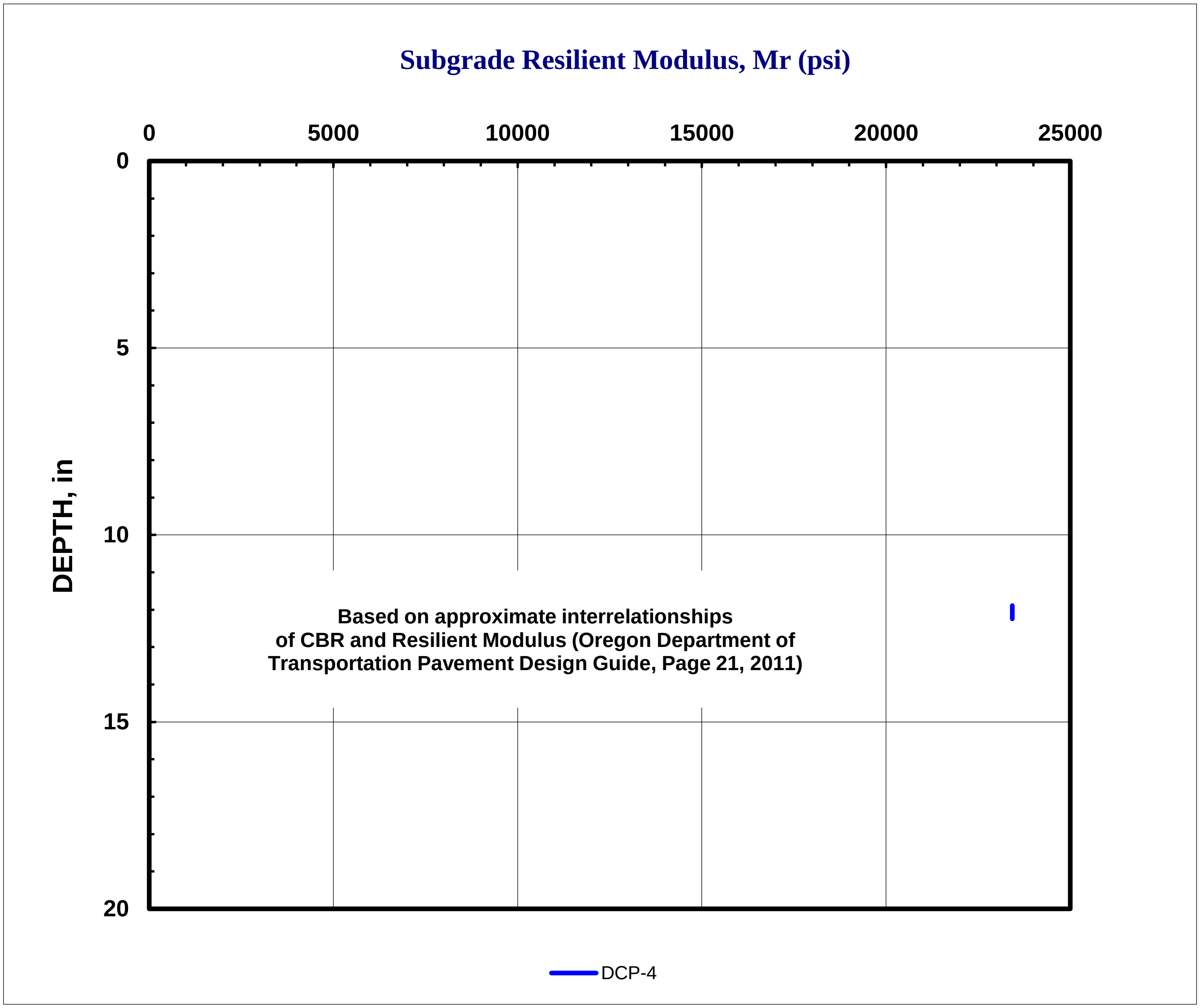


Figure C-4. HC-4 DCP Correlations

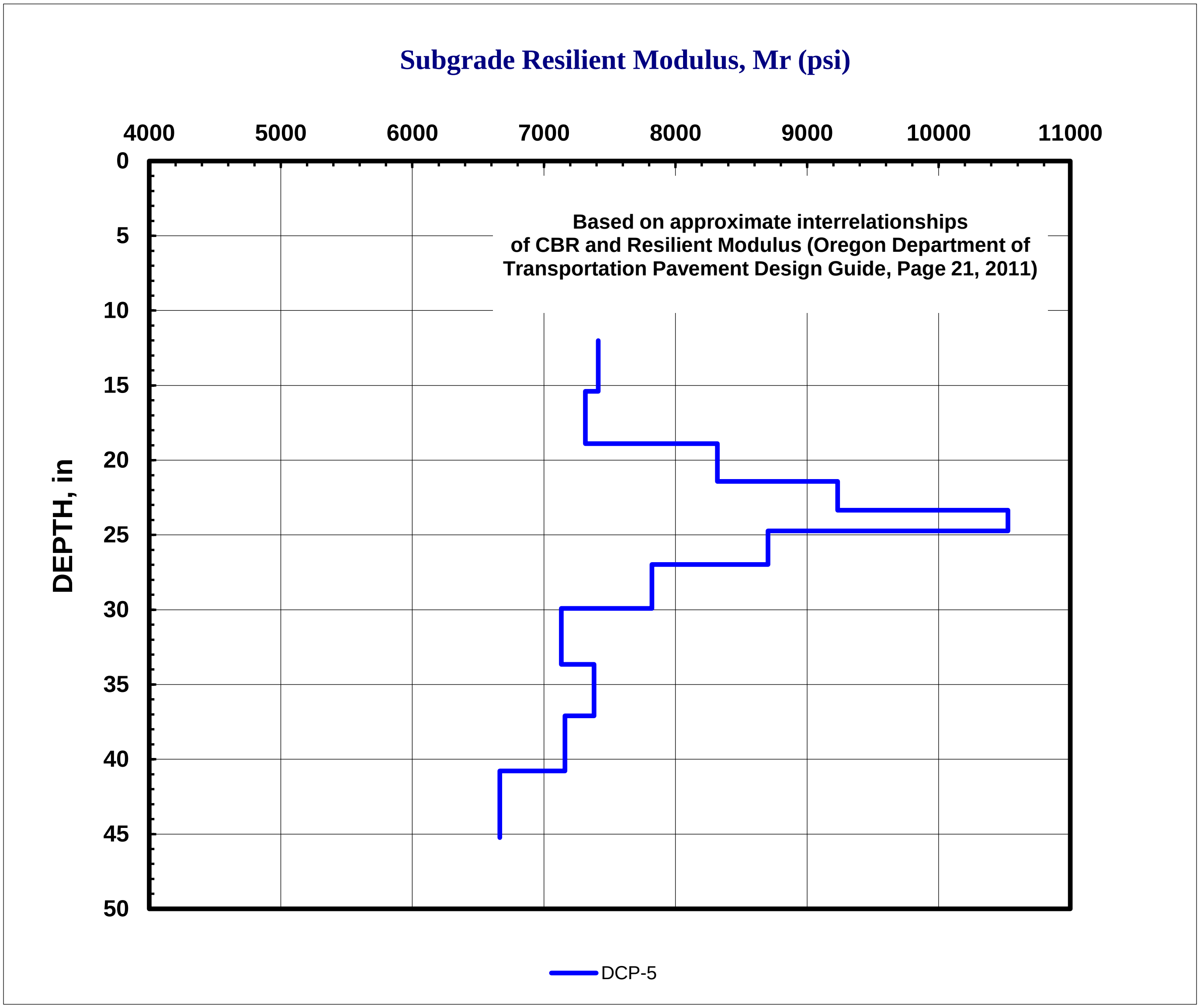


Figure C-5. HC-5 DCP Correlations

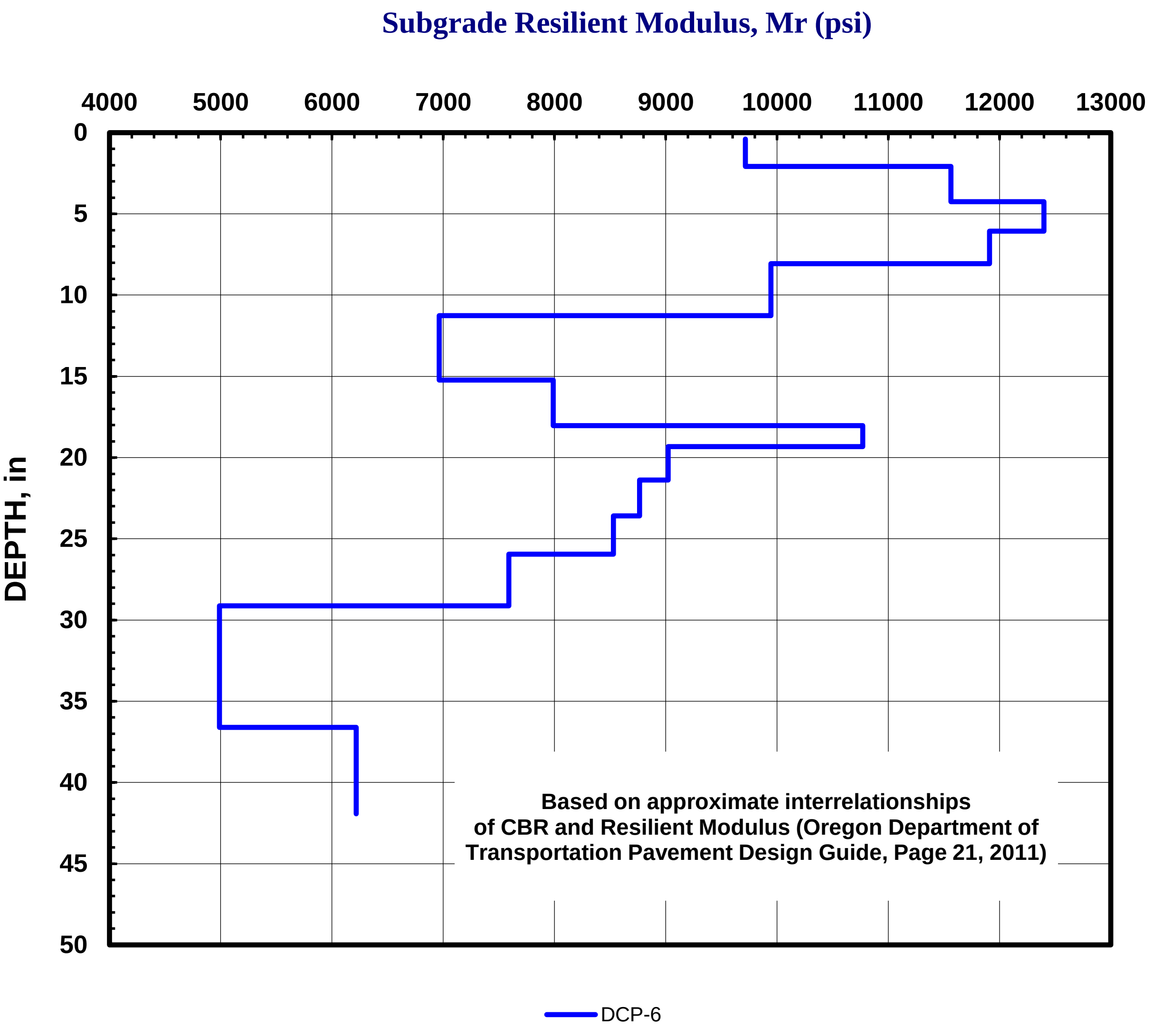


Figure C-6. HC-6 DCP Correlations

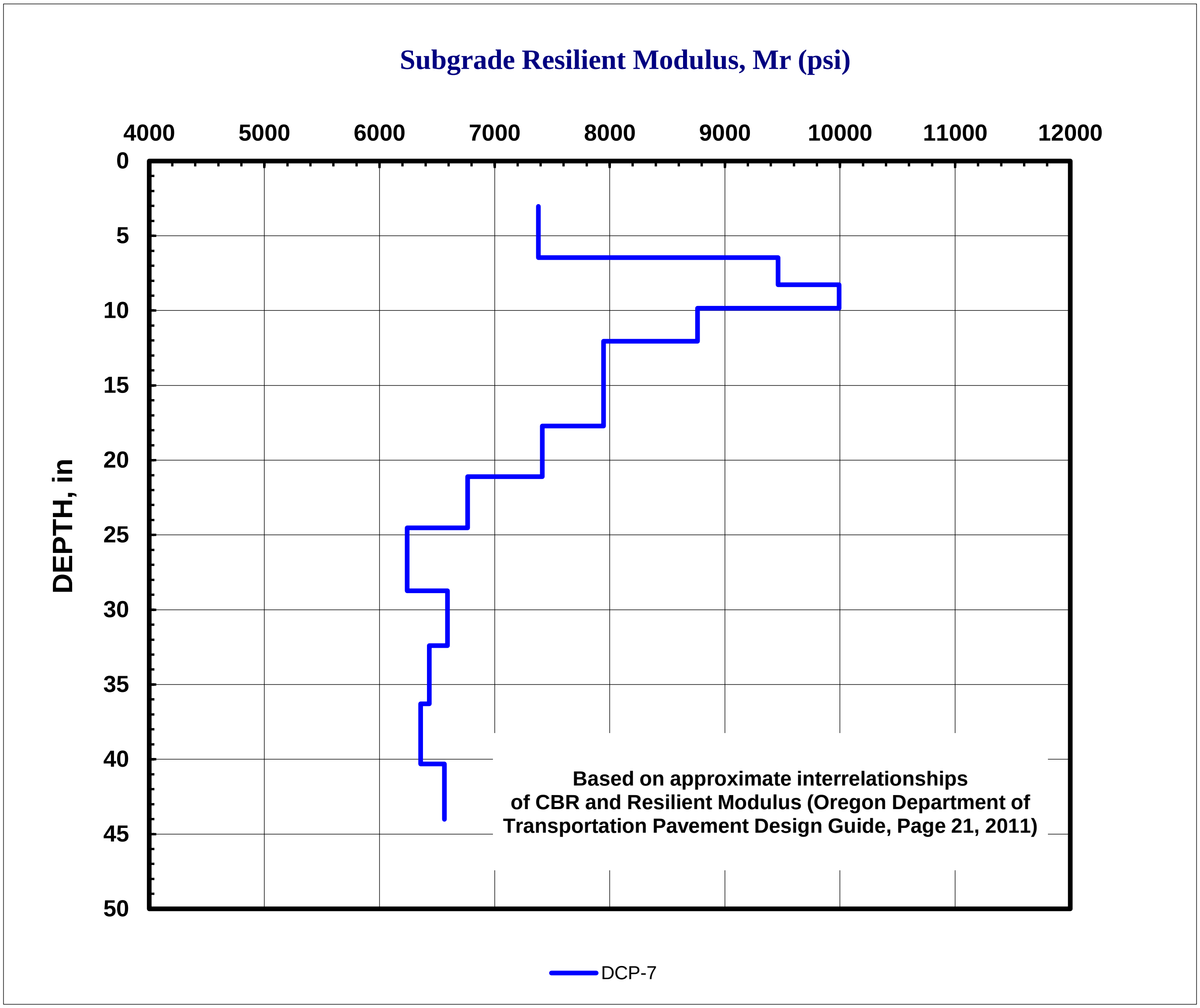


Figure C-7. HC-7 DCP Correlations

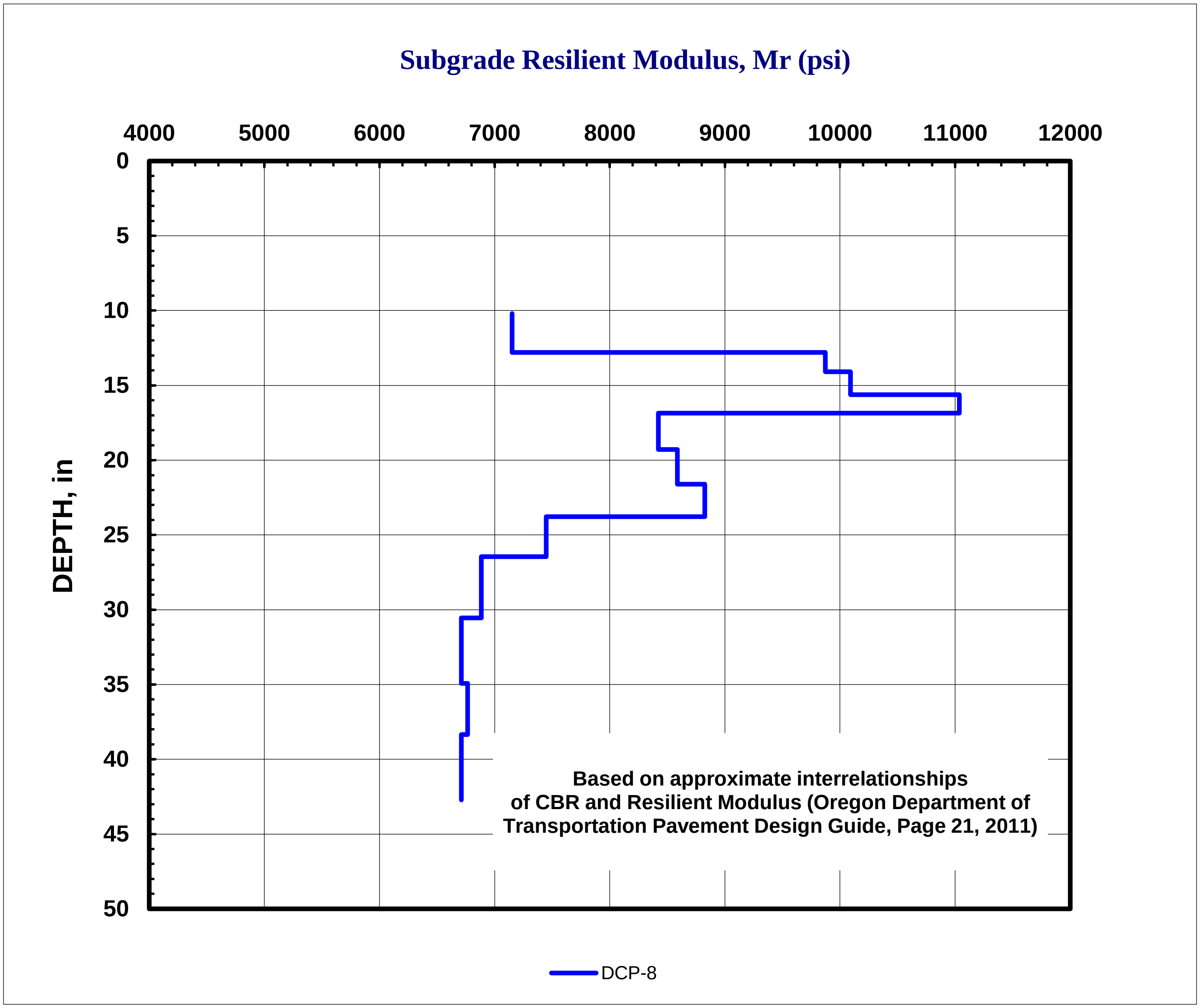


Figure C-8. HC-8 DCP Correlations

ATTACHMENT 3

STORMWATER STUDY

MAUL
FOSTER
ALONGI

MEMORANDUM

To:	Suttle Road Property Owners	Date:	August 16, 2017
From:	Ada Banasik, PE	Project:	0106.24.01

RE: Conceptual Stormwater Study for Proposed North Suttle Road Improvements

---

Maul Foster & Alongi, Inc. (MFA) has prepared this memorandum to outline the conceptual design of a stormwater management system to manage runoff from the proposed North Suttle Road pavement and sidewalk improvement project. The conceptual stormwater system design includes conveyance features and infiltration planters designed consistent with the City of Portland (the City) 2016 Stormwater Management Manual (SWMM). The design assumes that all runoff will be managed through infiltration with the project area to avoid overflow into the municipal storm sewer or receiving waters. The design assumes, based on the results of three in-situ infiltration tests, that stormwater will be infiltrated along the central and western sections of the road. The eastern section was considered unsuitable for infiltration, although this assumption should be further evaluated during final design.

HYDROLOGIC MODEL

The hydrologic conditions for the drainage basins were modeled using HydroCAD® hydrologic software, version 10.0. Consistent with the SWMM requirements, stormwater runoff volumes and peak flows were estimated using the Santa Barbara Urban Hydrograph method and utilized the Natural Resource Conservation Service Type IA hydrograph. The HydroCAD output report is attached to this memorandum.

DESIGN STORM

The infiltration planters were designed to infiltrate 100 percent of runoff (under a 100-year, 24-hour design storm scenario) to manage all runoff without the need for an overflow system. The 100-year design storm equates to 4.40 inches of rainfall over a 24-hour period.

HYDROLOGIC DESIGN FACTORS

The proposed area was modeled as two drainage areas (Drainage Area 1 and Drainage Area 2). The drainage basins were modeled using a hydrologic curve number of 98, which is based on the soil conditions observed during infiltration testing. Drainage Area 1 consists of the western section of the road and sidewalk (31,840 square feet [SF]) and Drainage Area 2 consists of the central and eastern section of the road and sidewalk (82,828 SF).

INFILTRATION RATES

Infiltration tests were conducted at three locations within the footprint of the proposed infiltration facility. Infiltration tests were conducted on the in-situ soils along the side of the road using the encased falling head infiltration test method. The design infiltration rates (infiltration rate measured in the field divided by the SWMM-recommended factor of safety) were found to be 6.25 inches per hour in the western section of the road (Drainage Area 1), and 25 inches per hour at the central section of the road (Drainage Area 2). The infiltration test along the eastern section of the road showed minimal measured infiltration; however, the soil profile from adjacent borings logged similar sandy fill material as the remainder of the road. Although, the conceptual design conservatively assumed that stormwater would not be infiltrated along the east section of the road, it is recommended that this assumption be re-evaluated during the final design with additional infiltration tests.

The Geotechnical Engineering Report (Attachment 4) shows the infiltration test results.

DEPTH TO GROUNDWATER

The depth to groundwater is approximately 8 feet below ground surface (bgs). The bottom of the infiltration planter will be 2 feet bgs; therefore, the planters meet the SWMM-defined minimum separation between the bottom of the infiltration planter and groundwater (5 feet).

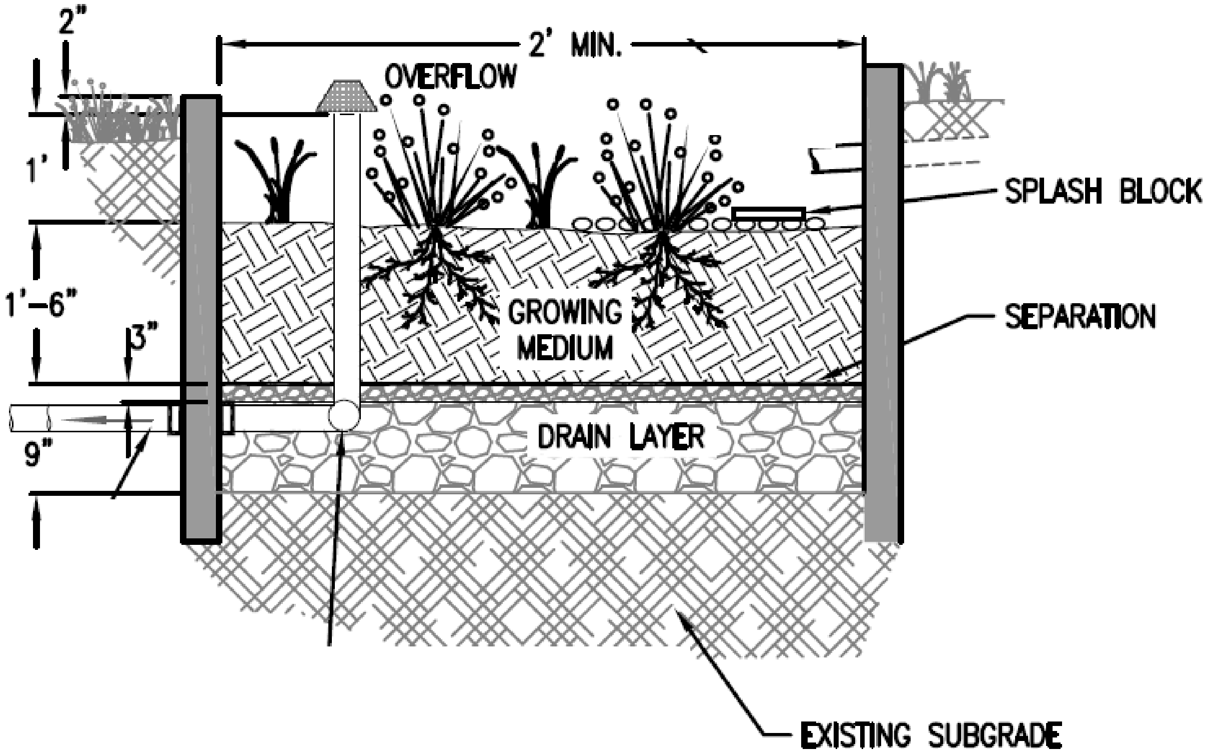
INFILTRATION FACILITIES

The infiltration planters were sized based on a design ponding depth of 18 inches. Infiltration Planter 1 (infiltrates runoff from Drainage Area 1) requires a minimum footprint of 1,110 SF and Infiltration Planter 2 (infiltrates runoff from Drainage Area 2) requires a minimum footprint of 1,310 SF. These footprints will require that the area between the proposed road and the proposed sidewalk or properties north of the road be utilized for infiltration. Based on a conceptual review of the area (aerial photographs and visual observations), there is sufficient space in this area to accommodate infiltration. The attached figure depicts the conceptual-level design footprints of the paved areas (sidewalk, curb and roadway) and the vegetated infiltration planters.

Each planter would consist of the following components:

- Vertical reinforced concrete walls with curb cuts and piped inlets.
- An 18-inch deep layer of compost-amended soil to filter stormwater and provide a growing medium for vegetation.
- Water-tolerant vegetation to provide water-uptake and erosion control.

A typical cross-section of an infiltration planter is shown below (no overflow or drain layer would be necessary in the N Suttle Road planters).



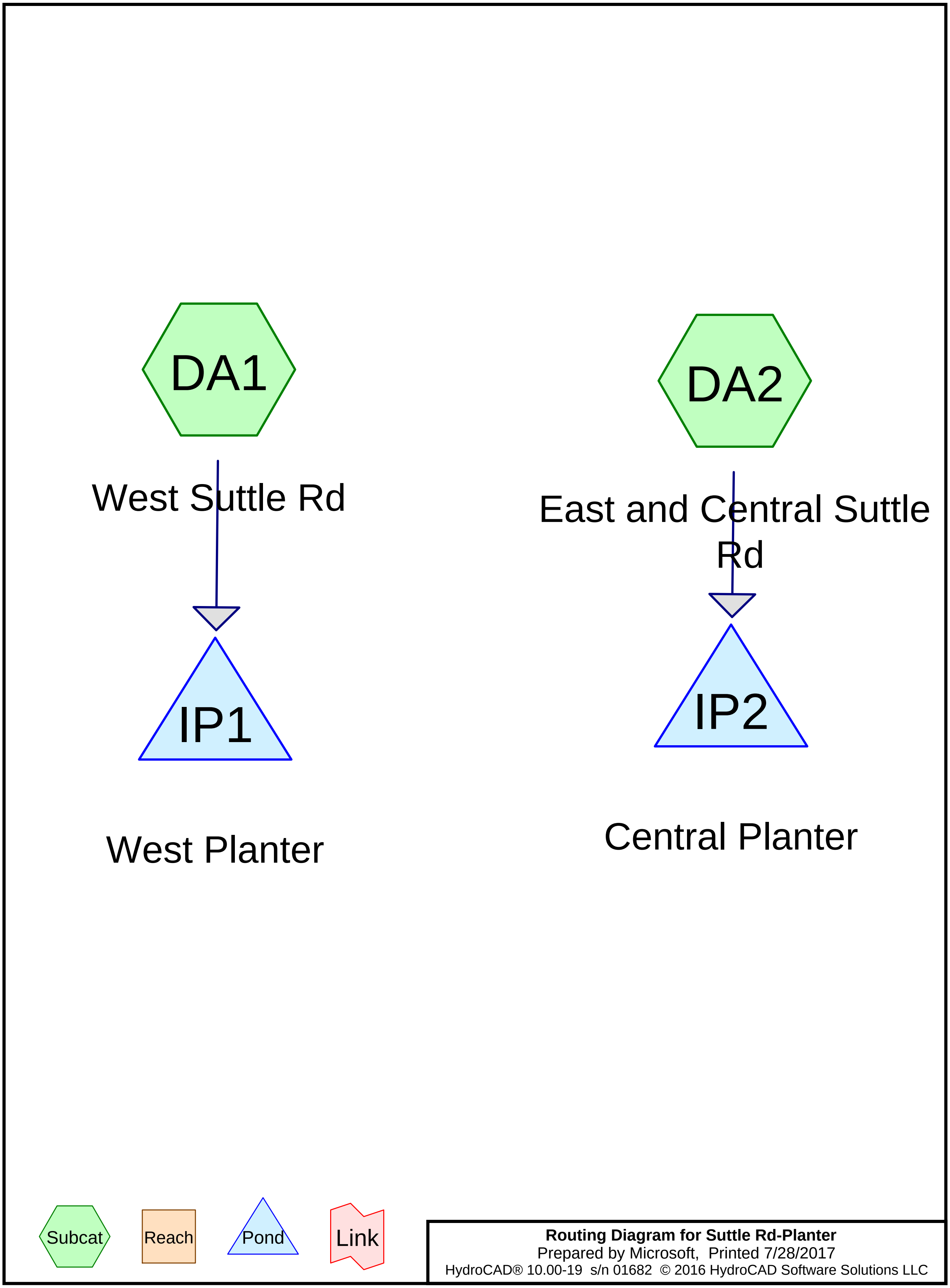
CONCEPTUAL DESIGN ASSUMPTIONS AND FINAL DESIGN CONSIDERATIONS

The conceptual design was based on the following assumptions, which should be evaluated further during the final design phase:

- The subgrade soils and groundwater in the areas proposed for infiltration are not contaminated by past activities and/or releases of pollutants. Although several properties along N Suttle Road have documented historical releases of contaminants and have entered into the Oregon Department of Environmental Quality (DEQ) Voluntary Cleanup Program (VCP), MFA's conceptual-level review did not identify releases in the areas proposed for infiltration. A more detailed review of the VCP files and/or communications with the DEQ project manager(s) should be conducted to confirm this assumption.
- In the event that soil and/or groundwater contamination in the areas proposed for infiltration is identified, the final design phase may include:
  - Soil sampling to evaluate contaminant leaching potential and the potential for stormwater infiltration to exacerbate existing contamination.
  - Evaluation of groundwater gradients to determine whether stormwater infiltration has the potential to exacerbate existing plume(s).
  - Excavation of contaminated soils to remove the source of contamination from the areas proposed for stormwater infiltration.
  - Lining portions of the stormwater facilities to minimize the potential for exacerbation of contamination and conveyance to infiltration facilities located in areas that are not contaminated.
- The area between the proposed road and proposed sidewalk or properties north of the road is available for infiltration. Final design should include the following steps to confirm this assumption:
  - Topographical and property line survey to outline boundaries and ownership.
  - Development of easements and/or similar legal agreements to facilitate construction of infiltration facilities on private property, if necessary.
  - Development of Operation and Maintenance Plans.
  - An assessment of below- and aboveground infrastructure in the areas proposed for infiltration that may require relocation (e.g., utility poles).

CONCLUSION

Based on the conceptual design outlined in this memorandum, infiltration of 100 percent of stormwater runoff generated from the proposed road and sidewalk is feasible. Managing stormwater via infiltration is the preferred disposal method (per SWMM discharge hierarchy). Infiltration is also likely to be the most economical method of managing stormwater, as discharge to the municipal storm sewer would require installation of an extensive pipe network and potentially require pumping. Furthermore, stormwater infiltration replenishes groundwater aquifers and keeps stormwater pollutants out of receiving surface waters, protecting Oregon's lakes and rivers.



Routing Diagram for Suttle Rd-Planter
Prepared by Microsoft, Printed 7/28/2017
HydroCAD® 10.00-19 s/n 01682 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment DA1: West Suttle Rd

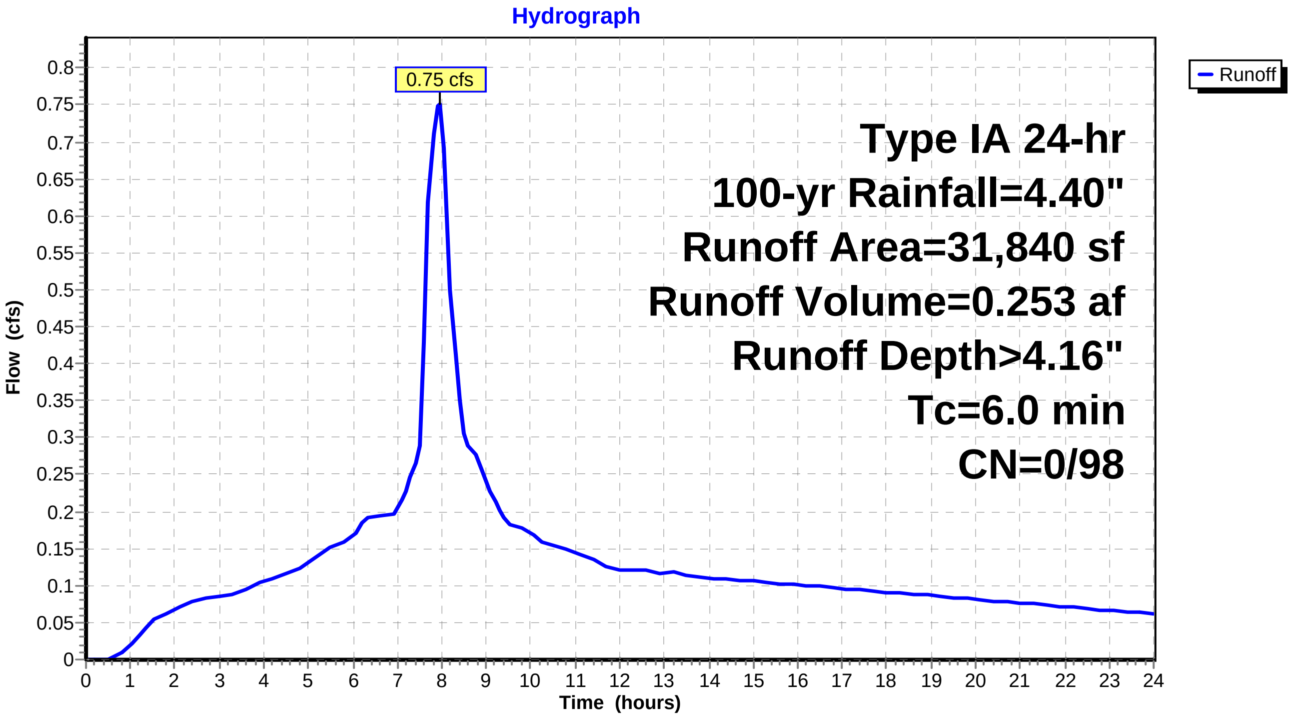
Runoff = 0.75 cfs @ 7.94 hrs, Volume= 0.253 af, Depth> 4.16"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Type IA 24-hr 100-yr Rainfall=4.40"

	Area (sf)	CN	Description
*	31,840	98	Pavement and sidewalk
	31,840	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment DA1: West Suttle Rd



Summary for Subcatchment DA2: East and Central Suttle Rd

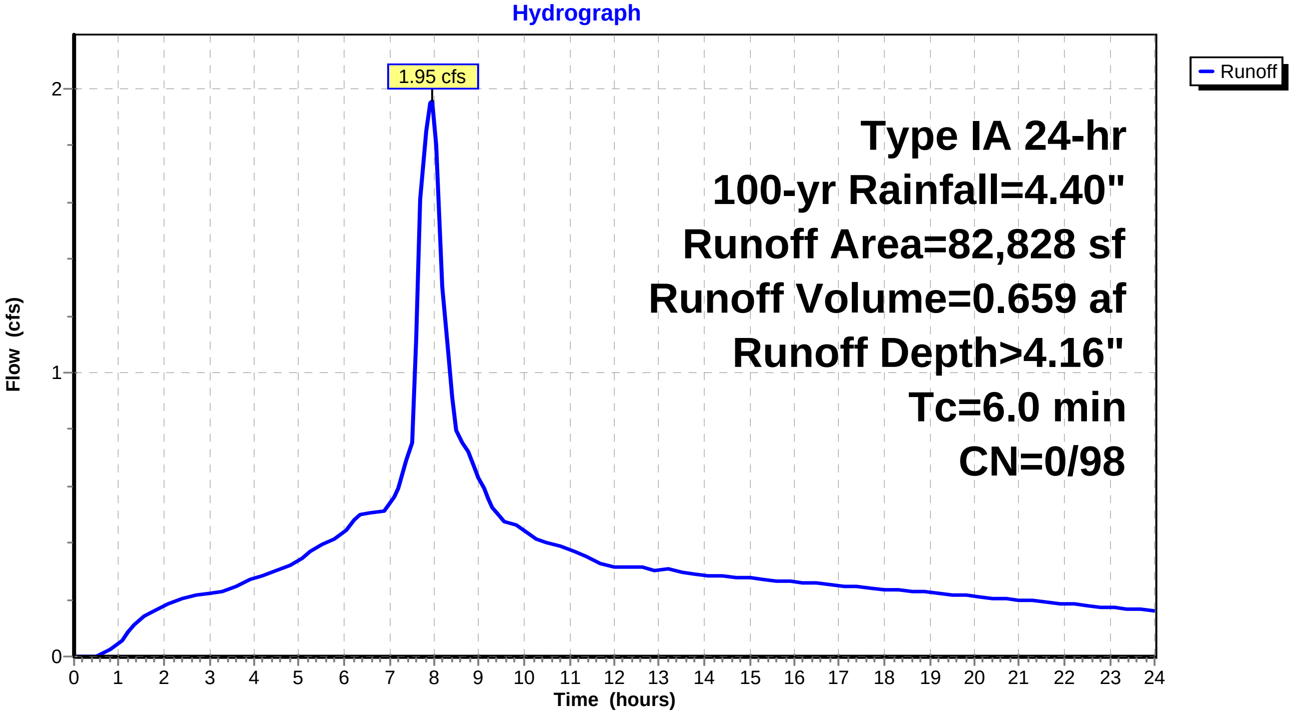
Runoff = 1.95 cfs @ 7.94 hrs, Volume= 0.659 af, Depth> 4.16"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Type IA 24-hr 100-yr Rainfall=4.40"

	Area (sf)	CN	Description
*	82,828	98	Pavement and sidewalk
	82,828	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment DA2: East and Central Suttle Rd



Summary for Pond IP1: West Planter

Inflow Area = 0.731 ac,100.00% Impervious, Inflow Depth > 4.16" for 100-yr event
Inflow = 0.75 cfs @ 7.94 hrs, Volume= 0.253 af
Outflow = 0.21 cfs @ 9.21 hrs, Volume= 0.253 af, Atten= 72%, Lag= 76.4 min
Discarded = 0.21 cfs @ 9.21 hrs, Volume= 0.253 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Peak Elev= 1.49' @ 9.21 hrs Surf.Area= 1,110 sf Storage= 1,659 cf

Plug-Flow detention time= 50.0 min calculated for 0.252 af (100% of inflow)
Center-of-Mass det. time= 49.2 min (708.7 - 659.5)

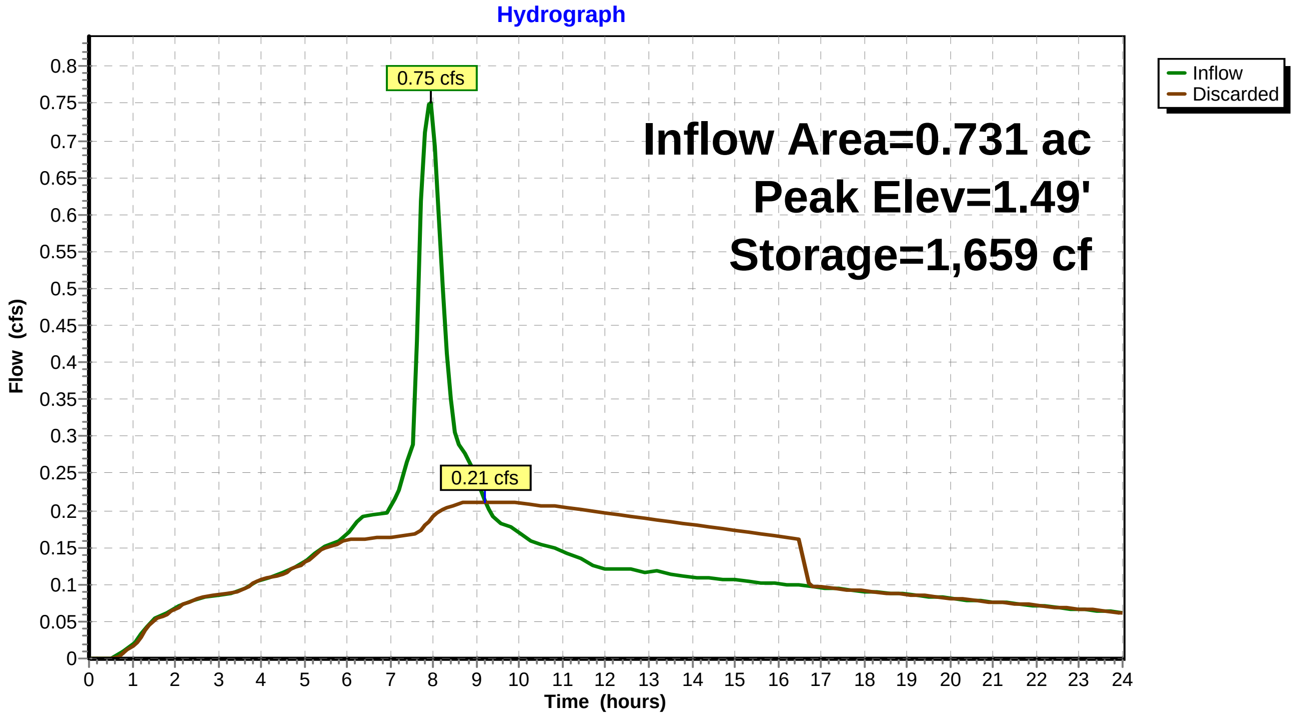
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	2,220 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
0.00	1,110	0	0	1,110
2.00	1,110	2,220	2,220	1,346

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**6.250 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = -10.00'

Discarded OutFlow Max=0.21 cfs @ 9.21 hrs HW=1.49' (Free Discharge)
└─**1=Exfiltration** (Controls 0.21 cfs)

Pond IP1: West Planter



Summary for Pond IP2: Central Planter

Inflow Area = 1.901 ac,100.00% Impervious, Inflow Depth > 4.16" for 100-yr event
Inflow = 1.95 cfs @ 7.94 hrs, Volume= 0.659 af
Outflow = 0.99 cfs @ 8.35 hrs, Volume= 0.658 af, Atten= 49%, Lag= 24.8 min
Discarded = 0.99 cfs @ 8.35 hrs, Volume= 0.658 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Peak Elev= 1.49' @ 8.35 hrs Surf.Area= 1,310 sf Storage= 1,954 cf

Plug-Flow detention time= 6.5 min calculated for 0.656 af (100% of inflow)
Center-of-Mass det. time= 6.3 min (665.8 - 659.5)

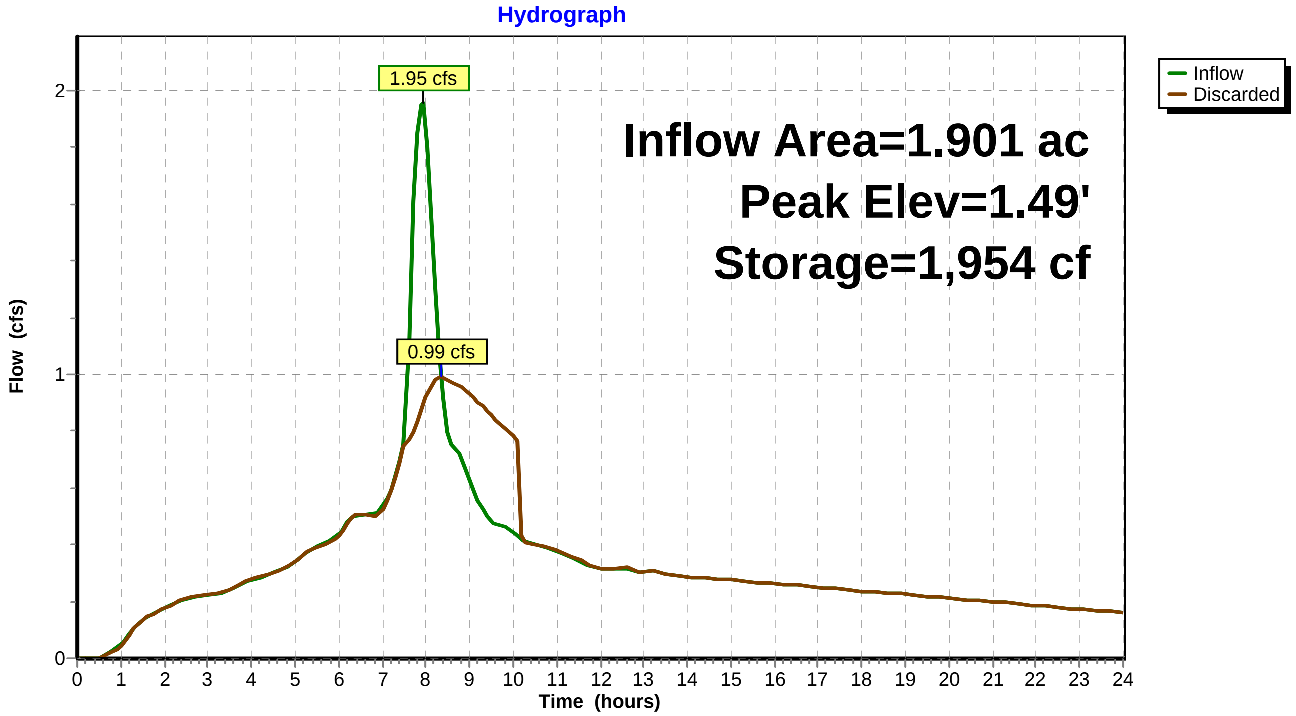
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	2,620 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

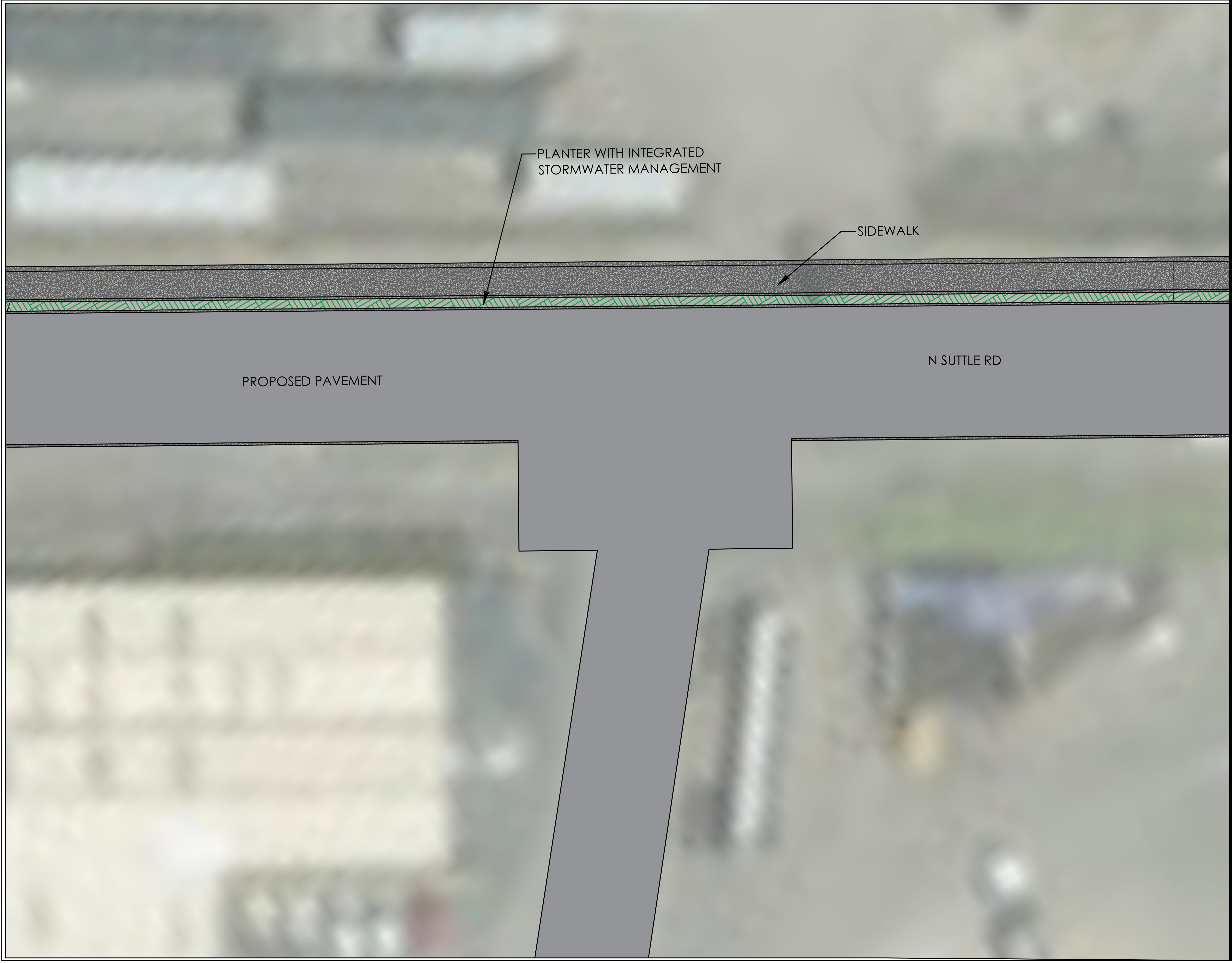
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
0.00	1,310	0	0	1,310
2.00	1,310	2,620	2,620	1,567

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**25.000 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = -10.00'

Discarded OutFlow Max=0.99 cfs @ 8.35 hrs HW=1.49' (Free Discharge)
└─**1=Exfiltration** (Controls 0.99 cfs)

Pond IP2: Central Planter





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NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

Conceptual Stormwater System Design

North Suttle Road
Engineering Study
Portland, Oregon

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